Noesis

The Journal of the Mega Society
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About the Mega Society

The Mega Society was founded by Dr. Ronald K. Hoeflin in 1982. The 606 Society (6 in 10^6), founded by Christopher Harding, was incorporated into the new society and those with IQ scores on the Langdon Adult Intelligence Test (LAIT) of 173 or more were also invited to join. (The LAIT qualifying score was subsequently raised to 175; official scoring of the LAIT terminated at the end of 1993, after the test was compromised). A number of different tests were accepted by 606 and during the first few years of Mega's existence. Later, the LAIT and Dr. Hoeflin's Mega Test became the sole official entrance tests, by vote of the membership. Later, Dr. Hoeflin's Titan Test was added. (The Mega was also compromised, so scores after 1994 are currently not accepted; the Mega and Titan cutoff is now 43—but either the LAIT cutoff or the cutoff on Dr. Hoeflin's tests will need to be changed, as they are not equivalent.)

Mega publishes this irregularly-timed journal. The society also has a (low-traffic) members-only e-mail list. Mega members, please contact the Editor to be added to the list.

For more background on Mega, please refer to Darryl Miyaguchi's "A Short (and Bloody) History of the High-IQ Societies"—

http://archive.today/K32e

—the Editor's High-IQ Societies page—

http://www.polymath-systems.com/intel/hiqsocs/index.html

—and the official Mega Society page,

http://www.megasociety.org/

Noesis is the journal of the Mega Society, an organization whose members are selected by means of high-range intelligence tests. Jeff Ward, 13155 Wimberly Square #284, San Diego, CA 92128, is Administrator of the Mega Society. Inquiries regarding membership should be directed to him at the address above or:

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Opinions expressed in these pages are those of individuals, not of *Noesis* or the Mega Society.

Editorial

Kevin Langdon

This is the 200th issue of *Noesis*, the journal of the Mega Society. It's gratifying that we have several fine submissions, making possible this unusually large issue.

First we have "Viruses Create More Biodiversity Than Any Other Comparable Taxon," by evolutionary biologist David Seaborg. In this paper he develops some of his ideas about the role of viruses in evolution, one aspect of his theories regarding the origins of biodiversity. David is writing a book about his theories; this paper is part of that project. He is founder and President of the World Rainforest Fund, a nonprofit dedicated to preserving rain forests by empowering indigenous peoples:

http://www.worldrainforest.org

And this issue includes Part Five of the long interview with Rick Rosner by Scott Doug-las Jacobsen, from the *In-Sight* journal site—

http://in-sightjournal.com/

—where the interview originally appeared. As in the previous parts, the interview covers a lot of ground; this part includes wide-ranging comments on mathematics, logic, consciousness, evolution, cosmology, and much more.

Next is a new member introduction by Sam Thompson. Welcome to Mega, Sam.

We have a thought-provoking essay on the future of artifical intelligence. "What Does AI Want?", by May-Tzu (Richard May). How similar to us will advanced artificial intelligence be?

The issue concludes with "Dr. Capgras Before the Mirrors," by someone using the pen name "May-Tzu" who may or may not exist, or possibly exists *and* does not exist, like a surreal quantized Buddha.

See May-Tzu's "Stains Upon the Silence" site:

https://ferdlilac.wordpress.com/

As no one has responded to last issue's call for candidates for Editor, Internet Officer, or Administrator, I'm afraid that you're stuck with Chris, Jeff and me for another year.

