

**COSMOLOGY COURSE NOTES : TWO DECADES  
OF CAE/U3A DISCUSSIONS.**

OUR EMERGING COSMIC  
PERSPECTIVE.....

"BIG HISTORY" AS A BEACON OF HOPE  
FOR AN ANXIOUS WORLD.

*Abstract. Cosmology ("Big History") is the study of the origin , evolution ("on-going creation of complexity"), and future of the universe and its contents. ("All science is cosmology, I believe" ....Karl Popper). This encompasses the rise of life on Earth, including humankind. We are here, probably as an exceedingly rare phenomenon in a mainly lifeless universe, with a complex brain and its emergent mind, capable of attaining some understanding of our nature, origins, and cosmic environment. We each have a 13.8 billion years cosmic pedigree, including 4 billion years of biological evolution*

by natural selection of adaptive traits. These traits include collaborative social behaviours, with the potential to conduct local and geopolitical human affairs rationally, promoting environmental sustainability and free enquiry into humankind's origin and nature. Our unfolding comprehension of the universe and our place within it can assist us to attain a global collective maturity, renouncing environmental irresponsibility and inter-tribal strife. Opposing this, the ongoing breakdown of nuclear non-proliferation has the potential to endow primitively despotic (pre-Enlightenment) tyrannies and sociopathic tribal groups with historically unprecedented asymmetric coercive powers to impose arational belief systems. As this is non-adaptive if humankind's progress and survival are dependent on free enquiry, to control access by despots to catastrophic weaponry seems now to be of global (and even cosmic ?) significance.

OUR INSTANT IN COSMIC HISTORY,  
AND ITS ANXIETIES.

**Welcome. Or, as Arthur C. Clarke (co-author of 2001 – A Space Odyssey) might have said: “Greetings, fellow carbon/water-based bipedal course-participants”.** Here presented for your consideration and discussion, is an attempt to review optimistically some of the deep questions of our times – scientific, environmental and geopolitical -- from a *cosmic perspective, based on “Big History”* -- what we think we know of the origin and evolution of our observable universe and its contents, including humankind and our conduct of our affairs on this small world. As **these course notes** are necessarily brief distillations of the topics and questions raised for discussion during the past decades by participants from many walks of life, your thoughts and opinions are most welcome for their further development. (As there are now over 60 pages of text, I’ve **bold-faced the main point(s)**, to enable a quick scan for topics of interest).

It is 420 years since Galileo’s telescope confirmed Aristarchus’ heliocentric concept (240 BCE!) that we are not central to all creation. By 2019 AD. science has revealed that **we humans are rare (unique?)**

**citizens of a vast, ancient, mainly lifeless, yet inspirationally magnificent universe**, each of us living our “cosmic eyeblink” on a minor planet of an average star, lost in the mid-latitudes of a spiral galaxy, just one among billions. The “*gee-whiz* aspect” of our cosmic origins and heritage includes **the cosmic time-line: an unbroken chain of cause and effect** which helps to make sense of the “swirling maelstrom of human affairs” on our *plundered planet*. This **cosmic context reinforces reasons why our lives are significant, and our civilisation is worth bequeathing in good order for following generations to build upon.**

As a **starting point**, we review the **state of Thomas Freedman’s “Hot, Flat and Crowded” planet** (“flat” refers to global aspirational “first-world” demands on resources.) Although this state is fraught with difficulties (summarised below to provide context for this course), we find much cause for optimism; yet “doom and gloom” so prominent in our media implies that “lighthouse beacons, able to guide us through the reefs and shoals of life’s journey”, are in short supply. So: **what guidance might a “cosmic big picture” – frequently derided as “stargazing” –**

**provide**, countering concerns that “*dark night has come down on this rough-spoken world, and the banners of darkness are boldly unfurled*” (e.g. IS’ black flag); is our benighted planet “going to hell in a hand-basket”? (For a **rapid restorative rebuttal, try Bone’s reminder, at p.49**).

Many of our generation recall our parents’ alarm at the 1930’s rise of European fascism and bushido imperialism, culminating in humankind’s worst-ever catastrophe: the Second World War, during which this country barely escaped invasion in 1942. History’s most lethal conflict killed some 55 millions of us, causing global anguish and destruction. We are still experiencing “superpower cold war”, with “hot” local conflicts, and the pervasive threat of nuclear war; e.g. the 1960’s Cuban missile crisis, when a USSR submarine commander (“The man who saved the world!”) refused to fire a nuclear torpedo at a US Navy blockade. As that threat recedes, new secular and theocratic tribalisms arise, with politically and religiously rationalised coercive terror attacks. These expose cities and nations to “**asymmetric internal guerilla**

**attacks”** using (by 2019) guns, vehicles, explosives, hijacked aircraft, with far worse threats: fundamentalist despots unable to be quarantined from **catastrophic CBNR (chemical, biological, nuclear, radiation) mass-destructive technologies.**

And yet, from an historical perspective, **many civilisations have experienced “dark nights”, and have recovered:** *“two steps forward, one backwards”*. As the dissident Russian physicist Andrei Sakharov said, human societies have been characterised by their ability to repeatedly toil their way up onto the plateau, emerging from the shades into Churchill’s “broad sunlit uplands”, only to slip back promptly into the Sisyphian abyss. The estimated 120 million human beings who perished under communist regimes (Stalin, Mao, *et al*) during the twentieth century, provide further grievous warning of Sakharov’s abyss. Recorded history demonstrates our recurring inability to avoid tyrannies, Orwell’s “totalitarian” despotisms, warfare, societal decay and breakdowns. Historian **Kenneth Clark**, discussing the *“quite fragile”* nature of civilisations, despite their apparent complexity and security, recalled the

philosophy, poetry, laws, art, architecture, civil engineering (and imperfections) of 600 years of Western Mediterranean Graeco-Roman civilization; these barely escaped obliteration when invaded by Hun and Germanic tribes with limited understanding of the legacy which had come into their possession. Clark considered that such **collapses occur when a society becomes internally exhausted**...when its people assume the permanency of their rights, privileges and material prosperity , **focusing on their society's perceived deficiencies**, and **no longer valuing its assets** sufficiently to defend, maintain and build on them.

Timothy Garton Ash (*Free World: America, Europe and the Surprising Future of the West*: 2005) is among many analysts concerned at democracies' **potential for large-scale decivilisation**...the breakdown of the “*wafer thin...crust of civilisation on which we tread...remove the elementary staples of organized civilised life – food, shelter, drinkable water, minimal personal security - and we go back within hours to a Hobbesian state of*

*nature, a war of all against all.*" He cited looting, rape and terror that follow natural disasters (e.g. New Orleans hurricane: *Time*, 09/02/05), or during man-made strife: e.g. Nanjing (1937), WW2 holocaust, post-war gulag, Naples (1944), Berlin (1945); currently, failed states, e.g. Syria, Somalia, Libya, Iraq, Afghanistan. Local breakdowns – assaults, road rage, “yobbo” discourtesy, lack of civility in public places – further evince **civilization’s fragility**: *“I can’t avoid the feeling that there will be much more of this as we go deeper into the 21<sup>st</sup> century. There are just too many big problems looming....unpredictable storms, flooding, temperature change....terrorist attacks provoking outrage, fear, restrictions on civil liberties, mass hysteria and vigilantism....the pressure of mass migration from the planet’s poor and overpopulated south to the rich north.... the resulting encounters, especially those between Muslim immigrants and European residents, are proving to be explosive”* (e.g. recent Paris, Berlin, London, Brussels attacks.) Following England’s Aug. 2011 multi-city looting and arson, PM David Cameron denounced “welfarism-induced moral collapse”: *“Irresponsibility. Selfishness. Behaving as if your*



*choices have no consequences. Children without fathers. Schools without discipline. Reward without effort. Crime without punishment. **Rights without responsibilities.** Communities without control. Some of the worst aspects of human nature tolerated, indulged...even incentivized, by a state and its agencies, in parts literally demoralised”.*

For decades, “*a peculiar Western self-hatred*” (Benedict XVI) has been promoted by much of the West’s sociopolitical punditocracy (*serial denigrators: moral indignation as a default mental setting?*). Over-criticism of our civilisation and its history, politics, cultural roots; over-emphasis of its imperfections (*What’s Gone Wrong With Democracy?* The Economist, 01/03/2014); insufficient balancing celebration of its achievements: these generate “*Apocalyptic angst of the Western world*” (Bruckner, 2012): democracies demoralised by a “*dictatorship of cultural relativism*”. Oxford historian Felipe Fernandez-Armesto (foreword to *Millennium*, 1997): “*The relative performance of rival cultures depends on the self-perceptions and mutual perceptions of the peoples concerned. History is scattered with the debris of (societies) whose peoples*

*talked themselves into decline and of victories won by superior morale. The 'course of history' is influenced less by events as they happen than by the **constructions** – often fanciful, often false – which people put on them*". So, in this course, we "get negative about negativity": we consider **our place** in a **magnificent unfolding cosmic perspective, revealed mainly through Western civilisation's freedoms of enquiry. To provide context, we first precis Earth's major problems.**

## ENVIRONMENTAL AND SOCIAL PROBLEMS:

### A SYNOPSIS.

*"Call it Mother, if you will...but Earth is not a doting parent."* (Isaac Asimov). Rather, a "tough love" mother?

*"Everything is connected to everything else."* (Ecologist/economist Barry Commoner, ca. 1970). Also Commoner:

*"Environmental impact = population x consumption per capita x impact per unit of consumption (ie. technology)."*

*“The tragedy of the commons”*, Garrett Hardin’s 1968 essay: global abuse of atmosphere, oceans, rivers, lands, forests.

We face **historically unprecedented** local and global environmental “5/50” problems: since 1900 AD, Earth has had to sustain a 5-fold human population increase (1.5 to 7.6 billion), with a 50-fold increase in global GDP demands on planetary **resources**. Today, without delay, our **spaceship Earth entire**, with its 7.9 billions of us increasing by *70-80 million annually* (Lester Brown, 2009), surely needs **unifying , calming , non-divisive influences**. Our quarrelsome species has to establish a climate of international cooperation, to address our planet’s **three major priorities**: (1) How to control disastrous **population increases** in impoverished nations, minimizing their distress? (2) How to keep the **global peace** while denying Earth’s tyrants and terrorists an unprecedented access to catastrophic weaponry? (See “Geopolitical Questions Arising”, at p. 21). (3) How to persuade economically developed countries to adopt **sustainable use and a fair distribution** of global biospheric, atmospheric, mineral, agricultural and water resources?

The World Wildlife Fund estimates that an extra Earth is needed by 2050 to retain even today's remaining biodiversity, as our **population approaches** (and exceeds?) **planet Earth's carrying capacity** (Thomas Malthus' "*feeding outrun by breeding*"). Brown (2009): global population increase had slowed from 90 to 70 millions per year; hence Sanyal's 2012 claim that falling *global* TFR (total fertility rate), then 2.4 births per woman, would limit us to 9 billion by the 2050's, thereafter decreasing. This forecast has been offset by Africa's unanticipated population increase (Sci. Am. Dec 2014): U.N. amended prediction is now 10.9 billions of us by 2100.

Accelerating these problems, is **climatic change**. Some (not all) mathematical climate models indicate that humankind's industrial/agricultural "greenhouse emissions" (2/3 carbon dioxide, 1/3 methane/nitrous oxide/halocarbons) have warmed our world by 0.6 degree in 100 years, with another 2 to 2.5 degrees (or worse?) locked in despite any "carbon neutral" emission controls. Warmer oceans, melting glaciers & polar ice caps, are raising sea levels (30 cm/century?), weakening

thermohaline ocean circulation, including Gulf Stream and Antarctic currents. Thawing Arctic permafrost releases additional greenhouse methane. **Climatic models predict**, for Australia, 50% less inflow in the Murray-Darling basin by 2050 (Wahlquist, 2008): a **limiting factor on population growth?** Jared Diamond (2005), reviewing our depleting soil/water resources, estimated Australia's long-term *sustainable* population at present living standards to be 8 *millions!* By 2017, with 25 millions, are we "*the first-world's miner's canary?*" Jet stream "wobbling" (Sci. Am. Dec. 2014) means more frequent weather extremes (e.g. Feb.2009 Victorian "Black Saturday" megafires), droughts, shrunken urban water supplies (Sydney down 60%, Melbourne down 35% by 2030, requiring energy-guzzling desalination); also, salinity-damaged agricultural production, intensified tropical cyclones and diseases, flooding (Brisbane, 2011), and loss of essential animal/plant habitat. Globally, we face extinction of 25% of animal and plant species by 2050. **Threatened national treasures** include Kakadu wetlands (saltwater incursion), Great Barrier Reef (coral bleaching, oceanic acidification), tropical rainforests (drought), Alpine snowfields (heat).

Even allowing for **uncertainties in climatic models**, this “future-eating” outlook is alarming. In *The Weather Makers* (2005), palaeontologist Tim Flannery, a strong supporter of the above scenario, admitted to large unknowns, e.g. *“Although it is a greenhouse gas, **water vapour** is also an enigma in the climate change arena, for it forms clouds, and clouds can both reflect light energy and trap heat. By trapping more heat than reflecting light, high thin clouds tend to warm the planet, while low thick clouds have the reverse effect. **No single factor contributes more to our uncertainty of future climate change predictions**”*. Although CO<sub>2</sub> only slightly warms the atmosphere, cloudy and clear bands move away from the tropics, while high clouds form higher, both warming it further (positive feedbacks); more watery less icy clouds cool it (**Marvel, 2017: satellite data indicate more warming than cooling**). Smith (2007), Lloyd (2017): **cosmic rays** (high-energy charged particles from distant supernovae) generate ions forming molecular clusters (e.g. O<sub>3</sub>/SO<sub>2</sub>/H<sub>2</sub>O), which increase cloud condensation, reflect solar radiation, and increase planetary cooling. Cosmic ray inbound flux is reduced (deflected

away from Earth) by “historically high levels of solar activity”; planetary warming *may* decline, and precipitation increase, as solar activity reduces during the next few years of the solar cycle. However, 5 IPCC climate experts (Collins *et al*, 2007), reviewing uncertainties in the 10 major modelled “radiative climate forcings”, have claimed a **“hands-down win” for anthropogenic (human-induced) warming forcings**; see also Houghton (2009); recent IPCC Reports.

An alternative opinion: **climate has always changed, is a self-correcting system**; we can **adapt to “lukewarming”** without economic ruin. E.g. palaeoclimatologist Robert Carter (2008), citing the long record of climate change within ocean-floor sediments, maintained that CO<sub>2</sub> is “the best aerial fertiliser”, boosts crop yields, helps to feed the world. The \$trillions Kyoto Protocol would “deliver no significant cooling – less than 0.02C by 2050”; “deep cuts to Australia’s 1.4% of global emissions would...delay warming by 0.001C.” The past (Pleistocene) 2.5 million years have seen 50 glacial and interglacial periods, with Earth *colder* for 90% of the past 400,000 years, and brief warmings of about 10,000 years; the last

glaciation's cold peak was only 20,000 years ago. With civilisation's 10,000-years "long summer" ending, "reputable climate change scientists" (Trenberth, 2018) agree that climate will again *cool* (are greenhouse gases delaying an ice age?). Northern hemisphere was *warmer* than now in Roman times (200BC-400AD) and in mediaeval times (800-1300AD), with a "little ice age" (70 yr solar Maunder Minimum; frozen Thames) 1550 to C<sup>18th</sup>. Global mean surface temperature cooled 1880-1910, rose until 1940, cooled until 1970, again rose (0.19C per decade), peaking in 1998's El Nino event; despite rising CO<sub>2</sub>, the 5-year moving average global temperature has since *stabilized*, with 2017 marginally warmer (by 0.04C: NASA, 2014; geophysicist Michael Asten, 2015; Lloyd, 2017). Meteorologist W. Kininmonth (2008): evaporative cooling from vegetation and warming oceans, extra cloud formation, extra precipitation and removal of atmospheric H<sub>2</sub>O vapour (***negative feedback***) will restrict global warming, to 0.5C rather than IPCC modelled 2.5C, even if pre-industrial CO<sub>2</sub> doubles to Garnaut's "realistic goal" of 550 ppm; modelling "grossly exaggerates" human-induced climate change. On geological time scales, temperature rises *precede* CO<sub>2</sub> increases, including



the Keeling CO<sub>2</sub> graph used in Al Gore's *An Inconvenient Truth*. Without natural greenhouse effect, average Earth temperature would be -18C ("icehouse Earth") instead of +15C. Carter (2008): H<sub>2</sub>O vapour causes up to 95% of this greenhouse effect, with CO<sub>2</sub> a trace gas responsible for 3.6%; only 0.12% or 0.036C is due to human activity. Monckton (2011): European cap/tax "a costly fiasco"; late C<sup>20th</sup> warming due to "natural blocking highs".

**If** such arguments are correct, then **mitigating climate change is Carter's "futile quest"**. However, starting in 2006, the American Association for the Advancement of Science (Dayton, 2006) has strongly denied that "catastrophist" climatologists fail to consider deep time, and reminders (e.g. by geologist Ian Plimer, 2009) that Earth has been warm and wet for most of geological history, and claims that climate change is natural and poses no serious hazards. Plimer also reminds us that at least some Pacific "rising sea levels" are due to crustal subsidence; during such times, coral atolls are actually *produced* by reef growth (first described by Charles Darwin in 1845). However, an AAAS

panel of experts on ancient climate states that we are performing a **high-stakes climate experiment** by burning fossil fuels, increasing greenhouse CO<sub>2</sub> by 1-2 ppm/year. Past extreme global warming events (e.g. 3 million and 55 million years ago) suggest that abrupt climate change could occur, far worse than predicted; these greenhouse warmings were triggered by volcanic eruptions and massive release of gases trapped in icy “methane hydrates”. Palaeoclimatologist James Zachos maintains that *“the emissions that caused the PETM episode of global warming (Palaeocene/Eocene Thermal Maximum, 55 million years ago) probably lasted 10,000 years; by burning fossil fuels we’re likely to emit the same amount over the next three centuries.”* While Earth is resilient and will adapt to rapid warming, burgeoning human societies – especially those in coastal areas – are another matter. Palaeobiologist Scott Wing (Smithsonian Museum) said: *“hoping that we need not curtail GHG’s is equivalent to hoping the tooth fairy will come.”* For Australia, decarbonised electricity generation (40% wind, 60% solar thermal “power tower”/molten salt storage, hydro

& biomass backup) could be economically feasible within 10 years (Wright & Hearps, 2010).

Although annual global demand for fossil fuels is rising, due to population increase and rising living standards, tree planting and increased plant growth in CO<sub>2</sub>-enriched air can help its re-absorption. CO<sub>2</sub> capture/sequestration (CCS) occurs in soil biochar, oceanic 2.7 km depths, or below 800 m in worked-out coal seams, oil fields or deep porous sandstone: e.g. 1 megatonne/yr since 1996 in Utsira aquifer, North Sea (no leakage), and in an Otway Basin depleted gas well (Williams, 2008). A “hydrogen energy economy” (e.g. reacting coal/steam/oxygen to obtain H<sub>2</sub> while burying CO<sub>2</sub>) *may* augment solar photovoltaic, lithium-ion battery storage (SA’s 100 MW), wind and geothermal energy, safer post-Chernobyl thorium reactors and waste disposal, even deuterium fusion power (e.g. ITER’s 500 MW reactor, 5-30 power gain: Hole & O’Connor, 2009). Renewable biofuels (ethanol), petrol/electric (regenerative braking) motors, electric cars (range 600 km), can assist. Resource recycling, including minerals and fresh water, is increasing. Wildlife reserves,

breeding programs, help to conserve remaining biodiversity. Consumer capitalist economies have brought prosperity to majorities in many nations (share-owners partly realising Marx's vision of workers owning the means of production!), and could rescue "third-world" populations from poverty *if* their ruling elites reform their economies to enable fair access to goods and services. If "first-world" populations are weaned from reckless over-consumption of resources to **responsible sustainable economies** (see, e.g. Wald, 2009), Earth *may* be able to support a population of 10-11 billions at reasonable living standards during a return to sustainable population levels (Fernandez-Armesto, 1997; Foley *et al*, 2010; Flannery, 2010; and below, 2019).

**Our best reason for optimism** lies in a **rapid diffusion of the knowledge of our planet's resources** ("*a problem stated is a problem half-solved*"). When the 1970's "UV ozone hole" formed, nations did cooperate in remedial action: the Montreal protocol's phasing out of ozone-depleting CFC's (chlorofluorocarbons). Likewise, the 2010 Copenhagen non-binding agreement among major emitters *may* yet reduce their CO<sub>2</sub>

outputs. The technologies exist to avoid Gandhi's 1928 warning: "*God forbid that India should ever take to industrialism after the manner of the West....if an entire nation of 300 (now 900) million took to similar economic exploitation, it would strip the world bare like locusts*". (Gandhi also once remarked: "*Western civilisation? That sounds like it could be a good idea*"). Political and business leaders are responding to global priorities as well as local constituencies' immediate demands. Humankind at large can still avoid the "ecocide" of agrarian civilisations such as the Maya, Khmer, Sumerians, and Rapa Nui (Easter Islanders), who in ignorance trapped themselves in what population ecologists call the **MIGODS pattern of development** when a species enters a new ecological niche: **Migration, Innovation** (e.g. from foraging to farming), **Growth** (of population), **Overexploitation** (of food, soils, water, etc), **Decline of population, Stabilisation** at reduced carrying capacity in a degraded environment; e.g. Kaibab's stable 30,000 deer population's rapid J-curve overshoot to 63,000 after removal of cougar predators, then collapse to 10,000 (O'Connor, 2018; Wright, 2005; Christian, 2004; Flannery, 1995/2010; Diamond, 2005; Brown, 2009).

These matters surely need full attention. Yet we in the developed world allow ourselves to be distracted by a ceaseless din of belligerently intolerant political punditry (“*decibel democracy*”), commercial cacophony, intercultural hostility and economic argument - a sound and a fury often signifying little other than trivia-driven political party barracking or similar raucous tribalisms. **Heat where light is needed**.....“*fiddling while Rome burns?*” Anyone who dares to disagree with cherished social, political, or theological ideologies is liable to be lampooned and denigrated, as frequently occurs in Australia’s Parliament and media, where reasoned debate of serious issues often descends into polarising misrepresentations, silly analogies, and crude invective. Scientists are not immune; the irascible astronomer Fritz Zwicky once responded to his colleagues’ rejection of his discovery that the Coma galactic cluster needed dark matter to hold it together (he was right) by labelling them “spherically stupid bastards, stupid any way you look at them.” While the West indulges in so-called robust debate, “third world” nations experience mass

poverty and ignorance which produce human distress (800 million undernourished people: Brown, 2009) , environmental degradation, and failing states with armed-to-the-teeth secular or theocratic tyrants and warlords who export chaos and destabilisation (piracy, drugs, terrorists, refugees, disease, weapons). Given the turmoil in the Islamic world, and multicultural tribalism within most Western societies, internal Islamist guerilla terrorism will have to be endured for many years (Evans, 2015).

While support declines in Europe (and Australia: e.g. Frame, 2009) for Western core philosophies, demands increase for entitlements, regardless of increasing national debts (a “*magic moneytree mindset*”?). Kenneth Clark: personal prosperity matters; so does a **society’s confidence in itself, its future**, its belief in its laws, philosophies, disciplines, governmental powers and institutions. Taking these assets for granted undermines “*a civilisation’s vitality*”, generating a perceived *moral equivalence* of tyrants and terrorists with defenders of oppressed victims: “*does social justice stop at our shorelines?*” Are we “*eroding our democratic freedoms, appeasing rival secular or theocratic despotisms*”,

while “a demoralising servile dependency on benefits provided by intrusive states” evolves (Minogue, 2010; Veliz, 2010)? Do entitlements prevail, with no balancing responsibility to “ask also what you can do for your country”(JFK, 1962), or to conserve liberal democracies which alone endow our rights? Do we need “social climate change” to remedy “debt and deficit denial”? Optimistically, celebrating **one of Western civilisation’s major intellectual achievements, our cosmic perspective of humankind, our “seamless chronology from the Big Bang to the Big Brain”**, may help us to appreciate our democratic heritage.

### **OUR RECENT COSMIC PERSPECTIVE : BIG HISTORY AND THE PALE BLUE DOT.**

*“The new cosmic story...overwhelms all previous conceptions of the universe, because it draws them all into its comprehensive fullness – and corroborates in profound and surprising ways the ecological vision of Earth celebrated in every traditional native spirituality”* (Brian Swimme, 1998). The “Milky Way”, the “backbone of night”, is



now seen as humankind's interior view of "our" galaxy's spiral arms, and the aboriginal "emu dreaming" as its dark nebulae.

*"Beneath the awesome diversity and complexity of modern knowledge, there is an underlying unity and coherence, ensuring that different timescales really do have something to say to each other.....They constitute what indigenous Australians might call a modern "dreaming"-- a coherent account of how we were created and how we fit into the scheme of things":* David Christian (2004), one of the emerging "specialised generalist" historians in Sydney, Melbourne, Canberra, Perth, Amsterdam, Santa Cruz, San Diego, etc., who offer university (including U3A) history courses on the largest possible scale, within the *cosmic context* wherein life and ultimately humanity have arisen.

A recent social phenomenon (known , somewhat tongue-in-cheek , as *scientism*), may help to focus our attention on issues that matter. **Scientism, or "big history"**, building on the European "scientific/political

enlightenment”, is a world view supporting **natural explanations** for natural phenomena, eschewing paranormal or supernatural beliefs while respecting the **allegorical “kernels of truth”** within many traditional cosmologies, and embracing **empiricism and reason** as twin pillars of a philosophy of life. Human affairs are viewed as phenomena whose foundational explanations are contained in our species’ biological, planetary and cosmic history. Its proponents – science communicators including the late Carl Sagan, Stephen Hawking, Paul Davies, Richard Dawkins (overly aggressive?), Armand Delsemne, David Christian, Brian Cox - attempt to bridge C.P. Snow’s famous (infamous?) “two cultures”, in writings which purport to engage those trained in the sciences, while presenting the frequently counter-intuitive discoveries of modern cosmology , astronomy , physics, and the biological sciences to the wider audience whose interest (and taxes!) support these fields of research.

Often questions are asked: what is the point of investing in huge telescopes? Of what practical use are they when we no longer need the

stars for navigation? Similarly, any **need for basic research** in particle physics, evolutionary biology, or Earth's geological history is questioned, as is other research lacking obvious economic application. (You never know: Michael Faraday, the discoverer in 1832 of electromagnetic induction, the dynamo principle, is said to have been asked by British P.M. Benjamin Disraeli: "Of what use, Mr. Faraday, is electricity?" His reply: "Electricity, sir, is like a baby. One day it may grow up, and then, sir, you may tax it.") Giant telescopes, particle accelerators, and economically disinterested research can serendipitously produce **taxable technology, and an emerging appreciation of ourselves as an exceedingly rare, complex and significant phenomenon in a stupendously vast, ancient, mainly lifeless cosmos.** This new perspective may yet assist us all to calm down, to attain a more mature respect for our world and ourselves, to "*sort ourselves out*", as it were.

In early 1990, a Voyager space probe, well beyond Neptune, was commanded to look back to the distant inner worlds and Sun, without "frying its optics". It recorded a mosaic of 60 frames ; slow video

transmission from past its design range took 3 months. Our Earth entire was seen as one pale blue pixel, at first mistaken for a speck of dust on the image. As Carl Sagan saw it : “.... ***a dust mote suspended in a sunbeam*** : *on it everyone you love.....every human being who ever was lived out their lives.....every hunter and forager , every hero and coward , every creator and destroyer of civilization .....every saint and sinner in the history of our species lived there.....on this dust mote*”. The cloud-and-sea embossed blue marble we know from near-Earth satellite images dwindles to this featureless **pale blue dot** when viewed from Saturn (Cassini probe, 2008), or from further out (Voyager, 1990).

This **recent cosmic perspective** has the potential to complement what is best and most inclusive in human cultures, religions, philosophies and traditional cosmologies. An emergent view – by any standard , quite inspirational – of the universe and our place within it, may be **diffusing into global consciousness** ( into Freeman Dyson’s “***world soul***”) **just in time to help save us from ourselves**. It is not

mere dilettante or recreational “stargazing” which is involved ; rather , an on-going foreground awareness that human affairs may well be a part of something far greater , far more inspirational, even possibly of cosmic significance, than our usual inwardly-turned perspective of ourselves and our discontents on this small world. Critics of “stepping back to take in the big picture” have said that, in the process, we lose sight of suffering humanity; the intention, in fact, is to attain a better understanding of the historical and evolutionary causes of humankind’s joys and sorrows, in the hope that understanding can be followed by amelioration of humankind’s problems.

Even political pundits (for example, Charles Krauthammer’s post-New York 9/11 opinion piece: Melbourne Age, 19/02/03) are beginning to see **current human affairs as a cosmic eyeblink** in the history of a vast and ancient universe. As Krauthammer noted, this planet has been around for some four billion years, intelligent life for perhaps 200,000 years , weapons of mass destruction for less than 100

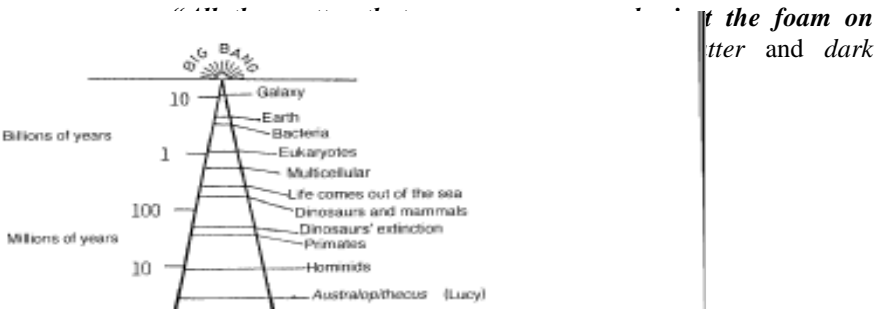
years...what are the odds , he asks , that our species will manage to contain this awful knowledge without self-destruction.....not for a million years or even a thousand , but just through our children’s lifetimes: *“Before our eyes , in a flash , **politics has gone cosmic**...The question before us is very large and very simple : can....and will....the civilised part of humanity disarm the barbarians who would use the ultimate knowledge for the ultimate destruction?”* Likewise , an Age editorial (13/07/02) has reflected upon evolutionary explanations for the pathologically cruel aspects of humankind’s recorded history; as Jacob Bronowski said in TV’s *The Ascent of Man*, we are indeed “lower than the angels”. (See also “The Evils Of Evolution”, at p. 19).

With these thoughts in mind , let us review our **unfolding comprehension** of whom we are, whence we have come, and whither we may be going.

## REALM OF THE GREAT GALAXIES: A SCIENTIFIC WORLD VIEW.

*‘The evolution of the universe can be likened to a display of fireworks.....some few red wisps , ashes ,and smoke remain . Standing on a well-chilled cinder , we see the fading of the suns, and we try to recall the vanished brilliance of the origin of the worlds.’* (Georges Lemaitre , “father” of the Big Bang Theory).

*“Big Bang – the great silent fire at the beginning of time . Everything that exists has this common origin. We are the first generation privileged to look into the night sky and see the birth of stars, of galaxies , the cosmos in its entirety .”* (Brian Swimme ).



energy (“zero point vacuum energy”?)...discussed in “Quantum Cosmology” section.

### 13.82 “BIG BANG” ORIGIN

This diagram *briefly* summarises

our “**SEAMLESS BIG HISTORY**”, from  
 Billions of years 13 First stars, galaxies form.  
 our **cosmic origins** to the present time. 4.6 Solar System, Earth form.  
 The time-scale is non-linear (logarithmic), to 3.5 Prokaryote life – bacteria, archaea.  
 compress early events and include recent 1 Eukaryote unicellular life.  
 history. The *increase in complexity* – cosmic, 0.8 Multicellular life, e.g. early worms.  
 Millions of years 300 Early terrestrial life; Amphibia.  
 biological, technological, sociopolitical -



Reptiles; abundant plant life: coal.  
 has produced planet Earth's "**experiment**  
 240 Dinosaurs, early mammals.  
**of civilisation**". For a more detailed outline,  
 Dinosaurs dominant.  
 see Appendix ("Big History" Summary,  
 Early birds, e.g. *Archaeopteryx*.  
 pp 39-43) and relevant sections in these notes.  
 150 Anoxic warm oceans: oil/gas.  
 63 Dinosaur extinction, except birds.  
 Tertiary – rise of mammals.  
 7 Hominin primates – African  
 savanna,  
 Palaeolithic "old stone age"  
 commences.  
 2 Australopithecines, eg. "Lucy".  
*Homo habilis*; also, 5 other proto-  
 humans (p.42)

Thousands of 500  
stone/bone/wood tools;  
years  
to

100

Americas.

tribes; early cosmologies.

15

domestication.

chiefdoms, ceramics, metallurgy;

Political elites emerge: kingdoms, empires.

*Homo erectus* – fire,

migration into Eurasia. Give rise

*Homo neanderthalensis* bands.

*Homo sapiens* migrate from  
Africa

into Eurasia, Australia, the

Nomadic hunter-gatherer

Agriculture – animal/plant

Village settlements merge:

Bronze and iron “ages”.

Hundreds	3	European “scientific/political
Enlightenment” vs. totalitarian orthodoxies;		
of years.		Broad-franchise
democracies, freedom of inquiry. science-based cosmologies;		
	2	Industrial revolution: coal,
		oil. Modern nation-states,
		rapid population increase.
0.5		Space exploration, nuclear
		technology. Humankind’s
		planetary impacts. Next: ?

***The Long Twilight:** our galaxy is now in the brief springtime of its life...a springtime made glorious by brilliant blue-white stars such as Sirius and Vega, and, on a more humble scale, our own Sun. Not until all these have flamed through their incandescent youth, in a few fleeting billions of*

*years, will the real history of the universe begin...illuminated only by the reds and infra-reds of dully-glowing stars. (Our remote descendants)... may envy us, basking in the bright afterglow of creation; for we knew the universe when it was young (Arthur C. Clarke, in 1964, concluding Profiles of the Future). Recent discoveries of 1000's of exoplanets (those orbiting stars other than our Sun) indicate that our good planet Earth is "well past its prime, and the biosphere is fast approaching its denouement....our planet is only marginally habitable" in cosmic terms, due to our star's total luminosity brightening by about 10% every billion years. In about half a billion years, this would re-locate our world inside the Sun's habitable zone, making it too hot for complex multicellular life to exist (Rene Heller, Scientific American, Jan. 2015). Many astronomers now think that surface liquid water should be present on many "super-habitable worlds....larger super-Earths orbiting long-life smaller stars", and "more conducive to life", further into the future, than our planet. Massive moons orbiting plentiful gas-giant exoplanets, could also be "superhabitable".*

In brief synopsis, our present understanding, from cosmological theory and observational evidence, is as follows. Our **observable universe** (one of perhaps countless parallel others....a possible “multiverse”, discussed further under “Black Holes”) erupted into shining existence (“*fiat lux*”) some 13.8 billion years ago (13.8 Ga, or  $13.8 \times 10^9$  years), possibly as a **quantum fluctuation** in a “false vacuum” or “inflaton” field, mediated by a universal wave function or other unclear mechanism. The *modus operandi* of its origin is intensively researched (see *quantum cosmology*, p.9). Some 380,000 years later, the cosmic microwave background radiation (CMBR) had formed; its minute temperature variations and polarisation patterns, seen by NASA’s **Wilkinson Microwave Anisotropy Probe (WMAP)** and ESA’s **Planck Explorer**, have refined our universe’s vital statistics: **age** 13.82 billion +/- 200 million years; **flat spacetime** due to its initial inflation; **first light** (first stars and galaxies) some 380 million years later. The universe consists of **5% ordinary matter** (protons, neutrons, electrons) of which galaxies, stars, planets, you and I, are made; **27% dark matter**, the *cosmic scaffolding* which has gravitationally shaped

galaxies and galactic clusters; and **68% repulsive dark energy** (1 joule/km<sup>3</sup>, =1 burning match per cubic km of space!) causing its accelerating expansion: a “**5/27/68 model**”. The **Hubble Constant** (expansion rate) is 71 km/second/megaparsec (71 km/s/Mpc); one parsec, “parallax arc-second”, = 3.24 light years.

There now seems little doubt that we inhabit “*a minor planet of an average star, lost near the edge of an inconsiderable galaxy*”, one of some 200 billion galaxies within our observable cosmic horizon: a sphere of radius about 42 billion light years – the distance light has travelled since the Big Bang began, greater than 13.8 billion light years because cosmic expansion has lengthened distances (Tegmark, 2006). This is bounded by the **cosmic microwave background radiation (CMBR)** -- a remnant “cosmological fossil”, a fading echo of the original expanding fireball, now cooled to 2.7 K (-270 C). Analysis of **WMAP data** for “paired matched circles” shows that, because the primordial universe briefly inflated at faster-than-light speed, its “topology scale” (width) is about 92 billion light years (radius 41 billion ly). Further

evidence for this inflation spurt, lasting one trillion-trillion-trillionth second, has been obtained by mapping the polarization (directionality) of the CMBR's "faint Big Bang afterglow". This polarization has revealed the "shape" of the space preceding it, and, since the first stars affected it, confirms that first stars formed about 400 million years after the Big Bang. "*We have never understood the infant universe with such precision.*" (Charles Bennett, Goddard Space Centre). By 2014, South Pole's BICEP 2 had also observed CMBR polarization patterns, probably of galactic origin.

Following the **instant of origin** of 4-dimensional space-time (" $t = 0$ "), symmetry-breaking processes deposited all the "*mass-energy capital*" of the future universe into a rapidly inflating bubble of space and time. From decades of patient research using satellites, giant telescopes and particle accelerators, we deduce the genesis of **gravity, the strong and weak nuclear forces, and the electromagnetic force**. These "condensed" the original energy into **hydrogen, helium, and dark matter** of uncertain composition, which have undergone slow

gravitational accretion to yield billions of galaxies and their constituent massive stars. These stars have generated the **heavier metallic and other elements**, dispersed by **supernova explosions and neutron star merges** into nebulae which have given birth, by local gravitational accretion processes, to long-lived stable stars and planetary systems, including ours. This ongoing process (our closest **starbirth nebula being the Great Orion Nebula (M42)**, 1500 light years distant, visible in small telescopes) will probably continue for some six times the present age of the “**stelliferous**” (**star-forming**) **universe**, until the next **dark era** when all stellar raw materials (mainly **hydrogen and helium**) have been consumed, and the stars will cease to shine. Our *very* remote descendants would then need to find alternative sources of life-sustaining energy (gravitational cosmic strings, if such exist, or a rotating black hole’s ergosphere?)

**Recent developments** (*Understanding Origins*; Turner, Sci. Am. Sept.2009): as far back as we can extrapolate, the universe has been expanding, thinning and cooling. Starting with **inflation**, the newborn



universe was featureless, *without form and void*, until inflation filled it with almost uniform intense radiation which rapidly imposed order on itself as electrons, protons and other particles condensed out (analogous with water droplets condensing out of steam). Inflation also generated acoustic sound waves (“**cosmic harmonies**”), whose compression and rarefaction patterns in the primordial plasma were “frozen” into the **cosmic microwave background radiation (CMBR)**.....the radiation afterglow (“fading echo”) of trillion-degree Big Bang temperatures, imaged by WMAP probe to reveal our infant universe at about 400,000 years old. The power spectrum of slightly denser (warmer) and rarefied (cooler) regions indicates that the major components of today’s cosmos are invisible *dark matter* which provides the gravitational attraction to hold the galaxies together in their clusters, and repulsive (“anti-gravitational”) *dark energy*, with its gravitational repulsion due to its *negative (inwards) pressure* (analogous to that within a stretched rubber sheet). See also Krauss (2002, 2012).

**Dark energy** (postulated in 1917 as Einstein’s “cosmological constant”) may explain a 1998 discovery: the universe has experienced an **accelerating expansion** since its gravitational retardation came to be dominated by an outward force which, unlike mass-energy and its consequent gravity, does not dilute and weaken with expansion (Sci. Am. Apr. 2009).



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Recent Hubble Space Telescopic observations of distant bright Type 1a supernovae (“**standard candles**” used for estimating cosmic distances) are showing that early cosmic expansion was indeed slowed by gravity while mass-energy density was greater , before commencing to speed up some 6 billion years ago; this should help to reveal the nature of **dark matter, dark energy**, and the **ultimate fate of the universe**. **Type 1a supernovae**, some 10 billion years old, are binary stars in which a white dwarf attracts matter from its companion star until immense core temperature and pressure ignites a “thermonuclear firestorm” (Cowen, 2007). This destroys the star, leaving a radioactive

cloud of nickel and other elements shining for weeks with several million-fold brightness increase, approximately equal for all Type Ia's. (Barrow and Webb (2005) claimed evidence in the spectra of remote quasars, for **“inconstant constants”** which may yet require modification of the above concepts, *if* it can be confirmed that “universal constants” such as the speed of light or the gravitational constant have not always had their current accepted values).

### **EINSTEIN'S UNIVERSE: THE SPECIAL AND GENERAL THEORIES OF RELATIVITY.**

*“The most incomprehensible thing about the universe is that it is comprehensible”* (Albert Einstein, commenting on human mental capacity to do complex mathematics and deep science – abilities seemingly surplus to evolutionary requirements for our species' survival and reproduction).

In 1905, Einstein made two far-reaching proposals: that all inertial (Galilean) frames of reference are equivalent (anyone, at rest or moving with constant velocity relative to (say) Earth's surface, will measure the **same result for any experiment**, dynamic or electromagnetic: e.g. playing table tennis or watching TV in a stationary or constant-speed airliner); also, the speed of electromagnetic radiation is the same for all observers, regardless of their relative velocities (“thou shalt not exceed the **speed of light**”....  $c =$  approx 300,000 km/second, or about 7 times around Earth per second). This **Special Theory of Relativity** treats our three dimensions of space and one dimension of time as being mere shadows of a deeper reality: a *unified four-dimensional space-time continuum*. This “flat” (Minkowski) space-time concept produced some very counter-intuitive discoveries. These include *time dilation* (“**moving clocks run slow**”,  $t' = t/(1-v^2/c^2)^{1/2}$ ); as measured by 3 synchronized caesium clocks in London, New York, and on a 747 airliner, the airborne clock loses 40 nanoseconds during the flight – not much, but the effect increases rapidly if (like upper atmosphere cosmic muon showers) your speed approaches  $c$ . This leads to the “space-twins

paradox”: you need “only” travel out into space at (say) 99% of light speed and return after 10 years by your clock, which has been running 7.1 times slower as seen by your observers back home on Earth, and you would find your grandchildren now older than you. Time-travel into the stay-at-homes’ future is limited by our propulsion technology, and physiological problems (!) while accelerating to near-light speed. Also, like time, **space is elastic** – it shrinks along your direction of motion (**the “Lorentz contraction”**), so that your car, as seen by a stationary observer, is about an atomic diameter shorter when moving at 60 km/hour than when parked. Space and time are not a fixed immutable stage or “backdrop”, as Newton assumed; we each have our personal space-time, which warps slightly as we move about. Also, your inertial **mass *slightly increases*** while you run (“the faster, the heavier”); this need not deter dieters, as you return to normal “rest mass” when resting. (To visualise all these distortions, we can see what would happen if  $c$  was only 10 m/sec, instead of  $3 \times 10^8$  m/sec).

The other famous finding from Special Relativity is the **equivalence of mass (matter) and energy**,  $E = m c^2$ . This has resulted (*inter alia*) in nuclear power stations, fission (uranium, plutonium) and fusion (hydrogen thermonuclear) weapons, and our understanding of **how the stars shine** - by conversion of mass to energy, e.g. by **fusion of hydrogen to helium** in “main-sequence” stars. The Sun, for example, converts 4 million tonnes of its mass every second into radiant light and heat, of which our tiny world intercepts the miniscule amount which has, for some 4,600 million years, warmed it, driven its weather systems and ocean currents, and made life possible.

Einstein’s field equations of **General Relativity (1915:  $G_{uv} = 8\pi G T_{uv}$ )** arise from his “*Principle of Equivalence*” – the *equivalence of gravity and acceleration*. Their solutions accurately describe the large-scale structure of the cosmos. Mass and energy ( $T_{uv}$ , the stress-energy tensor) create warps ( $G_{uv}$ , the Einstein curvature tensor) in the spatial landscape, which appear as gravitational fields (G is Newton’s universal

gravitational constant; a tensor is a geometric or physical quantity represented by an array of numbers.) Gravity is treated as an effect of this hidden *curved geometry of space-time* (which we discuss using appropriate visuals). Instead of being pulled by other bodies, as proposed by Newton, falling apples and orbiting moons or planets are “sliding down or around the slopes of space-time”: *Matter tells spacetime how to curve; curved spacetime tells matter how to move* (physicist John Wheeler). This predicted a **bending of starlight** as it follows a geodesic path through the curved spacetime containing a massive object such as the Sun (confirmed by Eddington’s observations of a 1919 solar eclipse); also predicted were “collapsed objects” – **neutron stars and black holes**. GR is used in GPS navigation systems. Small masses (e.g. you and I) cause tiny curvatures in our personal space-times, resulting in tiny gravitational “forces”: **we are all personally attractive**, at least gravitationally.

Powerful as it is, GR theory breaks down when the history of our expanding universe is “run backwards” in time to the instant of



origin, producing a *cosmic space-time singularity* – an infinitely small point of infinite energy density and temperature, wherein the laws of physics lose their descriptive and predictive powers. Such infinities in a theory signal that its mathematics have been pushed too far - extrapolated beyond their useful limits - and that **GR theory is incomplete**. Further observational evidence, e.g. the advance of Mercury's perihelion, the success of GPS technology, and radio Doppler ranging of NASA's Cassini probe as it passed behind the Sun in 2002, still falls short of the experimental evidence for quantum mechanics, the other pillar of modern physics.