Cover: Pluto's largest moon, Charon, from NASA's New Horizons spacecraft

Viruses Create More Biodiversity Than Any Other Comparable Taxon

David Seaborg

Some definitions of terms used in this article
anagenesis: evolution within a lineage (as opposed to the splitting of a lineage)
angiosperm: flowering plant
archaea (archaebacteria): microorganisms that have RNA sequences, coenzymes, and a cell wall composition that are different from all other organisms, often found in very hot or salty environments
chemolithotroph: an organism that can use inorganic compounds as a source of energy
clade: a grouping of organisms that includes a common ancestor
domain: there are three domains of cellular organisms: bacteria, archaea (see above), and eukaryotes (see below). In addition there is non-cellular life (viruses)
eucaryote: organism that uses aerobic cellular respiration to break down compounds including oxygen into cellular energy.
heterotroph: an organism deriving its nutritional requirements from complex organic substances
lysis: disintegration of a cell by rupture of the cell wall or membrane (*lyse*, verb)
photic zone: the first 100 meters or so of the upper ocean, where almost all photosynthesis occurs
procaryote: a single-celled organism without a distinct nucleus or organelles, e.g., bacteria
ribosome: molecular machine responsible for the production of protein in living cells
SAR11: the most common marine bacterium
telomere: protective cap at the end of a strand of DNA
titer: a measure of concentration
trophic: of or relating to feeding and nutrition
viral shunt: virus-mediated movement of nutrients from organisms to pools of non-living organic matter

The following discussion draws on several excellent reviews (references 1-10; see also references therein). Where statements are not referenced, they are supported by one or more of these reviews. Because of anomalies of viral genomics, many scholars refer to viral species as types, and I will be conservative and use this terminology here.

Viruses influence horizontal gene transfer, nutrient cycling, system respiration, the carbon cycle and climate regulation, algal and procaryote species numbers and distributions, control of phytoplankton blooms, sinking rates of sea particles, and dimethyl sulfide formation (Fuhrman 1999). They also affect the evolution of the species they infect.

Viruses are by far the most biodiverse taxon on Earth by any measure. There are tremendously more types of viruses than there are species in any other comparable taxonomic group. Some viruses infect more than one species, but every species of every taxonomic group is likely host to several viral species. Thus, there are many more types of virus than species of all eukaryotes and procaryotes combined, which is spectacular considering the number of species of procaryotes. Even a conservative estimate of 10 virus types infecting each species of cellular organism would mean there are 10 times as many virus types as all species of organism on Earth, from bacteria to human. Viruses are also the most abundant in terms of organism numbers. They are very abundant in aquatic environments (Bergh et al. 1989). There are 3 to 50 million viruses in each milliliter of sea water. The vast majority have not been identified or characterized. Viruses of bacteria, known as phages, are the most abundant and diverse form of nucleic acid replicating agents in the world, and the biosphere's major life form. Viruses are 94% of all entities in the ocean that have nucleic acid. They are the most abundant biological entity in the water column of the worlds oceans, and the second largest component of biomass after prokaryotes (in the sea, 95 to 98% of biomass is procaryotes). In the ocean, viruses are 10 times as abundant in numbers as bacteria and archaea combined. They are the most abundant organisms in the sea, typically numbering ten billion per liter (Fuhrman). Microbiologists found even higher viral numbers in soil. There are estimated to be 10^{30} bacteria worldwide (Whitman et al. 1998), and an estimated 10 times as many phage as bacteria, for a total of 10^{31} phage worldwide (Hendrix et al. 1999). Hendrix (2003) reiterated this same estimate later. Suttle (2005) made an actual calculation of the number of viruses in the sea, arriving at 4×10^{30}. There are 10^{23} stars in the Universe. So there are estimated to be 100 million times more bacteriophages on Earth than there are stars in the Universe! If a phage were as big as an insect, they'd cover the earth several miles deep. The total number of virus particles is 10 times the total number of cells on earth. If all of the viruses in the ocean were stretched end to end, they would span about 200 million light years. This is about 100 times the distance across our own galaxy, or farther than the nearest 60 galaxies. They also are the worlds largest genetic reservoirs in aquatic environments, and the soil environment is a more diverse habitat for viruses than aquatic ones (Kimura, 2008). Thus, in terms of both number of types and number of individuals, viruses are nature's most successful organisms.