**Quantum theory** predicts the interactions of matter and energy at **subatomic scales** with extraordinary accuracy...to 10 or more significant figures. **Serious discrepancy** exists between general relativity's description of forces in terms of space-time geometry, and quantum mechanics' concept of forces as an exchange of particles, leaving us with different descriptions of the same universe. This tension becomes irreconcilable where extreme gravity coincides

with small scales, including the Big Bang and black holes. A more fundamental theory is needed, possibly the as-yet **untestable string or brane theory** which envisions particles as ultra-minute strands or sheets of energy vibrating in 11-dimensional space-time (there are non-mathematical visual means of explaining this concept).

To better understand our universe, we need to test general relativity to high precision. Any tiny flaws in GR theory will help to decide which **quantum gravity theory** can work, possibly leading to a new “golden age of physics”. Gefter (2005) reviewed experiments to test Einstein’s equations, including measurements of Earth-moon distances to millimeter resolution, to test the Equivalence Principle; NASA’s Gravity Probe B satellite, to measure Earth’s geodetic effect and frame-dragging; J0737-3039 binary pulsar’s orbital decay and energy loss through gravity waves; and black hole shadows due to gravitational lensing of galactic centers. By 2015, no discrepancies have been detected.

**QUANTUM COSMOLOGY: IN THE  
BEGINNING.....NO CAUSE ?**

*“The reality exposed by modern (quantum) physics is fundamentally alien to the human mind and defies all power of direct visualization....the culmination of these ideas is the so-called superstring theory, which seeks to unite space, time and matter and to build up all of them from the vibrations of submicroscopic loops of invisible strings inhabiting a ten-dimensional “imaginary” universe.”* (Davies and Gribbin, discussing the deep structure of matter).  
A brick, solid to our macroscopic eyes, dissolves into a *swirl of energy*, of almost nothing material, at the quantum scale.

*“We are more fecund emptiness than created particles – each atom is mainly nothingness, all empty – if all emptiness were taken out, you become a million times smaller than a grain of sand- – this emptiness is simultaneously the source of all being....”* (Brian Swimme, discussing

the *quantum vacuum*, the “*inner deep space*”, within our atoms’ electron shells).

At this point, quantum physics, the laws which very accurately describe the *microworld* of very small particles and their interactions, enable us to further investigate the “Big Bang” **instant of origin**. The primordial singularity is “smeared out” to a finite entity, able to be treated as a *quantum fluctuation* within an *inflaton field* (Cox, 2016). **Quantum “weirdness”** posits some seriously strange (counter-intuitive) phenomena, very different to our experience of the everyday *classical* (non-quantum) *macroworld*. These properties (which can be visually illustrated using well-established observations such as light’s interference pattern obtained from **Thomas Young’s “two-slit experiment”** ), include the following (adapted from Charles Lineweaver’s summary – see References):

1. **Atoms do not collapse**, as would occur if their “orbiting electrons” lose energy by emitting electromagnetic

radiation, which is what accelerated charged particles do in “classical” (non-quantum) physics

- 2 Electrons and other quantum particles behave like both particles and waves (***wave-particle duality***), and can be described as the *energy quanta* of their fields. A *field* is a function of space and time, whose oscillations are interpreted as particles – both the highly-curved condensed particles of matter (*fermions*), and the wave-like exchange particles (*bosons*) which transmit Nature’s ***fundamental forces: electromagnetism, the strong and weak nuclear forces, and (possibly) gravity*** Thus, “knotted-up spacetime” should be, at the deepest level, the “stuff” of which everything – you and I, the universe, *true reality* – is made. The properties and interactions of matter and energy are then the active, dynamical structure of spacetime - a “*cosmic dance*”, according to **particle physics’ *Standard Model***, of interpenetrating interacting fields (“*all is change*”- the *tao of physics*). Which raises the further question: just what do we

mean by these macroworld concepts, “space” and “time”? (See later section: “Are we inextricably connected with the entire Universe?”)..

- 3 An electron or other quantum particle can “tunnel through” classically impenetrable “potential barriers”. Until its **wave-function is “collapsed”** by some observation of (say) its position, it simultaneously exists everywhere within its “probability cloud”, materializing at some position with a calculable probability when an observation is made on it. (This re-raises Bishop Berkeley’s question : how does anything exist without an observer? It is also illustrated by **Schrodinger’s cat**, existing in a simultaneously “alive-dead” state until an observer opens its box, when the famous feline’s wave-function instantaneously collapses it into one or the other state). Was Einstein right: **“God does not play dice”**? Or: *“Subtle is the Lord, but not malicious?”*
- 4 Quantum particles do not have precisely measurable positions or velocities; the **Heisenberg uncertainty principle**,  $\Delta x \cdot \Delta p_x \geq$

$h/4\pi$ , or  $\Delta E \cdot \Delta t \leq h/4\pi$  ( to be further explained, if you wish). This leads to 3 more items:

- 5 Empty space (the *quantum vacuum*) is not empty – it has structure and energy, appearing as a “seething soup” of *virtual particle-pairs*, with effects measurable by the *Casimir effect* (p.8). So: *nothing matters?* No, “no-thing” (the quantum vacuum) greatly matters, as a possible driver of accelerating cosmic expansion.
- 6 There are **two kinds of empty space** – the *true* (low energy) and *false* (high energy) quantum vacua. Our universe exists in the true vacuum, and originated as a **random quantum fluctuation in the false vacuum**.
- 7 Some quantum events have *no cause* – there exists only a *probability* of their occurrence at a given place and time as a *quantum fluctuation* within a field.

This last property is of particular significance to cosmologists, philosophers, and theologians, as it raises the possibility that the “**instant of creation**” of the universe ( $t=0$ ) is **an event without a**

*cause.* Quantum events such as the emission of a photon of light by an atom's electron, or a radioactive decay event (e.g. the appearance of an alpha particle – a helium nucleus - outside a uranium nucleus) occur with a finite calculable probability, but with no apparent prerequisite cause. They “just happen”. We speak of the *wave function* of the alpha-particle, describing its “smeared-out” existence within and outside the nucleus, and its calculable probability of either being detected outside the uranium nucleus with no apparent cause or reason, or remaining unobserved within the nucleus.

Can such concepts apply to the “materialization” of our universe (and others)? Could the universe have **quantum-tunnelled into existence** from a stable timeless state – a false quantum vacuum, a “spacetime foam”, or Stephen Hawking's 4-dimensional timeless “space-space” - without a cause, with only a probability that this event would occur, as described by a *universal wave-function*? The big question in this recent *quantum philosophy* would then be: which came first? The physical laws, or the universe itself? Do the



laws of nature exist in some timeless “platonic” state, with a finite probability that universes of various kinds can materialize, each with its own space-time inaccessible to our observations? Would this “leave room for a Creator”? Is the physicists’ **“God of the gaps”** in danger of having this major gap in comprehension filled in? (See also “A Cosmology / Theology Appendix”, p 51).

However, despite years of effort by “superstring” and “brane” theorists, we do not yet have a **quantum gravity** theory (a **“theory of everything”**), which would bring the space-time curvature of General Relativity into mathematical consistency with the “flat” (non-curved) space and time used in the equations of quantum physics. Peat (2008) thought this is due to **inapplicable classical concepts** - particles, position, velocity, space, time, causality, etc. - i.e. the *language* used in the equations. Notions of fundamental symmetries and symmetry breaking - particles seen as Bohm’s *processes* rather than objects - may assist. As Albert Einstein said: *“Nature shows us only the tail of the*

*lion. But I do not doubt that the lion belongs to it, even though he cannot at once reveal himself because of his enormous size”.*

We should also be aware of **quantum non-local entanglement** -- another weird quantum property, whereby one particle of a pair (e.g. a pair of opposite-spin electrons or oppositely-polarised photons emitted simultaneously from the same source) instantaneously “knows” what measurement has been made on its distant partner particle. This appears to violate Einstein’s prohibition on faster-than-light transmission of information - he called it “**spooky action at a distance**”, and never accepted it. A Chinese group (*Nature*, 01 July 2004) has been able to entangle 5 photons, using beam splitters - a possible prelude to ultra high-speed quantum computing and “teleportation” of quantum states. Is every quantum particle in the universe instantaneously “aware” whenever one of us makes a measurement or observation on its distant entangled partner? Is the **universe somehow “held in existence”** through agencies such as human consciousness (Tipler’s “Final Anthropic Principle”)? See also

“Are we entangled with the entire Universe?” in these notes, and a review by philosopher/physicists Albert and Galchen (2009).

## **BLACK HOLES AND OTHER STELLAR CORPSES.....OUR DISTANT FUTURE? HAWKING’S INFORMATION PARADOX SOLVED AT LAST?**

Does the **distant destiny** of our universe end in a fiery “**Big Crunch**” (followed by a “**Big Bounce**”?), as gravity, overpowering all else, causes cosmic expansion to stop, reverse, and the universe to implode upon itself? Or do we foresee a “**Big Chill**” (“heat death”), as the **Second Law of Thermodynamics** (“*all becomes ruin, rust and decay*”) inexorably converts our ordered (low entropy) universe into an ultra-thin ever-expanding disorder of decay products, including electrons, positrons, and photons? Or does a “**Big Rip**” await us, as accelerating expansion demolishes the galaxies, stars, and matter itself?. The first outcome now seems unlikely, if evidence of **accelerating expansion** remains unchallenged. All three possibilities

seem in the long term, trillions of years in the far future, to culminate in Bertrand Russell's *firm foundation of despair.... and extinction of the noonday brightness of human genius*. But we don't know what other possibilities may yet emerge. For example, Turok and Steinhardt have proposed that the Big Bang was not the beginning of time, space and history, but was an *event within it* due to the collision of our "brane" universe with another "brane" existing in another dimension, repeating cyclically every trillion years or so.

In the "**medium future**", a mere few billion years ahead, we foresee "*the long twilight*": a universe of stellar corpses as the stars exhaust their nuclear fuel, and gravity crushes them down to remnants composed of matter unlike anything found on Earth. Low-mass main-sequence stars such as **our Sun** will fuse their hydrogen fuel to helium, then carbon, in the process first expanding to **red giants** and ingesting their inner worlds. Even larger are the red supergiant stars Betelgeuse (in Orion), Aldebaran (in Taurus), and Antares (in Scorpio). When a red giant's outer layers expand outwards

as a “**planetary nebula**” (e.g. the **Helix**), its white-hot collapsed core is an Earth-sized *white dwarf* “diamond in the sky” (e.g. Sirius B) composed mainly of super-dense carbon (several tons per matchbox-full), supported against further collapse by “electron degeneracy pressure”. This cools down over billions of years to a *black dwarf* “**death star**”, perhaps orbited by its remnant outer planets in the icy depths of space.

The relatively few short-life blue **supergiant stars** (among the largest known is R136a1, *320 times more massive, 20 million times more luminous* than the Sun!), burn their hydrogen fuel profligately in a few million years, fusing it into successively heavier nuclei: He, Be, C, O, Ne, Mg, Si, S, etc. This process culminates in an iron (Fe) core, which cannot support further nuclear fusion, and implodes. A gamma-ray burst, rebounding shock-wave and core oscillations (Cowen, 2007) explode the supergiant star as a **Type 2 “core-collapse” supernova**. If the remnant core exceeds 1.4 solar masses (“Chandrasekhar’s Limit”), gravity compresses it to a city-sized “giant atomic nucleus”, a rapidly-

spinning hyper-dense (million tons per pinhead) *neutron star*, supported by “neutron degeneracy pressure”. If the neutron star emits short-period radio and optical pulses towards Earth, it is called a *pulsar*, e.g. the 30 millisecond central pulsar in the Crab Nebula (M1 in Taurus), the remnant of a supernova recorded 1,000 years ago as a “guest star” by Chinese astronomers. **Once per second** somewhere in the observable universe (30 times per century per galaxy), a star explodes with the brilliance of an entire galaxy, either as a core-collapse supernova (above) or as a Type 1 white-dwarf accretion supernova (p.8).

If the collapsed core exceeds about 3 solar masses, no known force can prevent its gravity from crushing it down to a *space-time singularity* at the center of an *event horizon*, from which no light or other information escapes (except for possible “naked singularities”? Joshi, 2009). Such objects are the famous *black holes* (“*frozen stars*”). We detect some 1% of these by the **flickering X-ray signature** of their hot accretion discs, formed when a black hole can pull in material from a slower burning companion star (e.g. Cygnus X-1). Such **stellar-mass black holes** may

number in the 100,000's in the Milky Way Galaxy. **Supermassive** black holes, millions of solar masses, up to 0.5% of a galaxy's mass (Graham and Scott, 2013), formed at the centres of many large galaxies, including our Milky Way, during ancient early stages of galaxy formation, when black hole accretion discs formed super-luminous *quasars* (quasi-stellar radio sources, emitting giant jets of charged particles). After such a black hole has "gravitationally fed" on gas and stars of its galaxy's nucleus, it "quietens down" to a *radio galaxy* (e.g. Centaurus A), which may in turn **evolve** to a sedate **spiral or similar galaxy**, such as ours. The Milky Way's central 4 million solar mass supermassive black hole SgrA\* (in Sagittarius), is revealed by its high-velocity orbiting stars, through infrared and radio observations (also, in giant galaxy M87: Broderick & Loeb,2009).

A recently found **black hole** (Feb. 2007) is the first inside a **globular star cluster** – only the second cluster studied (*“bingo!”*) using the XMM-Newton satellite and Chandra X-ray Telescope. Both detected the fluctuating X-ray signature (*“dying scream”*) of gas from a companion star forming an accretion disc around the black hole, then being torn apart as it falls in across the event horizon. The globular cluster is a part of galaxy NGC 4472, some 55 million light-years away. Globular clusters, among the oldest structures in the Universe, contain thousands to millions of **ancient stars**, with a few rejuvenated “young blue stragglers”, packed into a space just a few tens of light-years across. These high densities should lead to frequent stellar interactions and even collisions; “intermediate” black holes - several hundred times the mass of our Sun - should form and be retained in the cluster’s dense inner regions.





The “Hawking information paradox” - when matter enters a black hole, all **information** of its composition **disappears from the universe** - violates fundamental conservation laws. Stephen Hawking (famous for black hole entropy  $S_{bh}=kC^3A/4hG$ , and Hawking radiation) considered information-destroying black holes in our universe were offset by **parallel universes** without black holes and singularities; such universes are necessary for our existence! Leonard Susskind: no, the information is preserved as a 2-D hologram “smeared over” the hole’s event horizon. Curiouser and curiouser?

**ANIMATED STARDUST.....THE**

**RISE OF LIFE.**

*“Go quietly amid the noise and haste.....**you are a child of the universe**, no less than the trees and the stars...you have a right to*

*be here...and doubtless your universe is unfolding as it should...”(excerpts from 16<sup>th</sup> century prayer, “Desiderata”).*

What do we mean by “life”? NASA defines this complex phenomenon as **“a self-sustained chemical system capable of undergoing Darwinian evolution”**. *Encyclopaedia Britannica* has decreed that:

**“A living system may be defined as a self-organised non-equilibrium system, such that**

**(a) Its processes are governed by a program stored symbolically (e.g. in DNA), and**

**(b) It can reproduce itself, including its process-governing program.**

**A self-organised non-equilibrium system** is a distinguishable collection of matter, with recognizable *boundaries*, which has a *flow of energy* and (possibly) *matter* through it, while maintaining, for *time-scales which are long* compared to the time-scales of its internal processes, a ***stable configuration far from thermal equilibrium***. This

configuration is maintained by the action of *metabolic cycles* involving the *transport of matter and energy within* the system, and *between* the system and its exterior. Further, the system is *stabilized* against small perturbations by *feedback loops* which *regulate the rates of flow* of the cycles.

We “self-organised non-equilibrium systems” seem close to elucidating **how life began**, in the seas of our rare (unique?) small planet, orbiting within its star’s “**ecosphere**” – a “Goldilocks” distance for conserving liquid water and carbon-based “**protobiont**” **molecules** derived from infalling cometary material. Chemical pathways, including polycondensations (denoted by “condens.” in the following summary diagram) produced the three groups of molecules: **amino acids** for proteins and enzymes; **phospholipids** for cell walls; **nucleic acids (RNA, DNA)** for storage and transmission of genetic instructions, which were needed for life to emerge, almost surely in water. *“The emergence of life is an expected phase transition from a collection of polymers which do not reproduce themselves, to a slightly more*

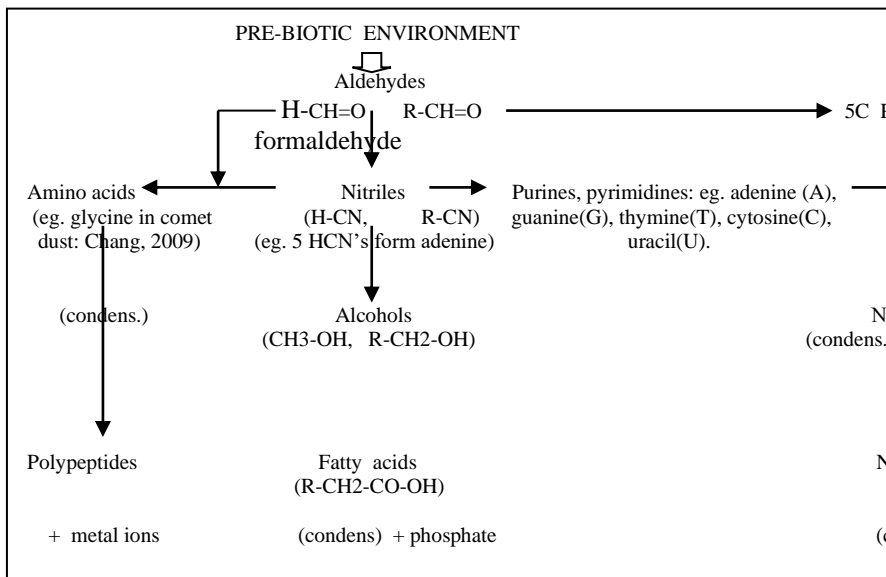
*complex collection of polymers, which do jointly catalyse their own reproduction.*” (Stuart Kauffman, *The Origins of Order*, 1993): hence the interest in auto (self)-catalysing “ribozymes” – polymers (“chains”) of RNA (ribonucleic acid) molecules - and the putative early “**RNA world**” dominated by RNA-based replicator molecules. Shapiro (2007) has reviewed the alternative small-molecule “**metabolism first**” approach to life’s origins.

**Life’s ancient traces** , some 3.5 billion years old , have been discovered around **Marble Bar** (microfossils, possibly photosynthetic cyanobacteria or thermophilic archaean microorganisms in the Apex Chert formation), and at North Pole (rocks containing excess sulphur 32, of bacterial origin), in Western Australia’s **Pilbara** region; also, in Greenland (Isua and Akilia, 3.8 billion old) and South Africa’s Transvaal Basin. There is debate (Simpson, 2003) concerning the formation of these ancient rocks, whether in low-temperature environments favouring bacteria or in higher-temperature locales where nonbiological reactions could mimic bacterial isotope patterns

and fossils. However, the **great antiquity of life** at other sites is generally accepted (see Appendix: Big History Summarised). Simpson also notes the probability that the ancient **Martian surface** has remained largely intact due to the absence of global tectonic plate motion which has “chewed up” (metamorphosed) Earth’s 4-billion-years old sediments, producing “fubarite” rocks (“fouled up beyond all recognition”, from a palaeontological viewpoint); if life did begin on Mars, evidence could be much easier to find there. Antarctica’s controversial ALH84001 Martian meteorite seems to contain at least one strong “biosignature”: pure tiny grains of magnetite (iron oxide,  $\text{FeO}\cdot\text{Fe}_2\text{O}_3$ ), identical with those found in aquatic MV-1 bacteria here on Earth. NASA’s Spirit, Opportunity and Curiosity probes have (since 2004) identified ancient sediments on Mars, which could contain microfossils.

The chemistry within interstellar **“giant molecular gas clouds”** (GMC’s), such as the Coalsack dark nebula adjacent to the Southern Cross, is revealed by microwave emission spectra of over 100

molecules, including many organics. These have been formed by the **mixing of primeval hydrogen and helium with oxidising and reducing “bubbles” (light-years size!)** of expanding gases generated by exploding **supernovae**. Formation of carbon monoxide (CO) left excess oxygen and silicates in bubbles from massive supernovae, while less massive stars produced carbon-rich reducing bubbles. The most important **pre-biotic molecules**, present in abundance within galactic spiral arms with plentiful young hot stars, are probably **water** (H<sub>2</sub>O), **formaldehyde** (H<sub>2</sub>CO), and **hydrocyanic acid** (HCN). On the frosty surfaces of solid silicate and carbon-rich dust grains, further reactions have produced larger organic molecules (see below) – the raw materials for future life, which have “seeded” rare bio-friendly planetary surfaces such as ours. This pre-biotic **“panspermia”** route which led to life seems to have used readily available “cosmic construction materials”; likewise, silicates of iron, magnesium, calcium etc. provided our “rocky water-world” for life to commence. The unknown author of *Desiderata* (above) was indeed prescient: *“Go quietly...you are a child of...the stars.”*





Physicist Freeman Dyson has said that , in some sense , “ *the Universe knew we were coming*”. We have arrived through an



immensely long period of Darwinian natural selection , from “protobionts” (above) to archaeobacterial

Physicist Freeman Dyson has said that, in some sense, “*the Universe knew we were coming*”. We have arrived through some **four billion years** of “**uninstructed chemical evolution**” based on protobiont molecules (above), followed by **Darwinian natural selection**: from archaeobacterial cells utilising gases such as hydrogen sulphide at ocean-floor hydrothermal “black smoker” and white alkaline “lost city” vents (Bradley, 2009; Lane, 2014), to oxygen-generating photosynthetic cyanobacteria (shallow marine stromalites), to light-sensitive autotrophic eucaryote cells, to multicellular diploblastic (two-layer “place-mat”) animals, found in Ediacaran sediments of the **Flinders Ranges**, to terrestrial tetrapod (4-limbed) animals with enough **concentrated nerve-tissue** for visual information-processing, prey capture or predator avoidance: **an “evolutionary arms race”**, leading through amphibians to reptiles to mammals, primates , and to **us** (see, e.g, Zimmer, 2006) - as well as the wondrous variety

of life-forms with whom we share our planet. (For a spectacular history of life, see Haines and Chambers, 2005). The late **Carl Sagan** famously summarised this history as follows :

*“For we are the local embodiment of a cosmos grown to self-awareness . We have begun to contemplate our origins : starstuff pondering the stars ; organised assemblages of ten billion billion atoms considering the evolution of atoms ; tracing the long journey by which, here at least , consciousness arose . Our loyalties are to the species and the planet. We speak for the Earth . **Our obligation to survive** is owed not just to ourselves , but also to that Cosmos , ancient and vast, from which we sprung”.*

Or , to quote **Paul Davies** : *“We are truly meant to be here”*. We are *“a part of the action, not just here for the ride.”* The late **Stephen Jay Gould.**, however, reminds us that our biological history is based on *“chaos.....extremely sensitive dependence on minute and unmeasurable differences in initial conditions, leading to massively divergent outcomes based on tiny and unknowable disparities in*

*starting points*.(aka. the “tropical butterfly/ hurricane effect”). *And history includes too much **contingency**, or shaping of present results by long chains of unpredictable antecedent states, rather than immediate determination by timeless laws of nature.*” It is worth quoting him at length, to demonstrate **how fortunate we are to be here as thinking, conscious beings**:

*“Homo sapiens did not appear on the earth, just a geologic second ago, because evolutionary theory predicts such an outcome based on themes of progress and increasing neural complexity. Humans arose, rather, as a fortuitous and contingent outcome of **thousands of linked events**, any one of which could have occurred differently and sent history on an alternative pathway that would not have led to consciousness. To cite just four among a multitude:*

*1. If our inconspicuous and fragile lineage had not been among the few survivors of the initial radiation of **multicellular animal life** in the Cambrian explosion 530 million years ago, then **no vertebrates** would have inhabited the earth at all. (Only one member*

of our chordate phylum, the genus **Pikaia**, has been found among these fossils. This small and simple swimming creature, showing its ancestry to us by possessing a notochord, or dorsal stiffening rod, is among the rarest fossils of the **Burgess Shale...in Canada's Rocky Mountains**). (Two more agnathan (jawless) fish, from China, are now (2008) known – see Summary).

2. *If a small and unpromising group of lobe-finned (Rhipidistian) fishes had not evolved fin bones with a strong central axis capable of bearing weight on land, then vertebrates **might never have become terrestrial**.*

3. *If a large **extraterrestrial body** had not struck the earth 65 million years ago, then dinosaurs would still be dominant and **mammals insignificant**, the situation that had prevailed for 100 million years previously.* (Alternatively, developing encephalisation in the theropod Dromaeosaur line – pack-hunting carnivores including Melbourne Museum's *Deinonychus* (“Terrible claw”) -- could have led to reptilian human-type intelligence?)

4. *If a small lineage of **primates** had not evolved upright posture on the drying African savannas just 2 to 4 million years ago, then our ancestry might have ended in a line of apes that, like the chimpanzee and gorilla today, would have become ecologically marginal and probably doomed to extinction despite their remarkable behavioural complexity.....(we are) the **single actualized version** among millions of plausible alternatives that happened not to occur. Such a view of life's history is highly contrary both to conventional deterministic models of Western science and to the deepest social traditions and psychological hopes of Western culture for a history culminating in humans as life's highest expression and intended planetary steward.”* In short, we seem to be here as a consequence of **“dumb luck”**. What do you think? (See p. 28 for the views of physicist Paul Davies, and astronomer/theologian George Coyne's theological/cosmological perspective). An alternative opinion -- **life and mind as cosmic imperatives** – has been stated by Christian De Duve (Nobel Prize for Physiology) in his 1995 book *Vital Dust*:

“The thesis that the **origin of life** was highly improbable is demonstrably false.....(life) must have followed a very long succession of chemical steps leading to the formation of increasingly complex molecular assemblages. Being chemical, these steps must have been **strongly deterministic and reproducible**.....given the nature of matter and the conditions that existed on the earth four billion years ago, life was bound to arise in a form not very different, at least in its basic molecular properties, from its present form.....The emergence of **thinking beings** (also) appears much less improbable than is often intimated. Once **neurons** emerged and started interconnecting, life progressed toward the formation of increasingly complex (neural) networks, no doubt furthered by the associated selective advantages.....Life and mind appear as cosmic imperatives, written into the fabric of the universe. Given the opportunity, **matter must give rise to life, and life to mind**. Conditions on our planet provided this opportunity. (De Duve, 1996). So: “**chance or necessity**”? Lane (2014): H<sub>2</sub>O, H<sub>2</sub>, CO<sub>2</sub>, olivine (iron magnesium silicate), serpentinisation and proton gradients at

alkaline deep-ocean hydrothermal vents could supply “proton-motive” electrical energy to assemble living “tiny battery” cells; our Galaxy has up to *11 billion* small rocky suitable worlds! (NASA’s Kepler data, 2013).

An early complex molecular assemblage was **DNA, deoxyribose nucleic acid, the double-helical replicator molecule** shared by all life on Earth except single and double strand RNA viruses: RNA, ribonucleic acid, has uracil (U) in lieu of thymine (T). DNA is found in our cells’ nuclear chromosomes (‘coloured threads’) and mitochondria. Think of a *very* long molecular flexible ladder, twisted to form a double-stranded helix (or spiral), whose two sides (“backbones”) are repetitive chains of deoxyribose (a 5-carbon sugar) and phosphate. Its “rungs” are long sequences of “Watson-Crick base-pairs”: adenine-thymine (A-T), and guanine-cytosine (G-C). These 4 nitrogenous bases – A, G, C, and T - are the 4 chemical “letters” of the genetic “language”. They occur in sequence along the “coding strand” of a DNA molecule; **during the assembly of a protein** (e.g. an enzyme), each successive “triplet codon” (3 bases) is responsible for adding one of 20 amino acids to the growing protein

polypeptide chain. There are  $4^3$ , ie. 64, of these codons, e.g. AAA, ATG, CTA, GTT: 64 possible “3-letter words”, 61 coding for one of the 20 amino acids. **During replication**, the two DNA strands “unzip” down the middle: each strand assembles a “complementary copy” of itself, C always pairing with G, and A with T, thereby producing 2 copies of the original molecule. (See p. 15a for diagrams of RNA and DNA molecules, and the RNA genetic code).

**Mutations**... “mistakes” during replication of a DNA molecule...may be a “point” substitution of a single base for another (e.g. a C replaces a G), or deletion of a block of bases, or insertion of new bases, or duplication, inversion or translocation of bases already present. Mutations provide a basis for spontaneous genetic variation within a species, enabling Darwin’s “natural selection” of individuals best adapted to prevailing environmental conditions, to take place. A reference sequence for the entire **3-billion-base-pair human genome** (23,000 genes) was completed in 2003; four years later, the personal genomes of James Watson and Celera founder Craig Venter were published. A side-by side comparison shows roughly



3.3 million single base-pair changes and a few 100,000 deletions and insertions of DNA sequences and whole genes (Kingsley, 2009): indeed, we are all different, each of us genetically unique (even if you have a monozygotic identical twin sibling).

### WHERE WE FIT IN .

Is the **universe** *neither hostile, nor benign, merely indifferent to the concerns of such creatures as us?* Or are we **rare, cosmically significant forms of matter**? We may approach this question by reviewing our current understanding of human consciousness and its implications.

*“From the fossil record , the **hominid cerebral cortex** has steadily increased in size over the past 4.5 million years ; hominids (*Homo erectus* ) were able to walk erect 2.1 million years ago ; and the faculty of speech probably appeared ( with mitochondrial Eve ?)*

*perhaps as recently as 125,000 years ago*". (John Maddox, former Editor of *Nature*).

***“Life?*** *Life uses energy. Life adapts. Some life-forms have developed large central processing networks. In at least one instance, life has become profoundly self-aware*”. Also: ***“Intelligence*** *is rooted in the emergence of structures which allow simple animals to sense their environment and seek food.....if we get to creepy-crawlies that look for food, then at some point intelligent life may emerge*”. (Palaeobiologist Andrew Knoll).

***“Humans*** *as individuals are not that much cleverer than chimps....but as a species, we are vastly more creative because our knowledge is shared within and between generations.*” (David Christian, reasoning that a major distinction between us and other animals is our ability to think abstractly and to learn collectively through the cumulative nature of our cultures). See also “A Mind Appendix”.

In a major treatise on the *anthropic cosmological principle*, Barrow and Tipler propose ten *polygenetic semes* (heritable traits under multiple gene control, i.e. requiring a **large amount of genetic information**), which are *unique* (i.e. appeared only once in the history of life), and are *essential* for the evolution of an intelligent species such as humankind. These can be discussed in detail if you wish, and are as follows:

1. The development of the **RNA-DNA genetic code**, with triplet-base codons assembling amino acids into proteins, seems universal to all life on Earth.
2. The appearance of **aerobic respiration**, essential to provide enough energy for multicellular (metazoan) life in a free-oxygen atmosphere.
3. The appearance of **glucose fermentation** to pyruvic acid, an essential stage in energy metabolism in some bacterial (prokaryote) and all eukaryote cells.

4. The origin of autotrophic (oxygenic) **photosynthesis**, to generate the **free oxygen** needed for metazoan aerobic metabolism.
5. The origin of **mitochondria** (by endosymbiosis – “internal adoption” – of bacterial cells within larger cells), and synthesis of **energy-storing molecule ATP**, adenosine triphosphate. (See also Lane, 2014)
6. The formation of the cellular “centriole-kinetosome-undulipodia” microtubule complex, essential for eukaryote **cell reproduction** (mitosis), for gametogenesis (**ova and spermatozoa** produced by meiosis), and for **nerve impulse transmission** by neuron (nerve cell) axons and dendrites.
7. The evolution of **eye precursors**, using the **same basic genes** for opsin-based photoreceptors and crystallin lens (known in at least 40 metazoan lineages: see, e.g, Zimmer (2006) for an explanation of the operation of ancient body-building **Hox** and other genes). **Sensory organs** supply essential information for the brain to process.

8. The development of **endoskeleton** (internal supportive structures), essential for large terrestrial animals.
9. The development of **chordates**, including the **vertebrate** line, assuming that DNA-sequencing shows them to be a monophyletic (single) lineage.
10. The evolution of *Homo sapiens* in the chordate lineage, with **high-level information processing** using a complex nervous system and its support systems (sensory , manipulative, transport and energy supply organs, etc).

The process of **encephalisation** (increasing brain mass / body mass ratio), thought to be a measure of information-processing ability, has produced the **human brain**, requiring about 20% of the energy consumed by the resting human body. The increase in encephalization in metazoan animal lineages, many of them marine, was relatively rapid until the major mass-extinction at the Permo-Triassic boundary, some 230 million years ago. It continued at a reduced rate in marine and terrestrial animals, with one mammalian

order – the arboreal primates – eventually leading to several ground-dwelling African hominin species, including the Australopithecines and the *Homo* line which has produced *Homo sapiens*.

There is a well-known evolutionary process termed “**neoteny**”, by which a new species may evolve by slowing the rate of development of parts of the body relative to (especially) the sexual organs, delaying sexual maturity, and retaining juvenile features in otherwise adult animals. For instance, we observe increased brain size in slowly-growing mammals with small litter sizes and intense parental care, e.g. some cat species and, arguably, humans. **We humans** may be neotenus apes (“apes that never grew up”), retaining juvenile ape features including large brain size and our limb proportions. During the past two million years, our hominid ancestors have experienced an **unprecedentedly rapid three-fold increase in brain size**, due probably to selection for traits including **eye-brain-muscular coordination**, the genesis of **speech, syntactic language, social co-operation** and **competencies** (eg. control of fire, cooking, food sharing),

and our exclusively language-based human ability to form **abstract mental concepts**.

Recent (2004) finds of 75,000-years-old abstract engravings and ochre-stained pierced shell beads in Blombos Cave, South Africa, some 30,000 years older than previous known human ornaments, indicate that our African ancestors were capable of **symbolic thought** and a **language** “capable of sharing and transmitting the symbolic meanings of these objects” (Wong, 2005). Two more bead sites (Es Skuhl in Israel and Oued Djebbana in Algeria), dated to at least 100,000 years, now indicate that humans were widespread over Africa and the Middle East by this time, and **modern behaviour** must have originated even earlier (160,000 BP) at some unknown place (Stringer, 2006). Today, after some 4,000 million years of biological evolution, we big-brained primates (the “upright naked ape which took over the world”) have acquired a mental capacity enabling us to investigate the cosmos, its universal laws, our origin and destiny, even our place in the great cosmic arena. The

**“intelligence-through-culture”** theory implies that the development of “proto-culture” (e.g. gregarious orangutans’ use of trimmed twigs as tools for extracting food from tree holes and spiny fruits...Van Schaik, 2006) predisposes species with some innovative capacities and an ability to learn through observation, living in social networks, to evolve towards higher intelligence. About 150,000 years after the appearance of our species in Africa, sophisticated expressions of human symbolism, such as art, musical instruments and burial gifts, were widespread. *“The explosion of technology in the past 10,000 years shows that cultural inputs can unleash limitless accomplishments, all with Stone Age brains. Culture can indeed build a new mind from an old brain”* (Van Schaik, 2006). This idea is supported by the startling language and other imitative skills displayed by “encultured apes” raised from infancy in human families. It seems likely that, among the great ape primates, we have achieved our present supremacy since our Australopithecine bipedally-striding tool-wielding ancestors entered the African savanna, collectively digging for tubers, de-fleshing and defending carcasses, inventing new



tools and strategies to better exploit available food and shelter. Up to 300,000 years after *Homo sapiens* emerged out of Africa (a 2018 discovery at Israel's Mt.Carmel), here we all are, globally beholden to "*Gaia's law*" of **planetary sustainability**.

Is all this of *cosmic, or merely Earth-bound, significance*? Could it be that our *universe can in some sense "become self-aware" only through the agency of "rare, cosmically significant creatures" such as us*? If complex life-forms exist elsewhere, it seems very likely that their emergence is also mediated by some form of *evolution by natural selection - a cosmic rather than a purely local process*. Our present understanding is that *intelligent life forms* based on water and a few cosmically common macromolecule-forming elements (carbon, hydrogen., oxygen, nitrogen, phosphorus, sulphur, iron) plus elements (sodium, potassium, magnesium, calcium) essential for cellular metabolism, are *very unlikely to be located within a few thousand light-years of us*, but may well have emerged at *rare and distant locations* scattered throughout the approximately 200 billion galaxies

within our cosmic horizon. After all , it has required some 4,000 million years of prebiotic and biological evolution for us to emerge on the surface of our **rare(?) bio-friendly planet**: a **“Goldilocks” world**, not too hot , not too cold, not too small or large, but “just right”, orbiting our **slow-burning stable long-life star**, now about half-way through its main-sequence life (about 10 billion years) before it will expand into a red giant , consuming the inner worlds of the Solar System .

## HUMAN CONSCIOUSNESS .....WHAT IS THE MIND?

*“My thoughts reach all, comprehend all . Inexplicable mystery : I their creator am in a close prison , in a sick bed anywhere ,and any one of my creatures , my thoughts , is with the Sunne and beyond the Sunne , overtakes the Sunne , and overgoes the Sunne in one pace , one steppe , anywhere” . (John Donne)*

*“O the mind! Mind has mountains,  
Cliffs of fall, frightful, sheer, no-man-  
fathomed.*

*Hold them cheap may who ne'er hung there.”* (Gerard Manly  
Hopkins)

*“Our understanding of the human brain is incomplete in one conspicuous way: nobody understands how **decisions** are made or how **imagination** is set free...The essence of the difficulty is to identify what patterns of the behaviour of neurons....signal making a decision or other cognitive activity. Perhaps decision-making has several alternative **neural correlates**, which will complicate the search”.* (John Maddox). See *“Our Future: Consciousness Solved?”* also, *“How Does Consciousness Happen?”* (neuroscientists Christof Koch, Susan Greenfield: Sci. Am. Oct 2007; also, pp. 17-19 & diagrams.)

**“Neural correlates of consciousness” (NCC):** techniques including functional magnetic resonance imaging (fMRI), positron emission

tomography (PET) and electroencephalography (EEG) enable us to “map” which structures are operating within the brain while performing some specific cognitive or other function, or which transient neuronal assemblies are firing in synchrony, briefly coalescing and disbanding during its conscious, dreaming or anaesthetised states.

The *cosmic significance of human-type intelligence , or consciousness* , is to be found in its probable **extreme cosmic rarity**, and in its status as the sole known means whereby the vast and ancient cosmos can , in some sense, **“become self-aware”....through us**, able to ponder its existence and meaning. On this planet , human consciousness has emerged as a property of the three-pound three-pint lump of exceedingly complex matter within each of our adult crania . Each adult human brain contains more interneuronal connections (synapses) than the stars in thousands of the great galaxies, which means that we can each lay claim to ownership and use of the most complex known (to date) piece of matter in the

universe. (See also “A Mind Appendix” and “A Love Appendix” in these notes).

**Whence came this *mighty universe within*?** We think its **evolution began with non-nervous electrically-conducting epithelial tissue** of early metazoan (multicellular) animals. For instance, the epithelium covering the swimming bells of some modern jellyfish (*Siphonophora*) contains neither nerve nor muscle, yet electrical depolarizing potentials between its cells are measured. Numerous such examples suggest that **non-nervous conduction** between epithelial cells originated **via “tight junctions”** in which adjacent plasma membranes fuse to form sheets of cells. These junctions, also common in embryos, have low electrical resistance and high molecular permeability needed for intercellular electrically mediated transmission of ions and nutrients. **The next stage...chemically mediated synaptic transmission between neurons...**probably began with **endothelial secretory cells** which could secrete chemicals, respond to stimuli, conduct impulses, and develop specialized outer

receptor surfaces and inner conducting fibres. Modern neurosecretory cells can propagate action potentials; many neurons secrete chemical neurohormones which influence cellular growth and regeneration elsewhere in the body. This suggests that **neurons first appeared** as neurosecretory growth-regulating cells whose elongated processes (future “axons”) enabled rapid conduction and chemical transmission by release of transmitters at their endings. As multicelled organisms developed, a system of **intercellular internal communication** (a primitive nervous system) evolved, enabling the animal to coordinate movement towards optimal light, temperature and other favourable conditions. Two general types...**diffuse** and **centralized** nervous systems... appeared. We apparently share the ancient origins of our prized mental faculties with our cousins, the jellyfish (e.g. Australia’s “sea-wasp” *Chironex fleckeri*: 4 separate “brains”, 20 “eyes”, world’s most toxic “nematocyst stinger venom”!).

**Human individual consciousness...**our *sense of self*, our unique personal identity...appears to arise from Antonio Damasio’s **“ongoing**

*movie in the brain*”: our “*personalised brain*” is able to continually recall, review, and compare with current sensory inputs (needing about *1 million* inter-neuronal connections during each second of our lives), the unique set of memories which we store in our “memory neuronal networks” as we “individualise our brains” during life.

Research is steadily revealing **how the brain stores memories**. When we pay attention to some specific sensory input - the sight of a familiar face, the sound of your name at a party, that 'phone number you're about to call – your transient attention is first converted into **short-term memory** within hippocampal and other medial temporal lobe structures. **Consolidation of declarative memories** (general facts and specific events) **into long-term memory** now requires their protection from competing stimuli, or disruption by disease or injury. Preston (2007): typically, within a few minutes or hours of a remembered experience, changes at **cellular/molecular level** occur. **New synapses** can form, enabling information exchange between new networks of neurons; alternatively, **existing synapses can be strengthened**, with increased

communication sensitivity between neurons. **Synthesis of new RNA and proteins consolidates** these new synaptic interconnections within the hippocampus. When a new memory is first formed, the hippocampus rapidly combines information processed by various neocortical regions (primary visual, auditory, etc.) into a single memory. Within days or even years, **systems-level** changes occur: cellular/molecular changes (**“long-term potentiation”**) strengthen direct neuronal connections among neocortical regions in which are distributed the elements of some event in your life. This enables us to access a memory independent of the hippocampus. Hence, damage to the hippocampus from injury or neurodegenerative disorder (e.g. Alzheimer’s dementia) may hamper the ability to form new declarative memories, while not impairing consolidated memories of previous facts and events.

All this involves transmission of countless nerve impulses via neurons, synapses and an array of neurotransmitter chemicals. **Learning produces changes in behaviour by modifying the strength of connections between nerve cells:** see, e.g. Nobel Prize-



winner Eric Kandell's *In Search of Memory* (2006). Neurophysiologist Francis Crick (James Watson's co-discover of the DNA double helix) said: "*You....your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behaviour of a vast assembly of nerve cells and their associated molecules.*" Within the brain there seems to be a physical basis for all our thoughts, aspirations, language, moral beliefs, sensation of consciousness and every mental faculty which makes us human. In short: ***the mind is what the brain does***; the mind is ***an emergent property*** of the ceaseless electrical and chemical activity within our brains' neuronal networks. An **alternative opinion** is philosopher/cognitive scientist Alva Noe's "**Out Of Our Heads**" (2009): "You are not your brain; rather, it is part of what you are": consciousness requires the joint operation of a larger system - **brain, body and world**. Noe: "Only one proposition about how the brain makes us conscious...has emerged unchallenged: we don't have a clue"; consciousness take place, not in the brain, it is **something we achieve**;

hence our inability to explain its neural basis (but see also Hauser, “A Mind Appendix”, p.54).

Our **memories** necessarily incorporate appetites, emotions – fears , rage , pleasures, love , aggression , and more -generated within the brain’s evolutionarily **ancient** structures...its **limbic system**. It is within the brain’s **recently-evolved** regions , including the **frontal and prefrontal ‘executive lobes’ of the large neocortex** , that we employ the recently-evolved facilities of syntactic language and abstract concept formation, to rationalize our emotions and the actions arising from them. The convoluted neocortex, about the size and thickness of a dinner plate, contains some 100 billion cells, each with 1000 to 10,000 synapses, with about 100 trillion interconnections and 90 million metres of neuronal “wiring”, arranged mainly in 6 cellular layers. Within these layers, different regions are responsible for vision, hearing, touch, the sense of balance, movement, emotional responses, and every feat of cognition, requiring about *1 million synaptic connections per second* to be made. Its frontal lobes (located

behind the forehead) have neuronal circuits which “tell the brain” what does or does not “feel right”, helping to create the **social brain** which melds emotions, cognition, error detection, volition, bodily sensations, and an autobiographical sense of self.

Many neuroscientists now consider that *the brain basically works by simulating reality*: sight, sound, touch and other sensory inputs (the “**instantaneous ghost in the machine**”) are put into the framework of what the brain anticipates on the basis of its previous experience and memory (the “**extended ghost**”). One example is “paraeidolia”, or “other mind” – the process whereby neuronal networks can “fire” without visual stimulation, superimposing images of things which aren’t there onto otherwise ordinary scenes, or filling in missing parts of things only partly seen. This enables the brain to complete the face of someone glimpsed in the dark, or to complete the shapes of animals formed by clouds or star constellations, or to sight apparitions unseen by others. How do our brains achieve all this?

Psychologist Steven Pinker says: “*brain cells fire in patterns*”, formed when “*neurons which fire together wire together*”.