Viruses are more varied than all other organisms combined. They may specialize in one host, or infect a huge host range; the rabies virus seems capable of infecting any mammal. Viruses are extraordinarily diverse in shape and structure. Their genetic material is surrounded by a container of protein called a capsid. The capsid can be enveloped with one to several lipid bilayers, or nothing. Their genome can be protected by one, two or even three capsids, which vary in shape. They have great variation in size. They have the highest genetic variability of any kind of life. The variation in their genomes as a percentage of their total genomes exceeds all other organisms. This is an excellent measure of genetic variability. Their biochemistry and mechanisms of replication of their genetic material are more varied than those of all other organisms. The replication methods for different kinds of viruses are radically different; each of the 83 virus families has a unique replication method that uses proteins and enzymes specific to it. Essentially all procaryotes and eukaryotes have double-stranded DNA as their genetic material. But viruses differ in their genetic material. There are some viruses with double-stranded DNA, some with single-stranded DNA, some with double-stranded RNA, and some with single-stranded RNA. Varying this much in something as fundamental as genetic material represents variability greater than that between a bacterium and a human. There are even viruses that attack other viruses, including capsid-containing virophage that parasitize and kill the viruses they replicate on (Fischer & Suttle); viroids, which consist of nucleic acid (DNA or RNA) without a protein capsule enclosing it; and prions, which are not viruses, but of relevance because they are protein and no more, and act as infectious particles (an example of a prion is mad cow disease).

The number of unique genes in bacteriophages is astonishing. Almost 2,000 partial sequences from phages in the sea were ran through a computer database of all known DNA sequences of animals, plants, fungi, procaryotes, and viruses, and only 28% of the phage sequences bore similarities to previously documented genes. The genomes of 10 soil-dwelling phages were also studied, identifying 1,600 genes (Pedulla et al. 2003). About half those genes are unique, not matching any previously described genes in any other organism. And bacteriophage G, which has 684 genes, many more than some bacteria, was sequenced. The proteins coded for by nearly 500 of those genes do not match any known proteins (Hendrix 2009). Studies of viral DNA have found a plethora of new viral types. It appears about 30% of marine phage DNA is different from known sequences in GenBank; certainly a large portion still has no significant match to sequences in databases. Angly et al. did a metagenomic analysis of viral communities that included between 41 and 85 individual samples from the Arctic Ocean, the coastal waters of British Columbia and the Gulf of Mexico, and 1 sample from the Sargasso Sea, obtaining about1.8 million sequences (Angly et al., 2006). On average, over 90% had no recognizable homology to previously reported sequences in GenBank.

Metagenomic studies in coastal waters (Breitbart et al. 2002) and sea sediments (Breitbart et al. 2004) show there are thousands of viral genotypes in 200 liters of sea water and a million in 1 kg of sediment. And 60-80% of the sequences were not similar (E-value 0.001) to those in databases, contrasting with 90% similarity of putative genes from metagenomic data for prokaryotic communities to database sequences (Edwards & Rohwer 2005), showing that marine viral communities contain great genetic richness, much greater and less sampled than their prokaryotic counterparts. Some marine viruses infecting one-celled eukaryotes have almost no recognizable similarity to known DNA sequences (Nagasaki et al. 2005). Of marine viral DNA gathered directly from environmental samples, 65-95% of it is not similar to previously described DNA sequences (Angly et al 2006; Breitbart et al 2002; Breitbart et al 2004), as opposed to only about a 10% difference from known cellular DNA gathered from the environment (Venter et al. 2004).This implies that we have only begun to scratch the surface of marine viral diversity. The oceans are also a reservoir of tremendous RNA virus diversity, unknown until recently (Culley et al. 2006). In the relatively few genome sequences available for tailed bacteriophages with large genomes of more than 200 kbp of DNA, called jumbo phages, the genomes are diverse, and the majority have no matches in current sequence databases (Hendrix 2009: Pope et al. 2015) sequenced and compared 627 phages that infect one species, Mycobacterium smegmatis, finding great genetic diversity, with 28 distinct genomic types (clusters) with related nucleotide sequences. Amino acid sequence comparisons showed considerable genomic mosaicism, showing phage types or strains exchange genetic material frequently. Quantification of relatedness within and between genomic clusters showed a continuum of genetic diversity. They found the mycobacteriophage population is not closed, having a constant influx of genes from other sources. Labonte & Suttle (2013) found 84% of single-stranded DNA viruses they sampled in the sea had no evident similarity to sequenced viruses. Viruses are one of the largest reservoirs of unexplored genetic diversity on Earth (Suttle, 2007). They are the major form of life, and the most diverse form of life, on Earth.

Marine phages kill 20 to 40% of ocean bacteria every day (Fuhrman 1999; Weinbauer 2004; Suttle 2005; Proctor & Fuhrman 1990)! Every second, approximately 10^{23} viral infections occur in the ocean. The viral shunt is as important as unicellular predators of microbes at regulating microbial populations. Since viruses also attack fresh water microbes at a high rate, they are essential to the regulation of both saltwater and freshwater ecosystems (4). The viral shunt profoundly promotes the productivity and diversity of marine procaryotes and phytoplankton. It releases large quantities of nitrogen, phosphorous, iron, and micronutrients into the sea (Suttle 2007; Gobler et al. 1997). These nutrients act as fertilizer for the growth of new procaryotes and phytoplankton, just as nutrients from upwelling do. The growth of unicellular organisms tends to be limited by these nutrients most of the time. So nutrients released by viral-induced bacterial lysis stimulate the growth of marine procaryotes, algae, and phytoplankton, thus greatly increasing the amount of photosynthesis in the ocean. The enhanced growth of phytoplankton from the viral shunt was clearly shown in a blog (2012). They increase photosynthesis even more because phage-infected cyanobacteria exhibit a higher rate of photosynthesis until they are eventually killed by the infection. The viral shunt aids blooms of unicellular organisms. Enough iron is released by the viral shunt to supply the needs of phytoplankton (Poorvin et al. 2004). Phytoplankton produce about half of Earth's oxygen, sequester a great deal of CO_2 when they die and sink, and act as the basis of the ocean's food webs. Increased growth of phytoplankton results in more of it sinking and being buried at the sea bottom, directly or as corpses or feces of organisms that ate it, sequestering carbon. The enhancing effect of the viral shunt on the growth of unicellular organisms is born out in laboratory experiments using microbes that predominantly occur near the seas surface. Viral lysis of a lab-infected bacterium released organic iron complexes that were quickly taken up by other marine bacteria. So non-infected organisms grew faster. In another experiment, removal of viruses slowed cell growth and proliferation of the cyanobacterium Synechococcus, presumably because of less nutrients released by viral lysis (Weinbauer et al. 2011).

The viral shunt likely does more than promote microbial growth; it probably promotes microbial diversification. The viral shunt is analogous to a forest fire fertilizing a forest, releasing nutrients, making them available, and allowing new life to flourish. The release of additional nutrients into the sea when angiosperms appeared spurred phytoplankton evolution, promoting their complexity and diversity. It is reasonable to assume, then, that the release of nutrients by the viral shunt similarly promoted in the past, and currently promotes, the evolution and diversification of bacteria, archaea, and phytoplankton, because the viral shunt makes largely the same nutrients available to these 3 groups of organisms as the rise of the angiosperms did for phytoplankton.

In spite of the fertilization provided by viral-induced lysis of unicellular organisms, the viral shunt does not promote toxic algal blooms. In fact, algal viruses are the main agents responsible for the rapid destruction of harmful algal blooms (Suttle 2005), which often kill other marine life (cdc.gov 2014). This is yet another way marine viruses maintain the diversity of marine systems and higher organisms.