**Neuroplasticity** refers to our **brain’s ability to re-organise** its internal structures and functions, e.g. during rehabilitation following trauma such as strokes or impact injuries, to compensate for damage to speech, motor function, cognitive processes, or other injury. *Self-directed neuroplasticity* enables those experiencing phobias, obsessive compulsive disorders (OCD), “panic attacks” or similar “brain locks”, to become “unstuck”. E.g., scanning technology has shown that a deep brain structure – the *caudate nucleus* – can “lock you” into an “error detection neuronal circuit” involving (say) the orbital frontal cortex; activity in the caudate nucleus and the error circuit decreases when you deliberately refocus your attention away from the false alarm which the brain is sending during a phobic or other episode. We can “rewire” our *plastic brains* throughout life, e.g. by learning a new language, or by moving from a childhood “cultural imprint” to a different society or way of thinking. Understanding brain plasticity mechanisms may yet help in reducing

intercultural suspicions and enmities. (See Barry Mernagh's précis for U3A; *The Brain That Changes Itself*, Doidge and Schwartz, 2009; Insel, 2010; Wexler, 2006).

Other consequences of neuroplasticity include our “**spectacularly unreliable and malleable**” memory (Dobbs, 2009): “*As research since 1980 has repeatedly shown.....we routinely add or subtract people, details, settings and actions to and from our memories*”, e.g. causing much over-diagnosis of PTSD-type syndromes; also, implantation of false memories (Loftus, 1997). Also, the “*plastic paradox*”: neuronal “rewiring” can produce flexible new thinking, *or* cultural and habitual rigidities.

**Neurogenesis in the adult brain** – the recently discovered daily genesis of thousands of new neurons from stem cells in the hippocampus, a structure involved in learning and memory – is reviewed by Tracey Shors (2009). Interneuronal connections can be made, from new neurons in its dentate gyrus to its CA1 cells. However, within a couple of weeks, most

newborn neurons die unless their owner's brain is challenged by **new learning; mental effort should delay cognitive decline** (“use it or lose it”). Exercise, antidepressants (and blueberries!) boost neurogenesis in adult rats; alcohol and nicotine reduce it.

James Shreeve (2005), reviewing the *great iceberg of the human mind*, quotes U.S. neuroimaging specialist Jay Giedd concerning the **prefrontal cortex, the last area of the brain to reach maturity**, the “executive brain” where we make social judgements, weigh alternatives, plan for the future, and control impulsively risky behaviour:

*“The executive brain doesn’t hit adult levels until the age of 25. At puberty you have adult passions, sex drive, energy, and emotion, but the reining in doesn’t happen until much later. We can vote at 18, and drive a car. But you can’t rent a car until you’re 25. In terms of brain anatomy, only the car-rental people have got it right.”*

**THE EVILS OF EVOLUTION : THE INFLUENCE OF OUR  
COSMIC AND BIOLOGICAL HERITAGE ON HUMAN  
AFFAIRS. A “DEMON-HAUNTED WORLD”?**

*“We have a universal set of human emotions that vary little between cultures and which drive us to universally exhibit egocentricity, tribal affiliation, susceptibility to charisma, nepotism, sensitivity to social pressures, altruism, excessive fear of threat, pair bonding and other deep-rooted tendencies that literature has identified as ‘human nature’ for thousands of years.”* (Playwright David Williamson, 2006).

*Why do the nations so furiously rage? And why do the people imagine a vain thing?* (G. F. Handel, *The Messiah*.)

An *Encyclopaedia Britannica* entry, “*Biology and ethics: the question of innate aggressiveness*”, compared the pro-innate views of Robert Ardrey (*African Genesis*, 1961), Konrad Lorenz (*On Aggression*, 1966), and William Golding (*Lord of the Flies*), with the anti-inborn thesis

of M.F. Ashley-Montagu (*Man and Aggression, 1968*), concluding that ***“The matter remains moot: but there appears to be a growing consensus that, given a certain genetic constitution.....whatever man is, he learns to be, especially in respect to values, morality and customs. Baser appetitive needs, however, may have a genetic component that is greater than an environmental one.”*** One balanced review of this dangerous debate (is man violent by nature?), summarising the evidence (and arguments!) from genetic, neurological, psychological, ethological, archaeological and anthropological perspectives, is John Kagan’s *A History of Warfare* (Hutchinson,1993), especially ***Why Do Men Fight?*** (pp.79-136). Opinions (Dalton, Freud, Einstein, Lorenz, Ardrey, Fox and Tiger, Boas, Benedict, Frazer, Mead, Malinowski, Levi-Strauss, Turney-High, the 1986 Seville Statement, and others) are compared, including “structural functionalism”, “cultural determinism”, the “hunting hypothesis”, kinship theories, territorial displacement, etc. One typical review of evidence from primate behavioural studies concludes that: ***“Of course, in evolutionary terms, xenophobia.....is certainly as old as the apes. Go back a million***



*years or so and one finds that xenophobia was the primordial attitude regulating the association of bands of violent prehumans, or low-browed protohumans, virtually everywhere you looked. Xenophobia is clearly a social problem.....it is clear that civil society cannot allow it to flourish unrestrained.....It is obviously an expression of the same unaccommodating instincts we share with countless other animals, including chimpanzees, and goes far back into the primate past.”* (Sandall, 2006, comparing xenophobia with “xenophilia”: 3,000 years of nostalgia for a non-existent “romantic primitivism”, Rousseau’s simpler “noble savage” pre-civilised communal “other” lifestyle.)

The term **“biological determinism”** can be used to misrepresent the view that Williamson’s “deep-rooted tendencies” of human behavior (quoted above) are influenced by our evolutionary history. However, there is no claim (at least, not in these notes) that we are “prisoners of our evolution”. Rather, the claim is that our large recently-evolved neocortex, with its linguistic facilities, has endowed us with an **ability**

**to rationalise behaviours which reflect evolutionarily ancient appetites or impulses** – rage, fear, envy, self-aggrandisement, aggression, for example - and to misconstrue their outcomes as the necessary consequences of some economic, social , religious or other cultural belief system or ideology. Of course, we also have the ability to see through such misrepresentations, and to reject them if we so choose . **“Biological influenceism”** would be a better descriptor than “determinism”. The “postmodernist” principle, that we are creatures of our immediate societies and their ideologies, has been dismissed both by evolutionary biologists and by humanist opponents of so-called “outcomes-based” teaching of English literature, which involves its “deconstruction” in terms of current Marxist, feminist, racial and similar perspectives. (For instance, playwright David Williamson, quoted above, is one who dismisses such thinking as “nonsense”).

It seems likely that one most unfortunate consequence of millions of years of selection for survival has been the **persistence of**

**aggressive behaviour patterns** , promoting undue competition for dominance within groups , and conflict between groups; see, e.g. Sandall (2006); Kagan (1993); Diamond (2013). Such primitive drives were adaptive -- or we wouldn't be here -- during the millions of years while our hominin ancestors were a prey species on Africa's savanna grasslands, or hunter-gathering nomadic tribes migrating out of Africa into Europe, Asia , Australia , and the Americas. Today, aggressive behaviours are **maladaptive**, threatening mass destruction . Human mental capacity for discovering how nature works , and for using this understanding to develop weapons for hunting and fighting, has accelerated the means of deadly conflict far in advance of the political means of controlling it. As physicist David Bohm saw it: *“stone-age minds...probably even more violent....with nuclear technology”.....minds still embedded in simpler dispersed tribal times, with irrational responses to charismatic leaders and power symbols, equipped not with spears and clubs but with modern mass-murdering weaponry (e.g. Mumbai, 2008; Peshawar, 2015; Paris, 2016).*

Another consequence of aggression, whether acquisitive, xenophobic, reactive or defensive, has been humankind's **pathologically cruel history**, evident when dominant "alpha" individuals and cliques use political power to "*stir the beast within Homo sapiens*", inciting otherwise civilised followers to inflict atrocities rationalised in the cause of this or that "ism". "*It wasn't easy*" to convert peaceable Germans into Nazism's mass-murderers (Hermann Goering, Nuremberg, 1945); whereas sociobiologists (e.g. John Docker, 2007) see an ancient *implacable dynamic* (an **evolutionary imperative**), too easily exploited by millennial inciters of inhuman genocidal depravity. For 100 of history's cruelest inciters, see Montifiore (2008); for recent psychopathy, Jaber (2006) in Iraq, or "Islamic State" Yasidi enslavement (2016) in Syria. Cummins (2006) cites *The Secret History of the Mongols* – a C13th sample of history's merciless killers - telling of a fearful general asking, "Who are these people who charge us like wolves pursuing sheep?" He is told: "*They are the four dogs of Temujin (Genghis Khan). They have foreheads of brass, their jaws are like scissors, their tongues like piercing awls, their heads are iron, their whipping tails swords...In the day of battle they devour*

*enemy flesh. Behold, they are now unleashed, and they slobber at the mouth with glee. These four **dogs of war** are Jebe, and Kublai, Jelme, and Subotai”... whose cavalry armies inflicted primal terror and genocidal “glorious slaughters” of millions of victims, through China, Asia to central Europe; ghastly mounds or carpets of horse and human skeletons marked cities which resisted and were destroyed by these “Tartars” (from Tartarus, or Hell). Towns enclosed by substantial stone walls to deter predatory “dogs of war” date back at least 9000 years, to Jericho.*

In discussing the recent discovery in northern Chad (Saharan Africa) of *Toumai* (“*hope of life*”), the 7 million years old skull of *Sahelanthropus tchadensis* dating from the divergence of the chimpanzee and hominin lineages , the “Age” editorial (13/07/02) compared this ancient find with “*other , more gruesome , bone discoveries that reflect more **the evils of evolution** than its positive side.....victims of the Stalinist purges in the basement of the Russian Supreme Court in Moscow.....the repulsive ossuaries of Pol Pot , or the mass graves in Hitler’s concentration camps*”. Indeed ,

humankind's history is replete with such **atrocities**, **ancient**, **mediaeval and modern**, with mass cruelties and terrors inflicted by Assyrian, Persian, Macedonian, Roman (the Roman Games!), Crusader, Mongolian, Ottoman, Nazi, Japanese, Soviet, Khmer Rouge, Rwandan, Serbian and Iraqi "dogs of war" representing but a sample of human inhumanity. **Retaliatory massacres** by nations attacked, e.g. WW2: London, Warsaw, Stalingrad, Pearl Harbor, "*who sows the wind, reaps the whirlwind*": Berlin, the Ruhr, Dresden, Tokyo, Hiroshima, Nagasaki, the bombing of Germany and Japan by the Britain/USA/ USSR alliance: these further augment history's list of horrors. Mass-destructive technologies are now accessible to power-corrupted tyrants, unaccountable to their dominated peoples through any electoral process, controlling at personal whim the resources of entire nations. This *primitive* need to exercise coercive domination (see, e.g. Horgan's report (2009): "The Evolution of Human Aggression: Lessons for Today's Conflicts") remains a **dangerous problem**: *primitive* dictators and terrorists have to be quarantined from nuclear, chemical and pathogenic weaponry.

The historically recent advance of **liberal democratic systems of government** seems to offer the most *adaptive* solution. In other words, liberal democracies, having some ability to place restraints upon aggressive and narcissistic “alpha individuals” who too often “claw their way” to the summits of humankind’s political hierarchies, make better evolutionary sense than despotism in its various forms. Our species, whose recorded history has been summarized by Francis Fukuyama as *“the human struggle to find the most sensible -- or least noxious – political system”*, has as yet come up with no system better able to promote life, liberty, the pursuit of happiness, and our increasing comprehension of ourselves and our cosmic origins. While other systems of government throughout the millennia have generated magnificent cultural achievements in architecture, the arts and sciences, philosophy, religions and literature, these have mainly advantaged small powerful “elites” at the wealthier levels of society, sustained by large substrates of peasants, slaves, and “lower orders” who were required to know their place, who did the essential work while denied reasonable access to its resultant benefits.

As described by Owen Harries during his Nov. 2003 Boyer Lectures , liberal democracy has two distinct aspects : *“democracy as a way of selecting the government by competitive election , and liberalism as a set of values and institutions , including the rule of law , an independent judiciary , an honest and impartial civil service , a strong respect for human rights and private property”*. Although far from utopian (for example, politically appointed judicial officials can impose judgements coloured by personal prejudice), yet such governments do impose some measure of accountability upon elected leaders who know that , in time , their foibles and deceptions are subject to Abraham Lincoln’s principle..... *“you can fool some of the people for some of the time but you can’t fool all the people all the time”* . Without the democratic safeguard, **absolute power can – and usually does -- corrupt absolutely .**



**GEOPOLITICAL QUESTIONS ARISING: ARE THERE EXISTENTIAL THREATS TO DEMOCRACY? DOES IT MATTER? CAN A “BIG HISTORY” COSMIC PERSPECTIVE HELP TO PROVIDE A SOLUTION?**

Fernandez-Armesto (1997) recounts the **large-scale spread of Atlantic democratic civilisation** based on liberal democracy, majority suffrage and citizen participation. It took off in the United States of the 1830's, despite contradictions such as promotion of equality while practising slavery, exclusion of women, and displacement of native populations by “manifest destiny” expansion. Alexis de Tocqueville was one European visitor who felt that he had “seen the future and found it to work”: societies with entrenched aristocratic privilege and limited political rights would follow suit, despite the risk that, in ignorance or civil strife, the people might elect a tyrant (e.g. A. Hitler, 1930's; Egypt's Islamic Brotherhood, 2012). **Lincoln's “government of the people by the people for the people”**...universal manhood suffrage... spread to Spain (1868), France (1871), Switzerland (1874), Britain (1884). Suffrage has since

included women as chauvinist male perceptions of their role in many societies (see, e.g. Conor, 2004) have been overcome. **Despite setbacks** since C<sup>20</sup>'s two world wars, democracy was established in southern, central and Eastern Europe during the 1970's to 1990's, by restoration or revolution. It has **so far survived severe strains** in India, Philippines, Peru, Colombia, Brazil, Chile, Argentina, South Africa, Japan, South Korea, Indonesia, with other Asian and African countries attempting (by 2018) to establish working democracies. Yet **secular or theocratic “quasi-fascisms”** still control North Korea, emergent superpower China, and some Islamic nations; is this resurgence (e.g. “Islamic State” in Libya, Syria) showing “the day of democracy” to be “a false dawn...a **brief historical spell** of wintry light”? Are prescient warnings by pro-democracy authors, e.g. Buruma (2006, 2008), Killebrew (2004), Kagan (2007), Carroll (2008), and many more since, being too readily discounted, ignored?

So : if we accept that liberal democratic governments are **better adapted** to provide the needs of human societies , including their

peoples' rights and freedoms, then questions arise. How to achieve **the end of despotisms** which have tended to **limit human progress** to favoured "upper-class" minorities, while overseeing human oppression, death and destruction throughout history? Can the "tides of history" remove Earth's despotic governments? **Nuclear non-proliferation treaties** seem ineffective, with a nuclear black market in cold war leftover "loose nukes", stolen weapon designs and components (e.g. the P2 gas centrifuge used to enrich uranium to weapons grade soon appeared in Libya and Iran, surprising the U.N. International Atomic Energy Agency: Traub, 2004). IAEA former head, Mohamed ElBaradei, regarded the risk of nuclear terrorism as "real, current and highly dangerous", with over 650 *known* unauthorised movements or possession of nuclear materials globally between 1993 and 2006 (Parkinson, 2005; Huisken, 2006). To date (2018), we have seen indiscriminate jihadist mass-murder – "*heart of darkness*": hijacked airliners smashed into buildings; pipe, pressure cooker, suicide vest, car/truck shrapnel bombs; airliner bombs in baggage, shoes, a fiance's handbag, even underpants(!); vehicle and AK47 machinegun attacks on pedestrian precincts, airports,

trains, buses, theatres, markets, schools, hotels, publishers' offices; hostages decapitated by hooded cutthroats. Security authorities, at vast national expense, try to counter such attacks , *and* the nightmare possibility of vapourisation of Western cities (Ash, 2004; “*God be praised*”, bin Laden, 2002) by *jihād blessed attacks* using nuclear *holy bombs* (hidden, e.g. in shipping containers: Cochran, 2008). With Iran’s **imminent access** to bomb-grade uranium (about 20% U235-enriched), and its UD3 (uranium deuteride) neutron initiator (Nelson, 2009; Hitchens, 2010), can client terrorists (e.g. Hamas) be quarantined?

Should the **liberal democracies unite** in support of Earth’s major economic and military power, itself a liberal democracy , in its efforts to contain tyrants and terrorists ? Or might **absolute pacifism** (“*the futility of war - wars never solve anything*”), based on economic aid, cross-cultural dialogue and a search for “root causes of conflict”, provide a realistic solution, despite **history’s dismal record** of failed attempts to appease aggressive autocrats? (Parkinson (2004), Bone (2004, 2007), Costello (2007), and many more up to 2019, warn of

the risks). Should we tolerate intolerant oligarchies and extremists, in the hope that we can avoid being devoured by *Churchill's crocodile* (the reptile from which we distance ourselves whilst it ingests its more proximate victims)? Can the *aspirations of ordinary people for basic freedoms and a decent life* (Barr, 2004) be harnessed while their lives remain at the whim of despotic rulers? Bone (2004, 2007) cites *Foreign Affairs*: “*The greatest potential danger to the international community is posed by rulers whose power over their own people and territory is so absolute that no matter how brutal, aggressive or irrational they become, no force within their society can stop them*”: there is a **responsibility to protect (“R2P”) captive peoples** (Gareth Evans, 2008) from subjugation and oppression, by force if diplomacy, sanctions, etc. haven’t worked. The **historic democratic dilemma is: “We don’t want war...nor do we want WMD-armed genocidal dictators or terrorists.”**

Many analysts (e.g. Mallaby, 2004) have proposed effective **intervention and nation-building** in chaotic states, to be legitimised by some “International Reconstruction Fund”, pooling global nation-building

expertise (including linguists), administered by a reformed Security Council where one or two recalcitrant nations could not veto attempts to help victims of local warlords. They note **four converging technological, demographic and ideological trends**: (1) catastrophic CBNR **weaponry proliferation** (chemical, biological, nuclear, radioactive); (2) media-driven (TV and internet) fanatical anti-Western **hatred**; (3) destabilizing **population explosion, poverty** and female **illiteracy**, especially acute in Afghanistan, Pakistan, Saudi Arabia, Yemen, Palestine; (4) **civil wars** in failed states (e.g. Iraq, Libya, Syria), fuelled by crime, kidnap ransoms, global communications. Conclusion: that these 4 factors have removed the former “luxury of choice”: whether to **leave alone** or to **take pre-emptive action** in totalitarian or chaotic states such as Iraq’s “Islamic caliphate”, Nigeria, or other sanctuaries for terrorists whose political and religious motives justify any atrocity (Beslan and Peshawar school massacres; Moscow, Mumbai, Nairobi, Brussels, Paris, even Sydney), to generate global publicity and fear.

The same question...whether to **appease or oppose**...is also raised by attacks such as the July 2005 mass-murder and maiming on the London underground rail system by “second generation terrorists”....young men born and educated in Britain. This event followed years of uncontrolled dissemination of anti-Western hatred by British Muslim clerics (still uncontrolled?). *“They’ll leave us alone if we leave them alone”*: a falsified appeasement theory, analogous with the 1930’s failure to stop a psychopath-led Nazi regime *before* it developed weapons of mass destruction (Wehrmacht, Luftwaffe, Kriegsmarine, and S.S.)? Similarly in Canada: the theory that al-Qa’ida citizen-bombers would not attack “distanced-from-USA pacifist countries” was negated by the conviction (Jan. 2010) of terrorists with 3 tonnes of ammonium nitrate (Allan, 2006) planning mass-murder in Montreal. This question also applies to conflicts in Iraq and Afghanistan: *“The consequences of what was done in **Iraq** are easy to see...the consequences of what might have been are by their nature unrecordable. But we know that history’s greatest tragedies could and should have been avoided.”* (Baker, 2006). Analysis by

Hitchens (2005), M. Costello (2007), Weisser (2007) of alternative outcomes if the Iraqi genocidal tyranny had been left to its own devices, concluded that its removal, despite ongoing attempts to destroy Iraq's elected government, was globally safer than a "do nothing" option. Others (e.g. Kelly, 2006) saw an "epic tragedy": the USA's "strategic blunder" upsetting a regional balance of power in favour of Iran's Shia regime, among "the most destabilising force in global politics", with policies including Holocaust denial, eradication of Israel, and uranium enrichment.

Analysts (eg. Sheridan, 2009) warned of yielding to attacks such as Paris (2015, Charlie Hebdo): *"If Islamic culture, and particularly that of radical Islamists who seek to impose Sharia law on Iraq and around the world, is honour-based, then Western culture, particularly its hard Left elements, focuses on guilt. A **strange and dangerous feedback loop thus develops between radical Islam and Western liberalism.** While one side demands concessions to protect its honour, the other apologises and gives in out of guilt over sins real or imagined...for example, the Danish cartoon controversy (2006), where*



*the heirs to the European Enlightenment let religious sensibility throw a blanket over the hard-won supremacy of secular free speech.*” (Editorial comment, *The Australian*, 09/05/2006). Also: “*We need...to reverse the culture of guilt and self-repudiation that has all but taken over sections of the media and university humanities departments*” (Burleigh, 2006), causing divisions within and between Western nations (Pearson, 2007).

So: can 2019’s **cosmic and biological “big history” perspective** of such political matters provide us with any guidance? On our *pale blue dot*, should we reconsider the convention of non-interference in the claimed “internal affairs” of states controlled by despots, or cultures which shelter advocates of indiscriminate mass-murder? Might the current U.S. administration find effective ways to control terrorist threats and economic dilemmas? If we agree that the survival of liberal democracies, the promotion of human rights and freedom of inquiry, and the consequent increase in understanding of who we are, are important in local, global, and possibly even cosmic contexts, then

perhaps that guidance is being offered. Concerning these highly contentious current political issues: **what are your priorities?** Does a “big history” approach warn us against Western internal ambivalence and moral relativism?

It also seems that another manifestation of a biologically ancient urge to dominate one’s group, is the exhibitionistic acquisition and **over-consumption of resources**, often evident among over-rewarded commercial, entertainment and hereditary aristocracies. If a remedy for socially provocative inequality and waste has become an environmental and social necessity for planet Earth, it may develop as an increasing **deterrence by ridicule** of immature self-indulgent self-promoting behaviour by *vacuous celebrities* (“*rich airheads*” – retarded pre-frontal lobe maturity?). Uncritical media adulation which encourages such behaviours makes neither evolutionary nor environmental nor social sense.

## “BIG HISTORY” AND US: SOCIAL AND CULTURAL DARWINISM?

*“Centuries of progress in **moral philosophy** seem irrelevant?.....why could the process of evolution not have produced a kinder, less rapacious, less murderous species ? Unfortunately, the answer is deeply rooted in the natural selection process – driven by amoral, ruthless competition.....which produced all species, including us.....the blind, uncaring, amoral processes of natural selection pit organisms against each other in a struggle for survival.....(this) could not be more manifest than in the history and prehistory of our own lineage.....(there seems) no credible alternative model for evolution other than by natural selection” (Irven De Vore, writing in Scientific American’s 2000 Millennial issue).*

*“Extraterrestrial intelligence ? Not likely.....**The hubris of our species**..... (is such that) we seem intent on destroying our planet for ephemeral creature comforts, while murdering each other on an increasingly relentless scale.....(exemplified by) the last*

*century in the blood – spattered history of our species .”* (Irven De Vore, 2000)

“..... *nature, red in tooth and claw*.....” (Tennyson).

“.....*survival of the fittest*.....” (Herbert Spencer)..

Such comments typify the bleak view of our evolutionary history which led to Herbert Spencer’s 19<sup>th</sup> century theory of **social Darwinism**. His interpretation of Darwin’s *On The Origin Of Species By Means of Natural Selection* and *The Descent of Man* led to the harsh view of Victorian Dickensian societies as struggles for existence, wherein “unfit” companies and individuals “got what they deserved”. The fittest survived and prospered, while measures to assist “the undeserving poor” were wasted, since the unfit were doomed to sink. For 100 years these hard-hearted opinions were (and still are?) widely held: that species, including ours, evolved solely by competition between individuals and groups. One major 19<sup>th</sup> century reaction was Marxism, still dominating some academic sociology departments, although application of collectivist economic

theories (Marxist theory producing Marxist actuality) grievously held back societies: “70 years to nowhere”, said an East German escapee after the Berlin Wall came down in 1989.

We now realize that this version of Darwinism is partial truth only: among primates, bats and other animals, behavioural studies reveal *competition and collaboration*. People certainly compete: they also collaborate, giving compassion and aid to the fallen. Social interaction is sometimes confrontational, even bloody, but is also cooperative or non-violently manipulative. Modern Darwinism has identified the central role of trust in human evolution: related people, sharing DNA, altruistically collaborate (it requires much provocation or greed to “do in” a relative). And the human mind has developed the ability to keep track of a large number of non-related persons and the favours or paybacks owed to them (the origin of our laws and virtues?). Modern social Darwinism has put a new spin on Spencer, seeing **individual competition**, whether in physical appearance, athletics, artistic, financial, or any other mode of

superiority, as a form of **genetic display**; demonstration of any superiority having some genetic component is almost unfailingly attractive to the opposite sex. Thus it seems that, for an economy to work, ***both competition and collaboration are necessary***, as postulated by Darwinian evolution (and ironically, also an echo of Hegel and Marx). Refer *anon, 2005: Trust me, I'm a social Darwinist*; and *Wilson, 2014: A good social Darwinism*).

So: can there be “...*on Earth, peace to men of good will*”? The new Darwinian reconciliation between competition and cooperation suggests an ***ongoing struggle***, not for existence, but ***between altruism and selfishness***, leading neither to utopia nor dystopia, but a balanced state between the two...a comforting possible outcome? If these neo-Darwinian (“post-modernist”) ideas are right, then the handfuls of animated stardust shaped into humankind by cosmic and biological evolution, may not stray too far from the balanced state needed for a society’s prosperity and progress.

Present inter-cultural enmities and rivalries seem to be a rationalized residue, or “**evolutionary burden**”, of the competitive aspects of our long biological heritage. When viewed in their biological context, humankind’s various cultures seem to be experiencing a **new type of evolution** which, although more rapid, does not fundamentally differ from that mediated by the ancient competition for survival of the fittest adaptations within and between non-human species. Warfare between cultural groups seems to be such a competition, using ever more ferocious technical means. With or without war, the “**fittest culture**” **survives**, sometimes “by the skin of its teeth”, as evidenced by the demise of fascist, nazi, bushido and soviet autocracies after 80 years of competition with the liberal democracies during the past century. The earliest known example of such intercultural competition may well be the apparent slow extinction of *Homo neanderthalensis* by modern *Homo sapiens* in Europe, completed about 25,000 years ago; for evidence of *H. sapiens*’ better-adapted culture (e.g. longer-range hunting weaponry), see Wright, 2005; Wong, 2009).

Within liberal democracies, according to many prescient analysts (e.g. Kronke (2004), competition and cultural polarisation (and ensuing political polarisation) between **rival sub-cultures** of the so-called “left” and “right” continue to worsen. These two exist in “*parallel mental universes*”, while sharing similar cultural rights, freedoms and life-styles. Both seem convinced that their world views are absolutely right, that the other side is egregiously misguided, and its opinions are not worth hearing. Kelly (2005) discussed a **major tension** between these two viewpoints: whether *top-down* **national responsibilities** should have primacy over *bottom-up* special **sectional interests and individual rights** within societies, or vice versa, or some beneficial combination thereof. He quoted Mancur Olson’s conclusion from *The Rise and Decline of Nations (1982)*: “*Special interests are harmful to economic growth, full employment, coherent government, equal opportunity and social mobility*”. At elections, the “fitter” internal sub-culture temporarily excludes the other from political supremacy, to an extent determined by the balance between rival political views within bodies such as Australia’s lower house,



senate and judiciary. This balance is determined by each nation's electoral and judicial appointment systems, and the extent to which these systems permit the will of a majority-elected party to be thwarted by minor parties or judicial officials in sympathy with minority views. Cumulative decisions and actions during periods of ascendancy then determine the "survival fitness" of the national liberal democratic culture relative to rival external cultures. Such ideas can provide a starting point for lively discussion, from both global and cosmic perspectives, of current contentious political issues: e.g, can liberal democracies **co-exist** with aggressive regimes or expansionist theocratic and secular totalitarian ideologies? How best can democracies achieve this?

Commentators, e.g Jose Ramos Horta (2004) have tried to bridge the divide by calmly questioning the **merits of both mind-sets** on complex issues such as a perceived "American hegemony", while avoiding partisan certainties. Even "left-liberal progressive" commentators are beginning to admit their lack of **logical coherence**

when consistently applying human rights principles to domestic issues but inconsistently to foreign policy, rationalising support for despots in, say, Iraq, while calling for their removal from, say, Darfur (western Sudan). For example, the “Euston Manifesto”...a statement of left principles by Britain’s Norman Geras, Nick Cohen and others...“*calls on the Left to support universal human rights, to abandon anti-American prejudice, to see all forms of totalitarianism as being essentially the same (“a tyrant is a tyrant is a tyrant”), to be willing to support military intervention against oppressive regimes if necessary, to promote democracy and women’s rights and free speech all over the world*” (Finkelstein, 2006). Cohen (*What’s Left? How liberals lost their way*, Fourth Estate, 2007) saw the remnant British Left as a tribe surviving by hatred of any who dared to disagree, befriending their perceived enemy’s enemies, supporting genocidal tyrants and factions which perpetrated atrocities including Serbian concentration camps, suicidal mass-murder in New York and London (the terror bombers were the real victims!), Iraqi mass graves and gas-bombing of

civilians (e.g. at Halabja), and the current (2019) strife. For such leftists, “*social justice stops at their shorelines*”? (Henninger, 2009).

**Cultural traditions**...humankind’s mental constructs and their physical manifestations...appear to augment a role formerly exercised by our species’ genes. A **gene** may be considered (simplistically) as a unit of heredity – a section of DNA with enough information encoded in its sequence of base-pairs for the assembly of a specific protein, e.g. an enzyme. The cultural equivalent is termed (by evolutionary biologists, e.g. Richard Dawkins) a “**meme**”, implying a “*unit of memory*”, such as a belief in a particular deity, or how to make and use a particular tool. Other memes constitute the set of ideas, habits, gestures, language skills (words, phrases, syntax), songs, stories, prejudices, trends, which accumulate from mind to mind, society to society, parents to children, via a process analogous to genetic DNA self-replication. So, complementary to genetics, we have the recent concept of “**memetics**”: a ***cultural transmission of sets of memes down the generations, and competition for survival of the “fittest***

**memes” when different cultures come into contact.** Evolutionary biologists regard this process as a new rapid kind of Darwinian **“memetic evolution”**, wherein “units of culture” (memes) can replicate, subject to “cultural natural selection” processes.

It seems that the competition for an ecosystem’s resources is frequently at its most exclusive between two species which have recently evolved from a common stock (an ecological concept known as **“Gause’s competitive exclusion principle.”**) Similarly, **violent enmities** can occur between cultures which have diverged from a common tradition: for example, Judaism and Islam (both “Children of Abraham/Ibrahim”) in the Middle East; India’s Hindus and Sikhs; Christians and Muslims in the Balkans; Christian denominations in Ireland. Such enmities, frequently arising from perceived inequalities in access to land or a society’s economic resources, are all too often **rationalised** by a tribal “group solidarity”, claiming religious and cultural certainties for its “in-group”, to the exclusion of all enemy “out-groups”.

We surely need to understand our biological origins, whether or not these concur with current political rectitude and social theories. For example, America, Europe and Australia are trying to form pluralistic **“multicultural” societies** based on coexistence of surging immigrant arrivals. If their cultures have different competing basic values, are we at risk of promoting biologically *primitive* non-adaptive anti-collaborative rivalries, disproportionately focusing on individual and minority rights, excusing personal irresponsible anti-social activities, and generating inter-tribal (inter-cultural) conflict?

The **basic values** (*organisational memes*) of **Western civilisations** include concepts of good and evil behaviour, respect for human life and individual rights, responsibility to maintain stable societies which endow us with those rights, equality of the sexes, education based on freedom of inquiry, tolerance and promotion of non-harmful behaviours, separation of church and state, freedom to express non-defamatory opinion and to elect leaders, access to adequate food and shelter; also, face-to-face contact, relied on in

courts, workplaces, all public precincts, for an estimated 50-90% non-verbal communication of trust, honesty, and emotions (Lichter, 2014). Unless we promote these values in children of all cultures, are we promoting ancient **competitive tribalisms**, inter-cultural conflict, **loss of “social capital”**? (Delsemne, 2000; Wood, 2007; and many since.)

**Current (2019) social experiments in multiculturalism and globalisation** have clearly generated **rival cultures** based on perceived grievances, rights and victimhood, encouraged by opportunistic power-seekers; further development of this tribalisation would not be a good prospect for us (see, e.g. Cohen, 2009), for any other nations based on Western values (above), or for international global cooperation. One sociological perspective of such issues, and their relevance to “anti-globalisation” movements, is McDonald’s *Global Movements: Action and Culture* (2006): ch.8 *Global Islam: Modernity’s Other?* and ch.9 *Islamic Makings of the Self*. Bardhan (2006), also reviewing effects of globalisation, concludes that it both helps and hurts the world’s poor: the real question is how to maximise the help while minimising the

hurt. He is among many economists who consider that expanding international trade and investment cannot help to alleviate poverty until developing nations get their **economic basics right**, by improving their infrastructure, political stability, land reform, social safety nets, and access to credit assistance and the global market. A tall order, requiring governance by elected, accountable leaders rather than secular or theocratic tyrannies?

To conclude this section on a more optimistic note, we need only realize that humankind now has a huge history of accumulation of **adaptive collaborative memes** since the birth of *Homo sapiens* cultures, probably more than 100,000 years ago. For instance, the centuries-old “eyeglass meme” has greatly improved the lives of the short-sighted, and the 80-years-old “insulin meme” has made life and reproduction possible for juvenile diabetics. Memetic evolution is **far more rapid** than genetic evolution, accelerated by the modern **Internet**.....an ideal copying apparatus for memes. If ideas have become the main “engine of change”, then our future human

evolution depends on selection of ideas favouring a stable functioning society, rather than divisive tribalisms? What do you think of the above concepts?

We need to encourage the rapid diffusion (“reproduction”) of adaptive *collaborative* memes.....those which foster **local and global cooperation** in solving problems.....while discouraging the reproduction of non-adaptive memes which generate enmity and strife. With catastrophic weapons technology (the ultimate non-adaptive memes) now becoming widely available, the sooner the better, if we are to heed **Albert Einstein’s warnings**: *“The splitting of the atom has changed everything, save man’s way of thinking, and thus we drift towards unparalleled catastrophe”*. And: *“There are only two infinities – the Universe and human stupidity. And I’m not too sure about the Universe.”*

**COSMOLOGY AND THEOLOGY: A POSSIBLE PURPOSE FOR HUMANKIND ?**



*“What is it that breathes the fire into the equations , and (gives them) a universe to work on ?”* (cosmologist Stephen Hawking). Has our universe been ***pregnant with mind*** since its instant of origin, 13.8 billion years ago?

*“The stage on which mankind struts his brief flickering moment is today set in a vast , ancient cosmos without a centre . Is it only sound and fury , or are there profounder questions to be gauged ? These are timeless questions , as meaningful today as in classical Athens . **Is the universe designed ? Is it made for mind ? Are we alone ?** Theist, atheist , existentialist alike can ponder them . **Perhaps the pondering of these questions IS the purpose of the universe?**.....From a theistic perspective , God is the Creator in the much larger sense of designer and intender of the universe , the powerful creator with a plan and an intention for the existence of the entire cosmos.....God is more than the omnipotence who , in some other spacetime dimension , decides when to push the mighty*

*ON switch .*” (Astronomer Owen Gingerich; see also Appendices “Heavens Above”, and “A Christian Perspective”).

The “nature-explaining” cosmologies of many cultures have relied on **super-natural beings** and an **afterlife**: Egypt’s Atum and all-seeing Eye, ancient China’s Phan-Kou-Che, the Hebrew Seven Days of Creation, Aztec’s Tezcatlipoca and Quetzalcoatl, Hindu Prajapati, Aboriginal Australia’s dreamtime ancestors, the Greek/Roman pantheon, and many more. “*The idea that launched a thousand civilizations: without religion we would still be living in the Stone Age*”, avers Norenzayan (2014). “Deist” physicists (e.g. Einstein) propose a “*grounded being, mathematician, external to spacetime*”, who “*breathes the fire into the equations and gives them a universe to work on*”; the **laws of nature could** be a manifestation of a “someone extra”? “Theists” may prefer evolving concepts, e.g. a personal God awaiting our arrival at some stage in our long evolution where we might conduct our affairs with a greater degree of maturity, akin to the patient Biblical father of the prodigal son, rather than an omniscient omnipotent non-interfering

Creator. “Atheists” reject any such notions: nothing exists inaccessible to our senses and instruments. “Agnostics” prefer to hold their options open.

13,800 million years of cosmic evolution, 4,000 million years of biological evolution and a few 10,000 years of cultural competition, have brought forth modern *Homo sapiens*, and the realization that each of us is a part of a **great truth-seeking continuum**. Many of us - scientists, philosophers, theologians, serious thinkers - actively extend this search for meaning. And **we all participate** in an unfolding human comprehension of the cosmos and our place within it, by helping to maintain the stable societies and institutions which alone make possible that search for meaning and purpose. After all, as pointed out by mathematician Gregory Chaitin: if everyone wanted to do history, philosophy, great art and deep science, no crops would be grown, the plumbing, electricity, water supplies and transport wouldn't work, buildings would fall down...catastrophe awaits. The world won't work without maintenance.

“Those who would dance on **religion’s grave** underestimate its staying power” (McCauley, 2014): humankind continues to search for meaning, for purpose, for *cosmos emerging from chaos*. Contributions from scientific, religious and philosophical cosmologies deserve consideration with due respect and without competitive rancour. Theologians such as Uniting Church’s John Williams (2004) increasingly recognize a **convergence between science and religion**: “*Engage in a thought experiment with me. Trace your genealogy...factor in the millions of years of evolutionary development that preceded the emergence of humanity. And keep going back, back to the so-called “Big Bang”. Or merely go back to the appearance of stars within which such elements as iron.... part of your make-up.... came into being. You are a child of stardust. Surely cause for awe and wonder and thankfulness. Of that...wonderful awe and thankfulness and humility, religion is born.*” Ayala (2009) surveyed “**science-savvy Christian theologians**” whose personal God, while continuously engaged in creation through cosmic laws and undirected Darwinian natural selection, does not intervene in the “*ruthlessness of nature*”; this concept

removes God from “evil” (which requires intentional acts of human free will) and suffering due to disease, earthquakes, tsunamis, fire, flood, storm and tempest, and other natural causes. (See also Armstrong, 2009, and “A Cosmology/Theology Appendix: The Two Books, Scripture and Nature”). Are we witnessing an emerging, *unifying* theology, able to repair millennia of inter-cultural rivalry and distrust? Or, are Western states, “having climbed the ladder of religion” to security and prosperity, now “kicking the ladder away”: “we don’t need a God any more”?

Perhaps **our comprehension is limited by our reliance on our senses (visual, auditory, tactile, etc.)**. It has been said that, while we may comprehend a purpose for, say, a car or a can-opener, a purpose for the Universe is beyond our limits. Perhaps, as expressed by American physicist John Wheeler: *as the island of our knowledge expands, so also expand the shores of our ignorance*. Or we may agree with the author of the Hindu *Rig Veda*:

*“Who knows for certain? Who shall here declare it?  
Whence was it born? Whence came creation?”*

*The gods are later than this world's formation.  
Who then can know the origins of the world?"*

Yet there is consolation in the perception that **life is no pointless rush** from birth to the dark portal; rather, that we are all part of an ongoing noble quest for understanding, a quest to be passed on down the generations. Do we exist as rare, complex, self-aware forms of matter, capable of "spreading the light of reason across the cosmos"? Here, for your enjoyment, are sample *belles lettres* of the thoughts and queries of a few notable scientists, poets, philosophers, authors, commencing with physicist Richard Feynman's ***Holistic Perspective***:

*"A poet once said 'The whole universe is in a glass of wine'. We will probably never know in what sense he meant that, for poets do not write to be understood. But it is true that if we look at a glass closely enough we see the entire universe. There are the things of physics: the twisting liquid which evaporates depending on the wind and weather, the reflections in the glass, and our imagination adds*

*the atoms. The glass is a distillation of the Earth's rocks, and in its composition we see the secret of the universe's age, and the evolution of the stars. What strange array of chemicals are there in the wine? How did they come to be? There are the ferments, the enzymes, the substrates, and the products. There in wine is found the great generalization: all life is fermentation. Nobody can discover the chemistry of wine without discovering, as Louis Pasteur did, the cause of much disease. How vivid is the claret, pressing its existence into the consciousness that watches it! If our small minds, for some convenience, divide this glass of wine, this universe, into parts – physics, biology, geology, astronomy, psychology, and so on – remember that Nature does not know it! So let us put it all back together, not forgetting ultimately what it is for. Let it give us one final pleasure: drink it and forget it all!"* **(Richard Feynman; is this the ultimate "cosmic toast"?)**

*"Prais'd be the fathomless universe....."* **(Walt Whitman)**

*“Not **how** the world is, is the mystical, but **that** it is”.* (**Ludwig Wittgenstein**). In other words: how *and why* is there anything rather than nothing ? The Higgs field and its boson (the “God particle”) endow matter with mass (Krauss, 2012).

*“I want to know God’s thoughts . All the rest is detail” . Or : “What I’m really interested in is whether God could have made the world in a different way, that is , whether the necessity of logical simplicity leaves any freedom at all” . Or : “ I want to know : did God have a choice?”* (**Albert Einstein**; see also pp. 31, 35).

*“What we don’t know , would make a very good book” .* (**Sydney Smith**, some 150 years ago; equally true today).

*“The unintelligible in pursuit of the indeterminable?”* (A **physicist’s comment** on “brane” theory, the recent extension of a superstring “theory of everything”: particles treated as vibration modes of high-dimension energy strings or membranes).



*“To see a world in a grain of sand, and heaven in a wild flower.  
Hold Infinity in the palm of your hand, and Eternity in an hour”*  
(**William Blake**). Blake also famously captured humankind’s ongoing search for meaning: *“Bring me my bow of burning gold; bring me my arrows of desire. Bring me my spear, O clouds unfold; bring me my chariot of fire. I shall not cease from mental fight, nor shall my sword sleep in my hand...”* (especially, for astronomers: *“O clouds unfold”*).

*“I do not know how I may appear to the world, but to myself I seem to have been only like a boy, playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me”*. (**Isaac Newton’s** poignant assessment of his discoveries in optics, the calculus, the laws of motion and the inverse-square law of gravity).

*“Nature and Nature’s laws lay hid in night;*

*God said, "Let Newton be", and all was light".*  
**(Alexander Pope).**

*"Stars scribble on our eyes the frosty saga, the gleaming cantos of unvanquished space"* **(Hart Crane).**

Twinkle, twinkle, little star: *"Scintillate, scintillate, globule coelific. How oft do I ponder your nature specific. Suspended on high in the firmament spacious, strongly resembling the gem carbonaceous."* (Anon...anyone know the author? Try singing it with the older grandkids?) For the younger ones, there's a cosmic lullaby:

*"Sleep then, my princess, O sleep. Slowly the grey shadows creep.*

*Forest and meadow are still. Night falls on valley and hill.  
 Luna appears in the sky, holding her lantern on high.*

*Stars now their night watches keep. Sleep then, my princess, O sleep. Good night....."*

*“We human beings.....we are but reeds, so insubstantial on the grand scale of the cosmos, but we are thinking reeds, and so greater than all the stars, for we know them and ourselves, and they know nothing”.* **(Blaise Pascal).**

*“If the stars should appear one night in a thousand years, how would we believe and adore, and preserve for many generations the remembrance of the city of God which had been shown. But every night appear these envoys of beauty, and light the universe with their admonishing smile”.* **(Ralph Waldo Emerson).**

*“Look at the stars! Look, look up at the skies!  
O look at all the fire-folk sitting in the air.  
The bright boroughs, the circle-citadels there!”*

**(Gerard Manly Hopkins).**

*“The sea is calm tonight, the tide is full,  
the moon lies fair upon the straits.....”*

....(yet) we are here as on a darkling plain  
 swept with confused alarums of struggle and  
 flight,  
 where ignorant armies clash by night.”  
 (Matthew Arnold’s famous poem: *Dover Beach*).

“I had a dream, which was not all a dream. The bright sun was extinguished, and the stars did wander darkling in the eternal space, rayless and pathless; and the icy Earth swung blind and blackening in the moonless air; morn came, and went – and came, and brought no day, and men forgot their passions in the dread of their desolation”. (From **Byron’s** “Darkness”: eerily prescient of the global nuclear winter threat during the 1949-89 bipolar super-power “cold war”; and still possible should “local” nuclear conflict erupt (eg. India/Pakistan, or Israel/Iran): *Sci. Am.* April 2010).

“The fleeting fraction of eternity during which the Universe will have known life, and heat, and order, will be infinitesimally,

*insignificantly minute.....our lives are less than atomic flickers on the scale of the cosmos, but they would be equally infinitesimal if they lasted ten million times longer, and they would still be infinitely precious to us. We have the chance to enjoy some morsel of the 100 trillion years that the sun and the stars will last. We should".* (Editorial, **Scientific American**, Nov. 1999).

*"If one had to answer the question , what's been happening since the Big Bang , in just one sentence , the best response might be to take a deep breath and say : Ever since the beginning , gravity has been amplifying inhomogeneities , and enhancing temperature contrasts – a prerequisite for the emergence of the complexity that lies around us now , and of which we are a part".* (**Martin Rees**, Astronomer Royal).