It is accepted that marine phages directly and indirectly have a significant influence on biogeochemical cycles and carbon sequestration in the sea (Danovaro et al. 2011). Marine viruses are likely profoundly modulating the biogeochemical cycles that run the planet (Suttle 2005). In fact, viruses are the most important mechanism for recycling carbon in the marine environment. An amazing 5 to 25% of the carbon fixed by primary producers is estimated to enter into the microbial loop via virus-induced lysis at different trophic levels in aquatic environments (Kimura et al. 2008). It is not known for certain whether viruses speed up or slow down the biological pump, by precisely how much, by what mechanisms, or all of the feedback systems involved. However, the viral shunt appears to speed up the biological pump, being very important in regulating climate by sequestering a great deal of carbon.

Marine viruses also maintain and increase the diversity of their bacteria, archaea, and phytoplankton prey by the mechanism called kill-the-winner (Weinbauer & Rassoulzadegan 2004; Kirchman 2013). This is the same mechanism by which animal predators promote diversity of their prey species by selectively attacking the most abundant and successful competing prey species, as illustrated in Paine's work on the sea star system. Marine viruses attack the most successful, abundant prokaryote among their competing prey species, causing its population to decline precipitously, and preventing it from driving its competitors locally extinct. They selectively attack the best competitor of their host species. The same is true for viruses that attack plankton. This keeps species diversity of marine procaryotes and phytoplankton high. Kill-the-winner is central in models of the population dynamics of phage-bacteria systems. It is the current working paradigm for microbial-phage community dynamics (Rodriguez-Brito 2010). Several studies reported dramatic changes in the relative concentrations of viruses and their prey, supporting the kill-the-winner model (Wommack et al. 1999; Fuhrman & Schwalbach 2003), and some of these support kill-the-winner in natural environments (Chen et al. 2009; Short & Short 2009; Winget & Wommack 2009).

It is supported by convincing observational evidence in phytoplankton systems (Bratbak et al. 1993; Brussard 2004; Tomaru et al. 2004), where blooms of a single species seem to result in very high infection rates (Bratbak et al. 1993; Brussard 2004; Tomaru et al. 2004). This can lead to collapse of the bloom (Bratbak et al. 1993), resulting in increased microbial species diversity. Viruses range from specialists to generalists. They range from viruses that infect just one strain of a species to viruses that attack any species in a large taxonomic group. In systems with specialist viruses where each host species has one unique virus attacking it, kill-the-winner occurs because the host species with the highest population tends to host the fastest-growing viral population, so the virus kills it proportionately more than its competitors. The winner's population plummets, and there is a precipitous drop in the titer of its virus, since it has little to feed on. The former dominant host's competitors increase in response to the low population of their viruses and the decline of their formerly successful competitor. Then the viruses of new winners increase and selectively kill them. In the process, new viral strains arise frequently and rapidly, and previously rare strains can quickly increase in abundance. Where generalist viruses are predominant, kill-the-winner tends to happen because generalist viruses attack cells that they come into contact with, and they bump into host cells that are more abundant more often. They kill the microbe species that is most abundant, switching to the microbe species that replaces it when the latter becomes the predominant microbe species. Constant, dynamic fluctuations in viral and microbial populations occur as a consequence of kill-the-winner. Kill-the-winner might even drive both viral and microbial diversification by altering the genetics of both, because of selection pressures from driving their populations up and down repeatedly. But more research is needed to prove this. At any rate, it is certain that kill-the-winner maintains existing microbial diversity.