*"Scientists have this stupendous story of the Universe – tell it , not only quantitatively , tell it with a feel for its music" .* (**Brian**

**Swimme**). Would you agree that the following two fragments poetically achieve this?

*In the beginning was the fire; out of the death of fire, rock and the waters;*

*and out of water and rock the single spark.....Far, far below, the millions of rock-years divide*

*to make a place for those who were born and died.....And walking here among the dying centuries –*

*the centuries of moss, of fern, of cycad, of the towering tree – the centuries of the flower –*

*I pause where water falls from the face of the rock. My father rock, do you forget the kingdom of the fire?*

*The aeons grind you into bread – into the soil that feeds the living and transforms the dead... (Judith Wright).*

*“There rolls the deep where grew the tree.*

*O Earth, what changes thou has seen.  
There, where the long street roars, has  
been*

*the stillness of the central sea.  
The hills are shadows, and they flow  
from form to form, and nothing stands.  
They melt like mists, the solid lands.*

*Like clouds they shape themselves,  
and go.* (**Alfred Lord Tennyson**, following geologists James Hutton and Charles Lyell's "noble concept of former worlds": e.g., as revealed at Siccar Point in Scotland: an Old Red Sandstone eroded land surface unconformably overlain by younger Palaeozoic sedimentary strata).

*"With increasing distance our knowledge fades and fades rapidly .  
Eventually we reach the dim boundary , the utmost limits of our  
telescopes. There we measure shadows , and we search among ghostly  
errors of measurement for landmarks that are scarcely more*

*substantial . The search will continue . Not until the empirical resources are exhausted need we pass on to the dreamy realms of speculation .”* (**Edwin Hubble**, following his studies of galactic spectral red-shifts and his discovery of *Hubble’s Law* of cosmic expansion).

*“...this most excellent canopy...this brave o’erhanging firmament, this majestic roof fretted with golden fire....”* **William Shakespeare**, *Hamlet*).

*“Some say the world will end in fire ,  
some say in ice .*

*From what I have tasted of desire , I hold with those who favor fire*

*But if it had to perish twice , and if I know enough of hate  
to say that , for destruction , ice  
is also great, and would suffice” .* (**Robert Frost**).



*“My suspicion is that the universe is not only queerer than we suppose , but queerer than we **can** suppose” . (Biologist **J. B. S. Haldane**).*

*“If it can be , it is.” (Physicist **John Wheeler** , speaking of black holes , neutron stars , and anything not yet known to be prohibited by the laws of physics: e.g. cosmic strings? naked singularities? higher dimensional strings or branes?).*

*“These are just a few of the things which hydrogen atoms do, given fourteen billion years of evolution”. (Carl **Sagan** , speaking of galaxies , stars , planets , also life , great art , fine music and literature , and deep science ).*

*“What does it mean? What is Man.....? I cannot believe that our existence in this universe is a mere quirk of fate, an accident of history, an incidental blip in the great cosmic drama. Our involvement is too intimate. The physical species Homo may count*

*for nothing, but the **existence of mind in some organism on some planet is surely a fact of fundamental significance.** Through conscious beings the universe has generated self-awareness. This can be no trivial detail, no minor byproduct of mindless, purposeless forces. We are truly meant to be here".* (Physicist **Paul Davies'** conclusion in his award-winning book *The Mind of God* , 1992).

*"Why did it take 60 per cent of the age of the universe for life to begin? How did we humans come to be in this evolving universe?.....It would be scientifically absurd to deny that the human brain is a result of a process of chemical complexification in an evolving universe.....Did all this happen by **chance or necessity** in this evolving universe?.....**It is both.** Furthermore, there is a third element here.....what I call "**fertility**".....the universe is so prolific in offering the opportunity for the success of both chance and necessary processes...(that) **it is the combination of chance and necessary processes in a fertile universe** that best explains the universe as seen by science.....Evolution, as many hold, is not*

*simply a random blind process. It has a direction and an intrinsic destiny*". ( Astronomer **George Coyne**, Director, Vatican Observatory; see also "A Cosmology / Theology Appendix").

Some physicists, biologists and theologians are now reaching agreement that the natural laws and physical constants of the universe are somehow "*precisely tuned*" to permit the emergence of mind and consciousness (a concept known as the ***anthropic principle***); also, that reductionist analysis of its component parts has its limits, that we exist in a "***synergistic***" universe whose holistic sum is greater than the sum of its parts; and that our universe from its beginning has been "***pregnant with mind***", although probably not specifically with *Homo sapiens*. There could be many life-experiments scattered throughout our observable universe; carbon-based life could have emerged 5, 6, 7 billion years ago, making it statistically highly probable that older, wiser life-forms exist, intellectually superior to *Homo sapiens*. (For further discussion, see following section: "Are we alone in the universe").

If so, what of the bleak (although distant) prospect that the universe will expand forever, with the galaxies receding, their stars burning out to a remnant set of embers, ending in a **lifeless, dead universe**? Or that Earth is destined to be destroyed by the life-giving Sun's expansion to a red giant star, before it fades and dies? According to theologians such as George Coyne SJ (quoted above), our universe may well evolve to a cold, cold death-state, but in us something else, something extra, has happened, something which *transcends* its physical/ chemical/ biological processes: the universe has been the cradle for the emergence of **both life and indestructible spirit**? Christians then consider that the physical universe, our physical bodies and lives, are of such importance that the Deity, external to the physical universe, space and time, was *incarnated* into it. We can then usefully spend our brief physical existences in attempting to extend our understanding of this. Other theologies, while doubting this incarnation, agree that faith in a "God" (*an "immanent grounded being"*) outside the known physical universe, who always has been

and always will be, is **not an arational belief**: i.e. there is no conflict with anything known to science. (Other aspects of this discussion emerge within the following sections).

The **search for a fuller understanding** will continue, provided that Kenneth Clark's "*intelligent, creative, orderly, compassionate*" aspect of human nature can prevail. He warned, however, of history's record of societies which have succumbed to "*fear of war, invasion, plague, making it not worthwhile constructing things or planting trees or even next year's crops. And fear of the supernatural, which means that you dare not question anything or change anything.....the late Graeco-Roman world was full of meaningless rituals, mystery religions which destroyed self-confidence. And then – boredom – the feeling of hopelessness which can overtake people with a high degree of material prosperity.*" Thirty years later, his words still resonate. (If you have any favourite cosmic quotes, I would be pleased to add them to this section).

## AN AFTERLIFE FOR THE INDIVIDUAL MIND? MIND-BRAIN DUALISM?

**A tricky topic, indeed.** One entry point is the pessimistic opinion of 12th century poet Omar Khayyam, in his *Rubaiyat* :

*“One moment in annihilation’s  
waste .*

*One moment at the well of life to  
taste.”*

Can science provide any input to humankind’s ancient hope that there exists some “ghost in the machine”, a soul , a spirit, which might enable us to somehow meet in an afterlife ? Is there evidence, other than anecdotal, to support some kind of **Cartesian “mind-brain dualism” (the mind “non-local” to the brain)?** Do “I think , therefore I am” (Descarte’s *cogito, ergo sum*)? Or, has evolution endowed us with a brain of such power that “I am , therefore I think”?

Here, science can only point to a deficiency of reproducible data, while noting that *absence of evidence need not constitute evidence of absence*. As one physicist has expressed it: death appears to constitute an ***impenetrable information barrier*** to whatever may lie beyond. In such matters, our knowledge is based on personal faith or mystical mental experiences, inaccessible to scientific enquiry. Quantum cosmology's putative universal wave function can, it seems, promise no "afterlife" in higher dimensions of space-time. Science can only adduce a few hard-to-explain reports ("***extraordinary claims require extraordinary proof***") of "**out-of-body**" (OBE) experiences, e.g. the Tart case (a woman *claimed* to report an inaccessible five-figure random number viewed during an OBE, while asleep); also, "**near-death experiences**" (NDE's) where resuscitated persons report seemingly unknown events (e.g. Maria's tennis shoe on a high windowsill, or Pam Reynold's neurosurgery), *apparently* seen, usually from above, while deeply comatose. Was Arthur Eddington right: "*The stuff of the world is mindstuff*"? Could the mind be "non-local to the brain"?

About 1 in 10 patients who recover from cardiac arrest report an NDE (see, for example, Raymond Moody's 1975 book *Life After Life*). Witchalls and Hamer (2004) reported that neuropsychiatrists Peter Fenwick and Sam Parnia commenced a large-scale study of **“veridical perception”** (OBE's) in British hospitals, in which cardiac patients were asked to report hidden targets (visible only from above), while “floating out of the body”: no positive results to date (2018). Such patients, who also tend to report being “pulled back” from a journey through a tunnel towards light, while experiencing joy, peace, whole-of-life reviews, perhaps meeting deceased relatives or friends or a supernatural being, have been “clinically dead” (e.g. no pulse, no pupillary response to strong light), but not “brain dead”, from which there is no return. Some EEG studies have shown that during cardiac arrest and advanced cardiac life support, global brain function ceases at least 10 seconds prior to the heart stopping, and there is no cortical electrical brain activity for up to two hours after the heart has been re-started. Says Parnia: “if it can be proven that this period of consciousness (i.e. the NDE) has indeed taken place



during cardiac arrest, it will have huge (seismic) implications” for 200 years of secular materialism. Fenwick (2002) asked how information is processed by the **non-functioning brain** during monitored “flat-line shutdown operations”, when the memory circuits are not working. Is information somehow retained outside the brain, to be later fixed in memory when consciousness is restored? Or does it somehow occur within the unconscious brain, and enter the memory? Or is there some other possibility?

Are **NDE experiences** transcendental, psychological (“autoscopy hallucinations” soothing our path to oblivion), or physiological? British psychologist **Dr. Susan Blackmore**, having experienced an NDE and studied 1500, thinks that the “light at the end of the tunnel” is “noise” in the visual cortex (i.e. neurons randomly firing), similar to that experienced by epileptics, migraine sufferers and those in deep meditation. It has also been suggested that it stems from re-living the patient’s own birth experience. An **out-of-body (OBE) experience** resembles a “bird’s-eye” perspective of yourself when you recall, say,

walking along a beach. As the last sense to be lost is hearing, unconscious cardiac arrest patients who report monitoring apparatus may have heard medical staff conversing. “Life reviews” are also reported by patients suffering from temporal lobe epilepsy, and have been artificially induced in subjects by temporal lobe stimulation. The “feel-good” factor could be due to release of endogenous endorphins into the brain during cardiac trauma. So, was Tom Wolfe right, years ago: “*Your soul just died*”, due to advances in neuroscience?

On the other hand, many who have experienced NDE’s are convinced of their **transcendental** nature. These include psychiatrist **Elisabeth Kubler-Ross** (dec. 24 Aug, 2004, after prolonged illness). When interviewed (Duval, 1996) on her landmark work on death and dying, she related her “more than once” experiences of the “other side”: *“It was fabulous (the near-death experience).....dying is no pain, no anxiety; it’s all peace.....When you see the light on the other side, it is incredibly beautiful....it’s just peace and love.....More and more people know that death is nothing to be*

*feared, but something beautiful.....My husband was so skeptical....before he died, he promised to give me a signal so I could know....if what I had been teaching was true. He did give me the signal....he was healthy again; he didn't have problems anymore..... One night, when everything is quiet, I will go....then it's like a butterfly coming out of a cocoon.....and then I will go dancing in all the galaxies....and meet all the people I have loved and who are on the other side....there are thousands of them. There is a god, but it is not a Christian or a Muslim one. There is one god for all mankind.....He created this incredible existence after death.”*

**So: can the mind have an existence separate from the brain?**

Can there be proof of afterlife? Can the “personalised aspect” of our brain – the sense of self, the set of personal experiences and memories which each of us stores in our neuronal circuits during life’s journey – can this survive the death and decomposition of the material brain? We may never know, while on our side of death’s

*impenetrable information barrier*. From a cosmic perspective, if one “purpose” for the existence of the vast and ancient cosmos is to bring forth mind capable of comprehending itself and its cosmic environment, then we would indeed value the opportunity to continue to share, beyond Earthly death, in humankind’s unfolding comprehension of who we are. Science, however, is not about what we would wish to believe (*“anecdotes do not a science make”*); it is about what can be supported by testable evidence, subject always to imperfections in observations and measurements, errors in misconstruing our best experimental data, and Hamlet’s stricture: *“There are more things in heaven and on earth, Horatio, than are dreamt of in your philosophy”*. For an entertaining overview of various attempts to measure an afterlife, see Roach (2006). Biologist **J.B.S. Haldane** has echoed the hopes of many in his essay “When I Am Dead”:

*“If death can be the end of me as a finite individual mind, it does not mean it will be the end of me altogether. It seems to me*

*immensely unlikely that mind is a mere by-product of matter.....It seems to me quite probable that (my mind) will lose its limitations and be merged with an infinite mind.....which I suspect probably exists behind nature.....When I think logically and scientifically and act morally, my thoughts and actions cease to be characteristic of myself and are those of any intelligent or moral being in the same position; in fact I am already identifying my mind with an absolute or unconditional mind.”*

**Could Haldane be right?** Has the soul returned, as a *quantum soul*? Stuart Hameroff (Tucson University Director of Consciousness Studies) studies **anaesthetized patients** who, while unconscious, experience no pain, awareness, memory, nor dreaming (unlike sleeping). Remaining brain electrical activity directs breathing and heartbeat (“like a motor idling”). He considers the microtubular cytoskeleton of neurons to be their “intracellular nervous systems”, processing information internally to organize cellular activities and interactions within the brain. Microtubules act as

“quantum computers”, with **superposition of information** in spacetime geometry (analogous to quantum wave functions). Such “information precursors” give rise to consciousness: the spacetime fabric of the universe is then connected to the brain by quantum processes in neuronal microtubules. While unconscious, “microtubular quantum coherence” ceases; information “leaks out” into spacetime, does not dissipate, being retained by quantum entanglement processes. **Consciousness** exists at least temporarily **outside the brain** during NDE’s, even in an “afterlife”? (Gale, 2012). Appleyard (2009) reviews investigations by Parnia and others. EEG palliative monitoring of dying patients (Leake, 2010) detects a spreading cascade of electrical brain activity lasting up to 3 minutes as oxygen levels fall: the cause of vivid NDE mental sensations? Most neuroscientists think conscious mind can be explained without **quantum-level** concepts. Shannon, Landauer and Bennett have shown that *ordered information stored in the brain (in memory) is physical*; the Second Law of Thermodynamics requires its return to the environment, post-mortem, as “information entropy”, but in a

disordered form, to balance the entropy reduction achieved during our lives (Vedral, 2014): is this Haldane’s “unconditional mind”?

We may conclude this discussion with a quote from **Thomas Hardy’s** poem “Afterwards”: *“If, when hearing that I have been stilled at last, they stand at the door, watching the full-starred heavens that winter sees; will this thought rise in those who will meet my face no more: he was one who had an eye for such mysteries”.*

Or **Dylan Thomas**: *“Do not go gentle into that good night, old age should burn and rave at close of day. Rage, rage against the dying of the light.”* Or the Diamond Valley pioneer settlers’ wife, worn down with her life of ceaseless domestic toil: *“Backward, turn backward, O time in your flight. Make me a child again, just for tonight.”*

And perhaps the **WW1 song**: *“Till we meet once again, you and I, wish me luck as you wave me goodbye*

**THE UNCERTAINTY PRINCIPLE :**  
**WHAT IS TRUTH?**

*“Certainty about progress, embodied in the history of western civilization; certainty about the verifiability of assumed truths, informing traditional western values, laws, social structures and moral precepts; certainty about the superiority of some ways of life, some uses and perceptions of the world over others.....We are now uncertain about everything: about science, religion, morality, philosophy, politics and economics. We doubt whether we can tell truth from falsehood in any field, or even whether such a distinction.... could be meaningfully expressed. Faith in science, logic and mathematics as a means of telling the truth has in some ways been more thoroughly undermined than faith in religious texts or churches.”* (Felipe Fernandez-Armesto, in a chapter, *Graveyards of Certainty*(1997), discussing the history of twentieth century Western thought).

Science can provide **no absolute certainty** in metaphysical– or any other – issues. Always there awaits the umpire – Mother Nature –



servicing up new observations which can require modification, or even discarding, of our best-founded concepts: “*We have this wonderful mathematically elegant theory....but has Nature heard of it ?*”. And therein may lie humankind’s greatest chance to attain **workable solutions for our global problems**: if we could be a little less certain of our cherished social and cultural theories, show a little more respect for the opinions of others, eschew the use in political discourse of polarising misrepresentations, caricature and invective (so-called “robust debate”, much of which is single-minded barracking for this or that political party), and be guided by actual empirical data rather than theoretical outcomes of social experiments, then we should have a better chance of attaining consensus on means of ameliorating local and global environmental and political problems. On the other hand, we share a small planet with some who possess a **fearsome certainty** of the rectitude of their social, political or religious theories, whose 6<sup>th</sup>-century desert deity rewards indiscriminate mass-slaughter of the infidel -- analogous with human sacrifice owed in the past to bloodthirsty gods such as Canaan’s

Baal, the Aztecs' Huitzilipochtli (thousands of prisoners' hearts torn out to dedicate one temple), the rain-god Tlaloc, and many more perversions of otherwise peaceful religions.

Perhaps the 19<sup>th</sup>-century physicist Lord Kelvin was right: ***“Man must measure, else is his knowledge of a meagre and unsatisfactory kind”***. We owe ourselves, our planet, and perhaps even our vast and ancient universal heritage, no less than an attempt to conduct our affairs with greater logic, and with due regard to Kelvin's dictum when assessing the **consequences** of political/religious theories and social experiments. How to persuade Earth's despots and terrorists of this need, is currently among our most intractable problems.

Increasingly, we recognize that the complexity of human lives, human affairs, and the universe in which we exist, is best considered by making **due allowance for uncertainty inherent in all things**, from the quantum domain of sub-atomic particles to our

understanding of the nature and meaning of our personal existence. Anglican Bishop Richard Holloway has said that, even if we cannot know whether human lives are a *journey from abyss to abyss*, from a non-existence of pre-conception to a non-existence after death, yet we can occupy our morsel of space and time in a state of ***permanent expectant uncertainty***: a joyful “singing in the rain”, without needlessly dwelling on what we cannot know with certainty. Perhaps we can be more aware, with Matthew Arnold, that *the moon lies fair upon the straits*, rather than viewing with despair his *darkling plain.....where ignorant armies clash by night*.

**Albert Einstein** once explained himself and his credo in this often-quoted passage:

*“Our situation on this earth seems strange. Every one of us appears here involuntarily and uninvited for a short stay, without knowing the whys and the wherefores. In our daily lives we only feel that we are here for the sake of others, for those whom we love and for many other beings whose fate is connected with our own.....Although I*

*am a typical loner in daily life, my consciousness of belonging to the invisible community of those who strive for truth, beauty and justice has preserved me from feeling isolated. **The most beautiful and deepest experience a person can have is the sense of the mysterious. It is the underlying principle of religion as well as all serious endeavour in art and science.** He who never had this experience seems to me, if not dead, then at least blind. **To sense that behind anything that can be experienced there is something that our mind cannot grasp and whose beauty and sublimity reaches us only indirectly and as a feeble reflection, this is religiousness. In this sense I am religious.** To me it suffices to wonder at these secrets and to attempt humbly to grasp with my mind a mere image of the lofty structure of all that is there.”* (Brian, 1996, contains the complete passage at p. 233).

When asked why a friend (Michele Besso) had never made any important mathematical discovery, Einstein laughed and replied: *“This is a very good sign. Michele is a humanist, a universal spirit., too*

*interested in too many things to become a monomaniac .Only a monomaniac gets what we commonly call “results”.....A butterfly is not a mole; but that is not something any butterfly should regret.”* Very encouraging for us lesser mortals? He also left us the following view of himself:

***“A human being is part of the whole, called by us “Universe”, a part limited in time and space. He experiences himself, his thoughts, and feelings, as something separate from the rest – a kind of optical delusion of his consciousness. This delusion is a kind of prism for us, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion, to embrace all living creatures and the whole of nature in its beauty. Nobody is able to achieve this completely, but the striving for such achievement is in itself a part of the liberation and a foundation for inner security.”*** (Brian, 1996, p.389).

**SO: WHAT CAN WE BELIEVE IN? DOES FAITH  
MAKE SENSE? OR DOES SCIENCE?**

*“Yet today I have a feeling of isolation, of having no belief in anything, least of all myself. All is awful and immense, as indeed it is – we have no idea of what we are, or even where.”* (Melbourne author Hilde Knorr, from *Journey With A Stranger*(1986), expressing the **overwhelming doubts** which at times assail all of us).

Everybody lives by **faith**, though not necessarily religious belief. We constantly accept information which we can't personally verify, and make choices with uncertain outcomes, in the hope that our faith in that information is justified. Physicists, astronomers, all scientists also have faith in the published data used to formulate their theories and research. Science-based rationalism (empiricism) tends to see faith as belief in anything not based on sensory observations and logical reasoning, i.e. any phenomena not subject to quantitative measurements

and falsifiable hypotheses. However, the dichotomy between **empiricism and religious faith** is not total, as “scientific evidence” often involves faith that measurements, observations, perceptions and reasoning are untainted by non-neutral personal values.

**Europe’s “Enlightenment Movement”**, now some 300 years old, was supposed to release humankind from superstition, ignorance, credulity and parochialism., and to bring about a “golden age “ of reason. Clearly this has not happened: capitalist materialism, communist collectivism, national socialism, and secularism have not replaced humankind’s search for meaning. We need to have **faith and hope for a better future** for ourselves and our offspring. Zwartz (2005) pointed out that **our lives are not mere chronicity**.....that we are not beings who accept that event after event happens with no unity or connection between them; faith in something is needed to give our lives the *“narrative unity that allows us to find **meaning and significance**.....faith to perceive what is good, then to desire it: faith to establish goals and to*

*achieve them; faith to find hope and strength in adversity.*” Zwartz considered that religious faith, although not essential for us to find meaning, is “its own advocate”, inextinguishable for many of us through wars, natural disasters, centuries of persecution, ridicule and apathy. He quotes St. Augustine: “*Thou hast made us for thyself, O Lord, and our hearts are restless until they find their rest in thee.*” Micklethwait and Wooldridge (2009) discuss “theotropic humankind” and the recent global resurgence of religions.

**Religious faiths**, whether or not provable or misplaced, remain ubiquitous. At a minimum, religions represent a necessary and unavoidable stage in our evolving species’ 100,000 years of pre-scientific search for meaning, for *cosmos emerging from chaos*. **Religion’s many detractors** seem unable to recognize its contribution, and that we could never have attained even our present incomplete understanding of the cosmos and our place within it, without passing through such a stage. For example, **Richard Dawkins** (*The God Delusion*, 2006) detests religion, in particular the



god of pre-Reformation Catholicism and Christian Bible fundamentalists; he expounds the harm and intolerance associated with religions for millennia, with little balancing regard for religions' artistic, cultural, philosophical and even scientific heritage, and social utility ("social glue"). For Dawkins, belief in a god or gods is a meme with former survival value, conditioned into children from times past when you had better obey authorities or a leopard would get you; there may even be a "god spot" in our brains whereby we are "hard-wired" to believe in some super-authority. However (discussed under "The Evils of Evolution"), we seem to have hard-wired tendencies to conform, to submit to authority, to behave fanatically, leading to enslavement, genocide, rape, life-sacrifice in the service of cultural ideologies; these *political religions* incorporate "human godlings" (from Pharaohs and Caesars to Hitler, Hirohito, Stalin, Mao, Pol Pot, Kim Jong Un, Saddam, alBaghdadi, etc.), in whose names genocidal crimes have been and still are perpetrated. **Intolerant ideologies, religious or irreligious**, are part of our evolutionary

burden; the fault lies not in our gods, but in us? Should Dawkins' book be re-titled *The Dawkins Delusion?* (See also Appendices pp.50-53).

Alexander Pope thought that "*The proper study of mankind is man*". Yet faith in science, progress and the perfectibility of humankind (see, eg, Hitchens, 2007: "*Above all, we are in need of a renewed Enlightenment*") cannot account for the awful history of the 20<sup>th</sup> century. For some, **our new cosmic perspective** seems **inadequate**, even harmful: science in secular cultures is seen to be transforming from a search for truth to a vehicle for myth. Zwartz quotes John Gray: "*The human needs that were once expressed in religion have not disappeared. From the cult of cryogenics to absurd neo-Darwinian ideas, the core myths of Western religion are being recycled as science. In the course of this transformation, the wisdom they contain is being lost.*" Gray considers that Darwinian natural selection may result in more complex "improved" life forms, or it may eliminate any such; however, "*The hopes bequeathed by Christianity are too deep and pervasive in the culture for such a*

vision of **purposeless change** to be accepted. As a result, Darwin's theory has been turned upside-down and used to prop up the belief in progress." So: is science merely a human instrument for curing the sick and alleviating poverty, winning wars or aiding genocide, depending on who are its users or abusers? Now that that humankind has *eaten from the tree of knowledge and must somehow live with the consequences*, can we hope that science, alone, can deliver humanity from itself? As ever: what do you think? (I personally hope that science's ongoing revelation of whence we have come, and who we are in a cosmic context, can *combine* with religious beliefs to help eliminate fearsome extremist certainties, while encouraging cooperative sharing of our small world and its finite resources. **Science/religion should be "and", not "or"**.) To quote from John Paul II's Encyclical Letter: *Faith and reason are like two wings on which the human spirit rises to the contemplation of truth*". Without this balance, faith without reason withers into superstition, and reason without faith can wither into a Dawkins/Hitchens view of science and religion as implacable

enemies, eg. *“Religion.....comes from the bawling and fearful infancy of our species, and is a babyish attempt to meet our inescapable demand for knowledge (and comfort, reassurance and other childish needs.)”* opined Hitchens (2007); also, *“what can be asserted without evidence can be dismissed without evidence”*.

## ARE WE ALONE IN THE UNIVERSE ?

This most intriguing question – the existence of other ETC’s (electromagnetically telecommunicating civilizations) -- is summarized by the **“Fermi paradox”**: they must be out there....so why is there a “Great Silence” - no evidence of their presence? Conclusion: any other ETC’s are too distant, or they self-destruct too rapidly for any of their periods of radio signaling to coincide with our brief search, or they are not transmitting in the “water-hole” radio frequency band searched for the past few years by programs including **SETI** (Search for Extra - Terrestrial Intelligence; more specifically, SET-T, the

Search For Extra – Terrestrial Technology). However, the search is in its very early stages. It is sustained by the “*Principle of Mediocrity*”: that the Sun is just another star of average age, size and brightness; if it has 9 planets, at least one able to sustain life, then other stars are also likely to have life-supporting planets. Continuous Wave (CW) detectors can scan 28 million channels per second, looking for a non-natural narrow-band signal appearing as a thin white line drifting across the computer screen due to the Doppler effect caused by Earth’s rotation relative to a distant source. And since Earth is a relatively young planet in an old galaxy: provided that prebiotic chemical evolution was possible in pre-Earth aeons, then **alien societies** could be **far more advanced** than ours, able to transmit messages via the “microwave window” – radio frequencies between 1200 and 3000 MHz, relatively free from cosmic static caused by galaxies, pulsars and other radio sources (“you can hear a pin drop out there”). A test signal has been supplied by the Pioneer 10 Jupiter/Saturn space probe, launched in 1972, now aimlessly outbound some 10 light hours distant, beyond our solar system, transmitting with less than the power of a hand torch.

**Planets are common.** In our galaxy alone, there are some 200 billion stars. Young stars frequently demonstrate a disc of gas and dust, wherein new planets accrete. By Feb. 2011, “wobble-watching” studies of small Doppler shifts in the spectra of nearby sun-like stars (within 200 light years), and “micro-lensing” studies of more distant stars, have located 519 “exoplanets”. Some 380 stars are orbited by at least one detectable short-period massive “hot Jupiter” (or “roaster”) planet, some 20 even showing visible light-dimming “micro-lensing” transits of their parent stars (Appenzeller, 2004; COROT satellite, 2007). A few stars, eg. 55 Cancri (4 planets including a “super-Earth” about 14 times Earth’s mass), also Vega and Upsilon Andromedae, have a planetary system. Star HD 70642 (95 light years distant) has a gas giant planet in a 6-year approx. circular orbit: possibly a “cold Jupiter” like ours, protecting possible inner worlds from cometary bombardment. Extrasolar planets have been **imaged**: eg. **2M1207b**, 5 times Jupiter’s size, orbiting a dim brown dwarf star (2M1207) about 200 light years distant near Hydra (Cauchi, 2005), with water molecules in its

spectrum confirming that it is a cold body; also, **Fomalhaut b**, a Jupiter-size world (Smith, 2008). A dim red dwarf star **Gliese 581**, 20.5 light years distant in Libra (Dayton, 2007) has a “solar system” with the first known possibly rocky habitable planets: “super-Earth” GL581c, 5 times heavier, 1.5 times our size, in a “Goldilocks orbit”: 13 days, mean temp. 0-40C, dark but warm, liquid water possible, therefore life? Red star **OGLE-2006-BLG-109L**, ~½ sun size, about 5000 light-years away, has 2 gas giants similar to Jupiter and Saturn, with room for inner terrestrial-type planets (Powell, 2008). NASA’s **Kepler probe** (706 prospective new planets: Hotz, 2011) and proposed (2018) James Webb Terrestrial Planet Finder Orbiting Telescope *may* detect atmospheric free-oxygen/methane signatures of **rare bio-friendly terrestrial-type worlds** (inner planets, or moons of “hot Jupiters”) with Earth-type plant life, if any such exist within a few hundred light-years.

**SETI** scientists have studied some 1000 yellow Sun-like stars within 200 light years of Earth (including about 200 using Parkes radiotelescope: reflections from overflying galahs, but no alien ET

signal). They avoid “bio-unfriendly” hot blue stars (giants, which don’t live long enough for planets to sustain life), and the abundant red dwarfs (too cool for habitable planets?). They also analyse deep-space radio data from a “piggy-back” receiver on the Arecibo radio telescope, using home computers (SETI at home). **So far.....galahs, the SOHO solar observatory, but no verified ET signal.**

**Biologists** point to the **special conditions**, specific non-repeatable history of *punctuated equilibrium* in the evolution of life on Earth, mass-extinctions following random climatic perturbations and meteoric or cometary major impacts, and the time required for one technological species to evolve (more than three billion years). **Physicists** tend to be optimistic that physics and chemistry somehow drive simple matter toward **ever-increasing complexity**, and that sufficient time and rare favourable conditions will eventually result in self-aware conscious life.



All agree that **primitive life** – the Archaean domain – is **hardy**. “Extremophile” micro-organisms (“**hell cells**”) live in boiling thermal pools, saline and corrosive habitats, Antarctic frozen lakes, arid deserts, submarine 2.5 km-deep volcanic vents, strongly acid (pH 2) and alkaline environments, and can survive high pressures (several hundred atmospheres), high vacuum, accelerations up to 10,000 g’s, and intense radiation including ultraviolet light. “Rock-eating **SLiMEs**” (Subsurface Litho-autotrophic Microbial Ecosystems) occur up to 7 km underground at temperatures up to 110 C, utilizing reactions involving iron or sulphur. Such life may possibly have commenced deep underground in planets, planetesimals, or even in the interiors of radioactive primeval comets. “**Transpermia**” is the concept that such microbes, or their precursor organic molecules, may have been widely distributed through the early Solar System by comets, meteors, asteroids, or material ejected from their collisions with planets. Even on carbonaceous or silicate dust grains in icy interstellar space, stellar ultraviolet light can form complex organic molecules contained within a lipid-like layer resembling cell

membranes. (See diagram at p.13 for more detail of “proto-biont” molecules).

**Primitive life** may be ubiquitous, existing where **liquid water** is, or was....e.g. on Mars, Jupiter’s moon Europa, or Saturn’s Enceladus in our Solar System. **Possible biosignatures** could include an excess of chiral molecules (the *left hand of creation*), or specific isotopic compositions of carbon /sulphide deposits. But the emergence of **complex animal life** and **intelligence** seems likely to be an **exceedingly rare** occurrence, requiring very long time-spans and very special conditions. We may indeed be a rare and significant cosmic phenomenon. We may also be flattering ourselves that we are intellectually and culturally unique. Detection by SETI of a faint signal, sent millennia in our past from a distant technologically advanced society, would swiftly dispel such hubris. (See also the **Drake equation**, in our Course Summary).

## CHAOS AND ORDER: INTELLIGENT DESIGN? HOW CAN COMPLEX ENTITIES EXIST?

**Complex durable structures** – galaxy clusters, stars, planets, life-forms, us and our social structures – seem at first glance to violate the **Second Law of Thermodynamics**, the natural tendency towards disorder, chaos and increasing *entropy*. The First Law is better-known as the “Conservation of Energy” Principle. The Second Law decrees that, although the total energy of a closed system such as our universe remains constant in accordance with the First Law, yet the amount of *free* or *usable* (or ‘*high-grade*’) energy, capable of doing useful work, tends to dissipate while the system’s component parts interact, tending towards a state of ***thermodynamic equilibrium***, also called the “**heat death**” of the universe. Usable energy requires a *temperature gradient* – some form of energy difference between adjacent regions, e.g. that between a star and its environs. So **long-lived “hot spots”** in frigid space are **essential for the emergence of complex entities**.

*In the beginning* of our particular expanding bubble of space-time (i.e. our observable Universe), quantum cosmology implies that our **original “energy capital”** appeared due to a **change of state** from a substrate “false vacuum” to our inflating bubble of “true vacuum”. Within this early universe...a hyper-dense hyper-hot homogeneous state in thermodynamic equilibrium...the “heavy lifting”, which created and sustains the temperature gradients and complexities all around us, was caused by **inflationary expansion and “symmetry breaking”** from a single original “super-force” to 4 separate forces: gravity, strong nuclear and weak nuclear, and the electromagnetic force. **Inflation amplified tiny initial quantum “fluctuations”**, producing slight differences in density and temperature within primordial hydrogen and helium gases. These fluctuations are seen in WMAP and PLANCK images of the **cosmic microwave background radiation** as 0.0001K variations in the Universe’s “background noise”: its base temperature, 2.74K, i.e. 2.74 degrees above absolute zero. These minute differences in temperature and density have been further

amplified by gravitational contraction to form **large-scale structures** (e.g. galaxies, stars, planets), while the nuclear forces have produced **atomic nuclei**, and the electromagnetic force has formed atoms, molecules and molecular assemblies including **mineral, vegetable and animal matter, and (eventually) us.**

In the “hot spot” energy gradients around stars, **complex structures** could form – cosmic dust grains, comets, asteroids, planets and moons. **On Earth**, some of this free (usable) energy today powers the internal “heat battery” (molten nickel-iron core) which drives crustal plate tectonics, earthquakes and tsunamis, and the deep-sea volcanic vents around which early non-aerobic chemosynthetic archaean bacterial life has arisen. How did such complex entities survive the Second Law of Thermodynamics, to evolve to ever-greater complexity, including humankind? As Paul Davies said: *“Matter and energy in far-from-equilibrium open systems” ...i.e. open to energy absorption and waste elimination...“have a propensity to seek out higher and higher levels of organization and complexity.”*

Paradoxically, the tendency toward **increasing entropy** – the **drive toward disorder** – may itself be the engine which temporarily generates order, *on the way to creating disorder!* Complex “*dissipative*” living structures draw usable energy from their environment and dissipate it as unusable heat, thereby increasing entropy overall and increasing the efficiency of the Second Law in generating disorder. You and I may be cunning manifestations of the Second Law of Thermodynamics, helping it to attain its long-term bleak goal of a universe without ordered structures. (“*You can’t win ? You can’t break even? You can’t even get out of the game.*”).

It is not clear whether there exist mechanisms which actively “**seek out complexity**”, working something like natural selection, randomly generating increasingly complex structures which persist if they fit their environments well. The emerging science of complexity is attempting to identify such laws, which may explain the difficult trick of creating stable structures which can channel and control

large flows of energy without falling apart – e.g. stars, starfish, stockbrokers and the stock exchange. The more complex the phenomenon is, the denser are the energy flows which it must control and the more likely it is to break down. Or so it seems. It also seems true that **complexity emerges incrementally**, step by step, linking existing patterns into larger and more complex patterns at different scales, each with newly *emergent* properties and rules of construction and change. We can discuss numerous examples, such as the unforeseeable properties of a water molecule which emerge from the combination of two hydrogen atoms and one oxygen atom, to illustrate these ideas; or you might refer to, say, David Christian’s appendix “Chaos and Order” in his book “Maps of Time” (2004).

An alternative (or additional?) possibility is *intelligent design* – the doctrine that “blind evolution” cannot explain the natural world, re-asserting Paley’s argument that a complex entity, such as a pocket watch or a living creature, requires an intelligent designer – a cosmic watchmaker. As the late Fred Hoyle wondered: has Someone been

monkeying with the laws of physics, to enable our universe, and us, to exist? Or, as Paul Davies has said (refer “Cosmology and Theology”): conscious beings cannot be a minor byproduct of **mindless, purposeless forces**. (See also Livio: *Is God a Mathematician?* Simon & Schuster, 2009). However, as pointed out by Guy Rundle (2005) and many others, no insoluble problems have so far arisen to require that we discard the theory of evolution by natural selection; the “unnecessary element” that there exists an *Intelligent Designer* is as yet in the realm of metaphysics, and therefore **cannot be tested** against physical evidence. This common rejection of a Designer was not necessarily shared by **Albert Einstein**: “.....*behind anything that can be experienced there is something that our mind cannot grasp and whose beauty and sublimity reaches us only indirectly.....*” (the full quote is given under “The Uncertainty Principle”); Einstein here echoes the sentiment expressed in the Christian hymn.....”*When I consider all the things thy hands have made, I see the stars, I hear the rolling thunder, thy power throughout the Universe display’d...*”. At the 2006 meeting of the American Association for the



Advancement of Science, its board of directors issued a statement: *“There is no significant controversy within the scientific community about the **validity of evolution**...(it) is one of the most robust and widely accepted principles of modern science”*. So: what do you think? Do *organs of perfection* (eg the bacterial flagellum, or the eye) require an interventionist designer? (See, eg, Zimmer, 2006, for explanations of their stepwise evolution using primordial *Hox* genes). Are proponents of intelligent design muddling science with religion? The United States Supreme Court has so decided, recently ruling against its inclusion in science classes, construed as an attempt to misrepresent religious teaching as science.

### **ARE WE INEXTRICABLY ENTANGLED WITH THE ENTIRE UNIVERSE?**

Cosmologists turn to the **quantum theory** of sub-atomic particles to rescue us from General Relativity's inference that our Universe

originated from an infinitely-dense infinitely-hot *space-time singularity*. Its quantum origin, from a seething *space-time foam* or a *false quantum vacuum*, would have been mediated by a universal “probability wave-function”, analogous with those which describe interactions in the *micro-world* of sub-atomic particles. Yet objects in the **macro-world of everyday experience** don’t obey the quantum rules of their constituent particles. Is the Universe processing information, as it processes mass and energy? Does this cause *decoherence*, a transition from possibility to actuality, from “fuzzy quantum probability” to our large-scale world? Can this occur without any need for conscious observers, whose presence seems embarrassingly (or consolingly?) unavoidable in order to *collapse wave-functions* when observations are made on quantum particles?

We first encountered *quantum non-local entanglement* under “Quantum **Cosmology**”. The Einstein-Podolsky-Rosen objection to “**spooky action at a distance**” (information seemingly transferred **faster than light** when a measurement is made on one particle,

thereby instantaneously determining the state of its distant partner), has been shown to be incorrect by experiments such as Alain Aspect's measurement of the polarizations of a pair of simultaneously-emitted photons. According to physicists such as Lee Smolin (author of *Life of the Cosmos*), it follows that:

*“Given any one electron, its properties are entangled with those of every particle it has interacted with, from the moment of its creation – indeed, quite possibly from the moment of creation of the universe. Once any two photons, or anything else, have interacted, one cannot separate any description of the properties of one from the properties of the other. ....We, who live in the universe and aspire to understand it, are **inextricably part of the same entanglement**.....we can only give a complete designation of ourselves, or any part of the universe (including its elementary particles), to the extent that we describe the entire universe.”* John Wheeler also thought we inhabit a *“participatory universe.”* Smolin (1998) is also one who considers “space” to be an illusion: the

*coherence* of the world must be behind and outside of space, and a fundamental *theory of everything* (TOE) cannot be about particles in space, which can emerge only as a kind of statistical or averaged description, rather like the temperature of a set of gas molecules. This implies that, at extremely small distances, “space” is made of discrete bits. Which further leads to his theory of ***cosmic natural selection***, whereby our universe constructed itself by selecting laws which result in the maximum structure and complexity.....a benign universe, hospitable to life, to humankind,, and to our societies’ evolving principles of justice, law and equal rights. Could he be on the right track? Or a bit “far out”? Like many cosmologists, Smolin emphasises the concept that we are a significant part of something vast, ancient, magnificent, with the potential to calm us down, to help us manage our affairs, as our comprehension of our cosmic origins unfolds.

## A SUGGESTION.

At their next opportunity to take time out from the cares and stresses of political life, planet Earth's leaders could do worse than to incorporate a little scientism into their deliberations, to escape for an evening from the lights of cities and conferences, to "*go quietly amid the noise and haste*" to some dark-sky location, or perhaps to the local observatory, and there look out and back into the immensity of deep space and deep time, perchance giving their heads a chance to **calm the turmoil** within. As Walt Whitman said ..... "*to wander in the mystical moist night air.....to look up in perfect silence at the stars*"... to consider what it is that has given rise to us.

Sounds ridiculous? Perhaps less ridiculous than much of the primitive posturing.....rationalizing the ancient drive to dominate.....which we call international (or local) politics. We could have a tough time, however, persuading the world's despots and terrorists that their conduct is probably no more than a **rationalized primitive residue** of their australopithecine ape-man

ancestry, several million years ago , whereby the alpha male could order his troop up the trees to escape a marauding predator , or commandeer unto himself all reproductive rights until displaced by someone bigger and stronger.

## .....AND FINALLY: THE THREE BIG QUESTIONS.

Historian Ronald Wright (*Short History of Progress*, 2005) sees three major questions facing humankind; posed also by Jared Diamond's *Collapse: How Societies Choose to Fail or Survive* (2005), especially ch. 13, "Mining" Australia:

***"Where Do We Come From? What Are We? Where Are We Going? ...anthropology has answered the first two: we now know that we are the remote descendants of apes who lived in Africa about 5 million years ago.....our main difference from (modern) chimps and gorillas is that over the last 3 million years or so, we have been shaped less and less by nature, and more and more by***

*culture. We have become experimental creatures of our own making.”*

*“This experiment has never been tried before. And we, its unwitting authors, have never controlled it. The experiment is now moving very quickly and on a colossal scale. Since the early 1900’s, the world’s population has multiplied by four and its economy – a rough measure of the human load on nature – by more than forty times (**the “4/40 model” of the 20<sup>th</sup> century; already, by 2018, the 6/60 model**). We have reached a stage where we must **bring the experiment under rational control**.....if we fail – if we blow up or degrade the biosphere so it can no longer sustain us – nature will merely shrug and conclude that letting apes run the laboratory was fun for a while but in the end a bad idea.”* In short, global economic and environmental interdependence means that population collapse would be global. Yet our future, our fate, may well be of local and even cosmic significance. One point is clear: where we are going is *our*

problem. In the words of Loren Eiseley (from *The Immense Journey*):

*“Lights come and go in the night sky. Men, troubled at last by the things they build, may toss in their sleep and dream bad dreams, or lie awake while the meteors whisper greenly overhead. But nowhere in all space or on a thousand worlds will there be men to share our loneliness. There may be wisdom; there may be power; somewhere across space great instruments, handled by strange, manipulative organs, may stare vainly at our floating cloud wrack, their owners yearning as we yearn. Nevertheless, in the nature of life and in principles of evolution we have had our answer. Of men (as are known on Earth) elsewhere, and beyond, there will be **none forever.**”* Or, on an inner world orbiting distant red star OGLE-2006-BLG-109L: *“Above a calm, dark ocean, a huge bloated red sun rises in the sky...small waves lap on a sandy shore, and, on the beach, something stirs....”*: just possibly so, but not like us, and unlikely to be similar to any Earthly advanced life-form.



Let us trust that *a problem stated is a problem half solved*. We have the knowledge, the technology and the means to share resources, clean up pollution, dispense basic health care and birth control, set economic limits in line with natural limits before our future spirals out of control (see MIGODS development....p.4) **Have we the will?** Or shall our ancient demons of irrational inter-cultural intolerance consign us to an age of chaos, strife, a new planetary “dark age”, Andrei Sakharov’s “Sisyphian abyss”?

**Political/religious ideologies**, whether Christian fundamentalist right or sectional interest left, or Islamic Sunni or Shiite, or Marxist Stalinist or Maoist, can only propel the democratic civilization experiment towards collapse. Perhaps the two most dangerous quotes from the twentieth century are (1) the United States’ Gordon Gekko, *“greed is good”*, encouraging further irrational waste of limited resources, and environmental damage; and (2) Algeria’s former President Houari Boumediene, *“the wombs of our women will give us victory”*, encouraging massive population increase and civil strife

when “*millions of men will leave Arabia to go to Europe. And they will not go there as friends. They will go there to conquer it. And they will conquer it with their sons.*” (cited in Fallici, 2005). Political analysts such as *The Spectator*’s Rod Liddle and Mark Steyn forecast a potential “Eurabian civil war” unless the Arab European League (the most important political Islamic European organization) ceases to liken integration or assimilation to rape, while calling on Muslims to resist such “cultural imperialism”, and to aim for the establishment of a new caliphate (“Eurabia”) in areas of northwestern Europe where burgeoning Muslim urban populations already approach or exceed 20%. By 2018, the collapsed “Islamic State” caliphate, emerged from the wreckage of Syria’s civil war, has recruited thousands of *jihadists* from Europe, America and Australia; these seek to return to mount guerilla warfare within their host societies, costing \$billions to counter. Burleigh, in 2006, has warned: “*Suddenly we have in our midst people who totally reject Western modernity and who fantasise about a future caliphate.....in which cleric and ruler will be one*”; Hizb ut Tahir is one current local example. Also **within Australia**, unfortunately, events

including Sydney’s “LBC gang” rapes, assaults (Windschuttle, 2005) on teachers, ambulances, firefighters, police and beach lifeguards, a beach reaction riot (Cronulla), Hyde Park brawl and Lindt Café siege; Melbourne’s 2017 deadly “copycat” car rampages; detection of terror plotters (e.g. Operation Pendennis) at vast expense; these demonstrate that cultural tribalism among impressionable or enraged young men requires non-tolerance of violent intolerance, and (somehow?) their safe re-inclusion to civil society.