Related to kill-the-winner is the fact that viruses also maintain microbial diversity by preventing microbial population explosions, as they clearly regulate their numbers. They are especially important in controlling marine bacteria and archaea populations. But they also regulate numbers of all species of organisms, including phytoplankton, fungi, plants, and animals. They can regulate animal populations through negative feedback, the way predators do. When the animal population gets high, it is subject to viral infection because of increased stress from crowding, and because of increased contact each organism has with other individuals in the population, increasing the odds it will come into contact with an infected individual. Hence, viral disease brings the population down. When the animal population is low, there is less stress and less contact with diseased individuals, so less susceptibility of animals to disease, and the population increases. This negative feedback decreases the probability of local extinctions.

Viruses also promote anagenesis by horizontal gene transfer. This has profoundly affected and accelerated the evolution of many taxa, causing the appearance of a great many evolutionary innovations and novelties. Horizontal gene transfer is particularly common in bacteria (Canchaya et al. 2003), but also occurs in eukaryotes. It promotes procaryotic diversity (Kichman 2013). Lysogeny, integration of viral DNA into host DNA, is widely distributed and very common (Williamson et al. 2007). When lysogenic viruses leave their hosts, they can take some of the host's DNA with them and integrate with it into a new host, and can even carry DNA from one species to another. They are a key natural mechanism for transferring genes between species (Liu et al. 2010), which increases genetic diversity, drives evolution, and allows rapid evolutionary change. It is thought that viruses played a central role in very early evolution, before the diversification of bacteria, archaea, and eukaryotes, and at the time of the last universal common ancestor of life on Earth. There is even evidence from genome analyses of tailed bacteriophages with double-stranded DNA that viruses evolve by the rearranging of genes by recombination and by the acquisition of novel genes as simple genetic elements. This suggests that viruses can be regarded less as having derived from cells and more as being partners in a mutual co-evolution with them (Hendrix et al. 2000). Viruses have likely been important in horizontal gene transfer through the entire history of life.

Evidence now indicates that viruses routinely use genes taken from their hosts to control host metabolism to better produce virus particles (Thompson). Genes for photosynthesis are examples of such genes (Sullivan et al. 2006; Zeidner et al. 2005; Lindell et al. 2004). Phages of photosynthetic cyanobacteria commonly have photosynthesis genes (Sullivan et al. 2006), even acting as genetic reservoirs for their hosts. This is significant to my theory because it means there was and still is selection favoring viral incorporation of host genes, the first step in horizontal gene transfer via viruses. Selection favoring this incorporation of host genes indicates that it is a common phenomenon in viruses. The alteration of host metabolism by the virus for its own benefit can be significant, even speeding up the biological pump. For example, some phage that infect cyanobacteria increase their photosynthetic rate. This increases carbon sequestration, because the cyanobacteria are either lysed by the phage, cause sinking of carbon, or are eaten and go up the food web until an animal up the food web dies and sinks, or defecates, with the feces sinking to the sea floor. The host cells' higher photosynthetic rate also increases the fertilization of the sea with nutrients, and sinking and burial of carbon, when the phage cause lysis of the host cells. Increasing nutrients in the sea allows other microbes to eat them and grow, causing a further direct and indirect source of sinking of carbon.

Viruses and their hosts underwent (and still undergo) mutualistic co-evolution, whereby viruses benefitted by getting a place to live and the use of host genes to control host metabolism, while hosts benefitted because viruses increased host variability, progressive evolution, adaptation, and diversification. The host benefitted at the level of evolution, unlike the case of most mutualists, which benefit by receiving an immediate ecological advantage.

It is now clear that viruses promote microbial diversity by a combination of kill-the-winner and horizontal gene transfer (Kirchman 2013). There is now also direct evidence that viruses increase microbial diversity. Luna et al. (2013) studied microbes in marine surface and sub-surface sediments down to 1 m depth in vegetated sediments (seagrass meadow) and non-vegetated sediments. They found that viruses promote differences in microbial species between different sub-surface layers, and play a role in microbial diversity within and between sediments.