To put all this into its “**big history**” context: surely we can hope that, after thousands of years of inter-tribal and inter-cultural strife, we humans...*each of us the product of 13.8 billion years of cosmic and biological evolution*.... have come too far for yet another global paroxysm of murderous inter-cultural (inter-tribal) rivalry? We urgently need more **common ground to establish friendly dialogue** between humankind’s cultural belief systems. Islam, for example, is honoured for preserving and building on the writings of the classic Graeco-Roman philosophers, astronomers, mathematicians, poets and

playwrights, during centuries of European recovery from the Western Roman Empire's collapse. During the 9<sup>th</sup> to 11<sup>th</sup> centuries, Islam was the world's leading scientific culture. Islamic Spain in particular...Al Andalus, "*the light of the dark ages*" during Spain's *Convivencia* centuries, when three diverse cultures enriched each other... preserved and amplified the heritage and learning of classical antiquity. This was an essential prelude for the Renaissance of science and the scientific/political Enlightenment in the Western world, with retention of Arabic astronomy (e.g. star names Aldebaran, Alpheratz, Betelgeuse, Fomalhaut), mathematics (e.g. *al jabr*, algebra), medicine, and much more. Carroll (2008) has discussed why Islam then stagnated for 500 years, closed to outside ideas, and now "blames the West". Could **historical commonality**...millennia of interest in extending our understanding of the sciences and humanities...provide a basis for reconciliation between Islamic and Western cultures? Or will Hizbolla-type "Party of God" jihadists, with their mushroom-cloud electoral flag bombast, make irrational demands on believers and infidels alike, reject free speech and social liberty, intimidate civilians in Middle East, Europe and world-wide,

acquire nuclear weapons, control Syria, Iraq, Afghanistan, and even their proposed “Eurabia”, and existentially threaten Western cities?

As the late Carl Sagan has said : ***In the vastness of space and the immensity of time , it is our privilege to share our instant together*** . Now *that* really puts human affairs into their fullest perspective – the sorely-needed “big picture” which can help us to get on together, to work together to better manage our one and only world , to stop acting as Tim Flannery’s “future-eaters”. Provided that all cultures are prepared to “take it on board”, our new cosmic *holistic* perspective could help to overcome the threat of further ideology-based rift, and help us to plan and act rationally for the benefit of global humankind, our home planet and our remaining fellow creatures. The alternative seems to be more of the same.....rival tribal cultures, based on fearsome religious or commercial or societal certainties, blindly flailing at each other in *the dark night of this rough-spoken world*. Jared Diamond’s analogy: humankind is in “a two-horse race between Rationality and Irrationality, with the winner as yet

unknown”. The cosmic “big picture” has the potential to provide a **unifying calming beacon of hope in an anxious world**; we surely have need for such a beacon, to help guide Rationality around the course.

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*Post scriptum: Myself, when young, did eagerly frequent  
doctor and sage, and heard great argument  
about it, and about, and evermore  
came out the same door as in I went.”*

As Omar Khayyam noticed, centuries ago, we’re a curious and argumentative lot. And likely to remain so. With respect to these course notes, some (much?) of their content could seem quaint in 20 or 50 years time; who knows what issues our grandchildren will be debating? Also, you may identify with the Duke of Gloucester’s comment when

presented with Volume 2 of *The Decline and Fall of the Roman Empire*:

*“Ah, Mr. Gibbon, another damned fat square book. Always scribble scribble scribble, eh?”*

**APPENDIX****A****CHEERFUL**

May I also invite you to share Monty Python's cosmic thoughts, from *“The Life of Brian”*, also available as a 3 minute video clip at <http://dingo..care2.com/cards/flash/5409/galaxy.swf>, if you'd

like to hear it sung (by Eric Idle, I think). See also p.38a for the latest (2013) version; also p. 66.

*Whenever life gets you down, and things seem hard or tough,  
 And people are stupid, obnoxious or daft, and you  
 feel that you've had quite enough.....  
 .....(here commences the cheerful refrain):*

*Just remember that you're standing on  
 a planet that's evolving  
 And revolving at 900 miles an hour.  
 That's orbiting at 90 miles a second, so it's reckoned,  
 A Sun that is the source of all our power.*

*The Sun, you and me, and all the  
 stars that we can see  
 Are moving at a million miles a day,  
 In an outer spiral arm at 40,000 miles an hour,*



*In a galaxy we call the “Milky Way”.*

*Our galaxy itself contains two  
hundred billion stars.*

*It’s a hundred thousand light years side-to-side.*

*It bulges in the middle, 16,000 light  
years thick,*

*Out by us it’s just 3,000 light  
years wide.*

*We’re 30,000 light years from Galactic Central Point.*

*We go round every 200 million years.*

*And our Galaxy is only one of  
hundreds of billions*

*In this wondrous and expanding Universe.*

*The Universe itself keeps on expanding and expanding*

*In all of the directions it can whiz,*

*As fast as it can go, that's the speed of light, you know,  
12 million miles a minute, that's the fastest speed there is.*

*So remember when you're feeling very small and insecure  
How amazingly unlikely is your birth.*

*And pray that there's intelligent life somewhere up in space,  
'Cause there's bugger all down here on Earth.*

Or, to quote Blaise Pascal, writing in more serious vein in *Les Pensees* (1670): “*For what is Man in Nature? A nothingness in respect to infinity, a whole in respect to nothingness, a median between nothing and everything.*” And: “*When I consider the brevity of my life, swallowed up as it is in the eternity that precedes and follows it, the tiny space I occupy and what is visible to me, cast as I am into a vast infinity of spaces that I know nothing of and which know nothing of me, I take fright, I am stunned to find myself here rather than elsewhere, for there is no reason why it should be here rather than there, and now rather than then. Who set me here? By*

*whose order and under what guiding destiny was this time, this place, assigned to me?"*

Or you may prefer the Biblical psalmist: *"What is Man, that Thou art mindful of him?"*

Or Immanuel Kant (1784): *"Enlightenment is man's emergence from his nonage (immaturity).....Sapere aude! Dare to know! Have the courage to use your own intelligence.....without another's guidance".*

Or Bill Bryson: *"It's an unnerving thought, that we may be the living universe's supreme achievement and its worst nightmare simultaneously."* This reminds us of the definitions of an optimist (one who thinks we live in the best possible world), and a pessimist (one who is terrified in case the optimist is right).

Poised between the macro-universe of space-time and the micro-universe of quantum phenomena, we continue to measure, to observe, to ponder the profound questions of existence. Our nation is among the fortunate few with its national flag bearing a symbol – *Crux australis*, the superb Southern Cross constellation – to remind us that

we are indeed a significant part of a cosmos vast, ancient, awesome and magnificent , and also endowed with a brain and mind enabling us at least to partially comprehend, to partially respond to Pascal's timeless questions.

### **A SERIOUS APPENDIX : “BIG HISTORY” SUMMARISED.**

As Australia has some of Earth's most important palaeontological sites, brief descriptions of these are included in the following summaries of the planet's geological periods. See also Willis and Thomas (2005): *Digging Up Deep Time*. We use BBC and local DVD's to illustrate the evolution of life on Earth (“ca” is “about”; “Ma” means “Million years ago”).

*IN THE BEGINNING.....*The “**Big Bang**”, **t = 0**, the “**Planck Instant**”, **13.82 billion years ago (13820 million +/- 200 million.)** Our

observable Universe “erupted into shining existence” (“*let there be light*”), possibly as an uncertainty, a random quantum energy fluctuation or “flicker” in a void -- a “false vacuum” of no-space and no-time. A **change of state (symmetry-breaking)** within this proton-sized **exponentially inflating** bubble (*inflaton field*) of space-time and pure energy, generated the 4 fundamental forces; plus all the positive mass-energy ( $E=mc^2$ ) of the future universe, exactly compensated by the negative (potential) energy of its gravitational field, so that the total energy of the Universe would always remain **nil.....**the Universe may thus be the “*ultimate free lunch.*” .

*THE FIRST THREE MINUTES.....*Intense gamma-ray energy in the ***inflaton field*** created matter-antimatter particle pairs including bosons (W, Z, X, Higgs?), axions, gluons, gravitons (?), photons, neutrinos, electron-positron and quark-antiquark pairs (***a “quark soup”***), which further condensed into “droplets” of quark-antiquark doublets (mesons) and quark baryon triplets (e.g. neutrons, protons, and their antiparticles), which mutually annihilated back to high-energy

photons. **Asymmetries** in decay of K-neutral mesons (1 in 500) and B-mesons, plus as yet unknown physics, ensured that, for every 3 billion photons today seen as the afterglow of the Big Bang (the cosmic background radiation), one extra particle of **matter** would remain, and no antimatter. This initiated the *flow of time*, and formation of the primordial light atomic nuclei: **76% hydrogen, 24% helium-4, and traces of deuterium, helium-3 and lithium-7.**

*THE DARK ERA.....*After about 380,000 years, the expanding star-like **plasma fireball** cooled down to about 4000 K, when free electrons combined with nuclei to form neutral atoms - a primordial gas of hydrogen (H) and helium (He). Photons stopped scattering from electrons: matter *decoupled* from radiation, the universe became **transparent and dark; gravitational contraction** slowly amplified slightly over-dense gas regions caused by quantum fluctuations in the original fireball. Dark matter (axions?) formed “dark stars” and early supermassive black holes? (Choi, 2010).

*FIRST LIGHT.* Within about the first half-billion years, **gravitational collapse** of huge clouds of primordial gases and “dark matter” (axions? big-bang neutrinos? neutralinos?) began to form dense hot objects. The **first stars** ignited as compressed hydrogen (H) fused to helium (He). Massive supergiants (among the oldest known is “gamma ray burster” GRB050904, 12.8 billion light years out in Pisces) re-ionised the H/He interstellar medium, and progressively formed elements up to iron in their cores, which collapsed into massive black holes, emitting *hypernova gamma ray bursts* (first thought, billions of years later, to be clandestine off-Earth cold-war nuclear missile tests!). Stars in their trillions gathered into **filamentary clusters and superclusters of great galaxies**, enclosing giant “WMAP cold spot” **voids**, up to a billion light years across, almost empty of galaxies, stars and dark matter. **Supernovae** seeded starbirth nebulae with “metals” (**elements heavier than helium**), enabling later generations of stars and their **planetary systems** to gravitationally coalesce.

*HADEAN “BLACK” EARTH.* About 4600 Ma (million years ago), in a spiral arm of the Milky Way Galaxy’s 200 billion stars, a supernova shockwave (it left excess Fe-60 in a Bishanpur meteorite) collapsed the **Solar Nebula** to form a G2 medium yellow star - our Sun - and its retinue of planets, their moons, and asteroids, meteors and icy “leftover” Kuiper Belt objects and Oort Cloud comets. Accretion of dust grains (“cosmic fluff”) formed rock debris, then planetesimals; these merged to form the planets. A Mars-sized body “Theia” impacted **proto-Earth; our Moon**, formed from material blasted into orbit, now stabilises Earth’s tilted spin axis, preventing extreme climate variations. A “late heavy meteoric bombardment” (3900 Ma) is still visible in the ancient cratered surfaces of many worlds, including our Moon. **Within the “ice line”, small rocky planets** were stripped of their volatile elements by the strong solar wind from the young “T-Tauri” Sun. **“Hellish” Earth, molten** due to intense meteoric/ cometary bombardment and radioactive heating, **differentiated** to form inner and outer core, mantle, and crustal tectonic plates, still being torn apart and recombined by **mantle convection plumes** causing



vulcanism, earthquakes and tsunamis. Earth's oldest known rocks (from Canada) are 3960 million years old. A **primitive atmosphere of volcanic gases** formed (mostly steam, hydrogen, CO<sub>2</sub>, CO, nitrogen, hydrochloric acid and sulphur gases). As *Black Earth*'s basaltic lava (Sci. Am. Mar. 2010) cooled, **oceans of cometary water** formed, with a **secondary atmosphere** of methane, nitrogen, carbon dioxide, steam, and carbon monoxide (**no free oxygen yet**). On Saturn's frozen moon Titan, a "hydrocarbon cycle" (Henderson, 2007) of methane "drizzle" (confirmed by Huygens lander), with evaporation from liquid methane lakes up to 70 km diameter (Cassini probe's circular and irregular dark radar images), partially resembles Hadean Earth's hydrology.

*ARCHAEOAN EON*, 4000-2500 Ma (million years ago). About 3800 Ma: the **origin of life** on Earth, inferred from carbon showing an elevated C<sub>12</sub>/C<sub>13</sub> ratio typical of living organisms, in BIF (Banded Iron Formation) from western Greenland; also, 3500 million years old rod-shaped bacterial cells from South Africa's Barberton Greenstone Belt cherts. Commencing with **pre-biotic simple organic molecules** generated by terrestrial and

(probably) nebular organic chemistry, **progressive molecular self-assembly** (the “replicating RNA world”? Ricardo & Szostak, 2009) produced the earliest chemosynthetic **prokaryote single-cell** organisms, at energetically favourable locations such as thermal springs and deep-sea volcanic vents: see, eg. Lutz (2000). These “hyperthermophile” Archaeobacteria, based on RNA/DNA primitive genomes, protein enzymes and silica/metal/phospholipid(?) semi-permeable cell membranes, could give rise to **surface blooms** of photosynthetic and heterotrophic bacteria. Solar photosynthesis evolved from some prokaryote species’ ability to detect hot water, weaning them from deep volcanic springs to colonise shallow waters (Kiang, 2008). Cyanobacteria, ca 2200 million years ago, began to form **oxygen-generating photosynthetic** stromatolite “living limestone” colonies, still present at places including Shark Bay, W.A. For over a billion years, this oxygen **precipitated iron** carried by rivers into lakes and shallow seas, turning the oceans from brown to blue, and forming huge BIF deposits (found, e.g., in W.A.’s Hamersley region). **2% free atmospheric oxygen** began to oxidize ferrous iron on land: “**RED**

**EARTH**, the **GREAT OXIDATION EVENT**, the earliest iron-stained “redbed” sandstones; also, forming a stratospheric **ozone layer** which shielded surface life from lethal solar ultra-violet (UVB) radiation. Extensive stable continental areas with marginal shallow seas began to form about 3 billion BP, from previous unstable regions of erupting lavas. *At Marble Bar Reserve, W.A. (“No Camping: Cattle Excepted”): Apex Chert “marble” has fossil stromatolites, with filamentous and spherical bacterial microfossils (possibly photosynthetic cyanobacteria?) dated at 3465 Ma.*

**PROTEROZOIC EON**, 2500-542 Ma. With increasing free oxygen, **aerobic respiration** evolved, enabling the Eubacteria to colonise surface waters. About 2000 Ma, “endosymbiosis” (prokaryote cells co-existing within larger “archaeon” cells) resulted in complex **eukaryote** cells (*e.g. Grypania*), with internal nuclei, mitochondria, chloroplasts and other membrane-bounded specialised-function organelles. These “acritarchs” included single-cell plants (protophyta) and protozoan microbes. Chloroplast DNA studies (Leake, 2008) imply that *all* higher

plants trace their origin to a single chance event when an amoeba-like cell incorporated a photosynthetic bacterium, enabling complex life to evolve from the bacterial slime. **Sexual “DNA-swapping” reproduction** greatly accelerated genetic variability and the rate of evolutionary diversification. Earliest **multicellular** life (Tonian) appeared about 1 Ma ago. Amalgamation of continents produced the **first supercontinent, Rodinia**. Ocean blooms removed atmospheric CO<sub>2</sub>: **ca 720-635 Ma, during Varenagian Ice Ages, the Cryogenian “WHITE EARTH’ was sheathed in ice up to several km thick (glacial rocks found, e.g, in Flinders Ranges)**. First known **mass extinction** (a decline of the acritarchs) occurred at about this time. Volcanic CO<sub>2</sub> emissions rewarmed Earth, ending global glaciations. Lichens colonized lands, atmospheric oxygen rose to 20%.

*The Bungle Bungle Dolomite (W.A.): 1500 Ma old fossil eukaryotic cells. Also, 850 million years old **cyanobacteria, green algal cells** and possible **fungi** and **dinoflagellates** from the Bitter Springs Chert (Central Australia). Also, 1200 million years old trails of **worm-***

*like(?) animals from Stirling Ranges (W.A.), and stromatalites dated at 2500 – 545 million years, from many W.A. localities.*

*NEO-PROTEROZOIC ERA, EDIACARAN PERIOD: ca 635-542 Ma.* With Earth warming again, **marine multicellular diploblastic** (two-cell-layer “place-mat” animals) and **coelenterate** (“hollow-bodied”) animals evolved from eukaryote single-cell ancestors; also, brown and green algae, “early worms” (e.g. *Spriggina?*) and other invertebrates.

*Ediacara Hills (S.A.), 550 Ma: primitive soft-bodied marine worms (*Dickinsonia*), jellyfish (*Mawsonites*), uarthropods (*Parvancorina*), arthropods (*Spriggina?*), sea pens, flatworms, a unique 3-fold symmetrical *Tribrachidium*, echinoderms, and a possible (controversial) ancestral vertebrate. Many Ediacaran life-forms are of doubtful affinity with modern phyla. *Fusaria*, 30cm erect “knobbly thin tubes”, 570 Ma old: the first animal to reproduce by sexual spawning?*

*PALAEOZOIC ERA: CAMBRIAN PERIOD*, 542-488.3 Ma. The break-up of Rodinia had created extensive near-shore shallow and deep-water environments. The “**Cambrian explosion**” of armored marine organisms with silica, calcite or calcium phosphate **carapaces and shells** took place (probably a response to the appearance of predators), with many “evolutionary experiments”, eg. 2 metre “proto-arthropods” *Hurdia* and *Anomalocaris*, and **ancestral vertebrates** *Pikaia* (jawless fish with dorsal notochord, primitive brain, from Canada’s 505 million-year-old Burgess Shale; also, 2 cm *Haikouichthys* from China). Corals, crinoids, brachiopods, molluscs, trilobites and other arthropods, nearly all modern phyla appear in the fossil record; the number of orders of animals doubled about every 12 million years.

*Kangaroo Island (S.A), Emu Bay Shale (520 million years BP): the Big Gully “lagerstätten” soft-bodied fauna includes primitive arthropods (Myoscolex), and an early large (60 cm) predator (Anomalocaris – “pineapple slice” mouth with 2 nasty “sawtooth” appendages). Also, shelled crustaceans, trilobites including Redlichia, up to 25 cm. long.*

**ORDOVICIAN PERIOD**, 488-443.7 Ma. Complex marine communities: sponges, corals, graptolites (many Vic. species), jellyfish, trilobites, molluscs (eg. truck-length cephalopod *Orthocone*), first true vertebrate fish (*Astrapsis*); intertidal swamp liverwort-like plants. This Ordovician radiation tripled animal diversity, aided by skeletal “scaffolding”, internal cell & organ specialisation. **Period ends with Gondwana supercontinent formation, ice ages, sea level fall, mass extinction of nearly ¾ of ocean species within a million years (gamma irradiation from a nearby supernova?).**

*Macdonnell Ranges: world's second oldest complete fish fossil - agnathan (jawless) Arandaspis, about 450 Myr BP.*

**SILURIAN PERIOD**, 443-416 Ma. Jawless bony fishes (eg, *Cephalaspis*). Terrestrial life – vascular plants (eg. *Cooksonia*: stems, water-regulation); 2m amphibious scorpion *Brontoscorpio*, 3m *Pterygotus*; millipedes, spiders: low-rise “first forests”. **DEVONIAN PERIOD**, 416-359 Ma. Fishes, e.g. 5m *Hyneria*, fearsome **6m Dunkleosteus**: jaws, teeth. First

sharks. **Amphibian tetrapods:** e.g. 2m *Hynerpeton*; Greenland's *Ichthyostega* – a “fish with legs”, mineralised internal skeleton, air-breathing lungs. First winged insects evolve from myriapods (centipedes, millipedes). **Ends with mass extinction.**

*Gogo Station (Kimberley, W.A.): 375 Ma coral reef - world's best-preserved armoured fish: Placoderms (3 major groups), Materpiscis with internal embryo (“world's oldest mother”). Also, 2 lungfish (Dipnoans); 2 lobe-finned fish - 4m Onychodus, Gogonasus. Mt. Howitt, Vic., 380 Ma ancient lake bed: an arthrodire placoderm, Austrophyllolepis - oldest male copulatory organ, a bony clasper fin: “world's oldest dad”. Canowindra, NSW, 360 Ma: 1000's of placoderm and lobe-finned fish in an ancient dried-up pool, including Mandageria (1.6 m), lungfish Soederbergia. Grampians, Vic.: 400 Ma footprints of tetrapod amphibian ( an ichthyostegid?): earliest known vertebrate on land.*

**CARBONIFEROUS PERIOD, 359-299 Ma.** Supercontinent Pangaea. Giant amphibians (*Eryops*). First reptiles, eg. *Petrolacosaurus*: efficient



heart, waterproof scales, terrestrial cleidoic amniotic eggs. Tropical swamps, **“GREEN EARTH”**: lycopods, horsetails, ginkgoes, giant cycads, 50m ferns: future **coal measures**. 1m dragonfly *Meganeura*, dog-sized spider *Mesothelae*, 4m centipede *Arthropleura*; air 1/3 oxygen, megafires. For Earth’s fire history, refer Hyland (2011).

*PERMIAN PERIOD*, 299-251 Ma. Begins with **Ice Age**. Large reptiles, e.g. 3m Pelycosaur “sailbacks” **Edaphosaurus, Dimetrodon**; mammal-like reptiles (Synapsids: temperature regulation, heterodont teeth). **Ends with Siberian eruptions, break-up of Pangea, major (90%) end-Permian mass-extinction**, including 1-tonne **Scutosaurus**, 5m **Gorgonopsids**.

*MESOZOIC ERA: TRIASSIC PERIOD*, 251-199.6 Ma. Vast *Lystrosaurus* herds. Climate warmed: weathering of exposed coal deposits, CO<sub>2</sub> release. **First dinosaurs** (eg. *Euparkeria*); complex social behaviour. Lizards; Cynodont ancestors of mammals. **First mammals**

(*Megazostrodon*). Australia joined to Antarctica – part of Gondwanaland.

*Sydney* – “a city built on fossils” 230-210 Ma old: mainly fish (many species, e.g. lungfish *Gosfordia*), and labyrinthodont amphibians (e.g. spectacular *Paracyclotosaurus*: head 1m ); also, dragonfly *Mesotitan* - 30 cm wingspan.

**JURASSIC PERIOD**, 199.6-145.5 Ma. Warm climate, no polar ice. Giant sauropod and ornithischian dinosaurs, pterosaurs, marine reptiles (ichthyosaurs, plesiosaurs, pliosaurs including 50m *Liopleurodon!*). First birds (e.g. *Archaeopteryx*). Rifting of supercontinent Pangea, forming Laurasia and Gondwana. Anoxic warm ocean events preserve organics as **oil/gas deposits**.

*Roma, Q'land*: 16 m sauropod *Rhoetosaurus*, 175 Ma. *Geraldton, WA.*: 2m theropod *Ozraptor*.

**CRETACEOUS PERIOD**, 145.5-65.5 Ma. Formation of chalk: seabed deposits of coccoliths with calcareous shells. Burial and heating of

organic matter: today's continental shelf oil fields. First **flowering plants** (angiosperms), marsupials. Giant carnivorous theropod dinosaurs, eg. *Tyrannosaurus* (recent finds at Liaoning imply feathery plumage!). First placental mammals. Pacific mantle plume volcanism, extensive warm shallow seas. **Gondwana and Laurasia separate**, bearing fauna and flora into new climatic zones. **Ends with Deccan Traps eruptions and mass extinction: 10 km asteroid impact, Yucatan's 180 km dia. 30 km deep Chicxulub crater, energy release approx. 1 megaton bomb/ km<sup>2</sup> of Earth's surface; crust shattered, melted; fires, acid rain, global winter. Extinct: dinosaurs, sea & air reptiles, birds, land plants.**

*Inverloch, Vic. (115 Ma): Allosaurus(?), Qantassaurus; 4m amphibian Koolasuchus; early placental mammals(?) Ausktribosphenos, Bishops. Lightning Ridge, NSW (110 Ma): opalised fragments of dinosaurs, plesiosaurs (eg. famous "Eric"); fish, crocodiles, turtles, molluscs, clams, squids, early monotreme Steropodon. Flinders Highway, Q'land (110 Ma): 7m ichthyosaur Platypterygius; 13m pliosaur Kronosaurus (teeth 30 cm); 9m plesiosaur Woolungasaurus ("Loch Ness monster"); giant turtle Cratochelone; 2 huge pterosaurs; true bird Nanantius; dinosaurs*

include 8m ornithopod **Muttaborrasaurus**, armoured ankylosaur **Minmi.** Dinosaur Cove, Vic. (106 Ma): cold-climate dinosaurs **Leaellynasaura**, **Atlascopcosaurus**, **Timimus**; a polar **Tyrannosaurid**. Winton, Q'land (98 Ma): huge sauropod dinosaurs 15m **Austrosaurus**, 16m **Diamantinasaurus** "Matilda", 20m **Savannasaurus elliottorum**; theropod carnivore **Australovenator** "Banjo": 30cm claws; Lark Quarry dinosaur trackway. Broome, W.A.: **Stegosaurus** track (the only known example - stolen); circular 1m+ footprints - a gigantic sauropod similar to **Brachiosaurus**(?): the largest land animal ever?

**CENOZOIC (TERTIARY) PERIOD: PALAEOCENE EPOCH, 65.5-55.8 Ma. Australia separates** from Antarctica, commences northwards drift. Return to warm wet climate, dense global forests. Vacant ecological niches re-occupied by **adaptive radiation of surviving small mammals (max. 35 kg: small, fast-breeding, scavengers); also reptiles, birds**, flowering plants. First **primates** – arboreal, with dexterous hands, larger brains, stereoscopic vision.

*EOCENE EPOCH*, 55.8-33.9 Ma. Cat-sized primate (*Darwinius masillae*), small horses, whales; large flightless birds. **Abrupt global warming (Dayton, 2009: Palaeocene-Eocene Thermal Maximum, PETM); probably clathrate release of greenhouse gases. 55 Ma: warmest climate in Cenozoic: high CO<sub>2</sub> and ocean temperature.** Mountain building (Himalayas, Andes); CO<sub>2</sub> absorbed by weathering of newly-exposed deep crustal rocks, starts **global cooling, continuing to present times.** *Murgon, Q'land (54.5 Ma): early marsupial and placental(?) mammal fragments; a bat, Austromycteris; Earth's first known songbird(?); crocodiles; a "soft-shelled" turtle; a primitive snake.*

*OLIGOCENE EPOCH*, 33.9 - 23.03 Ma. **Seasonal climate: Antarctic ice cap re-forms.** First apes (**Hominidae**). New World monkeys. Grasses evolve and spread, large herbivorous mammals appear..

*MIOCENE EPOCH*, 23.03 - 5.332 Ma. Separation of ape and monkey lineages ca 20 Ma. African forests dry out to savanna; ape and

Afropithecine hominin upright bipedal lines separate about 7 Ma: only 1% human DNA, e.g. HAR1 gene, has changed (Pollard, 2009). **Extensive Antarctic ice cap.** Uplift of Tibet, strengthening Indian monsoon. Oldest-known African hominin fossil *Sahelanthropus tchadensis* (about 7 Ma); then *Ardipithecus kadabba* (about 5.8 Ma), now know to have walked bipedally upright. **Palaeolithic** (Old Stone Age) period commences (late Miocene?) with basic stone/bone/wood tool use – fractured pebble cutters, scrapers, digging sticks, etc.

*Riversleigh, N.W. Q'land (25 – 10 Ma): World Heritage Area, one of Earth's top five fossil localities. A huge variety of rainforest animals: bats, monotremes, marsupial carnivores including many thylacines; diprotodontids, wombats, koalas, possums; kangaroos include fanged **Balbaroo** (“fangaroo”) and meat-eater **Ekaltadeta**; enigmatic “thingodonta”; numerous birds including enormous (2 m) flightless “thunderbirds” (dromonorthids) such as **Bullockornis** (a “demon duck”); crocodiles, snakes (elsewhere, Columbia's **Titanoboa** – 13 metres!), lizards, turtles, frogs, fish and snails, insects and other*

invertebrates. Lake Eyre Basin, S.A., also provides examples of a similar rainforest fauna.

Alcoota, N.T. (8 Ma): early in Australia's "great drying". Fossils from an ancient lake margin include diprotodontids up to horse-size (**Pyramios**), kangaroos, thylacines, a large marsupial cat (**Wakaleo**), huge flightless "superhook" birds (**Dromornis**), and crocodiles.

**PLIOCENE EPOCH**, 5.33 – 2.588 Ma. **Warm climate, 2010 CO<sub>2</sub> levels, extreme global warming 3 Ma; seas flood most of Murray basin** (Sandiford, 2009). Hominin fossils (Wong, 2009): bipedally upright **Ardipithecus ramidus** (4.4 Ma), followed by **Australopithecus anamensis** (4.1 Ma), then **A. afarensis** ("Lucy") and **Kenyanthropus platyops** (both ca 3.2 Ma). By 2.6 Ma there are at least two more Australopithecines, **A. africanus** and **A. garhi**, and **Paranthropus aethiopicus** from East & South Africa. South and North Americas are joined. **2 Ma: less CO<sub>2</sub> + orbital "wobbles", Northern Hemisphere ice sheets re-form**. By about 1.8 Ma the **human pedigree** (see Wong, 2009; Leakey and Walker, 2006) includes at least 6 African protohumans:

*Homo (Australopithecus?) habilis*, *H. ergaster* (Lake Turkana; also, the first hominin to leave Africa); *Homo (Kenyanthropus?) rudolfensis* and *H. erectus*; also, *Paranthropus robustus* (“nutcracker man”) and *P. boisei*. Indonesia’s “hobbit man”, *Homo(?) floresiensis*, shares its small brain, teeth and jaw features with *Australopithecus*.

**PLEISTOCENE EPOCH**, 2.558 Ma – 11700 yr ago. **Ice Ages: strong oscillations between warm and cool periods.** Only two known surviving *Homo* ancestors: *H. antecessor* (about 1 Ma), who gives rise to *H. heidelbergensis* (0.5 Ma), then *H. neanderthalensis* (about 240,000 yr) and *H. sapiens*, about 200,000 yr); and *H. erectus*, who had also migrated out of Africa into Europe, China and Indonesia, where one *Homo(?) floresiensis* “hobbit” population (Jones, 2009) survives until 17,000 BP on Flores Island. About 190,000 yr: first bands of modern *Homo sapiens* (“Cro-Magnon” humans) appear in eastern Africa, probably with well-developed languages, co-operative hunting and foraging skills. Some migrating bands reach Arabia at least 125,000 yr ago, start displacing Neanderthals (Wong, 2009; Smith, 2011); Gause’s



“competitive exclusion principle” in action? 25,000 yr: *H. sapiens* and *H(?) floresiensis* are the sole surviving hominins.

**About 100,000 BP: last Ice Age begins – maximum glaciation about 20,000 yr, then rising CO<sub>2</sub>, steady warming until about 13,000 yr, then abrupt much colder Younger Dryas event; about 11,500 yr, very rapid temperature increase (globally, about 4C in 50 years: compare current concern at 0.1C rise per decade!). Possibly due to “stop-start” of oceanic thermohaline circulation (driven by heat and salinity), caused by melting freshwater Arctic ice sheets at beginning of Younger Dryas event. Seas rise 130 metres at 2m/century, flood 8% of continents incl. Bass Strait.**

About 60,000 yr ago: colonization of **Australia** (by raft?) across 100 km Exmouth Trench, first by “robust” thick-boned (Kow Swamp) people, later replaced by “gracile” thin-boned modern *sapiens* people (Pellegrino, 2004). By 25,000 yr: Neanderthals everywhere extinct: our first “ethnic cleansing”? Or did some hybridisation occur? (De-fleshed bones in hearths: evidence of cannibalism?). About 13,000 yr: first clear evidence of human entry into Americas, via Bering Straits.

(1) Wellington Caves, central NSW (1Ma to present day): natural pitfall traps for animals including **Zaglossus** (a giant echidna), marsupial carnivores including leopard-sized “marsupial lion” **Thylacoleo carnifex** (“bolt-cutter” teeth); bilbys, wombats, “marsupial hornless rhinos” **Diprotodon** and **Zygomaturus**, kangaroos including **Propleopus** (70 kg predatory giant “rat-kangaroo”) and **Procoptodon** (a huge short-faced kangaroo as tall as *T. rex*); huge 5 m goanna (**Megalania**), a 6m snake (**Womambi**). Pellegrino (2004) adds “a Komodo dragon-like monitor lizard 13 metres long”.

(2) Thylacoleo Caves, Nullarbor Plain, W.A. (780,000 to 200,000 yr ago): claw-footed 300 kg giant kangaroo **Sthenurines**, 200 kg flightless **Genyornis** (heaviest known bird), **Thylacoleo** – altogether, 69 bird/reptile/opossum/wombat and kangaroo species (23, including 8 new, and 2 tree kangaroos). Vegetation (woods, shrubland) was more diverse, and flora/fauna seemed resilient to ice-age/interglacial climatic variations. Combining this recent (2002) find with megafauna/sediment studies at Naracoorte Caves (S.A.), Flannery (2010) sets **extinction of 90% of Australia’s megafauna** at about 46,000 years ago, when increase

*in bushfires (“firestick farming”?) reduced vegetation diversity. Overlap between people arriving and extinction was about 3,900 years; “Death of Australia’s Megafauna” resembles that of many large animals worldwide, such as the woolly mammoth, sabre-tooth tiger, large flightless birds, giant ground sloth, etc.; these were “doing just fine” (Dayton, 2007; Jones, 2010: Cuddie Springs; Death of Megabeasts, 2010) until humans arrived, when overhunting of breeding stock, introduced diseases, environmental destruction and aridity stresses drove them to extinction. With a post- WW2 global mass-extinction now in progress, we still seem ignorantly unwilling to leave room for many of our fellow-inheritors of four thousand million years of biological evolution: in Darwin’s famous ending to his small green book *On The Origin Of Species*, not enough room for “**endless forms most beautiful and most wonderful, (which) have been, and are being evolved.**”*

**HOLOCENE EPOCH....11,700 years to present time: human history since the end of Ice Ages - 4 major glaciations, the last ending about 11,500 years ago (the “Younger Dryas” event), with global**

rise in sea level. The current interglacial “Long Summer” commences, permitting the “experiment of civilization” to initiate and evolve to our modern world. European “Mediaeval Optimum” warming 800-1300 AD, then “Little Ice Age” to 1800 AD.

10,000 – 5,000 yr: intensive **tribal nomadic** foraging technologies, including “swidden” slash-and-burn forest clearings; some sedentary societies appear with early **agriculture**, including domestication of dogs, goats, cattle and cereal farming in the Middle East “fertile crescent”. As farming populations grow rapidly, large village communities (“**chiefdoms**”) appear, with greater social complexity and hierarchy.

About 5,000 BP: the first **cities, states**, and agrarian civilizations appear. In Sumer and Egypt, powerful “priest-king” elites emerge, controlling resources through tribute-taking and taxes, used to organize public works, monument building, large-scale worship, and warfare/conquest. Record-keeping and writing appear. Literate **urban/agrarian civilizations** spread from Tigris/Euphrates and Nile valleys into Persia and Mediterranean Europe, becoming the most

populous, powerful and technologically “superior” among human communities. They also arise independently in China, India, Africa, S/E Asia, and the Americas (Maya, Inca, Aztec, etc). Imperial kleptocracies (e.g. Roman and Mongolian empires) emerge.

***MODERN “ANTHROPOCENE” INSTANT***, since 1500 A.D.

About 500 yr BP (before present times): Afro-Eurasia and the Americas are linked to form the first “**world zone**”, with the first global system of exchange.

About 200 BP: the first capitalist societies emerge in western Europe; the “Industrial Revolution” exploits **fossil fuels**, generating major increases in the wealth and power of European states; European imperialism begins to dominate Earth, unstoppable by populations with little or no previous exposure to European guns, germs and steel.

100 BP: Industrial **coal/oil-based technology** starts to spread world-wide; atmospheric CO<sub>2</sub> now at 380 ppm (last seen during Pliocene), rising

at 2ppm/year. Major conflicts between capitalist states; communist backlash occurs.

50 BP: First use of a nuclear weapon: super-power armaments and cold-war rivalry endanger Earth's biosphere, including humankind. Human populations reach 5, then 6 billions, with accelerating adverse impacts (the **O**verexploitation component of **MIGODS** development (see p.4 of this essay) on atmosphere, climate, biodiversity, fisheries, soils and agricultural resources. Space exploration begins.

5 BP: To date, liberal democratic systems of government are ascendant. However, nuclear weapons technology is becoming available to rival theocratic systems. Environmentally **sustainable use** of global resources, and population stabilization (increasing by 70 millions per year: Brown, 2009) within **Earth's carrying capacity**, are yet to be achieved.

***THE FUTURE: REASONS FOR OPTIMISM?***

It is said that our history is an ongoing debate between the past and the present, concerning the future (“*journalism is but the first draft of history*”). Or, to quote Milan Kundera:

***“Man proceeds in a fog. But when he looks back to judge people of the past, he sees no fog on their path. From his present, which was their far-away future, their path looks perfectly clear to him, good visibility all the way. Looking back he sees the path, he sees the people proceeding, he sees their mistakes, but not the fog.”*** (Or: “*Isn’t hindsight marvellous?*” Or: “*It seemed like a good idea at the time.*”)

Opinions, often strongly held, often based on incomplete and unbalanced information and perceptions, vary widely. “**Futurology**” is a risky endeavour; in our lifetimes, we’ve witnessed antibiotics, television, jet engines, the atomic bomb, IVF, pharmaceutical proliferation, lasers, gene technology, disposable nappies, aerosol sprays, organ transplants, Botox injections, space travel – and more! Recall 1950’s predictions of domed cities, nuclear-powered vacuum cleaners / vehicles / free electric energy, and the **total failure to predict** computers, the Internet, current geopolitics and the climatic impacts of

industrialisation? Nobody predicted pulsars, quasars, gamma-ray bursts, the standard model of particle physics, cosmic dark matter and dark energy, and much more. So we foresee more unforeseeable discoveries (“unknown unknowns”). Here follows one person’s “**first draft**” (**incomplete, fog-bound**) to make some sense of humankind’s prognosis, from the perspective that **our common values and democratic freedoms**, derived from historical freedoms of thought from the Athenian polis to the European Enlightenment, are **worth conserving** for ourselves and following generations.

*In the short term – the coming few decades – geopolitical prospects?* Who possesses the more reliable crystal ball? Optimistically, we may hope that our growing comprehension of who we are, and whence we have come, can help us to calm down, to renounce intercultural inter-religious tribalism and warfare, and to **conduct our affairs more rationally** – provided that this comprehension is not rejected by too many of us.



Unfortunately, it seems that the fundamentalist wing of a major global cultural demographic enjoys considerable support in attempting to impose, by revolution, intolerant theocracy-based caliphates within Islamic states; diffuse terrorism could thereby transform into **implacably hostile belligerent nuclear-armed states** (Killebrew, 2004; Sheridan, 2007). Also, mass immigration, rapid natural increase, and refusal to culturally integrate, could achieve **political theocratic supremacy within** democratic European nation-states during the coming few decades. Already there are attempts to install “no-go” areas (e.g. Roubaix in France) – “mini-states” where non-Muslims are driven out, and national law is replaced by sharia-type courts overseen by local imams. Phillips (2007) sees the start of this anti-Western “Islamist pincer strategy” in Ayatollah Ruhollah Khomeini’s 1979 declaration of *jihad* – an intent to subjugate Western civilisation to Shia Islam, igniting global political and theocratic Islamism (including a rival Wahabi Sunni version), and leading to a series of actual or foiled terror massacres. She points to a recent history of **post-Enlightenment liberal states’ tolerance** and respect for

minorities, endowing freedom to practise their faiths and cultures in the private sphere, and in return expecting no demands on the parent state to change its “bedrock culture” – freedom of speech, monogamy, church/state separation, women’s rights, etc. Yet many beneficiaries of Enlightenment freedoms see jihadist attacks and subversion through a prism of perceived conspiracy by Israel and America to impose global hegemony, and support a “**multicultural**” **relativism**: minority values must have equivalent status with majority democratic culture, whose defenders are often assailed with “*BRIX*” insults (bigot, racist, intolerant, xenophobe).

Many well-meaning people see **demographic concerns to be exaggerated**: immigrants from various nations have successfully integrated with their host societies, often despite initial resistance to acceptance. Unfortunately, as pointed out by European observers, eg. Steyn (2007): *“Those (Irish, Greeks, Italians, Vietnamese, etc.) are nationalities. But Islam is an explicitly political religion .... for its adherents in the West, it becomes their principal expression – a pan-*

*Islamic identity (“umma”) that transcends borders.”* And: *“instead of assimilation, there’s conversion....the host country winds up assimilating with Islam.”* For the **survival of European liberal democracies**, we can hope that burgeoning European Muslim immigrant populations will accept liberal democratic values, including historically recent freedoms of enquiry unconstrained by religious orthodoxy. (Australia - no problems? See Zwartz, 2005; Neighbour, 2007/09/10; Warne-Smith, 2011). **What do you think?** (Personally, I would be pleased to be shown where Steyn, Zwartz *et al* are wrong. If they are right, then we need acceptance that serious problems exist, and agreement concerning remediation). Steketee (2007) reports that IAEA head Mohamed ElBaradei spoke in 2006 of “the new realities”: terrorists trying to acquire nuclear weapons; over 650 *known* cases of attempted smuggling of nuclear materials in the past decade. Yet analysts aplenty ignore the danger of *asymmetric attacks* on cities (Cochran & McKinzie, 2008), overwhelming any nation’s medical and economic resources. Muon (secondary cosmic ray) scanning tomography (Wolverton, 2007) *may* assist in detecting nuclear contraband.

Pipes (2006) reported a large-scale **survey of attitudes** to Western societies among Muslim populations in 10 countries (Egypt, Indonesia, Jordan, Nigeria, Pakistan, Turkey, France, Britain, Germany, Spain). Conspiracy theories flourished: the 9/11/01 New York attack was seen as a hoax perpetrated by the US government, Israel, or some agency other than its Arab perpetrators, by **majorities in all 10 countries** (52% in France, up to 85% in Pakistan). **Terrorism** by suicide bombing (*“The death of those who are killed for the cause of God gives more impetus to the cause, which continues to thrive on their blood”*: Sayyid Qutb, principal theoretician for the Muslim Brotherhood, quoted in Gove, 2006) was justified by 13% (Germany), up to 69% (Nigeria). **Alienation** (western infidels seen as violent, greedy, arrogant, immoral, women allowed beyond their appointed place in society) was widespread, being greatest among Britain’s “Londonistan” and Nigeria’s anti-Christian communities. Western scheming, intrigues, perceived double standards on terrorism, and the Israeli/Palestinian conflict, were widely held responsible for lack of

prosperity in Muslim countries, rather than lack of education and government accountability, and the presence of corruption and evangelical extremism. *“It is so much easier to blame others for our problems than to accept any responsibility ourselves”*: Benazir Bhutto (2008), expounding the *self-infliction factor* in human affairs, prior to her murder by suicidal assassins in Pakistan. With radical Islamists seeing Islam to be a revolutionary ideology, warfare (jihad against “infidels”) in its cause to be a duty and an exalted form of piety, and democracy to be replaced by “God’s government”, mutual distrust is prevalent (Pipes, 2006; Dhume, 2010). This most unfortunate problem seems to be rooted in centuries of inward-looking exclusive theocracy whose adherents, while resenting the failure of their source nations to keep up with Western prosperity, have so far significantly rejected **modernisation and integration** with their host societies -- unlike previous immigrants from many other cultures and ethnicities. (See also Gove (2006), Buruma (2007), Kelly (2006), Mallaby (2004), Phillips (2007), Fukuyama (2007), Aayan Hirsi Ali (2007), Gerech (2007), d’Ancona (2006), Husain (2007), for remedial analysis). Short (2009) reports **world overpopulation**, heading for James

Lovelock's catastrophic "crash" to half to one billion by 2100: eg. Pakistan, with "rivers of young men with no hope of a modern education, job or reasonable income...ripe fodder for terrorism"; "critical" in Palestine (half the population aged below 16), also Nigeria and across Africa. As summarized by Andrew Robb (2006): "*The last century was dominated by the **politics of ideology** and the contest between communism and socialism on one side and capitalism on the other. This century, because of globalisation and the anxieties it creates, will be dominated by the **politics of identity**. There are two trends at work. Globalisation creates opportunities for countries to open up and obtain its benefits. Yet there is a backlash from rising nationalism and tribalism, and those **countries that tolerate tribalism will see their societies pulled apart.***"

Reactions to Islamic theocracy may include European (and Australian?) re-discovery of "**cultural Christianity**" as a tribal consensus to **bind atomised Western societies** together (Burleigh, 2006; Micklthwait, 2009). Further civil and international rivalry and strife are all too

possible: as of 2011, proxy wars between militant Islam (Hezbollah and Hamas, armed by Iran and Syria) and Western democracy (Israel, armed mainly by U.S.A.) have again damaged an uneasy stalemate in the Middle East, with a messianic Iranian President awaiting the 12<sup>th</sup> Imam, saying he wants to “wipe Israel off the face of the map” in a world “free of America”, developing nuclear weapons and long-range missiles. *“History has told us that when **aggressive national leaders** make threatening pronouncements, it is as well to take them seriously. Adolf Hitler taught us that. So did Pol Pot. And many many others.”* (Sheridan, 2006).

Having rescued and garrisoned a significantly ungrateful Europe from tyranny during the past century, and following Europe’s accelerating demographic Islamisation (within two generations – *“fading elderly slow-breeding populations yielding to a young surging Islam”*: Steyn, 2006), the reviled U.S.A., possibly as the sole major survivor of Western liberal democratic culture, could revert to pre-Pearl Harbour (Dec. 1941) **isolationism** – a process fuelled by its current (2010)

financial problems? This would give its many detractors ( for an extreme example, see Adams, 2007) the option of preserving or regaining their democratic rights and freedoms without its assistance, if possible. Many in Europe and Australia (see, eg. Bendle, 2008/9) deride the **common interests** we share with the world's longest-established democracy, and its historically unique **exercise of power with restraint**, while similar prejudicial lampooning of Aboriginal, African, Arab or Asian cultures is correctly regarded as bigotry (see, e.g., Hing, 2006). Analysts (eg. David Selbourne, 2005/6) see **in Western liberal democratic societies a moral crisis**, typified by the USA: *“a condition of increasing bewilderment and internal division, often bordering on mutual hatred and reciprocated paranoia, among its political elite, its competing experts on Islam, its media and its population....a profound national disarray”*. To Selbourne, *“The US is a nation at war but one that has lost its sense of direction and that is therefore at war with itself. In contrast, Islam's new found sense of purpose, in its third great historical advance, increases with each new conflict that its jihadist ethic and strategy*



*provoke....whether such conflict is conducted with battlefield armaments or by means of ever-widening claims – legal, cultural, political and other - on the societies in which their diasporas are found throughout the world.”* Many others (eg. Van Olsenon, 2008) also warn that *a house divided against itself cannot stand*, that **disarray encourages despots**, that a possible outcome is Samuel Huntingdon’s hatred-driven “*clash of civilisations*”- another WW2- type Armageddon, between rival cultures armed with truly catastrophic weaponry.

Another looming change (**the next “hegemony”?**) is China’s economic, military and geopolitical power, soon to surpass the US? Growth has been disciplined, enforced: “*We can work very hard...achieve in one week what (the West) can achieve in one month*” (Zhang Yimou). China, globalisation’s “big winner” (Callick, 2010), is “*a vacuum cleaner for raw materials (coal, iron ore, etc.)... utilising cheap domestic labour and European and American technology, it has made and sent a tsunami of consumer goods back out across the world. China.... uses*

*the Orwellian machinery of the modern totalitarian state, from persuasion and surveillance (eg. its “Great Firewall” of Internet censoring) to imprisonment and the death penalty.”* (Buttrose, 2006). Up to 5 millions, including 1383 documented political prisoners (e.g. Liu Xiaobo, 2010 Nobel Peace Prize) are held in at least 909 *Laogai* labour camps (Stephens, 2010). Also Buruma (2008): “...*the comforting idea that capitalism, and the growth of a prosperous bourgeoisie, will inevitably lead to liberal democracy*” is negated by “*a middle class bought off by promises of ever-greater material gains, that hopes to **conserve** the political order: prosperity in exchange for political obedience.*” This “**China model**”, **autocratic capitalism** – no freedoms (e.g. trade unions, *falun gong* ) unless approved by an unelected oligarchy - is “***the most serious challenge that liberal democracy has faced since fascism in the 1930’s.***” It appeals to “***autocrats everywhere, from Moscow (Horvath, 2008) to Dubai, Islamabad, Khartoum***”, who rule by decree or single-party oppression, resisting “*human or civic rights as an outmoded or an arrogant expression of Western imperialism, (which sells) Olympic stadiums, skyscrapers, information technology, media networks, minerals*”

to China's leaders: "*we are the masters now*" of the West (Ferguson, 2010). Yet, lacking the "*in-built self-correcting mechanisms*" of democracies (Stephens, 2010), is China's repression-based pseudo-stability liable to eventual failure, Soviet-style ?

So: could our "*day of democracy*" revert to a "*day of autocracy/theocracy*" (see, eg, Kagan, 2007), unless enough of us sufficiently value our painfully-evolved historically recent democratic political systems to refrain from weakening them by undue pessimism ("*worst-case enthusiasm*")? Many of us indulge in *non-stop non-relative* denigration of elected accountable leaders, mainly local and USA. Yet, within Australia, there persists a **deep memory of United States aid** for our almost defenceless nation in 1942; for her 405,000 WW2 dead (Arnold-Forster, 1981), the majority killed rescuing Europe from Nazism (eg. Omaha Beach slaughter, 1944: 90% casualties); for post-war Marshall Plan reconstruction of war-ravaged countries; and for "holding the line" against Communist imperialism (starting with the Berlin airlift, 1946) for the next 45 years. Although motivated by US self-interest as well as

altruism, this has formed extensive cultural affinities between our two democracies. Yet a 2005 survey (Lowy Institute for International Policy) has claimed that many Australians consider the U.S.A. to be as great a threat to global peace as Islamist theocracy, al-Qa'ida terrorism, and Chinese/Russian autocracy. **Do we sufficiently appreciate** our hard-won freedoms of inquiry and expression, based in democracies with their origins in Periclean Athens, with their noblest expression in Lincoln's Gettysburg Address (*"government of the people by the people for the people"*), which have survived European and Asian fascism and Eastern Bloc communism? Are we permitting ourselves to be disproportionately influenced by self-styled "socially progressive" (!) movements, anti-institutional attitudes, and exaggerated critiques ("evidence-free hatred"?) of Western societies and their elected leaders? Can the current (2013) US administration **encourage a global renewal of belief** in Enlightenment-based values (Beinart, 2007; Switzer, 2009), rejection of moral relativism (Pearson, 2006), and commitment to building an inclusive model of citizenship which challenges irrational anti-democratic antipathies and divisive separatist

tribalisms? **If not, are we undermining our basic freedoms**, eg. our rights to conduct courses such as this one in cosmology, or in any other knowledge potentially deemed unorthodox or seditious by future clerical or secular autocrats?

***In the short term: environmental prospects?*** Additional pressure on Earth's stressed climate, agricultural resources, fisheries and remnant biodiversity also seems unavoidable. Our small planet's climatic balance and biosphere must somehow cope with **inter-tribal strife**, the **rapid catch-up industrialisation** of burgeoning "third world" populations, and **irresponsible "first-world" over-consumption** of limited resources. Evolutionary psychologists such as Geoffrey Miller (2006) consider the problems of wasteful consumption and **consumer-driven "adult infantilism"** to be curable: *"Darwinian critiques of runaway consumer capitalism should undermine the social and sexual appeal of conspicuous consumption. Absurdly wasteful display (by "excess airheads") will become less popular once*

*people comprehend its origins in sexual selection, and its pathetic unreliability as a signal of individual merit or virtue”.*

Inevitably, **Earth’s recovery of MIGODS sustainability** (see p.4) will prevail, with or without our management of it. While global warming requires a global response (greenhouse emission reductions), worst-case scenarios should be seen in context: *“Earth’s climate (is) extraordinarily complex... scientists do not yet fully understand it...we are looking at an intricate coupled system which links the behaviour of the atmosphere, oceans, land surface and the planet’s orbit around the Sun.....**climate change is not an aberration** or some malfunctioning of our planet; it is part and parcel of its natural behaviour* (Lamb and Sington, 1998; Calder, 2007; Aitken, 2008). Physicist Frank Wilczec (New Scientist, 18/11/06) is optimistic: *“The sun rains about 10.000 times as much energy onto Earth as we now use. We’ll learn how **to capture at least a thousandth of that energy** (eg. wind, solar thermal/salt storage), vastly increasing the world’s wealth”.*

Kurt Lambeck (President, Aust. Academy of Science, 2007) is less sanguine: **changes explicable only** by a 35% increase in atmospheric CO<sub>2</sub> due to coal/oil/gas combustion are as follows: **annual oceanic CO<sub>2</sub> absorption** has declined to 37% of emissions; **surface air temp.** is up by 0.7C last century, with probably a further 1.3C to 1.7C rise as early as 2050; global **ocean warming**, down to several hundred metres, accelerates **sea-level rise**; the **stratosphere** is cooling (not good news); northern hemisphere **sea ice and snow cover** are decreasing; **glaciers** are retreating; **more extremes** (heat waves, droughts, cyclones, intense rainfalls) are anticipated. **Australia** can expect a poleward shift in mid-latitude westerly winds and associated storm tracks, hence more frequent droughts and bushfires, eg. 2009 Victorian tragedy (Hyland, 2011); also declining S/E Aust. rainfall, increased rains elsewhere (eg. 2011 S/E Q'land floods), changing seasonal weather patterns and economic/social impacts. **Arctic sea ice is melting 30 years faster** than IPCC modelling (7.8% per decade, 3 times faster than predicted): *no* summer ice by 2020? **Greenland and West Antarctic ice sheets** are melting at about 125 billion tonnes /year; we face **global sea**

**level rise**, up to 1.4 metres by 2100, thereafter about 12 metres (Kristof, 2007). Bell (2008) warns that newly discovered abundant water under these ice sheets, lubricating accelerating slippage into the oceans, could hasten these rising seas. Lambeck: *“Our children will be living in a world well-nigh unrecognisable to us”*; forecasts include a major mass extinction, a Jurassic-type warm climate, acidic rising oceans, and *no* polar ice (as was the case for 89% of Earth’s geological history) unless we globally reduce greenhouse emissions.

Alternatively, can melting ice, with reduction in salinity and density, **shut down thermohaline deep oceanic circulation** including the Gulf Stream, causing Arctic re-freezing and a **rapid-onset ice age**? BBC TV, *The Next Ice Age (2006)*, presents evidence for such past events: Canadian glacial pebbles dropped from icebergs into French/Spanish offshore sediments, and temperature changes recorded in Greenland ice cores. Geologist Ian Plimer (2009) also considers that Earth is in a lull in an ice age that began in the Oligocene, 37 myBP, when the Antarctic ice cap began to re-form; climate is changing within its normal cyclic parameters, less dramatically



than during previous geological events, with none of the predicted catastrophic consequences. In short: **do we fry or freeze?** Can we **adapt** to climatic impacts, while being unable to **mitigate** them?

**The IPCC** has estimated (in **April, 2007**: draft 4<sup>th</sup> assessment report on global warning; physical climatic factors reviewed by Collins *et al*, Aug. 2007) that the rise in global emissions, with **75% coming from developing countries** including China and India, can be stabilised at a cost of up to \$US100 per tonne of carbon – a reduction of about 3% of GDP by 2030 (which is a great deal of money!). Its **top three recommended technologies** are **CO<sub>2</sub> capture and sequestration (CCS)**, advanced **nuclear power**, and advanced **renewables** (solar, wind, hydro, etc.); also, H-powered fuel-cell vehicles, biofuels, genetically modified energy crops, more efficient aircraft and electric/hybrid vehicles, integrated solar photovoltaic electricity, smarter metering, “new generation” cement and fertilisers, inert electrodes for aluminium smelting, and more. **Extreme possibilities** include “climate engineering” (“geoengineering”): eg. cooling the planet by injecting sulphate aerosols into the stratosphere to

enhance its albedo (reflectivity); uncertainties could include permanent overcast, no more blue skies, even an ice age.

***In the short term: scientific advances?*** This sample of “known unknowns” for the next 50 years is based on interviews with leading world experts, published in *New Scientist, 50<sup>th</sup> Anniversary Special Issue* (18 Nov. 2006). It also assumes that our Enlightenment-based freedoms of inquiry, to go whither the evidence leads us, will continue.

***Artificial intelligence (AI)?*** After 40 years, the “generic object recognition problem” remains unsolved. Our most powerful computers still cannot reliably view and identify a given class of objects (eg. shoes, or cups, or books), leaving robots trailing two-year-old children. The danger of being taken over by “**artilects**” (artificial intellects) is not yet upon us? Computers which pass the “conversational **Turing Test**” (you can’t tell them from another human) do seem closer. Neurophysiology and insights into the computational foundations of the brain (weighted neuronal networks?) do seem to be converging.

Proponents of “strong AI” consider that every process occurring in our brains, and the *neuroplasticity* of its outputs, will be matched and exceeded when computers access enough gigabytes and teraflops. (Switching off your computer – a new crime, “computericide”?).

***Alien life?*** In ancient Martian permafrost, Enceladus’ ice geysers, Europa’s frozen oceans, Titan’s methane/ethane lakes, or on possibly Earth-like planets Gliese581c,d or e? Or a “**shadow biosphere**” on Earth (Davies, 2007): chemically alien remnant “extremophile” microorganisms, eg. “nanobes”, DNA with different nucleotides, amino acids with opposite chirality, arsenic in lieu of phosphorus (nasa.gov/ntv, Dec. 2010: arsenic bacteria found in Mono Lake); silicon chains and rings in lieu of carbon? The living cell seen as a “chemical and computational machine” may help answer “what is life?”

***Biomedicine:*** Transplantable organs grown from human cells in animal hosts? Nano-sized surgical probes and repair machines? Regeneration/repair drugs for treating severed spinal cords, diseased

hearts, retinas and other organs, and lost limbs, seem close. (Whole-body replacement??). “Anti-ageing” pharmaceuticals, which mimic the molecular pathways of metabolic “molecular injury protection packages” in cells of long-lived animals (whales, bats, reptiles, us), may extend vigorous human life-spans by decades.

*Consciousness solved?* How does the brain create the “self” (the soul’s secular cousin)? A “factor X” in the brain-machine? Are there *two interacting “ghosts in the machine”*: (1) a “*minimal*” or “*core*” *self* of the present moment, a transient entity recreated for each and every object with which the brain interacts; and (2) an “*extended*” *self*, a unified continuous entity journeying from a remembered past to an anticipated future, with a repertoire of skills, stored knowledge and dispositions to act in certain ways? Can we identify the “**universal neural code**”- the rules which the brain uses to convert collections of electrical impulses into perception, knowledge and behaviour, creating these two interacting ghosts? Is the brain’s recently-evolved ventro-medial pre-frontal cortex the seat of emotion-based

moral “Sophie’s choice” decisions (refer *Nature*, Mar. 2007): have our brains evolved biologically and culturally to combine logic with compassion? Can Gazzaniga’s “**mirror neurons**” (Sci. Am. Nov. 2006) provide an improved understanding of human empathy and autistic behaviours? Are “neural cliques” in the CA1 hippocampal region (Tsien, 2007) a subset of populations of neurons which act in concert to **lay down memories**? Can sectarian tribal strife which plagues the globe be explained (and defused ?) by a hypothetical “**neurobiology of ideology**” (Wexler, 2006): the human brain moulding itself to its early environmental and educational inputs, causing distress and dysfunction when encountering unfamiliar disparities in later life? Is consciousness a form of “information energy”, having a *very* tiny mass-equivalence, and hence unable to be created or destroyed (does the First Law of thermodynamics point to survival of personal consciousness in some disordered form?). Can we detect the fleeting inarticulate “thoughts” of other species?

*Cosmic dark energy identified?* A quantum gravity “theory of everything” awaits, possibly based on E8 exceptional Lie group geometry (Lisi and Weatherall, Sci. Am. Dec. 2010), or a deterministic theory of certainties rather than probabilities? String or brane theory may help elucidate dark matter, dark energy (its density constant, or varying with cosmic expansion?), primordial quantum perturbations, inflation, and the “big bang” instant of origin. Underground detectors measuring the big-bang cosmic neutrino background, and new particle accelerators (eg. CERN’s **Large Hadron Collider**: Quigg, 2008), will assist. Do high-energy cosmic strings or superstrings exist? Exploding black holes? Other space dimensions? New forces of nature? Supersymmetric “sparticles” (“shadow matter” – squarks and gauginos)? Is time-travel possible? Nano-sized space probes? The underlying nature of matter and space-time, how elementary particles acquire mass (the **Higgs boson?**), field theory (combining quantum mechanics and special relativity), will all be better understood. Inflation-generated gravitational waves should be detected, perhaps

using laser interferometry. Steinhardt and Turok propose a “colliding branes Big Bang”, a cyclic universe, and a trillion-year “Big Bounce”.

***Evolutionary biology:*** a “consensus tree of life” should emerge from molecular genetics (eg. ancient homeotic *Hox* genes controlling body-building, common to all life?); also, from palaeontology, systematics, biogeography, conservation biology. Rates of evolution, mass extinctions, diversifications and more will be better understood. What “**common ancestry**” lies at the root of the tree? The role of “selfish genes”? Further comprehension of human evolution?

***Fractals:*** the numerical measure of an object’s “roughness” may help to quantify turbulence, metal fractures, music, stock markets, climate change, and many more phenomena incorporating **chaos and complexity**.

***Genome revolution:*** low-cost sequencing of individual genomes should identify “DNA glitches” (faulty genes), new treatments for

cancers and ageing, and interactions between genes and environmental factors (eg. “stress epigenetics”?).

“Computable embryology” – prediction of an embryo’s entire somatic development from its genome and cytoplasm?

***Life’s origins:*** a chemical fluke? Or written into the laws of nature, easy to get started, therefore widespread? Will proto-life be discovered as a rich organic molecular nano-layer (“nanobes”?) on some bio-friendly moon’s mineral surfaces, prior to its consumption by voracious Earth-type cellular-based life? Is Titan’s methane-based “hydrocarbon cycle” (liquid methane evaporating from lakes, then precipitating as “rain” and flowing intermittently in streams and rivers) a model for Earth’s early atmosphere of primarily methane/nitrogen, 4 billion years ago?

***Mathematics:*** Solving the “P=NP” (“proof = no proof”?) problem; further investigating Gödel’s and Turing’s undecidability results. The apparently random distribution of prime numbers (the “atoms of



mathematics”) may reveal resonances with energy levels in heavy atomic nuclei such as uranium.

***Metamaterials?*** Tuneable microwave “cloak of invisibility” bends microwaves around its contents. Optical cloaks (negative refractive index, unlike natural materials), and other synthetically-structured materials, seem imminent.

***Parallel universes?*** Are the laws of physics unique? Other space-times, each with its own physical laws? Other “big bangs”? Other complexities leading to other atoms, stars, planets, biospheres, brains able to contemplate their origins? Was our local “big bang” merely the time when our part of space-time stopped its explosive inflation? Theoretical horizons are expanding; testable concepts may emerge.

***Psychology, economics, social sciences:*** Applied **evolutionary psychology** (“*know thyself*” by *comprehending thy origins and thy evolution*) may further elucidate the biological bases of wasteful

consumption, human cognition, emotions and their rationalisation (more balancing input needed from the cerebral pre-frontal cortex, less aggressive input from the hypothalamus?); also, **social capital**, the “social mind”, a naturalistic moral philosophy, and remedies for our current tribally-generated abuse of our planet and each other. Can **fragmented ideology-laden social sciences** be replaced by an **objective Darwinian unitary theory of behaviour**, disentangling the feedback loop between brain development and ancient primate tendencies which apparently shape our societies? Co-operative collective activities, whereby individuals pay small costs to reap large group benefits, may then become standard human behaviour? Or will irrational anti-science tribalising tendencies prevail? Can behavioural economics based on neuroimaging and evolutionary concepts (competition, mutation, natural selection: Stix, 2009) restrain *Homo economicus* from irrational “boom-and-bust” overconfidence, herding, availability biases and panics, and inappropriate “physics envy”...a search for (say) 3 “Newton’s laws” to capture 99% of economic behavior, in lieu of 99 “laws” explaining 3% of economics?

*Quantum computers?* Require further major integration of physics (eg. “spintronics”) and information-processing theory. Stephen Wolfram’s “computational universe” - a “cosmic code” of all possible programs: eg. programmable nanostructures, algorithmic drugs, mass-customised art, computational irreducibility, a principle of computational equivalence? Search engines delivering organised knowledge in lieu of disorganised multiple choices?

*Science and religions?* Will religions be seen as humanity’s first great attempts to bind together the confusing inputs of experience, to make sense of the world? Are religious beliefs and thinking managed by the same parts of the brain (“God spots”) that we use to interpret another’s moods and intentions (Dayton, 2009)? Is science a child of the same impulse, the difference being that its findings are more precise, more testable, and its story-tellers more accountable? Can science and religion **combine** to give humanity something we can *all* believe – a story, a myth, a dreaming, a theory to give meaning to our lives,

motive to our intentions, something which “*weaves the separate threads into a common cloth, taking the Many and making it One*”? Could this **remedy the fearsome tribal certainties** which bedevil us? Hopeful signs include the St. Petersburg (Florida) Declaration (Albrechtson, 2007), in which a group of “Islamic Voltaire free-thinkers” (including Ayaan Hirsi Ali) call for an Islamic Enlightenment, with an end to sharia law, fatwa courts, male clerical rule and state-sanctioned religion, female submission and genital mutilation, honour killing, child-bride forced marriages, removal of savage penalties (flogging, stoning) for apostasy and blasphemy, and “*an open public sphere in which all matters may be discussed without coercion or intimidation*”, releasing Islam from “*the totalitarian ambitions of power-hungry men*”. Islam could then have a noble future as a personal faith embracing liberty, rationality and tolerance, not as a political doctrine. Hirsi Ali, while acknowledging **democracy’s many imperfections**, believes that its inbuilt self-correction mechanisms have made “*this culture, the West, the product of the Enlightenment, the best humanity has ever achieved*”. If we value the continuation of free inquiry into our unfolding comprehension of the

universe and humankind's place within it, is it wise to take for granted our historically brief Enlightenment-based rights and liberties?

**“Smart homes”?** Run by voice-recognition computer systems, which don't turn the water on when the dog barks, or tell the oven to grill instead of bake, or order your security system to lock you out (as did HAL, in *2001*)? Maybe, but not yet.

**Synthetic life?** Macromolecular reactions (eg. enzymes, DNA) displayed in real-time operation by advances in lasers, diffractometers and computers, enabling artificial organisms to be assembled? (Beware of “grey goo” escape?).

**To sum up:** surely, is it not time for 6.9 thousand millions of us who share our small planet Earth to accept that we are **one human family**, that we urgently need to *de-tribalise*, to come to our senses in time to concentrate on co-operative solutions to historically unprecedented global population-driven environmental problems? The

coming few decades will reveal whether Shelley's comment on the ruins of Ramesses 11's glittering civilization applies globally to our present use and abuse of our home planet:

*And on the pedestal these words appear:  
 "My name is Ozymandias, king of kings.  
 Look on my works, ye Mighty, and*

*despair."*

*Nothing beside remains. Round the decay  
 Of that colossal wreck, boundless and bare  
 The lone and level sands stretch far away.*

As pointed out by Pamela Bone (2008): "*In the **past century** there has been a **revolution in health, longevity, education, human rights**. The proportion of the world's population living in absolute poverty has dropped from about 80% in 1820 to about 20% today. You'd never think it by watching the nightly news, but since the early 1990's the number of armed conflicts in the world has fallen by 40%. The percentage of men estimated to have died in violence in hunter-gatherer societies is approximately 30%. The percentage of men who died in violence in the*

20<sup>th</sup> century, despite two world wars, is approximately 1%. The trends for violent deaths so far in the 21<sup>st</sup> century are still falling, despite wars in Iraq and Afghanistan. ***It's a story the media has missed.***" (Horgan, 2009, also reviews evidence that "levels of violence are much lower in our era than before the advent of modern states.") So we need to build on these global improvements, while heeding Shelley's warning.

***In the longer term,*** we are subject to the laws of biological, ecological, planetary and stellar evolution, beyond any human control. Some two hundred years ago, long before our planet's remote destiny as a scorched remnant of the sun's red giant expansion was known, poet Robert Burns presciently wrote: "*Though all the seas gang dry, my love, and the rocks melt wi' the sun...*" Perhaps our remote descendants, assuming their survival a few billion years into the future, will have to re-locate to a more bio-friendly world? We live **our instant, our cosmic eye-blink, our atomic flicker,** in Bertrand Russell's hope that "*all the labours of the ages, all the devotion,*

*all the inspiration, all the noon-day brightness of human genius” will not be dimmed or extinguished through our species’ wilful folly.*

Our **recent cosmic perspective** of ourselves and our origins can assist, provided that enough of us broaden our horizons in time for ancient tribal inter-cultural enmities to be overcome, and to be replaced by global rational co-operation. Among many optimists (see, e.g., New Scientist’s 50<sup>th</sup> Anniversary Special Issue, Nov. 2006) is bioethicist James Hughes, who espouses **“Enlightenment transhumanism”**: *“We can use scientific enquiry, religious tolerance, freedom, democracy and individual liberty to build a better future for ourselves. That idea is still young and the battle for it is still being fought.....If we defend liberal society and use science, democracy and regulation to navigate (the above-listed) challenges, we have a shot at an inconceivably transcendent future. We can become a new species of great diversity, united by our shared appreciation of the preciousness of self-awareness in a vast, dark universe. This is the positive vision of the Enlightenment, each of us reaching our fullest*



*technologically enabled potential while living as a single tolerant democratic society.....Whatever projects our descendants pursue, they – and perhaps even some of us – will look back on our lives with the wonder, pity and gratitude that we feel for our Palaeolithic ancestors. Just as they left their hunter-gatherer lifestyle to build farms and cities, we must now take rational control of our biological destiny...”*

To achieve such a future, we surely need policies that steer human evolution away from the dead ends of self-addictive absorption and suppression of our freedoms of inquiry, towards greater sociability, sustainability, self-awareness and reason. May courses such as this one assist in this endeavour.

## **A QUANTUM APPENDIX : COULD THE UNIVERSE BE THE ULTIMATE COMPUTER?**

The idea that the cosmos could be a **colossal computer**, producing everything we can see and experience as a by-product of its

continuing giant calculation, has been around for some years. Seth Lloyd, a leading American cosmologist and quantum computing researcher, has now published *Programming the Universe: A Quantum Computer Scientist Takes On The Cosmos* (Jonathan Cape, 2006), arguing that the universe.....seen by James Jeans as “more like a great thought” than some Newtonian machine.....is starting to look more like “pure information” in the form of “qubits” – quantum information from “parallel worlds”.

Your desktop PC or mobile phone chip operates on **binary information “bits”**. Each bit is a single choice with 2 mutually exclusive “yes or no” answers. E.g. does theory A match experimental results better than theory B? Shall I turn left or right at this T-intersection ? But what if 4 or 5 roads are available? Choose one, and all the other possibilities “collapse together” into the roads not taken. At the **quantum level**, when a photon of light travels from a lamp to this page and reflects to your eye, it always takes the **“path of least action”** – the shortest possible path. In

quantum theory, it is treated as having taken all possible pathways, which **“sum over all possible histories”** (combine) to generate that shortest path.

Now, at the deepest level, we think that **everything** in the cosmos is composed of **energy quanta** which **interact** by these **quantum laws**. **“True reality”**, underlying our sensible macroscopic world, is then a “seething maelstrom of **superimposed alternatives**”, which can be described, not by one/zero or yes/no binary choices, but by **“qubits”** - units of information which contain both yes *and* no, one *and* zero. Then, according to Seth Lloyd, every atom and elementary particle is a **tiny quantum computer** which registers information, processes it, passes it along, not as a stream of binary code, but as a “quantum blur” of superimposed (but tightly constrained) possibilities.

To date (2006), only limited quantum computers have been built. Future quantum computers should be able to **explore *simultaneously***

**all possible solutions** to a given question: the correct solution is almost instantly found, as incorrect “out of phase” possibilities cancel out.

So: if the **universe** is a cosmic quantum computer, what is it computing? Lloyd thinks it is **calculating itself**: it is seen as a hyper-colossal computation in which all possible “multiple drafts” simultaneously come into existence, and interfere constructively and destructively (think of many sound waves combining to produce one tone). *“In this picture...the universe embarks on all possible computations at once”*. From our human perspective, a computation is seen as a “strictly organized thought”. Then: *“Some of the information processing the universe performs is indeed thought – human thought.....but the vast majority....lies in the collision of atoms, in the slight motions of matter and light....Such universal “thoughts” are humble: they consist of elementary particles minding their own business”*. As the universe expands and cools, Lloyd sees life reaching out to *“encompass first stars and galaxies, then clusters*

*of galaxies, and eventually it would take billions of years to have a single thought”.*

This concept ....**a universe of infinite pathways**....was first proposed by Jorge Luis Borges. Perhaps, if we are part of an immense cosmic computation, carrying our thoughts and memories forward , that computation is not finally meaningless? As Lloyd writes of his friend , science author Heinz Pagels (*Perfect Symmetry*,1985), accidentally killed while scaling a mountain: *“While he lived, Heinz programmed his own piece of the universe. The resulting computation unfolds in us and around us.”* This is a quantum cosmologist’s way of saying that **each of us influences and endows our personal share of the cosmos with our individual thoughts and actions, during and after our brief tenure of that cosmic personal participation.** So: could creation be an ongoing process in which we all participate, rather than seen as the product of an original draft written upon the void: *“Let there be light”* ? If so, then who or what composed the laws of quantum computation? Or

have such laws always existed in some “Platonic” state, external to humankind’s observable space and time? Such are the **deep questions** arising at the confluence of theology, philosophy, and quantum cosmology.

## A METAPHYSICAL APPENDIX: HEAVENS ABOVE.

Here follows a summary of a discussion by a panel of leading British astronomers, theologians and authors (including Peter Atkins, John Spencer, Christopher French, Christopher Moss, David Pailin, Rodney Davis), recorded in a BBC video documentary “Heavens Above” (1998). The questions raised seem both up-to-date, and relevant to this course in astronomy/cosmology.

We humans have long demonstrated a **deep psychological connection with the night sky**. Many cultures have perceived a “message from above”, implying a hope for a better life, the personification of natural

phenomena, a need to believe, a search for meaning, for God as creator. Our former geocentric (Earth-centred) and anthropocentric (human-centred) perspectives are being replaced by **heliocentric and cosmic perspectives**, as astrology (“cave-man ideas” with a kernel of truth) is succeeded by astronomy. Using giant telescopes and particle accelerators, we can now look back almost to the “Big Bang”, the origin of our universe, attempting to answer questions including: **How? Why? Is it all meaningless?** Or started by some “God-pushed cosmic button? If God....then Who or What? What kind of button? Was there an instant of origin needing no intervention or precursor? Such questions, currently beyond the reach of science, may be brought into focus by, eg., quantum cosmology, leading to verifiable answers? Or will such questions be left for religious faith, theology, and philosophy?

So: *what is truth?* One large enigma lies within the **patterns found by science**: are they “true discoveries”? Or fictions arising from the way our brains “instinctively” seek out and perceive patterns in the “Book of Nature”.....patterns which do not necessarily coincide with those presented

within the various “Books of Scripture”. It has been said that **“we compress, therefore we are”**: **compression of data** is the essence of science, finding the simplest rules to explain the prodigal jumble of the world. Myths and sacred rituals are also compressions, ways of “mapping the cosmos”? Eg. the **reality** of God: the initiator of the universe, then a **passive watcher** of its development (seems hardly credible)? Or **intimately involved** in an ongoing creation? Is God that which lies behind our recent comprehension of the vastness of space, the immensity of time (see Albert Einstein...pp. 30-31). Religions have tended to see a central special place for humankind as the pinnacle of God’s creation, whereas science has tended to remove us from that special aspect, leaving a need for some kind of replacement? Currently, the **universe** seems to present as **a transient phenomenon**, with our extinction assured by a “heat death”, with decay of matter to ultra-thin radiation. So: no long-term hope? Or *“hope springs eternal”* – some kind of cycling universe with no beginning or end, with new wonders forever? Is there some continuation of individual existence in some life-transcending place or state where *“...I shall sleep in peace until you come to me”*, some form of reincarnation,



some abode in the unattainable sky, or as part of some “universal mind” (see J.B.S.Haldane...p.30). Are all such concepts **metaphors based on our limited ability to comprehend?**

Our new **cosmic perspective**, reinforced by the Apollo moon landings, emphasises the **fragility** of our civilisation, our small world, our responsibility for its care. Yet it can also promote a **“crisis of faith”** in any purpose, or meaning: are we a random **insignificant accident** in a vast, dark, lifeless universe? One response can be a belief in UFO’s, “new age” mythologies, a need for a “father/mother figure” to replace the **security** of Judaeo/Christianity, Islam or other religion. Or we may perceive a **fundamental order**, apparent in the discoveries of astronomy and cosmology. Do we exist by accident, by chance? Or by the **“anthropic principle”**: conditions seem exactly right for life to arise (as on Earth), with the fundamental laws and constants **“fine-tuned”**, with particle masses, gravity and other constants **“put in by hand”**. Had there been minor changes, or if the universe were any smaller or younger, life (based on carbon and water) would be impossible. **Is the universe “designed**

**for us”?** This seems not to be a compelling argument while there exists the possibility of a **“multiverse”**: an infinity of “parallel universes”, each with its own constants and properties. We seem to be left with the question: are we inconsequential (“interesting?”) beings in a universe neither hostile, nor benign, merely indifferent to our existence?

So: is it all **meaningful or meaningless**? Where are the **limits to knowledge**? Is God not confined by the laws of nature, but a more complex entity than we can hope to conceive? (Compare chimpanzee brains, not equipped to “think outside their box”, to compose symphonies, Shakespearean plays, or quantum mechanics). What about **other sentient beings** – a possibility consistent with Christian views? So far, no contact via Pioneer 10-type “space bottles”, radio/microwave leakage, or passive listening (SETI). Is natural selection a local or a cosmic principle? Would any aliens be “humanoid” – similar to us? There is a **spectrum of theories**, from objective “nuts and bolts” thinking to other “planes of being”, other dimensions, spiritual energy, stellar salvation (eg. the Raelian cult with us as star-children, an Elohim embassy, a planet of

eternal life, a coming unclothed golden age, the skies as realms of the gods). What can be said of the **seeming decline of traditional religions**? Is there a “two-level failure”: (1) lack of imagination, failure to present a sense of divine mystery, with services and liturgies too prosaic? (2) too “tied in” with outmoded world-views, with failure to incorporate new knowledge?

**Can science help with the deep questions of existence and personal survival?** If science is “about truth, not happiness”, then are such questions meaningless to science? Is science cold, inhumane, heartless? Its discoveries can deepen our delight when we look into the night sky, comprehending why Betelgeuse is red, or the 10,000 light-year chasm to the star-clouds of the Sagittarius spiral arm in the Milky Way, or why the day sky is blue. Or when we view a beautiful landscape, understanding the geological processes which have formed it. Yet, is this comprehension a kind of “trade-off” for **loss of certainty** in religious beliefs, and uncertainty concerning the deep questions – life, mind, the universe, the underlying nature behind everything? Can religions absorb astronomy,

cosmology, biology, leading to a synthesis of thought as our best way into the future? Can we ever *‘squeeze the immensity of creation into our tiny heads’*? Could an understanding of the nature of space and time provide an “answer to everything”? Or a partial answer? Even if the universe seems to obey mathematical laws (including Godel’s incompleteness theorem), are we seeing only *Plato’s shadows of our own minds*? Is science, at root, no less an act of faith than religious belief?

**A            COSMOLOGY / THEOLOGY**  
**APPENDIX: THE “TWO BOOKS”.....SCRIPTURE AND**  
**NATURE, AND THE EVOLVING CONCEPT OF THE**  
**CREATOR, FROM A CHRISTIAN PERSPECTIVE.**

The following is based on an ABC Radio National Encounter interview, “God, the Universe and Everything” (08 April 2007), featuring astrophysicist/clergyman Bill Stoeger SJ, adjunct associate professor of astronomy at the University of Arizona in Tucson with the Vatican

Observatory research group, studying (*inter alia*) the cosmic microwave background radiation and the astrophysics of galaxies, quasars and black holes, and the relationship between religion and science.

**How did it all begin? Is creation finished?** What can science tell us about the Creator? Fr. Stoeger: history, from the Big Bang to the emergence of our Earth and planetary system, and then through life on Earth, emphasises and underscores the deep inter-connectedness of everything that is. We are not apart from creation, we are a part of it, we have been generated by creation, by all the events that have preceded us, back to the “Big Bang” origin until now. *“As a physicist and also a believing Christian, I understand God working in the world precisely through the laws of nature, which are the **regularities** and the **processes and structures of nature** itself, which....depend on God ultimately, but in some way God also endows these regularities and processes with their own dynamisms and.....lets them unfold according to those **inherent dynamisms**.”* The Creator does not intervene in the laws of nature, trying to make up for our perceptions of their failures and deficiencies.

To Fr. Stoeger (and many scientists), cosmology is a branch of astronomy and a branch of physics (**“Big Physics”**), where we look at the entire Universe as a single object of study: as it is now, as it was, even **“before” the Big Bang** (quantum cosmology/philosophy – see pp. 9-11), as it **evolves on all scales** (first realised about Einstein’s time, following Darwin’s discovery of biological evolution), and we now ask how we came to be here. **After its “Big Bang” origin**, about 13.7 billion years ago, the universe was a hot smooth expanding cooling ball of still-mysterious “dark matter” and acceleration-driving “dark energy” (about 90%); also, hydrogen and helium gas, and radiation. For about 300,000 years there was no structure: no “lumpiness”, no stars, no galaxies. Then **astronomical structure** began to develop: super-clusters and clusters of galaxies, containing stars and their planets, including our Earth, between 4.5 and 4.8 billion years old. Cosmic evolution set the stage for **chemical evolution**: the other 90 natural elements, the building blocks of chemistry and of life, formed inside massive stars, and were dispersed by supernovae and stellar expansions into star-forming nebulae. Cooling produces

lumpiness: every star system of the trillions of stars in the universe is a separate evolutionary experiment. As the temperature goes down, new things are possible, which can combine to become **more complicated objects and entities**.

And the universe, interestingly, seems to be **fine-tuned for the emergence of life and us** (the “*anthropic principle*”, known to its detractors as “puddle theory”: the rain always fits the hole.) Had the values of a few fundamental constants or other key parameters been changed by just a little, 1% here or there, complexity – especially chemical complexity and conscious life - would have been impossible. Why? One possibility (for which there is some limited theoretical support) is that there is a “**multiverse**” of billions of universes, of which ours happens to have just the right physics. This might explain “fine-tuning”, but not **why** there may be such a multiverse to begin with: we are **forced back to philosophy or theology**, to try to answer the questions: why is there something rather than nothing, why is there order rather than disorder, why has this order

led to life and consciousness? *“You can’t really escape the fact that order had some rational source in God, or in something like God.”*

When we look **out into deep space, back into deep time** (due to the constant finite speed of light), we see beyond the stars and galaxies, until our line of sight meets an impenetrable fog-bank of ionized hydrogen gas, at 4000 degrees temperature, releasing diffused microwave “light” – the cosmic microwave background radiation. We are looking back over 13.5 billion years to see the universe as it was about 300,000 years after the Big Bang. If we could look through this fog-bank, we would reach a place, a vertex, so hot that all our known physics, space and time as we understand them, break down, at the **“Planck Era”, the first instant** of our universe’s “Big Bang”. We have no really good idea, accessible to reliable observation or experimentation, of what happened at this instant. So the Big Bang is really the **past limit, the beginning**, of hotter denser phases (models) of the universe. No physicist would say that the Big Bang was a transition between absolutely nothing and something. Quantum cosmology (see pp. 9-10 of these notes) is trying to specify the nature of the physical



energy or system at the Planck Era. Was this the moment of theological creation? No....we don't even know if there was such a moment.

The following **“Inflation Era”** was apparently a split-second instant of extremely rapid expansion, cooling and change of state, which generated density fluctuations - the seeds of future galaxies, including ours. Then followed the **early “classical” cosmological evolution** of an almost homogeneous system; then the **late classical evolution**, structure formation when gas clouds stopped expanding and collapsed and fragmented, forming galaxies and stars. The formation of the heavier chemical elements led to **“uninstructed chemical evolution”** – the formation of smaller molecules (see p. 13); then **“instructed chemical evolution”** on our Earth, about 4.5 million years ago (and maybe on other worlds?), guided by information stored in reproducing macromolecules (RNA, DNA), governing how life evolved. **Darwinian natural selection** produced primitive prokaryote cells (no distinct nucleus or organelles). Cyanobacterial waste-products, including the free oxygen in Earth's atmosphere, opened up new ecological niches for new eukaryote cells,

about 1.5 billion years ago. Multicellular (metazoan) animals followed about 800 million years ago, leading to **us**, sharing the same biochemistry, genetic code, nucleic acid bases, amino acids, RNA transcription and translation into proteins, with all inter-related life on Earth. And so we arrive at humankind's ***present on-going phase of creation: cultural evolution***, of ideas and structures.

So science, the history of the universe, shows us that **everything is inter-related, deeply interconnected**, in many, many different ways – by innumerable nested levels of complexity. Beginning with very simple things, interrelationships at every level of combination are crucial for bringing forth new types of systems and beings. For Fr. Stoeger : *“There is the whole issue of what we call the **formational and functional integrity of creation**, that everything is working together and everything has inherent dynamical characteristics to enable it to be what it is. God created things that way....God calls everything into being and endows things with their abilities, with their dynamisms, so that they can continue to unfold and evolve, to participate in the **creative act** of bringing always*

*new and exciting things into existence: the evolution on all scales, the transience and fragility of creation, in some sense **death and demise** is part of nature, without death and demise there would be incredible evolutionary bottlenecks and we wouldn't be here. (For example) without the death and extinction of the dinosaurs we wouldn't be here.....these key characteristics (from science's teachings) in some sense **complement** and are consonant with characteristics we know about creation and about God from scripture. **Relationality**, for instance, is something that reflects the (Christian tradition of) Trinitarian relationality of God....as a community of beings sharing a community of love, Father, Son and Holy Spirit. And that relationality then works its way back into creation, and as creation is fulfilled and continued and gradually moves towards completion in God, comes back to full relationality in Christ.”*

Fr. Stoeger is in agreement with, eg, **Albert Einstein** (pp. 30-31), or **John Wheeler** (p. 27), in his philosophy of ***two types of the laws of nature***. One type sees these laws as provisional and imperfect descriptions of the regularities, processes, structures and relationships of nature. These

descriptions are theories, often very accurate (because of the ‘blood, sweat and tears’ invested into them over centuries of hard work). The other type is the “other” laws of nature: the way nature actually does function, its laws as they actually work, not just as we model them or think they work, from our experiments and observations: *“We think that we have complete control over nature, or completely understand nature, and then we begin to realise that **there’s a lot more going on** in the regularities and processes of nature **than we actually understand**. And it may be true that there are aspects of the laws of nature that we will never understand but which are essential to the way in which nature works....only God understands.”* For example, our dynamic world is deeply marked by suffering, by death in transience, tragedy due to earthquakes, tsunamis, flood and fire, disease, famine.....yet **without transience** there could be no evolution of life and complexity at each stage, only eternal stagnation and evolutionary paralysis. **Humankind could never have arrived on Earth.**

So: God, perceived as **the creator and sustainer of nature, is at the basis of the laws of physics and nature.** (Is a physics text a mathematical/religious scripture?). God is the answer to the questions: why is there something rather than nothing? (Although unstable “no/space/time” must produce a multiverse: Krauss, 2012). Why ordered cosmos rather than chaos? Why are there laws of nature at all? God is seen as *immanent* in the dynamic relationships and processes of nature, deeply present and holding them in existence, not in a way that could be distilled out by physical experiment, but in the sense of being the ground of their very being and operation. **Science is limited** to truth based on repeatable experiment and direct observation, using our senses and sense-extending instruments. Is this “all there is”? Many scientists think so. Fr. Stoeger thinks otherwise: *“There is **much more to reality than that.** That’s a very important aspect of reality, there’s no doubt about it, but certainly there is a depth to reality and a depth to the world which is much more basic than what is revealed by the sciences.”* For many others, the stories and symbols of myth and religion, their **“kernel of truth”**, taken not

literally but as **allegorically true**, convey deeper morals and messages, deeper values and truths which go beyond where science can take us.

So: science **cannot prove or disprove God's existence**, but can **indirectly support theology** and some of its conclusions. Gaps in scientific understanding, eg. of the origin of life on Earth, are not filled by inserting a "God of the gaps" who gets "squeezed out" by advances in knowledge: this is not a viable way of explaining God or the cosmos, either theologically or philosophically. From both these viewpoints, God is a "*primary cause*" or "*first cause*", where even the word "cause" is an analogy: God is understood as completely unlike any other cause, and therefore doesn't act like any other cause. The remaining dichotomy – the **gap between God and science** – is in the ontological and metaphysical gap between something and absolutely *nothing*: no space, no time, no energy, no-thing. ("*Whereof we cannot speak, thereof we must be silent?*")

Science has certain competencies and abilities in connecting us with our universe and the forces by which it works, while theology can provide

**deeper insights.** The two are fundamentally **intertwined.** Theology, being radically interdisciplinary, is traditionally defined as *faith seeking understanding*; hence, faith has to consider all the sources by which we may understand the world, ourselves, and whatever we image as God. One such way of understanding ourselves, nature, and our relationships with one another and the transcendent, is **through the sciences.** We are products of nature, part of it, not divorced or separate, not above and in control of nature, as was often thought in the past. Without nature's air to breathe, or its stars to produce our constituent elements, we couldn't be here. To Fr. Stoeger: *"The key evidence which invites me to faith....personal commitment to God within a particular tradition....is not the same as the evidence that I use to support a scientific theory....(it is essentially the fruitfulness and the life-giving character of the experiences I have in trying to live out that faith.)"*

Any "**clash of truths**", tension or conflict between science and religion, seems due to **misunderstandings or misconceptions** concerning older concepts of God, operative in theologies where "God was (and still is?)

much **too small**". Also, the universe is "unfinished": we don't know what the ultimate destiny of creation may be. Nor can we *know* our **personal destiny**: yet theology implies that *"somehow this all will lead, despite the sin and suffering, to greater communion.....to afterlife of some sort, that there's something beyond death, that in some ways nothing will be lost. We can't.....prove that scientifically, or philosophically, we simply see indications of that from experiences of transcendence, the values of authentic love and the values of beauty and goodness and those sorts of things that seem to point us beyond our life now, and from some intuitions of a completion which will achieve full meaning and full communion with the grounded being"*. (See also Haldane, p. 30).

The **two books**, in which we investigate the truth about God and reality, are the book of the **Scriptures** and the metaphorical book of **nature**. The book of nature is read through the sciences; also, through our contemplation of nature, through poetry, fine art and music, through being who we are and sensing whom we are....our part in creation, God's greatest work. In coming to know more fully what creation is and how it's



put together, we can understand God more fully. And the two books really correspond to one another.....**no conflict**, if we properly understand them. *“The call is not just to reconnect with the earth, but to inter-connect with the entire cosmos.....in order to understand what the earth is all about, and what the earth produces, we can only understand that by looking at the greater whole of which the earth is a part. That is, our galaxy and our cosmos”*. (See also Carl Sagan, quoted at p.14 of these notes, and Albert Einstein, at p. 31).

#### **A HUMAN MIND APPENDIX: HOW DID IT ARISE? WHAT DISTINGUISHES IT FROM ANIMAL MINDS?**

In this and other U3A courses, much interest in the nature and origin of the human mind and consciousness is evident. This summary of Marc Hauser’s *“The Mind”* (Scientific American Special Issue “Understanding Origins”, Sept 2009) complements previous notes (pp. 15-20, 47). Hauser is professor of psychology and human evolutionary biology at Harvard University.

Charles Darwin (*The Descent of Man*, 1871) and subsequent scholars have argued that a continuity of mind exists between human and other animals: difference is “of degree, not of kind”. Mounting evidence also indicates a huge mental gap between us and our fellow creatures. Bonobos (sharing 98% of our genes), bears, beavers, baboons, birds and bees, your pet dog or cat, all lack the kind of brain which can create soufflés, computers, guns, makeup, language, plays, operas, sculptures, equations, laws, religions. While they possess some basic foundations of human cognition, the human mind has “added a skyscraper to these foundations”. Since the hominid lineage separated from chimpanzees some 7 million years ago, small rearrangements, deletions and copying of universal genetic elements have produced massive differences in computational power. “Humaniqueness” includes **four unique properties**, common to hunter-gatherers, philosophers, scientists, all of us.

- (1) GENERATIVE COMPUTATION (GC operation) enables humans to create an almost limitless variety and arrangement of words, actions, musical notes, math symbols, concepts and objects. *Recursive GC* is

the repeated use of a rule to create new expressions and combinations: eg. “a rose is a rose is a rose”, repeated musical phrases, the cylinders of a collapsible metal cup or telescope, motor actions including walking (one step after another – while sharing this one with other animals, we have released it from its “motor prison” to combine it with other domains of thought.). *Combinatorial GC* is the mixing of discrete elements to engender **new ideas**: eg. a “Walkman” radio, “cubist” art, “higher” dimensions.

- (2) **PROMISCUOUS COMBINATION OF IDEAS** from different domains of knowledge such as art, sex, space, causality, friendship, to generate new laws, social relationships, technologies: eg. we decide it is wrong and forbidden (moral domain) to push someone (motor action domain) in front of a train (object domain) to save the lives (moral domain) of five (number domain) others.
- (3) **MENTAL SYMBOLS** encode our sensory experiences, real and imagined, forming the basis of a rich and complex system of communication. We can keep these to ourselves, or choose to express

our experiences to others through spoken and written language, art, music, dance, computer code, U3A courses, and more.

- (4) ABSTRACT THOUGHT permits contemplation of things beyond what we can see, hear, touch, taste or smell. Animal thoughts are largely anchored in sensory and perceptual experiences. We alone ponder unicorns, aliens, nouns and verbs, infinity, God, an afterlife, our cosmic origins and evolution, and much more.

From the archaeological record, a **major transformation** of the human mind spanned an evolutionary history “eyeblick”, starting some 800,000 years ago in the Palaeolithic (Old Stone Age) era: eg. control of fire, cooking, warmth, improved social interactions. This crescendoed around 40,000 years ago, when we first see multipart tools (eg. axe+handle), bone/ivory flutes, burials with accoutrements, cave art. Today, human cultures vary widely with their mix of ingredients of human uniqueness.

No other animal approaches our variety of lifestyles...even a chimpanzee is relatively a cultural nonstarter. We differ from them in the relative sizes

and interconnections of regions of the cerebral cortex. While these differences generate thoughts with no analogue in the animal kingdom, we do observe **animal behaviours**, eg. single-material single-use tools, **which presage some human capabilities**. Bower-birds assemble construction and decorative materials (twigs, feathers, leaves, buttons, crushed berries “paint”). Chimps use twigs to obtain termites, wooden spears to impale small “bush baby” prey, and store projectiles for use (to have fun?) against unwanted human observers. Orangutans and chimps create novel solutions: eg. to access a peanut from a fixed plastic tube, you spray in mouthfuls of drinking water until the peanut floats within reach (a “folk physics”). Bottlenose dolphins have distinct “non-human personalities”, a strong sense of self, and can think about their future. Social behaviours include training juveniles: eg. bees (“waggle dance”) and ants guided to food, meerkats (scorpion dismemberment), dogs’ “inequity aversion” to unfair food distribution, variable dominance status, caring for infants, finding new mates, and more. Yet we see no equivalent even to the basic lead pencil: 5 materials, and combinatorial uses (writing, erasing,

thoughtful chewing, desk tapping, securing a hairstyle, bookmarking, insect deterrence, head scratching, etc.)

**Animal communication** includes a range of sounds, facial expressions and movements which seem to convey information (eg. food and predator types) as well as emotional states (eg. aggression, submission, sexual display), yet is vastly less than human linguistic abilities to make promiscuous connections between systems of understanding. For instance, we share with many other species up to three non-linguistic systems for quantifying objects and events: our linguistic counting ability retains ancient vestiges such as the “universal rule” that anything other than “one” is pluralized (eg. “I see one apple”, but “I see 0, 0.2, 1.0, -5, 5 or 100 apples”, not apple). Animal minds are exquisitely adapted to singular problems, but application of skills to novel problems is limited. Our minds probably also have inherent limits, eg. trying to “think outside the box” to imagine the mind of an intelligent alien, or a supreme being. Prof. Hauser concludes: *“The roots of our cognitive abilities remain largely unknown, but having pinpointed the unique ingredients of the human mind,*

*scientists now know what to look for....although (we) do not yet understand how genes build brains and how electrical activity in the brain builds thoughts and emotions, we are witnessing a revolution in the sciences of the mind which will fill in these blanks,,,”*

### **A LOVE APPENDIX: DID BIG BRAINS AND BIPEDALISM LEAD TO THE EVOLUTION OF AMOUR?**

*“The sweetest thing you’ll ever learn, is just to love, and be loved in return”* (from a 1950’s song lyrics).

Evolutionary anthropologists (eg. Rutgers University’s Helen Fisher, 2009) note that, for most creatures, procreation seems emotionally uncomplicated. In us, however, it is frequently accompanied by romantic love, on a spectrum between bliss and despair, depending on your beloved’s response. So: **what is this thing called love?** Could it be **an adaptive trait accompanying big-brained bipedalism**, arising early in the evolution of our lineage?

Two ancient hallmarks of human evolution...upright walking (bipedalism) in ancestral “upright apes”, and increasing brain size...should have favoured the emergence of love. Bipedal mothers had to carry helpless infants unable to cling to their backs: with her hands occupied, bipedal mum needed a partner to help provision and protect the newborn. Postcranial fossil material indicates that Lucy, the famous 3.2 million-years-old *Australopithecus afarensis* hominin, walked bipedally upright; she probably pair-bonded only long enough for her child to be weaned and walking. The advent of larger brains, some two million years later, probably extended these monogamous relationships. Our forward-tilted pelvis, adapted for bipedalism, constrains the size of the baby’s head at birth. As a result, human infants are born at an earlier more helpless stage of development than other primate infants, and require an extended childhood for growing and learning. Longer-duration pair-bonding should therefore have enhanced our ancestors’ reproductive success rate.

Fisher notes that our ballooning brain, and its accompanying organizational features (social, linguistic, tool-making, &c), enabled our



ancestors to seriously woo one another....through music, art, poetry, dance, behaviours all apparent by at least 35,000 years ago. It would seem that love (and lovesickness?) have been around for a long, long time, and are of cosmic significance: romance and firelight dinners have been needed for our species to survive until now, with a mental capacity for elucidating the nature of the universe. *Ain't love grand?* also, needful for cosmic comprehension (O'Connor, 2016).

## REFERENCES AND CITATIONS.

The literature in which humankind ponders matters cosmic, is truly enormous. Many authors and journalists, from both sciences and humanities, have concerned themselves with the matters discussed in these notes. Here follows a sample of the sources drawn upon over 10 years, and recommended for further reading or viewing. Further references can be provided if you would like additional detail for any of our discussion topics.

Recommended reading: Brian Cox and Jeff Forshaw (2016), *Universal Guide to the Cosmos* (Penguin Books); Armand Delsemne (2000), *Our Cosmic Origins : From the Big Bang to the Emergence of Life and Intelligence*. (C.U,P). Two “Big Histories” of everything (David Christian; Bill Bryson) are listed in the following references; also *The Whole Shebang* (Timothy Ferris), and *Out of Sight* (Kullender and Larsson). *What On Earth Evolved: 100 Species That Changed The World* (Christopher Lloyd, 2009) also explains how today’s world evolved. National Geographic’s *The New Universe: Here, Now and Beyond* (2010) and *Exploring Space* (2013); also, *Universe - Exploring the Astronomical World* (2017, Phaidon Press).

Further sources include *Scientific American* (e.g. Dec. 2000 Millennial Issue; Sept. 2009 Special Issue *Origins of The Universe, Life, Love, The Human Mind, Computing*, and much more; Fall 2014 Special Issue *Secrets of the Universe - Past, Present and Future*); and *New Scientist* (e.g. 18 Nov. 2006 50<sup>th</sup> Anniversary Special, 1956-2006: *The Big Questions*;

also 2014, *The Collection, Issue 1, The Big Questions*, and *Issue 2, The Unknown Universe*). Both these readily accessible journals (library and internet) feature reviews and forecasts by experts in their various fields. Other sources include listed television documentaries available for use in our seminars. For controversial current *geopolitical* questions arising from previous participants' discussions, I have cited "even-handed holistic big-picture" global analysts (Australian, UK, USA); many prescient articles ("*first drafts of history*"), e.g. from the last two decades' Opinion pages of *The Age* (Melbourne) and *The Australian*, have been brought to my attention by course participants. Please feel free to disagree with my geopolitical conclusions; copies are retained (or refer to these journals' websites) if you wish to check anything. Selected internet astronomy / cosmology websites are also listed.

**AUTHOR INDEX.** Authors cited or quoted, or reports/editorials sourced for these notes, are at page(s) given in parentheses.

Aayan Hirsi Ali (pp.44,48). *Cruellest cut in the name of Islam: genital mutilation and forced marriage occur even among educated Muslims in some countries*. Weekend Australian Inquirer, 3 Feb. 2007: edited extract from *Infidel* (Free Press, 2007).

Adams, Phillip (p.45) asserts “*No nation has a more bloodstained history than the U.S.A.*” Weekend Aust. Mag. 15/09/07.

Age, The (p.20). Editorial comment: Toumai, hope of life; the evils of evolution.

Aitken, Don. (p.46). *Good science isn't about consensus: dubious global warming data*. The Australian, 09/04/2008.

Albert, D. & Galchen. R. (p.11) *A Quantum Threat To Special Relativity: nonlocal particle entanglement*. (Sci Am Mar '09).

Albrechtson, Janet (p.48). *Desperate for Enlightenment: Aayan Hirsi Ali, the voice of reason*. The Australian, 06/06/ 2007.

Allan, James (p.22). *How did peace-loving Canadians become terrorist targets?* The Australian, 07 July 2006.

Anon. (p.23). *Trust me, I'm a social Darwinist*. The Economist: reprint in The Australian, 24 Dec. 2005.

Anon. (p.26). Twinkle, twinkle, little star.....scintillate, scintillate, globule coelific.....

Appenzeller, Tim (p.33) *Search For Other Earths*. 350 extrasolar planets. National Geographic, Dec. 2004

Appleyard, Brian (p.30). *Life after life*.  
[www.theaustralian.news.com.au/story/0,,24916862-5012694,00.html](http://www.theaustralian.news.com.au/story/0,,24916862-5012694,00.html) (20 Jan '09).

Ardrey, Robert (p19). *African Genesis*. Arguments for the evolution of aggression in *Homo sapiens*.

Arkam-Hamed, Nima et al.(p.10) *The Universe's Unseen Dimensions*. Scientific American, Aug. 2000.

Arnold, Matthew (p.27) ...The moon lies fair upon the straits....we are here as on a darkling plain...

Arnold-Forster, Mark (p.45). *The World At War*. Includes WW2 casualties. (Thames Methuen, 1981).

Armstrong, Karen (p.25). *The Case for God: What Religion Really Means* (Bodley Head, 2009); Weekend Aust 15/08/2009.

Ash, Timothy Garton (p.2). *The Veneer of Civilisation Is Easily Eroded*. The Age, 09/09/2005.

Ash, Timothy Garton (p.21) *The Paris Bombing of 2009*: a possible future destruction of a Western city by a portable nuclear device, detonated by suicidal “home-grown” terrorists. Foresees London 2005 train/bus attacks. The Age, 09/02/2004.

Asimov, Isaac (p.2), Mother Earth ....not a doting parent.

Aspect, Alain (p.35). Quantum entanglement of photons demonstrated.

Asten, Michael (p.3). *NASA data: temperature changes fall within natural warming cycles*. The Australian, 22 Jan 2015.

Australian, The (p.22). Editorial comment: strange and dangerous feedback between apologetic liberalism and extreme Islam.

Ayala, Francesco (p.25): Interview with geneticist/priest Ayala, *The Christian Man's Evolution*. Sci. Am. Nov. 2008.

Baker, Gerard (p.22). Geopolitics: reprints from *The Times* in *Weekend Australian*, 18-19 Mar. 2006; 15-16 Sept. 2007.

Bardeen, Pranab (p.24). *Does Globalization Help Or Hurt The World's Poor?* Scientific American, April 2006.

- Barr, Drew (p.21) *A False Analogy..basic freedoms and a decent life..* Melbourne, The Age Letters , 14 May 2004.
- Barrow, John D. and Webb, John K. (p.7). *Inconstant Constants – Do the inner workings of nature change with time?* (Absorption spectra of remote quasars show a *small* increase in the electromagnetic fine structure constant,  $\alpha=e^2/(4\pi\epsilon hc)\sim 1/137$ , hence a variable speed of light? Still requires confirmation). Sci. Am. June 2005.
- Barrow, John D. and Tipler, Frank J. (p.15) *The Anthropic Cosmological Principle*. (O. U. P., 1996).
- Barratt, Graham.(p.21) *The Great Paradox of Our Century...appease or oppose?.* Melbourne, The Age, 16 Feb 2004.
- Battersby, Stephen.(p.11) *The Universe Gives Up Its Dark Secrets*. Dark matter. New Scientist, 03 Jan 2004
- Beinart, Peter (p.46). *The Good Fight: Why Liberals and Only Liberals Can Win the War on Terror* (MUP); a precis, *Reclaiming the US's Liberal Soul*, in The Australian Inquirer, 18-19 Aug. 2007.
- Bell, Robin (p.46). *The Unquiet Ice: models of potential sea level rise have ignored subglacial water*. Sci. Am. Feb. 2008.

Bendle, Mervyn (p.45). *Radical "Postmodernist" Pacifists Deny a Murderous Reality*. Australian, 22 Sept. 2008; *Don't count on luck to avert jihadi terror; Islamists' determination to wage war against liberal democracies*. (Australian, 05/08/2009).

Benedict XVI, Pope (p.2). A peculiar Western self-hatred, without reference to far worse political systems.

Bishop Berkeley (p.10). How do you know that an unseen object exists? (Samuel Pepys, kicking a rock: I refute him *thus*).

Besso, Michele (p.31). Einstein: a butterfly is not a mole...not something a butterfly should. regret.

bin Laden, Osama (p.21). *God be praised*: his widely reported reaction to al Qa'ida suicidal jihadists' success (9/11/2001) in collapsing the New York World Trade Center twin towers rather than merely igniting the upper levels, thereby killing almost 3000 workers rather than the anticipated few hundreds.

Bhutto, Benazir (p.44). *Reconciliation: Islam, Democracy & The West* (Simon & Schuster); extract in Weekend Aust. 9/02/08



Blackmore, Susan (p.29). Are out-of body experiences real? Or autoscopic hallucinations? Or what?

Blainey, Geoffrey (p.43). *A Very Short History of the World*. (Viking, 2004); also, *Triumph of the Nomads* (Sun Books, 1982).

Blake, William (p.26). O clouds unfold....bring me my chariot of fire...

Bohm, David (pp.10,20). Quantum “particles” as *processes*? Stone-age minds and nuclear weapons.

Bone, Pamela (pp.1,21,49). *Sadly, wars do tend to settle things: fighting is sometimes necessary*. Australian, 27/04/07; Age, 20/03/04; also, *Bad Hair Days* (MUP, 2007): her optimism despite illness and “*the world.... going to hell in a hand basket*”.

Borges, Jorge Luis (p.50). A universe of infinite pathways? Humankind as part of an immense cosmic computation?

Boumoudienne, Houari (p.36) ...we will conquer you through the wombs of our women....

Bradley, Alexander (p. 14). *Expanding the limits of life: a new type of sea-floor hot vent ecosystem*. Sci. Am., Dec. 2009.

- Brian, Denis (p.31; see also Einstein citations). *Einstein: A Life*. (Wiley, 1996). Einstein's complete credo at p.233.
- Broderick, A. & Loeb, A. (p.11). *Portrait of a Black Hole: the monster's lair, dark disc & event horizon*. Sci. Am. Dec. 2009.
- Brown, Lester, (pp.2,43). *Could Food Shortages Bring Down Civilization?* Sci. Am. May 2009; *Plan B3.0: Mobilizing To Save Civilization* ( Norton, 2008). Water shortages, soil losses, climate change = food shortages = failed states, global chaos.
- Bryson, Bill. (p.38). *A Short History of Nearly Everything*. (Black Swan, 2003). Illustrated edition (Doubleday, 2003): funny!
- Bruckner, Pascal (p.2). *Apocalyptic angst of the Western World, despite unparallel high living standards*. Australian, 21/04/12
- Bucher, Martin, and Spergel, David (p.7) *Inflation in a Low-Density Universe*. In the beginning... Sci. Am., Jan. 1999.
- Burleigh, Michael (pp.22,37,44,45). *Godless Europeans Turn To Cultural Christianity: Fear of Islam Is Prompting a Search for a Common Identity in the West*. Australian, 02/06/2006; *Earthly Powers: Politics and Religion in Europe* (Harper Collins).

Burns, Robert (p.49). ...though all the seas gang dry, my love, and the rocks melt wi' the sun....Earth's destiny.

Buruma, Ian (pp.21). *Murder in Amsterdam: The Death of Theo Van Gogh and the Limits of Tolerance*. Penguin Books, 2006. Australia); edited extract *Unenlightened Behaviour* in The Australian Weekend Enquirer, Dec. 9-10, 2006.

Buruma, Ian (pp.44,45). *With Prosperity Must Come Personal Freedom?* Australian Weekend Inquirer, Jan. 12-13, 2008.

Buttrose, Larry (p.45). *US power is being sapped not only by war but also by simple economics*. Australian, Dec. 30-31, 2006.

Byron, Lord George (p.27). Darkness....the sun did wander rayless and pathless...and men forgot their passions...

Cadogan, Peter (1985) (p7) *From Quark To Quasar. Notes on the Scale of the Universe*. (Cambridge University Press).

Calder, Nigel (p.46). *Relax, it's only the Sun*. Reprint from The Sunday Times in The Australian, 20 Feb. 2007. Also, with Henrik Svensmark: *The Chilling Stars – A New Theory of Climate Change* (Icon, 2007): cosmic rays and the Sun controlling low-level cloud formation, and hence

global climate; CERN CLOUD (2012): controlled cosmic ray/atmosphere experiments.

Callick, Rowan (p.45) *The big winner from globalization... the People's Republic of China*. Asia-Pacific, Aust. 2/3 Jan 2010

Cameron, David (p.2). The PM blames Britain's Aug. 2011 riots and looting on demoralising welfarism, and warns the West.

Carroll, John (pp.21,37). *Taming hatred in our midst: can democracy help dissolve Islamic radicalism?* Australian, 23/08/'08.

Carter, Robert (p.3). *The Futile Quest for Climate Control*. Quadrant, Nov 2008; summary in *The Australian*, 19/12/08.

Cauchi, Stephen (2005). *Photograph Confirms a Far-Flung Planet*. Science Report, *The Age* (04 June 2005).

Chandrasekhar's Limit; Chandra X-Ray Telescope (pp.11,12). White dwarf stars; black holes.

Chaitin, Gregory (p.25). Too much deep science... the world wouldn't work.....

Chang, Kenneth (p.13). *Building block for life found in comet Wild 2*. *The Age* 20/08/2009 (from New York Times).

- Choi, Charles (p. 39). *Dark matter could explain the early universe's giant black holes*. Sci. Am. Mar. 2010.
- Christian, David (pp.4,5,15,35). *Maps of Time: An Introduction To Big History*. (University of California Press, 2004): 642 pp
- Churchill, Winston (p.21). The last to be devoured by the (Nazi) crocodile...the vain hope of 1930's appeasement.
- Clark, Arthur C. (p.1). Greetings, carbon-based bipedal life-forms.....
- Clark, Kenneth. (pp.2,5,29). *Civilization, Part 1: "By The Skin Of Our Teeth"*. BBC TV documentary series (1985).
- Clarke, Arthur C. (p. 7). *Profiles of the Future: an inquiry into the limits of the possible*. Pan Books, 1964, 1973.
- Climate Change* (pp.3,4): *An Australian Guide: Science and Potential Impacts*. Australian Greenhouse Office Report (2003).
- Coal: Special Report* (pp.3,4). Local and world use; coal seam gas; CO<sub>2</sub> capture/sequestration. The Australian, 26 Apr. 2007.
- Cochran, T. & McKinzie, T. (pp.21,44). *Detecting Nuclear Smuggling*. Sci. Am. April 2008.

Cohen, Barry (p.24). *Not all cultures are good: Australia should be multiracial, not multicultural.* The Australian 21/08/2009

Cohen, Nick and Geras, Norman (p.24). *The British Left and the Euston Manifesto.*

Collins, W; Colman, R; Haywood, J; Manning, M; Mote, P.(p.3) *Physical Science behind Climate Change.* Sci. Am. Aug '07.

Commoner, Barry (p.2). *Environmental impact: a definition.*

Conor, Liz (p.21) *The Spectacular Modern Woman: Feminine Visibility In The 1920's* (Indiana University Press, 2004) Costello, Michael (former Sec. Foreign Affairs: pp.21,22). *Quitting not an option.* Aust. Weekend Inquirer, Mar. 24-25, 2007).

Couper, Heather, and Henbest, Nigel (p,6). *Big Bang: The Story of the Universe.* (Harper Collins, 1997).

Cowen, Ron (p.11). *The cataclysmic death of stars...a supernova every second.* National Geographic, Mar. 2007.

Cox, Brian & Forshaw, Jeff (p 10) *Universal:A Guide To The Cosmos* (Penguin, Random House: 2016)

- Coyne, George (pp.14,15, 28). *Infinite Wonder of the Divine: a fertile Universe*. The Tablet, 10 Dec 2005.
- Crawford, Ian.(p.33). *Where Are They?* The search for extraterrestrial intelligence. Scientific American, July 2000.
- Cummins, Joseph (p.20). *History's Great Untold Stories: ch. 3, Subotai the Valiant*. Mass murder. (Murdoch Books, 2006).
- d'Ancona, Matthew (p.44). *The West must construct a new world order to beat terror*. The Australian Inquirer, 10 June 2006.
- Damasio, Antonio (p.17). *How the Brain Creates the Mind*. "Ongoing movie in the brain." Sci. Am. Dec 1999
- Darwin, Charles (pp.4,14,23,43,51). Evolution by natural selection...endless forms most beautiful and most wonderful...
- Davies, Paul (pp.5,9,14,28,34,35,47). *The Matter Myth* (with John Griffin). Also: *The Mind of God: Science and the Search for Ultimate Meaning*. (Simon and Schuster, 1992). Also: *The Fifth Miracle: The Search for the Origin of Life*. (Penguin, 1999). Also: *Are Aliens Among Us?* A review of astrobiology and alternative life on Earth. Sci. Am. Dec. 2007.

Dawkins, Richard (pp.5,24,32). Memes; *The God Delusion*. Challenges to Dawkins' views from religious and secular perspectives (Archbishop Mark Coleridge, *Quadrant* editor P.P. McGuinness): Weekend Australian Review, 24 Feb 2007.

Dayton, Leigh (p.3). *Science: A Test For Society*. (Reports the 2006 AAAS annual meeting). Australian, 25 Feb 2006. Also (p.42). *Beasts Hounded To Extinction*. (Aust. Jan. 27-28, 2007). Also (p.33). *First "habitable" alternative to Earth found?* The Australian, Apr. 26, 2007. Also (p.41): *On climate change, Ian Plimer has diverged*. The Aust. 06 May 2009. Also (p. 47) *Our brains are wired up for god*" ( The Aust. 10 Mar 2009), reporting fMRI studies by Grafman *et al*.

Death of Megabeasts (p.42). SBS: Extinction of Aust. megafauna by "firestick farming" within 3900 years of human arrival.

De Duve, Christian (p.14). *Vital Dust – Life as a Cosmic Imperative*. (Basic Books, 1995); also Sci. Am. Jan. 1996.

Descartes, Rene (p.29). Cogito, ergo sum.....or sum, ergo cogito? Mind-brain dualism?.



De Tocqueville, Alexis (p.21). The future seen to work in America: full adult voting rights.

De Vore, Irvine (p.22). A murderous species...intent on destroying our planet for ephemeral creature comforts...

Delsemne, Armand (pp.5,13,24,53). *Our Cosmic Origins*. Cambridge Univ. Press, 1998, 2000. Big Bang to Big Brain.

Dhume, Sadanand (p.44) *India's Islamic Terror Threat Close to Home*. The Australian, 19/03/10 (ex Wall Street Journal).

Diamond, Jared (p.4). *Guns, Germs and Steel: The Fates of Human Societies*. Vintage Books, 1998.

Diamond, Jared (pp.2,3,4). *Collapse: How Societies Choose to Fail or Survive* (Penguin, 2005); Ch.13, "Mining" Australia.

Diamond, Jared (pp. 19,67). *The World Until Yesterday*, ch. 4 *A Longer Chapter; About Many Wars*. Penguin Books, 2013.

Disraeli, Benjamin (p.5). Of what use, Mr. Faraday, is electricity?

Dobbs, David (p.18). *The Post-Traumatic Stress Trap: the concept of PTSD disorder is itself disordered*. Sci. Am. April 2009

Docker, John (p.20). *The Challenge of Genocide*. Griffith Review, Spring '07, cited in Aust. Lit Review, 06/02/2008.

Doidge, Norman and Schwartz, Jeffery (p.18). *Neuroplasticity: The Brain That Changes Itself*" (Scribe, 2009).

Donne, John (p.17). What is the mind? My thoughts go beyond the Sunne.....

Doolittle, W. Ford. (p.13). *Uprooting The Tree of Life*. Life's common ancestor. Sci. Am. Feb 2000.

Duval, Jean-Francois (1996) (p.29). *Dancing in the galaxies*. Interview with Elisabeth Kubler-Ross: The Age, 07/09/2004

Dyson, Freeman (pp.5,14): Our world soul. Also Eddington, Arthur (p.29): Mindstuff?

Einstein, Albert (pp.8,9,10,11,25,26,31,35,51,52). Special and general relativity; humankind's problems; God's thoughts.

Eisley, Loren (p.36). "...of men...there will be none forever...." We are unique in the Universe.

ElBaradei, Mohamed (pp.21,44). Nuclear smuggling...the nightmare scenario.

- Emerson, Ralph Waldo (p.27) ....every night appear these envoys....
- Encyclopaedia Britannica (pp.12,19). Life; aggression.
- Evans, Gareth (p.21). *The Responsibility to Protect: Ending Mass Atrocity Crimes Once and For All*. Australian, 02/09/2008.
- Evans, Michael (p.4). *The Shirt of Nessus: Rise and Fall of Western Counterinsurgency, 2004-2014*. Quadrant, Jan. 2015
- Fallici, Oriana (p.36). *The Force of Reason* (2005) has this ominous quote: Hisb-ut Tahir's plan for a European caliphate.
- Faraday, Michael (p.5). Electricity is like a baby...one day it may grow up and then, sir, you may tax it.
- Fenwick, Peter and Parnia, Sam (p.29). BBC TV documentary, *Near Death Experiences*, 2002.
- Ferguson, Niall (p.45) *China is set to be Asia/Pacific's dominant power*. Wall Street Journal; Australian, 18/19 Dec 2010
- Fernandez-Armesto, Felipe (pp.2,4,21,30,31). *Millennium – A History of our Last Thousand Years*. Black Swan Books, 1997.
- Ferris, Timothy (p.2). *The Whole Shebang: A State-of- the-Universe(s) Report*. (Orion Publishing, London).

- Feynman, Richard (p.26). The universe in a glass of wine...
- Finkelstein, Daniel (p.24). *Anti-US Mentality Blinds Liberals To the Importance of Taking On Tyrants*: reprinted from *The Times* in *The Australian* (01 May 2006). (Also at [www.eustonmanifesto.org/joomla/](http://www.eustonmanifesto.org/joomla/)).
- Fisher, Helen (p.55). What is this thing called love? A consequence of big-brained bipedalism? *Sci. Am.* Sept. 2009, p.55.
- Flannery, Tim (pp.4,37,42). *The Future Eaters: An Ecological History of Australasian Lands and People*. (Chatswood, 1995).
- Flannery, Tim (p.3). *The Weather Makers: History and Future Impact of Climate Change*. Text Publishing, 2005.
- Flannery, Tim (pp.4,42). *Here On Earth: An Argument for Hope*. Text, 2010. "Blitzkrieg extinction" of 60 Aust. megabeasts.
- Foley, Jonathan (p.4) *Boundaries For a Healthy Planet*; in *Sci. Am.* Special Report Apr. 2010, *Solutions for a Finite World*.
- Frame, Thomas (p.4). *Godless nation ( reasons for Australia's shift to non-belief .)* *The Aust. Lit. Review*, 05 Aug. 2009.
- Friedman, Thomas (p.1) *Hot, Flat and Crowded*.

Frost, Robert (p.28). Some say the world will end in fire, some say in ice....

Fukuyama, Francis (pp.20,44). *A question of identity: the West's postmodern elites are being challenged by migrants who are more sure of who they are*. Extract from *Journal of Democracy*, in Weekend Australian Inquirer, Feb. 3-4, 2007.

Gandhi, Mahatma (p.4). Like locusts stripping the earth bare.

Garnaut, Ross (p.3). Acceptable CO<sub>2</sub> atmospheric level.

Gause's competitive exclusion principle (p.23): applicable to competing social/religious tribalisms?

Gazzaniga,(p.47) Human empathy explained by mirror neurons? Autism due to their impaired function? Sci. Am. Nov. 2006

Gefter, Amanda. *Putting Einstein to the Test*. Australian Sky and Telescope, July 2005.

Gekko, Gordon (p.36). Greed is good.....?

Genghis Khan (p.20). His four dogs of war; their glorious slaughters.

Gerecht, Reuel Marc (p.44). *After the retreat, the catastrophe: a genocidal civil war between Sunni and Shia Arabs, drawing in Saudi Arabia, Iran,*

*other Middle East nations, and further inciting jihad.* The Australian Weekend Inquirer, 20 Jan. 2007.

Gibbon, Edward (p.37). *Decline and Fall of the Roman Empire* ...always scribble scribble scribble, eh?

Gingerich, Owen (p.25). An astronomer's thoughts on the "big questions". God (pp.10,25,50-53). Who? What? A God of the gaps? Beyond our ability to comprehend? Immanent in ongoing creation?

Goering, Hermann (p.20). Aggression training: not easy.

Golding, William (p.19). *Lord of the Flies*.

Gore, Al (p.3) *An Inconvenient Truth*.

Gould, Stephen Jay (p.14) *The Evolution of Life on the Earth*.. Sci. Am. Oct. 1994 , Special Edition Feb. 2004.

Graham, Alister & Scott, Nicholas, cited in The Age (18/01/13): largest (0.5% galactic mass) central supermassive black holes in large galaxies; intermediate black holes (0.2%) and/or dense star clusters in smaller of 72 galaxies studied.

Gove, Michael (p.44). *How To Counter Jihad*, from *Celsius 7/7* (Allen and Unwin), in *The Australian Inquirer*, 15 July 2006.

- Gray, John (p.32). Human needs, lost wisdom.
- Greene, Brian (pp.8,9) *The Fabric of the Cosmos*. (Penguin.Books, 2004).  
SBS TV 3 x 1 hour documentary programs.
- Haines, Tim and Chambers, Paul (p.14) *The Complete Guide To Prehistoric Life*. (BBC Books, London, 2005).
- Haldane, J.B.S. (pp.28,30,51) ....queerer than we *can* suppose; ...when I am dead, I merge with an infinite mind?
- Hameroff, Stuart (p. 30). Quantum consciousness....external to the brain?
- Handel, Georg Friedrich (p.19). *The Messiah*.
- Hardin, Garrett (p.2) *The Tragedy of the Commons*.
- Hardy, Thomas (p.30). When I am gone....the full-starred heavens...
- Harries, Owen (p.20). Boyer Lectures, 2003: what makes a liberal democracy.
- Hauser, Marc (pp.18.54). *The Mind: What distinguishes us from other creatures*. *Sci. Am. Special Issue Origins*, Sept. 2005.
- Hawking, Stephen.(pp.5,12,25). *The Illustrated Brief History of Time*. (Bantam Books, 1996). Who breathed the fire...?

Hawking, Stephen, and Penrose, Roger (p.8). *The Nature of Space*. Scientific American, July 1996.

Heisenberg, Werner (p.10) The Uncertainty Principle.

Henderson, Gerard (p.4). *The Cause Is Still A Just One*. (liberating Kuwait & Iraq from Hussain). *The Age*, 11 May '04.

Henderson, Mark (p.39) *Titan probe data draws closer match to Earth*. Reprint from The Times: The Australian, 17 Jan 2007.

Henninger, Daniel (p.24). *Obama's engagement with tyrants while ignoring pro-democracy oppositions*. Australian, 02/10/09

Hing, Barry (p.45). *Bigotry too easily accepted: all men are equal, except those dumb Americans*. The Australian, 4 July 2006.

Hitchens, Christopher (p.22). *Why co-existence with Saddam Hussein was impossible for the West*. Australian, 03 Sep. 2005.

Hitchens, Christopher (pp.32,33). *God is NOT great: How religion poisons everything* (Allen and Unwin). Edited extract: *Religion as a primitive and destructive absurdity*, in The Australian Inquirer, 19-20 May 2007. Also (p.21): *Mullahs indubitably fancy a mushroom cloud ( the poster icon of Hezbollah, the Party of God)*. The Australian, 08 Jan. 2010.



- Hitler, Adolf (p.21). Failure to stop him before he acquired WMD: humankind's biggest mistake, and most lethal catastrophe.
- Hobbes, Thomas (p.2). A war of all against all between pre-state human bands and tribes, and within failed states?
- Hole, Matthew & O'Connor, John (p.46). *Nuclear Fusion, The Next Energy Source: ITER*. [www.ainse.edu.au/fusion](http://www.ainse.edu.au/fusion), 2009.
- Holloway, Richard (p.31). Our lives: a journey from abyss to abyss? Joyous expectant uncertainty.
- Hopkins, Gerard Manly (pp.17, 27). *O the mind...; ....the bright boroughs, the circle-citadels...*
- Horgan, John (pp.20,49,67). *Taming the Urge to War: Lethal Conflict-Inevitable Part of Human Culture?* Sci. Am. May2009
- Horvath, Robert (2008). *Beware the rise of Russia's new imperialism*. The Age, 21 Aug. 2008.
- Hotz, Robert (p.33). *Zooming on planets with life?* NASA's Kepler study: 156,000 stars, 400 possible planets. Aust. 29/01/11
- Houghton, Sir John (2009) *Global Warming:The Complete Briefing (4<sup>th</sup> Ed.)* (CUP). Includes IPCC 4<sup>th</sup> Assessment Report.

Hoyle, Fred (p.35). .....is Someone monkeying with the laws of physics.....?

Hubble, Edwin; Hubble Space Telescope. (pp.8,28) ....the dreamy realms of speculation....

Hughes, James (p.49). Enlightenment transhumanism.

Huisken, Ronald (p.21). *Iran Bomb Poses a Nightmare Scenario. Weekend Australian, Defence Special Report, 27 May 2006.*

Huntingdon, Samuel (p.45). A clash of civilizations?

Husain, Ed (p.44). *Faithfully Honing the Killer Instinct: How Islamism Motivates Violence.* Extracts from Husain's book *The Islamist* (Penguin Australia, 2007): jihadist Islamism and its planned global caliphate. In *The Australian*, 01/02 July 2007.

Hutton, James (p.27) The noble concept of former worlds, revealed by geology.

Hyland, Adrian (pp.41,46) *Fire: an illuminated history;* in *Kinglake-350* (Text, 2011): Victoria's Black Saturday firestorm.

Insel, Thomas (p.18). *Faulty Circuits: malfunctioning connections underlying depression, OCD's &c.* Sci. Am. Apr. 2010.

- IPCC (Intergovernmental Panel on Climate Change). (pp.3, 46).
- Jaber, Hala (p.20). *The Daily Depravity That Is Iraq*. Reprinted from The Sunday Times in The Australian, 19 June 2006.
- Jeans, Sir James (p.49). The Universe...more like a great thought than a Newtonian machine?
- John Paul 11, Pope (p.32). Science and faith are like two balancing wings....
- Johnson, David (2004). *The Geology of Australia*. (C.U.P). 4.4 Myr evolution of the Australian continent.
- Jones, Cheryl (p.42). *Hobbit species may not have been human*. The Australian, Higher Education, 38 Sep 2009. Also (p.42): *Camels to rescue ecosystems – plugging the gap left by our extinct megafauna*. The Aust. Higher Education, 10 Feb. 2010.
- Joshi, Pankaj S. (p.11). *Naked Singularities: black holes without event horizons could be out there*. Sci. Am. Feb. 2009.
- Kandell, Eric R. (p.18) *In Search of Memory: The Emergence of a New Science of Mind*. (W.W.Norton, 2006).

Kagan, Robert (pp.21,45). *Renewing the liberal vision. Optimism that followed the end of Cold War has vanished, revealing the same old faultline between liberalism and autocracy: 1.5 billion people in China & Russia, alone.* The Age, 16 Aug. 2007.

Kant, Immanuel (p.38). Sapere aude....dare to know....

Kauffman, Stuart (p.12). What is life.

Keegan, John (pp.19,20). *A History of Warfare*, especially pp. 79-136 *Why Do Men Fight? The Beginnings of Warfare.* (Hutchinson, London, 1993). A summary of theories of aggression.

Kelly, Paul (pp.22,23,44). *The struggle between the national interest and section interests is at the heart of democracy:* The Australian, 24 Sept. 2005; *Europe juggles influx: millions of Muslims live without problems of integration, but a minority poses a lot of threats:* 10-11 June 2006; *Future in the balance: the attack on the West cannot be separated from the crisis within Muslim nations:* 10 Sep. 2005; *A strategic/moral dilemma, Iran's defiance over nuclear weapons:* 30 Aug. 2006.

Kelvin, Lord (p.31). Man must measure....

- Khayyam, Omar (pp.29,37). One moment in annihilation's waste...; .myself, when young....
- Khomeini, Ayatollah Ruhollah (p.44). Jihad declared...subjugation of West to Shia Islam.
- Kiang, N. (p.34) *The Color of Plants on Other Worlds (photosynthesis adapted to surface light)*. (Sci. Am. April 2008).
- Killebrew, Robert (pp.21,44). *The evolution of al-Qaeda: the threat...to rise*. *Washington Post* reprint: *The Age*, 16/08/2004.
- Kingsley, David (p.15). *From Atoms to Traits*. In Scientific American Special Issue *The Evolution of Evolution*, Jan.2009
- Kininmonth, William (pp.3,4). *Illusions of Climate Science*. *Quadrant*, Oct. 2008: pp. 12-19; *The Australian*, 29 April 2009.
- Knoll, Andrew (p.15). Life and intelligence.
- Knorr, Hilde (p.32). *Walking With A Stranger* (Collins Dove, Vic. 1986). ...yet today I have overwhelming doubts...
- Koch, Christof and Greenfield, Susan (p.17). *How Does Consciousness Happen?* *Sci. Am.* Oct. 2007.

Krauss, Lawrence (pp.8, 26, 53) *Cosmological Antigravity*. (Sci. Am. *The Once and Future Cosmos*, Special Issue, 2002); also, *A Universe From Nothing: why there is something rather than nothing*. (Simon & Schuster, 2012).

Krauthammer, Charles (p.6). Politics gone cosmic.

Kristof, Nicholas (p.46). *Climate change has the potential to do massive damage*. New York Times, in The Age, 18/08/2007.

Kronke, David (p.23). *The nipple that divided America*. Los Angeles Times: reprinted in The Age, 31 Aug. 2004.

Kubler-Ross, Elisabeth (p.29). On death and dying...dancing in the galaxies....

Kuhlmann, Meinard (p. ). *Quantum Physics: What Is Real?* (Scientific American, Aug. 2013).

Kullender, Sven and Larssen, Borje (p.54). *Out of Sight! From Quarks to Living Cells*. (C.U.P. 1994, 2006).

Kundera, Milton (p.43). Man proceeds in a fog....

Lamb, Simon and Sington, David (p.46). *Earth Story: The Shaping of Our World*. (Princeton University Press, 1998).

- Lane, Nicholas (p.14). *Life: Inevitable, a Fluke, Or Both?* New Scientist, The Collection: Issue 1, The Big Questions (2014).
- Lambeck, Kurt (p.46). *On the edge of global calamity*. The Australian , Higher Education, 07 Feb. 2007.
- Leake, Jonathan (pp.40,30). *Chance encounter in the slime; Deathbed walk towards light* The Aust. 10/11/08; 31/05/10.
- Leakey, Meave & Walker, Alan (p.42). *Early Hominid Fossils from Africa*. New Look at Human Evolution, Sci.Am.'03.
- Le Maitre, Georges (p.5). The Big Bang...as seen by us, “standing on a well-chilled cinder”.
- Lichter, Ida (p.24). *The Islamic Veil: Unmasking Islamist Stakeholders*. Sydney Institute Quarterly, Dec. 2014.
- Liddle, Rod and Steyn, Mark (p.37). Demographic changes in Europe....the coming Eurabia?
- Lincoln, Abraham (pp.20,21). Can't fool all the people all the time.
- Lineweaver, Charles (p.10). *In The Beginning...The Origin of the Universe*. In *Newton(1)*, Sept/Oct 2000 (*Aust. Geographic*).
- Livio, Claudio (p.35). Is God a Mathematician?

- Llewellyn-Smith, Chris (p.47). *The Large Hadron Collider*. Sci. Am. July 2000.
- Lloyd, Graham (*The Australian*, 20/12/2017): models underestimate, by up to 7 times, cooling due to variable solar activity.
- Lloyd, Seth (pp.49,50). The universe is a quantum computer.
- Lloyd, Christopher (p. ) *What On Earth Evolved? 100 Species That Changed the World*. (Bloomsbury Publishing, 2009)
- Loftus, Elizabeth (p.18). *Creating False Memories*. Sci. Am. Sept. 1997.
- Lorenz, Konrad (p.19). On Aggression.
- Lovelock, James (p.44). Population overshoot and collapse to 0.5-1 billion (one sixth or less of 2000 population) by 2100?
- Lowy Institute (p.45). America seen to be a major threat to global peace?
- Lutz, Richard (p.13). *Deep sea vents: science at the extreme*. Nat. Geographic , Oct. 2000. Also Aust. Geographic, Jan..2011
- Lyell, Charles (p.27). His concept of former worlds, poetically described by Tennyson.
- Maddox, John (pp.15,17). *The Unexpected Science To Come*. Scientific American, Dec. 1999



- Mallaby, Sebastian (pp.21,44). *America Searches For A New "Imperialism"*- *Washington Post*, in *The Age* (11 May 2004). Marvel, Kate (p.3). *The Climate Conundrum: high clouds form higher, clouds less icy, more watery*. *Sci. Am.* Dec. 2017.
- Malthus, Thomas (p.3). Feeding outrun by breeding.
- Marx, Karl (pp.4,23). Workers owning the means of production; disastrous social policies.
- McCauley, Robert (p.25) *Natural Religion, Unnatural Science*. New Scientist Collection, Issue 1, The Big Questions (2014).
- McDonald, Kevin (p.24). *Global Movements: Action and Culture*. (Blackwell, 2006).
- Mernagh, Barry (p.18). A report on neuroplasticity, for Manningham U3A's philosophy course.
- Micklethwait, John & Wooldridge, Adrian (pp.32,45). *God is Back: How Global Rise in Faith is Changing the World*. (Penguin, 2009): reviewed in *The Australian Inquirer* 20-21 June 2009.
- Miller, Geoffrey (p.46). In *New Scientist* 50<sup>th</sup> Anniversary Special Edition, 18 Nov. 2006.

- Minogue, Kenneth (p.5) *The Irresponsibility of Rights*. (Quadrant, Nov. 2010: extracts from *The Servile Mind: How Democracy Erodes the Moral Life (when governments relieve citizens of personal responsibilities)*. Encounter Books, 2010.
- Monckton, Christopher (p.3). *Climate Crisis Ain't Necessarily So (measurements vs. modelling)*. Australian, 22/23 Jan 2011.
- Montefiore, Simon (p.20). *Monsters: history's most evil men and women*. 3000 years of awful cruelty. (Quercus, 2008).
- Moody, Raymond (p.29). Life after life?
- Musser, George (p.7): cosmologists review acoustic cosmology and large-structure mapping. Sci. Am. Feb. 2004.
- NASA (National Aeronautic and Space Administration; Goddard Space Flight Centre) (pp.7,9,12,13,33)
- Nature, Mother (p.30) ...has Nature heard of this mathematically elegant theory?
- Neighbour, Sally (p.44). *Self-made terrorists: radicalised sons of middle-class immigrants*. The Australian, 17/08/2007; *The anger, venom and*

*hatred among potential terrorists (Somali detainees, Melbourne):The Australian* 08/08/2009, 16/02/2010.

Nelson, Dean (p.21).. *Terrorists closing in on Pakistan's nuclear arsenal.* The Age 13/08/2009.

Newton, Isaac (pp.9, 26) Universal gravity constant; the great ocean of truth lies all undiscovered.

Noe, Alva (p.18). *Out of Our Heads: Why You Are Not Your Brain....The Biology of Consciousness.* (Hill and Wang, 2009).

Norenzayan, Ara (p.25). *The Idea That Launched a Thousand Civilisations.* New Scientist, The Collection, Issue 1(2014).

O'Connor, John (pp.5-20). *Cosmology: From the Big Bang to the Big Brain* (2005-2018). Illustrated course notes, compiled from discussions with students attending this course at Victorian Council for Adult Education and various U3A venues.

O'Connor, John (p.66) *A View, from the Outer Reaches, of a Troubled Planet:* The Age, Faith column, 31/08/2002. Also, (p.55) *The Evolution of Love and Suicide:* Quadrant, May 2016: Helen Fisher's 3 stages of sexual attraction and attachment.

- Orgel, Leslie (p.13). *The Origin of Life on the Earth: The DNA World*. Sci. Am. Oct. 1994.
- Orwell, George (pp.2, 45). Totalitarian despots (eg. 1984's "Big Brother") need to control you totally...body and mind.
- Pagels, Heinz (p.50). A universe of perfect symmetry.
- Parkinson, Tony (p.21). *Absolute Pacifism? An Unlikely Utopia In a Mad, Bad World*. The Age, 28 Feb 2004.
- Pascal, Blaise (pp.27, 38). We are thinking reeds.....: ....who or what set me here....?
- Pearson, Christopher (p.46). *Cultures are not all equal*. The Australian Inquirer, 17-18 June 2006.
- Pearson, Noel (p.22). *"United, we'll fight terrorism"*. The Australian Inquirer, Oct. 27-28 2007.
- Peat, David (p.10). *Trapped in a world view: something obstructing physics' Grand Unified Theory*. New Scientist 5 Jan '08.
- Peeble, James; Schramm,David; Turner, Edwin; Kron, Richard (p.7). *The Evolution of the Universe*. In *Magnificent Cosmos*, Sci. Am. Special Edition (2000).

Pellegrino, Charles (p.42). *Ghosts of Vesuvius* (Harper Collins, 2004). Recounting the effects of catastrophic volcanic eruptions on human history, he writes (at p.67): “Both (Neanderthal and modern tribes or races) are toolmakers, and both have demonstrated (before 30,000 BC) an ability to build and navigate boats into Australia, across 62 miles (100 km) of the Exmouth Trench: First Neanderthals arrived. And everywhere gracile (thin- boned) people followed, Neanderthals began dwindling towards extinction, sometimes leaving their de-fleshed and partially cooked bones in someone’s camp-fires.”

Penrose, Roger (p.17). *Shadows of the Mind*. Vintage Books, U.K 1995 (Also *The Emperor’s New Mind*, 1990).

Phillips, Melanie (p.44). *Do not appease hatred: Britain and the West remain in a state of galloping cultural surrender to the Islamists*. The Australian, 02 Mar. 2007. Phillips is the author of *Londonistan* (Encounter Books, 2006).

Pinker, Steven (p.18). How the brain works, in 5 words.....

Pipes, Daniel (p.44). *Divided By Conspiracy And Hate*. A review of a survey (Pew Research Centre): *The Great Divide: How Westerners and Muslims View Each Other*. In *The Australian*, 28 June 2006.

Plimer, Ian (pp.4,46). *Heaven and Earth; Global Warming, Missing Science* (Connor Court,2009); reviewed Aust. 18/04/09.

Pollard, Katherine (p.42). *What Makes Us Human: human & chimpanzee genomes differ by 1%*. *Sci. Am.* May 2009.

Polya, Gideon (p.13). Yarra Valley U3A course notes... cellular metabolism, drugs and celebs.

Pope, Alexander (pp.26,32). .....And all was light...the proper study of man...

Popper, Karl (p.1) All science is cosmology...

Powell, Sian (p.33). *Clouds of Alien Worlds: planetary systems like ours could be plentiful*. *The Australian*, 12 April 2008.

Preston, Alison (p.17). *Ask the experts: How do short-term memories become long-term memories?* *Sci. Am.* Dec 2007.

Python, Monty (p.38). The meaning of life...pray that there's intelligent life somewhere out in space...

- Quigg, Chris. (p.47). *The Coming Revolutions in Particle Physics: the Standard Model and the LHC*. Sci. Am. Feb. 2008.
- Ramos Horta, Jose (p.23). *Silence in the face of genocide*. Melbourne, The Age, 26 Aug 2004.
- Redfern, Martin (p.51). *Proofs of God in a Photon?* Independent Observer, 24 Dec 1995.
- Rees, Martin (p.27) *Exploring Our Universe and Others*. Scientific American, *The Once and Future Cosmos*, 2002.
- Ricardo, Alonso and Szostak, Jack (pp.13,40). *Fresh clues how first life arose from inanimate matter*. Sci. Am. Sept.2009.
- Rig Veda (p.26) ...Whence came creation?...The gods are later....
- Roach, Mary (p.30). *What Happens After You Die?* (New Scientist 50<sup>th</sup> Anniversary Special Edition, 18/11/2006). By the same author: *Spook: Science Tackles the Afterlife*. (W.W.Norton, 2006).
- Robb, Andrew (p.44). Toleration of intolerant identity tribalism can tear a society apart.
- Roth, Gerhard (p.18). *The Quest To Find Consciousness*. In Sci. Am. Special Edition 14(2) *Mind.*, Feb.2004.

- Rundle, Guy (p.35). *Intelligent Design Is Taking Us Backwards*. Melbourne, The Age, 24 Aug 2005.
- Russell, Bertrand (pp.11,49). The noonday brightness of human genius extinguished?
- Sagan, Carl (pp.5,14,28, 37). *Pale Blue Dot: A Vision of the Human Future in Space*. In Sci. Am., May 1995.
- Sakharov, Andrei (p.2). Our Sisyphean societies.
- Sandall, Roger (p.19). *The Savage Garden of Eden*. Quadrant, June 2006; Aust. Inquirer, 10-11 June 2006. Sanyal, Sanjeev (p.2) *Population Loss Is the Way of the Future*. Australian, 01 Nov. 2011.
- Sandiford, Michael (p.42). *Geology points to dangers ahead: a geologist opposes Plimer's views*. The Aust. 06/05/2009.
- Sayyid Quth (p.44). The cause thrives on the blood of its martyrs.
- Schrodinger, Erwin (p.10). His alive/dead quantum cat.
- Selbourne, David (p.45). *The Losing Battle With Islam*. (Prometheus Books, 2005). Also: *Losing Sight of Reality: The Islamists Are Winning* (The Australian Inquirer, 22 July 2006).



Shakespeare, William (pp.28,30) ...this most excellent canopy...fretted with golden fire;...more things in heaven and earth....

Shapiro, Robert (p.12). *A simpler origin for life: energy-driven networks of small molecules*. Sci. Am. June 2007.

Shelley, Percy Bysshe (p.49). ....the lone and level sands stretch far away.

Sheridan, Greg. (pp.22,43,44,45). *The Australian's* foreign editor (08/07/06) discusses threats and access to WMD and long-range missiles, by Iranian, North Korean and Burmese leaders. Also: *Global Order In Free Fall*; *Hate beyond reason* (20/01/2007); *Wearing down the West* (12/05/2007); *Israel still looks good, warts and all* (Aust. Lit. Review, 06/05/2009).

Shermer, Michael (p.5). *The Shamans of Scientism*. Scientific American, June 2002.

Shors, Tracey .(p19) *Saving New Brain Cells: fresh neurons in the adult brain help learn complex tasks*. Sci. Am. Mar.2009

Short, Roger (p.44). *Population Explosion Heralds Disaster*. Report of international conference in The Age, 06/03/09.

- Shreeve, James (p.19). *The Mind Is What The Brain Does*. National Geographic, March 2005
- Simpson, Sarah (p.13) *Questioning the Oldest Signs of Life*. Sci. Am. April 2003.
- Smith, Deborah (p.42) *Ancient tools (at Jebel Faya, Arabia): first H. sapiens migration from Africa?* The Age 28 Jan 2011.
- Smith, Lewis (p.3). *Star rays help make our clouds*: reported in *Proc. Royal Society*. The Australian, 13 Feb 2007.
- Smith, Lewis (2008). *First visible-light image of planet outside solar system*. The Times, in The Australian, 15 Nov 2008.
- Smith, Sidney (p.26). What we don't know.....
- Smolin, Lee (p.35). *Did the Universe Develop by a Process of Cosmic Evolution?* (Time, *Summer Science*, 1997/98).
- Snow, C.P. (p.5). *The Two Cultures*.
- Spencer, Herbert (pp.22,23). Survival of the fittest...."social Darwinism".
- St. Augustine (p.32). ...our hearts are restless....
- Stephens, Bret (p.45). *Dark Side of the Chinese Miracle: Beijing's suppression of dissent*. The Australian, 13 Oct 2010.

Stephens, Bret (p.45). *Cruel systems...compound political error with historical ignorance*. The Australian, 28 Dec 2010.

Steyn, Mark (pp.44,45). *America Alone: Rapid Change in Global Demography, Islam's Conquest of Europe*. (Regnery,2006).

Stix, Gary (p.48). *The Science of Bubbles and Busts: a reassessment of how financial markets work*. Sci. Am. July 2009.

Stoeger, William R. (pp51,52) . *Contemporary Physics and the Ontological Status of the Laws of Nature* (in *Quantum Cosmology and the Laws of Nature: Scientific Perspectives on Divine Action*, eds. R. J. Russell, N. Murphy, C.J. Isham: Vatican Observatory Publications, 1999.

Summarised in ABC Radio National *Encounter- God, the Universe and Everything* (08 April 2007):

<http://abc.net.au/rn/encounter/stories/2007/1888705.htm>

Stringer, Chris (p.16) *Creativity Older Than (we) Thought*. From The Times, in The Australian, 24/06/2006.

Susskind, Leo (p.12). A possible solution to Stephen Hawking's "information paradox" when black holes ingest matter.

- Suzuki, David (p.17). *The Runaway Brain*. Final program in TV series *A Planet For The Taking* (2000).
- Swimme, Brian (pp.5,6,10,27). *The Universe Is A Green Dragon*.(1998); ...tell it with music.
- Switzer, Tom (p.46). *Return of the Realists* (ALR 06/05/2009). Containment vs. preventive action; *pax Americana*.
- Tarter, Jill and Chyba, Christopher (p.33). *Is There Life Elsewhere in the Universe?* Sci. Am. Dec 1999.
- Tegmark, Max (p.7). *Parallel Universes*. Scientific American, May 2003; also Sci. Am. updated *Special Report*, 2006.
- Tennyson, Lord Alfred (pp. 22,27) ...Nature, red in tooth and claw; ...the hills are shadows...
- Thomas, Dylan (p.30). Do not go gentle....at close of day.
- Thorne, Alan & Wolpoff, Milford (2003). *The Multiregional Evolution of Humans*. Sci. Am. *New Look at Human Evolution*.
- Tipler, Frank (p.11). The final anthropic principle.
- Tononi, Giulio & Cirelli, Chiara (p...) *Perchance to prune: during sleep, connections are weakened*. Sci. Am. Aug. 2013.

Traub, James (p.21). *Nuclear Nonproliferation Treaty: Iraq, Iran, North Korea, Libya*. The Age "Good Weekend", 10/07/2004.

Trenberth, Kevin (p.3) US Nat. Atmos. Resrch Centre; *We're now in global cooling*, Matt Ridley, The Australian 06/01/2018

Tsien, Joe Z. (p.47). *The Memory Code – the rules that the brain uses to lay down memories*. Sci. Am. July 2007.

Turing, Alan (p.47). The Turing test for computer intelligence.

Turner, Michael (p.7). *Understanding Origins: The Universe*. Before Big Bang: 4 theories. Planck era, inflation, quark/lepton soup, dark matter axions (Sci. Am. Jan. 2018), protons/neutrons, H/D/He/Li nuclei, atoms, CMBR, dark ages, first stars & galaxies, peak star formation, galaxy clusters, Solar System, dark energy/accelerating expansion, today. Sci. Am. Sept. 2009.

Turok, Neil and Steinhardt, Paul (pp.11,47). *A cycling universe?*

Van Olsenon, Peter (p.45). *Sage foresaw cultural clashes: Samuel Huntingdon's predictions have turned out to be right, which is bad news for Western democracies*; also obituary, *Seer of 21<sup>st</sup> century cultural conflicts*. The Australian, 30 Dec. 2008.

- Van Schaik, Carel (p.16). *Why Are Some Animals So Smart?* Scientific American, April 2006.
- Vedral, Vlatko (p.30). *In From The Cold: a thermodynamics “metatheory”?* New Scientist, The Unknown Universe, 2014.
- Veliz, Claudio (p.5). *The Big State and the Servile Mind*. (Quadrant, Oct. 2010). A review of *The Servile Mind* (Minogue, 2010): the unintended personal immaturity which accompanies indiscriminate State takeover of personal responsibilities.
- Venter, Craig (p.15). The human genome.
- Vott, Mark (2000). *Hubble Space Telescope: New Views of the Universe*. (Smithsonian Institution/Space Telescope Institute)
- Wahlquist, Ada (p.3). *Waiting for rain in vain..* In *Climate Change Special Report*, Weekend Australian, Mar. 29-30, 2008.
- Wald, Matthew (p.4) *The Power of Renewables: how alternatives to fossil fuels are stacking up*. (Sci. Am. Mar 2009).
- Warne-Smith, Drew (p.42). *Australian Muslim numbers to rise 80%, to 714,000 by 2030*. Pew Centre; Australian, 29/01/2011
- Watson, James and Crick, Francis (pp.15,18). DNA; consciousness.

- Weinberg, Steven (pp.9,12). *Life in the Universe*. Sci. Am. Oct. 1994.  
 Also *A Unified Physics By 2050?* Sci. Am. Dec.1999.
- Weisser, Rebecca (p.22). *Strategist behind war gains: Counterinsurgency expert David Kilcullen*. (The Australian, 18/08/07).
- Weisman, Alan (2008). *The World Without Us*. (Virgin Books, UK). How Earth might recover from human depredations.
- Wexler, Bruce (pp.18,46). *Brain and Culture: Neurobiology, Ideology, and Social Change*. (MIT Press, 2006).
- Wheeler, John (pp.8,26,28,35,52). General relativity – spacetime curvature, gravity. Limits to knowledge.
- Whitman, Walt (pp.26,36). Prais'd be...; ....the mystical moist night air....
- Wilczek, Frank (p.46). We can capture one thousandth of the sun's daily energy....solving our energy problems.
- Williams, John (p.25). Science and religion: a convergence. Melbourne, The Age, 19/02/2004.
- Williams, Nikki (p.4). *We can bury CO<sub>2</sub> forever (like natural oil/gas)*. The Australian, 09/04/2008.

- Williamson, David (p.19). *Weekend Australian*, 22/04/2006: “*Writer backs P.M. Howard*” (in English literature curricula).
- Wilson, David Sloan (p.23). *A Good Social Darwinism: How Evolution Can Reform Economics*. (Aeon, 2014)
- Witchalls, Clint; Hamer, Michelle (p.29). *Are Powerful Near-Death Experiences Real?* The Independent; The Age, 23/03/ 04
- Willis, Paul and Thomas, Abbie (pp.39-43) *Digging Up Deep Time: Fossils, Dinosaurs and Megabeasts* (ABC Books, 2004).
- Windschuttle, Keith (p.37). *It's not racial conflict, it's a clash of cultures*. The Australian, 16 Dec. 2005.
- Wing, Scott (p.4). Climate change and the tooth fairy.
- Wittgenstein, Ludwig (p.26). Why is there anything rather than nothing?
- Wolfe, Tom (p.29). Your soul has died due to advances in neuroscience?
- Wolfram, Steven (p.48). A computational universe?
- Wolverton, Mark (p.44). *Muons for peace: new way to spot hidden nukes gets ready for debut*. Sci. Am. Aug. 2007.
- World Wildlife Fund (p.3). Two extra worlds needed.



Wong, Kate (p.16,42). *The Morning of the Modern Mind*. Sci. Am. June 2005; also *The Human Pedigree*, Sci. Am. Jan. 2009; also *Twilight of the Neandertals*, Sci. Am. Aug. 2009.

Wood, Alan (p.24). *Multiculturalism becomes poison for social capital (Robert Putnam's study)*. The Australian, 26/09/07.

Wright, Judith (p.27). ....far, far below, the millions of rock-years divide....

Wright, Matthew and Hearps, Patrick (pp.4, 46). *Zero Carbon Australia Stationary Energy Plan* (pp.4,46). A detailed practical plan to decarbonise electricity generation in 10 years, using mainly wind and solar heliostat mirrors/"power towers" /molten salt storage, with hydro and biomass backup. Melbourne Energy Institute, University of Melbourne, July 2010.

Wright, Ronald (pp.4,23,36). *A Short History of Progress*. 2004 ABC Radio Massey Lecture Series. Text Publishing. 2005.

Young, Thomas (p.10). The wave nature of light.

Zachos, James (p.4). Eocene climate warming.

Zhang Yimou (p. 45). We (China) can do in one week what takes you (the West) a month.

Zimmer, Carl (pp.14,16,35). *A Fin is a Limb is a Wing: How Evolution Fashioned its Masterworks*. Nat.Geographic, Nov. '06.

Zwartz, Barney (pp.32,44). *The Making of Meaning*. The Age A2, 23-24 Dec.2005. Also: *The Battle Within: Melbourne's Muslim community is caught up in a struggle between fundamental and moderate believers*. The Age, 03 Aug. 2005.

Zwicky, Fritz (p.4). "Spherically stupid bastards".....an irascible astronomer lets fly at any who dare to disagree.

#### COSMOLOGY      VIDEO/DVD      DOCUMENTARY PROGRAMMES.

A partial listing; appropriate excerpts are used to visually illustrate many concepts discussed in this course.

*Are We Alone?* (2008). BBC TV, 1h. Includes exoplanet Gliese c (warm & wet?) and SETI update (Shostak).

*Catalyst / Quantum*. ABC science reports: various excerpts concerning Australian palaeontology and other topics.

*Cosmos*. Sagan, Carl (1980); Tyson, Neil deGrasse (2014). 13 x 1h episodes. Sagan's 1980 classic *Personal Voyage*, still one of the best-presented visual accounts of the universe, has been fully up-dated for Tyson's *Spacetime Odyssey*.

*Crude* (2007). ABC TV, 1.5 hours. Geological history of petroleum; economic and climatic impacts; "peak oil" already here?

*Death of the Megabeasts*. SBS TV (2009). Extinction of Australian megafauna due to "firestick farming", 40,000 BP.

*Discovery Channel: Through the Wormhole, Seasons 1 and 2* (2011): Morgan Freeman, 20 intriguing science programs.

*Elegant Universe* (2004). SBS TV 3x1hour series: string and brane "theories of everything", presented by Brian Greene.

*Evolution* (2002). SBS TV 6-part series; especially Pt. 6, *The Mind's Big Bang*

*Heavens Above*. BBC TV, 1 hour: astronomers and theologians discussing the deep questions of existence.

*Homo futurus*. SBS TV, 1 hr (2005), discussing evolution from prosimians to modern and future *H. sapiens*.

*Human Universe*, (2016). Brian Cox' BBC TV series, 4 x 1 hr programs: excerpts from these and other Brian Cox programs. *Killing the Creator?* (2004). BBC TV 3 x 1 hour series: eminent scientists and theologians discuss religion and science.

*Mass Extinctions* (1998). SBS TV, 1 hour. A summary history of life on Earth.

*Near-Death Experiences: The Day I Died..* (2002). BBC TV, ½ hour; also, *Secrets of Sleep* (2004). “Out-of body” events.

*Nuclear Black Market*. ABC TV 4 Corners program, 26 April 2004, detailing the clandestine sale of stolen nuclear weapons technology by Pakistani nuclear physicist Abdul Qadeer (A.Q.Khan). Updated in Oct. 2006 (SBS TV).

*Open Learning: Astronomy*. Selections from this series of ½ hour Open University programs (AST 1 & AST 2).

*Powers of Ten* (1980). ABC TV, 15 min. A journey from deepest space, down into the deepest structure of matter.

*Regaining a Balance* (2000). SBS TV, 1 hour. A history of human use and abuse of Earth's bounty, and remedial technology.

*The State of the Planet* (2000). BBC TV, 3 x 1h parts. Attenborough: loss of biodiversity, population pressures, solutions.

*The Next Ice Age*. (p.4). BBCTV, 2006. Are human activities delaying a climate change even more dangerous than warming?

*The Hawking Paradox* (2005). BBC TV ‘Horizons’ program: destruction of information by black holes?

*The Hobbit Enigma* (2008). ABC TV (1hr). *Homo floresiensis: H. erectus ? Australopithecine ?* “Out of Africa” or Asia?

*Toumai: Hope of Life. The New Ancestor.*(2005). SBS TV 1½ hours programme.

*Through the Wormhole*. Discovery Channel (2010), 8x 50 min episodes..

*What The Bleep? Down the Rabbit Hole* (SBS, 2008). interconnections between quantum mechanics and everyday reality.

### **COSMOLOGY WEBSITES:** A brief sample.

Astronomy Picture of the Day. (apod).  
<http://antwrp.gsfc.nasa.gov/apod/lib/aptree.html> Includes years of

archived telescopic images and detailed explanations/links. Any topic search finds an Editor's Selection of good "starter" items.

SETI homepage. <http://setiathome.ssl.berkeley.edu/> Search for Extraterrestrial Intelligence: analyse your own data set from Arecibo radio telescope. World fame awaits if "they" contact you. (6 months at Parkes: "not a sausage – only galahs").

NASA homepage [www.nasa.gov/](http://www.nasa.gov/) Links to almost everything of cosmic interest.

Australia Telescope National Facility. [www.atnf.csiro.au/](http://www.atnf.csiro.au/) One major local contribution.

The size of our world: how small are we relative to other celestial bodies?  
[www.rense.com/general72/size.htm](http://www.rense.com/general72/size.htm)

For a trip around the cosmos: [www.google.com](http://www.google.com) Also current Stellarium freeware.

Micolich (2009): Youtube's library of physical phenomena/simulations.

## **COURSE SUMMARY: ASTRONOMY AND COSMOLOGY -- THE PROFOUND QUESTIONS.**

Each session features visuals (DVD, software), with summaries, and your discussions. No background in science or mathematics is needed; all participants, from all walks through life, are welcome. Observation evenings (clear skies permitting – *O clouds unfold !*) are difficult to schedule in Melbourne; however, we use excellent astronomy software (Stellarium, Distant Suns, Skywatch &c) to explore our local night sky, and deep space. Topics for the 35 x 1.5 hours meetings are structured as follows; any “questions arising” are welcome at any time during the course. Suggested readings from these Course Notes, for prior or follow-up discussions of each topic, are given in parentheses.

*1. REALM OF THE GREAT GALAXIES. What is the large-scale structure of deep space and deep time? What controls cosmic expansion? Why so vast, so ancient? What evidence supports “Inflationary Big Bang” theory, and the cosmic time-line? What might*

*have existed “before” the Big Bang? (pp 5-8, 11, 23-29, 31-32, 33, 36, 37).*

2. *EINSTEIN’S UNIVERSE. What is the evidence for time dilation? Curved spacetime? Black holes? Singularities in space-time? What causes gravity? What are Nature’s four fundamental forces? (pp 8-9, 11, 47).*

3. *QUANTUM COSMOLOGY. In the beginning...what happened? A “Multiverse”? Did the “Big Bang” have a cause? Parallel universes? What is the deep structure of matter? The Large Hadron Collider. **Stephen Hawking:** “Who or what breathed the fire into the equations, and gave them a universe to work on”? A string or brane “theory of everything”? (pp 10-11, 35, 48, 49).*

4. *STARBIRTH, STARDEATH: How did the galaxies and stars form, and evolve? Are such processes still in action? How may it all*



*evolve: our near and far destinies? “Big Crunch”, “Big Bounce”, “Big Chill”? (pp 12-15, 25-28, 34, 39).*

*5. THE RISE OF LIFE. How do planets form? Other solar systems? How did life on Earth originate and evolve? Are we alone: possible exobiologies; shadow life here on Earth? How goes the search, SETI? (pp 12-19, 33-35,48).*

*6. COSMOS, CHAOS, COMPLEXITY. Are we in a fractal universe? Is there a self-organising principle driving matter towards ever-increasing complexity? Has the universe always been “pregnant with mind”? (pp 34-35, 47).*

*7. CONSCIOUS MIND, COSMIC SIGNIFICANCE. A “self-aware universe”? Mind-brain duality? How does mind emerge from brain function? Whence came the “Big Brain”? What is the mind ? (pp 15-19, 25-36, 47, 62).*

**8, SCIENCE, RELIGION. AND HISTORY.** *What is it all for? Can scientific cosmology complement philosophy, theology, and traditional cosmologies, in our search for meaning, for “de-tribalisation”, for political, social and environmental maturity? Can the histories and evolution of modern societies be seen in a cosmic and biological context? Could this “big history” perspective assist in solving environmental problems and inter-cultural conflicts? (pp 1-5, 12-19, 19-21, 23-31, 50-53).*

To view more detailed summaries of the topics discussed during the above Cosmology seminars, please consult your up-dated fully referenced Course Notes (available on enrolment, or by prior arrangement with your course co-ordinator). Also, please note that every statement and opinion contained in the Course Notes is open for debate and discussion by you, the course participants. In particular, this applies to the attempt to view contentious current and historical geopolitical topics from a cosmological and biological

perspective. I hope you will find the course stimulating, enjoyable, and some of its concepts maybe a bit challenging (as I do!).

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2018  
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An OPTIMISTIC thought, from Harvard cosmologist Abraham Loeb (Scientific American, Nov. 2006): *“When I look up into the night sky, I often wonder whether we humans are too preoccupied with ourselves.....**the universe puts things in perspective**.....my own life, for example....it gives me a sense of longevity.....because of the big picture. Perhaps the greatest triumph of the past century has been a model of the universe that is supported by a large body of data. **The value of such a model to society is sometimes underappreciated.** When I open the daily newspaper.....I often see lengthy descriptions of conflicts between people about borders, possessions or liberties. Today’s news is often forgotten a*

*few days later. But when one opens ancient texts that have appealed to a broader audience over a longer time, such as the Bible, what does one find in the opening chapter? A discussion of how the constituents of the universe – light, stars, life -- were created. Although we humans are often caught up with mundane problems, we are curious.....**as citizens of the universe, we cannot help but wonder** how the first sources of light formed, how life came into existence and whether we are alone as intelligent beings in this vast space. Astronomers in the 21<sup>st</sup> century are uniquely positioned to answer these big questions.”*

**COURSE SUMMARY (continued) : OUR GALACTIC SIGNIFICANCE.**

**FRANK DRAKE’S EQUATION: Number of ETC’s (at least one) in the Galaxy,  $N = S \times P \times T \times B \times I \times C \times L$ .**

**(Alternatively :  $N = R \cdot f_p \cdot n_e \cdot f_i \cdot f_e \cdot L$ ).**

To help us to organise and simplify our thinking – our attempt to make sense of a cosmic “Big History” influenced by countless variable factors -- we can use American radio-astronomer Frank Drake’s “equation” to estimate the probability of any other “**ETC**” (***Electromagnetically Telecommunicating Civilization***) co-existing with us, elsewhere in “our” Galaxy. Drake proposed seven *sequential* factors – three astronomical, two biological, and two sociological (these last two cause most of the arguments!). For each factor, we can estimate a non-zero probability (low to high), or a value (for S, T and L). The chance of finding another ETC in the Milky Way Galaxy is then estimated by multiplying together the values assigned to each factor. So: here goes.

**S** is the rate of formation of *stars, per year*. The number of stars in the Galaxy is 200 to 400 billion, formed during some 12 billion years. Drake estimates that about 20 new single long-life (Sun-like) stars form every year within the Galaxy’s habitable zone (“ecosphere”), as detected by infra-red observations within its “giant molecular clouds” (dark nebulae).

**P** is the fraction of these new stars with *planetary systems*. Angular momentum conservation during planetary accretion (cosmic dust/ “sticky fluff”/ “putty balls”/ planetesimals/ planets); observations of proto-planetary gas/dust discs around young stars; “wobble-watching” & Kepler planetary transit studies indicate a high probability for **P**: 0.95 (95%) or greater.

**T** is the *average number of terrestrial-type planets per planetary system*, able to support life. Our own Solar System, and detection of 500+ extrasolar planets, imply the existence of bio-friendly terrestrial-type planets. “Inner solar systems” seem necessary, protected from infalling comets and asteroids by outer Jupiter-type “punching-bag” gas giants, with at least one rocky silicate/carbon inner water world orbiting within the “ecosphere” of a long-life parent star: a “Goldilocks” world, enough gravity to retain an atmosphere, warm enough for liquid water. But: excess carbon over oxygen forms bio-unfriendly worlds - graphite crust,

diamond interior, tar oceans. **T** *could* be 0.1 (ie.1 “Earth 2.0” planet/10 systems), or much less.

**B** is the fraction of these “bio-friendly water-worlds” on which a *self-sustainable living biosphere* originates and develops. Based on the ubiquitous presence of small organic molecules in dark nebulae, chondrite meteorites and cosmic dust grains, and the apparent ease of synthesis of “protobiont” organic molecules in experiments with primitive reducing atmospheres and oceans, it seems that B could be high: 0.5 or greater. However, it seems likely that any life on Mars was short-lived. Are other “exobiologies” possible, not based on water and carbon? We know only one life-bearing planet: Earth (the “*n=1 problem*”).

**I** is the fraction of these primitive (procaryote, bacterial?) biospheres which evolve to include complex *conscious self-aware “intelligent” life-forms*. Some 9 billion years for supernovae to generate enough “metals”, plus 4 billion years evolution on Earth, have been needed. **I** could be very

small. Are we among the first to attain intelligence? Hence, SETI's "great silence"?

**C** is the fraction of intelligent life-forms which discover the necessary *communications technology*, and are willing and able to send/search for radio and other electromagnetic signals from other ETC's. On Earth, among many cultures living in settled communities, those using Western science-based technology have entered this stage of development. **C** seems to depend on the development of non-nomadic societies (eg. agriculture-based city-states with stable institutions - universities or similar), able to undertake evidence-based research into nature's workings, unobstructed by totalitarian or other orthodoxies. Can we assume that, given time (some 100,000 years, if Earth is any guide), **C** is greater than 0.5? Again, the "n=1 problem": might any other ETC's conduct their affairs more rationally and responsibly, avoiding waste and tribal warfare?



**L** is the estimated *life-span of an ETC*, from its emergence to its extinction. The “n=1 problem” again looms large. Our civilization has existed for some 70 years since radio-communication came into wide use, and the first radio-astronomers detected extra-terrestrial signals (Jansky, 1930’s, found radio noise originating from Jupiter’s turbulent atmosphere and the Sun’s corona). Provided that our technological civilization is able to sustain itself, avoiding collapse due to planetary climatic impacts, over-use of limited resources, or catastrophic inter-tribal conflict, it could conceivably last for another billion years or so before Earth becomes uninhabitable due to gradual solar warming (about 10% per billion years). Or it could collapse to a primitive state, with loss of radioastronomy and other advanced technologies, within (say) 100 years? Would a life-span somewhere within this huge range be typical of other ETC’s? Would “they” be interested in searching for signals from other ETC’s? Multiplying all the estimated values, we arrive at an estimate that *ETC’s are probably exceedingly rare, at best none within thousands of light-years of Earth, far beyond the nearest stars*. Indeed, we could be the only one within the Milky Way Galaxy’s 200,000 million stars. Other

galaxies are too remote for radio contact to be possible. In which case, the means by which we manage our small world and conduct our affairs could be of galactic, even cosmic significance? **Conscious mind**, capable of “bringing self-awareness to the Universe”, could be an **exceedingly rare** phenomenon. We may usefully recall Monty Python’s pithy injunction (taken from A Cheerful Appendix, p.38 in these course notes): *“So pray that there’s intelligent life somewhere out in space, ‘cause there’s b#!@%! all down here on Earth.”*

A CHEERFUL APPENDIX (continued from p. 38).

For our enjoyment, here’s the latest addition to Monty Python’s cosmic chant (chanson?), composed by Eric Idle and John Du Prez, and used by Brian Cox in the BBC TV series “Wonders of Life” (2013). Feel free to add your own verses?

Just remember you're a tiny little person on a planet.... in a universe expanding and immense,

That life began evolving and dissolving and resolving....in the deep primordial ocean, by the hydrothermal vents.

That on Earth which had its birth about five billion years ago....from out of a collapsing cloud of gas,

Life really is quite new, and eventually led to you.... in round about three billion years or less.

Deoxyribe nucleic acid helps us replicate....and randomly mutate from day to day.

We left the seas, and climbed the trees, and our biologies.....continue to evolve through DNA.

We're ninety eight point nine percent the same as chimpanzees....whose trees we left three million years ago,

To wander swapping genes, out of Africa, which means....we're related to everyone we know. (G'day, luv...)

Life is quite strange, life is quite weird....life is really rather odd,

Life from a star is far more bizarre....than coming from a bearded old bloke they call God.

So gaze at the sky, and start asking why....you're even here on this ball?

Although life is fraught, the odds are so short....you're lucky to be here at all.

We're standing on a planet which is spinning round a star....which is one of just a billion trillion suns,

In a universe that's ninety billion light years side to side....wondering where the heck it all came from.

You've a tiny little blink of life, to try and understand....just what on Earth is really going on,

In biologies and chemistries, which made you you and made me me.....but don't ask me, I only wrote the song.

Right of reply, from the Bearded Old Bloke (per humble animated stardust servant J. O'Connor):

Can't think why We created them, We're not at all amused....what an undeserving bunch of ne'er do wells.

They cost Us seven days of toil, but wait, they're on the skids, Our Second Law of Thermo rings their funereal bells.

Our entropy will get them all, and serves them jolly right....next time We shall not make the same mistake.

Our multiverse will come up with the constants and the laws.... to generate big brains which cannot make.....

SUCH INFERNAL COSMIC NIGHTMARES  
OF THEMSELVES !!!

EXOPLANETS AND EXOMOONS: Of the approx. 1,000 exoplanets found during the last decade by indirect means including planet-induced wobbling or dimming of their host stars, only a few have been directly observed, as most are orbiting very bright young stars (less than 200

million years old). Now (AAP, 11/11/2013), the first “lonely planet” (PSOJ318.5-22) floating solitary “out there all alone” in space, not orbiting a star, has been detected by the Pan-STARRS1 wide-field survey telescope on Hawaii. Its faint and unique heat signature, 80 light-years from Earth, reveals similar properties to young gas giant planets (formed some 12 million years ago) orbiting young stars; it should provide Niall Deacon’s “view into the inner workings” of Jupiter-like gas-giant planets. Presumably, it has been catapulted out of its star’s planet-forming disc by gravitational interactions with sibling planets (a fate which could conceivably overtake Earth in the distant future). Many such “lonely planets” may populate the voids of interstellar and even intergalactic space.

Also, Overbye (2013) reports that NASA’s Kepler spacecraft’s 4 years of data (recently terminated due to a gyroscopic pointing malfunction) have also identified some 3,500 potential planets in one small patch of the Milky Way, indicating that the Galaxy has about as many planets as stars (i.e. 200-300 billions). Petigura and Marcy (Nov. 2013) estimate that some 40 billion planets (22% +/- 8%) could be habitable Earth-sized (“eta-

Earth”, or “Earth 2.0”). One of every 5 sunlike stars has an eta-Earth in its habitable liquid-water “goldilocks” zone; the nearest *could* be only 12 light-years away, orbiting a naked-eye star. Within a Kepler subset sample of 42,000 “brighter well-behaved” sunlike stars, 603 have planets; 10 of these are between 1 and 2 Earth diameters, in orbits receiving from 4 to 1/4 times Earth’s sunlight (i.e. from inside Venus’ to just outside Mars’ orbits). From 15% to 50% of the smaller more numerous red dwarf stars should have eta-Earth planets in their habitable zones. About 1 in 100 orbits are aligned edge-on, enabling us to observe the “telltale winks” of planetary transits. However, nobody yet knows eta-Earths’ masses, whether rocky or icy frozen gas balls, or if habitable; one planet (Kepler 78b) has similar size and density to Earth, but is in an 8.5 hours orbit, too hot for life.

On life’s origin on Earth: “Spark of life” proton gradients generated at alkaline “deep-ocean lost cities” white hydrothermal vents, mimic those inside mitochondrial intracellular “micro-batteries” derived from LUCA, a proposed “last universal common ancestor” of all life on Earth (Brian

Cox). On the evolution of life on Earth from LUCA to us: “Darwinism is not a theory of random chance. It is a theory of random mutation plus non-random cumulative natural selection” (Richard Dawkins). However, long before the Sun burns out, Earth’s core will cool; volcanic replenishment of atmospheric CO<sub>2</sub> will fall to levels too low for plant photosynthesis, in ½ billion years or so, similar to multicellular life’s appearance on Earth.

On meteors: Following the 2012 Chelyabinsk “near- miss” by a 20 metre meteor which exploded with energy equivalent to about 40 Hiroshima atomic bombs, in the atmosphere some 30 km above the city, injuring 1000 people by its shockwave, it appears that these small meteors are some 10 times more numerous than previous estimates. For an increasingly crowded world, this magnifies the risk of impact by these hard-to detect incoming objects.

On climate change, Lloyd (2009, p.225) notes that, according to a Nov. 2006 UN Report, planet Earth “plays host to 1.3 billion cattle”, with environmental consequences including deforestation and “a giant



contribution to global warming”. 18% of greenhouse gases are directly emitted from the bellies of domesticated livestock; that’s 5% more than total worldwide emissions from global transport systems (road, rail, sea and air), with cows “by far the major culprits because of their huge numbers and their penchant for producing nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>), far more powerful greenhouse gases than the CO<sub>2</sub> produced by human industry”. To keep up with global food demand, meat (230 million tonnes in 2009)) and milk production will have to more than double by 2050, unless people are persuaded (by extra taxes?) to eat less “ecologically unsustainable meat”. And: “turning vegetarian is probably the biggest single personal contribution any one person can make in today’s battle against global warming”. Also, some good news: heat is “not undermining Greenland’s ice sheet” (Matt King et al, PNAS, 19 Nov. 2013). Measurements of Greenland’s immense ice cap in 2012 show that its movement, using GPS tracking of poles in a 120km strip of ice in its S/West, has slowed to 6% less ice flowing into the ocean than during the “average” melt year of 2009, despite a 2012 (July 12) warm episode when 99% of the ice sheet experienced some melting. It now seems less likely

that its feared slippage into the ocean, lubricated by meltwaters, will occur, causing increased sea level rise and iceberg production.

On “true reality”, Kuhlmann (2013) notes that, while physicists speak of the world being made of particles and force fields, it is not at all clear what these actually are in the quantum realm. Many think that “particles” are not things at all, but excitations in a quantum field (the modern successor of classical magnetic and other force fields). But “fields” are also paradoxical. If neither are fundamental, then what is? Some think that the world, at root, does not consist of material things: “particles” are better thought of as bundles (or “tropes”) of properties such as mass, charge, spin, energy and momentum; what really matters are the *relations* between particles and their fields, a viewpoint called “ontic structural realism”.

On a physicist’s definition of energy: “The length of its spacetime 4-vector in the time direction” (Brian Cox, 2013). This mathematical definition complements the Newtonian concept of energy as the ability to do work on an object, by applying to the object a force which causes it to accelerate,

and/or deform (elastically or non-elastically), while the original high-grade energy is dissipated into lower-grade higher-entropy disordered forms of energy (heat, noise, etc.).

On the mind: “To sleep, perchance to prune”. Tononi and Cirelli (2013) report evidence that sleep (which all animals do) weakens (“prunes”) connections among neurons, keeping the brain’s nerve cells from becoming over-saturated with daily experience, and thereby consuming too much energy. Paradoxically, during wakefulness, strengthening synaptic connections among neurons supports learning and memory. Dreaming during sleep is also detected (by EEG) among many animal species.

On politics, and human affairs in general, it seems difficult to improve on U.S. President Lincoln’ opinion: “Better to remain silent and be thought a fool, than to speak and remove all doubt.” Also, Wittgenstein: “Whereof thou canst not speak, thereof thou shouldst remain silent.” Or: “A little knowledge is a dangerous thing”. Or: “Wag not prematurely your tongue

lest it not be in gear with your brain.” Additionally, the assassinated President Kennedy’s appeal to “ask not (only) what your country can do for you, ask (also) what you can do for your country”, seems highly appropriate (The Aust., Letters, 02 Sept. 2013) for the repair and maintenance of Western societies damaged by over-emphasis on individual rights, while neglecting our responsibilities to avoid disproportionate and destructive self-laceration, and to sustain liberal democracies which alone endow us with our historically recent and taken-for-granted rights. Also, Albert Einstein’s call for peace among nations, post WW2: “I know not with what weapons world war 3 will be fought, but world war 4 will be fought with sticks and stones.”

For an optimistic conclusion: as pointed out by Pamela Bone (2008, updated), “*In the past century there has been a **revolution in health, longevity, education, human rights**. The proportion of the world’s population living in absolute poverty has dropped from about 80% in 1820 to about 20% today. You’d never think it by watching the nightly news, but since the early 1990’s the number of armed conflicts in the world has*

*fallen by 40%. The percentage of men estimated to have died in violence in hunter-gatherer societies is approximately 30%. The percentage of men who died in violence in the 20<sup>th</sup> century, despite two world wars, is approximately 1%. The trends for violent deaths so far in the 21<sup>st</sup> century are still falling, despite wars in Iraq and Afghanistan **and Syria. It's a story the media has missed.**"* Horgan, (2009) and Diamond (2013) also review evidence that levels of violence are much lower in our era than before the advent of modern states.

So: with all best wishes for 2018, John O'Connor.

ON OPENING HIS COMPUTER, OVER HIS  
BREAKFAST CORNFLAKES, OUR HUMAN  
FRIEND CHECKS HIS INBOX:

(1) Dear Human, You are a tiny speck dwarfed by even the tiniest object in the heavens. Sincerely, The Universe.

(replies) Well, that's sad. You mean, like, I'm insignificant?

(2) Dear Human, Your slightest actions can cause chain reactions that propagate forward, like the butterfly flapping up a hurricane, eventually reaching all of space and time. Sincerely, Chaos Theory.

That's really cool!! I can change the universe...here goes...

(3) Dear Human, Your “actions” are merely the result of your brain’s chemical structure and its neurons firing or not firing at any given time. Sincerely, Causality.

You mean...I’m not in charge??? Oh no, that cannot be.....

(4) Dear Human, Causality is LYING. Also NOT LYING. Also an entangled superposition of lying and not-lying states. Sincerely, Quantum Mechanics.

Okay. Huh???

(5) Dear Human, We've invented lots of neat things to distract you from the void of meaning that is your existence. Sincerely, Art.

Ooooh....sounds much more promising...let's get started...

(6) Dear Human, ALL EXISTENCE IS VOID OF MEANING. Sincerely, Postmodernism.

Okay, so what's the point...I'm gonna end it all...

(7) Dear Human, Your selfish genes program you to live . Sincerely, Evolution.



Okay. Then I'll descend into hedonism...

(8) Dear Human, You can't afford it. Sincerely, Economics.

Okay, that does it. Dear Reality, I'm computing a new simulated reality program where I'm in charge and everything works the way I like...

(9) Dear Human, Welcome to the Club. Sincerely, God.

Er...oh??? Thanks, but, um,  
er...look at Your mess...too much responsibility...  
(Deletes all messages, concentrates on the  
cornflakes.)