Scientists found bacteriophage are important in deep sea sediments (Danovaro et al. 2005). They sampled sediments from scores of ocean sites, at depths from 595 ft (183 m) to 14, 959 ft (4,603 m). This is the dark, nutrient-poor, inhospitable deep sea, the last great unexplored ecosystem on Earth. Below 3,250 ft (1,000 m), procaryotes make up 90% of the total biomass. They found an astonishingly high viral count, showing viruses infect and lyse prokaryotic cells in the ocean depths, recycling nutrients, and making them available to other procaryotes, keeping the system functioning and maintaining prokaryotic diversity. There are between 5 x 10^{12} and 10^{13} phage per sq m in deep sea ecosystems. They kill huge numbers of microbes, liberating and recycling their nutrients, making the system healthier than if microbes stayed alive and breeding, much like viral lysing of procaryotes at the sea's surface, and like forest fires liberating nutrients in forests. Thus, viral infections are responsible for transferring a tremendous amount of nutrients from living forms into organic matter dissolved in sea water and detritus. This explains why nutrients are recycled so efficiently and at such high rates in deep sea sediments. Although the deep sea receives a cornucopia of nutrients raining down on it from the shallower seas above it, nutrients are often limiting there, and the nutrients liberated by viruses are a necessary, substantial addition to the nutrients of the deep sea ecosystem. Surprisingly, the nutrients released from the death of prokaryotes due to viruses are significantly more important to deep sea ecosystems than the nutrient input from the seas' shallow waters. This system is self-sustaining, allowing the ocean depths to overcome severe nutrient limitations. Since carbon in the deep sea can be locked up for ages and not available to life, the liberating of carbon and making it available to organisms by viral attacks is crucial to the health and diversity of life in the deep sea. Small deep sea organisms can utilize the nutrients that result from viral lysis of procaryotes at the seas bottom. The nutrients then flow up the food webs, as larger organisms eat smaller ones. The researchers responsible for this study also found a great portion of viral-liberated deep-sea nutrients ascend to the upper, shallow seawaters, and contribute substantially to the ecosystems in the photic zone which have phytoplankton at the base of their food webs. This ascent is no doubt via heterotrophs, chemolithotrophs, upwelling, and other standard ways nutrients surface in the sea. This is a surprising discovery, that deep-sea viruses supply nutrients to the ecosystems of the upper ocean, sustaining large fish and invertebrates, including seafood that people eat. And it means the photosynthetic zone near the sea surface and the deep sea feed nutrients to each other, in a recycling system in which each keeps the other healthy and diverse. Amazingly, the two ecosystems, far apart, aid each other.

Viral attack of procaryotes in the deep ocean keeps a substantial amount of carbon from being buried under the sea floor, and keeps it in the biosphere, without sending a significant amount into the air. This is important because it conserves carbon in the biological system without heating the Earth, helping solve the atmospheric temperature versus carbon conservation dilemma. And deep sea ecosystems are very important in biogeochemical cycles of the Earth, so deep sea phages greatly influence earth's major nutrient cycles, including the carbon, nitrogen, sulfur, and phosphorus cycles.

Viruses also benefit life by cooling the earth while conserving carbon, because when they lyse unicellular organisms dimethyl sulfide is released. This gas starts a process that ultimately cools the atmosphere.

Phytoplankton infected with a virus tend to contain a smaller proportion of polyunsaturated fatty acids, which are needed by all organisms. This makes them a poorer quality food, which is passed up entire food webs. Yet, for reasons that aren't clear, tiny organisms tend to prefer to graze on infected cells. This results in poorer nutrition to marine food webs. If the nutrition is reduced enough, it can potentially reduce diversity. This possible apparent contradiction to my theory needs more study.

The SAR11 clade is also called the Pelagibacteraceae, and consists of very small bacteria. They have the smallest known genetic structure of any independent cell on earth. They are very abundant (Morris et al. 2002; Zhao et al. 2013), comprising about a third of all cells on the sea's surface. They can live in water too low in nutrients for most other organisms. They consume carbon. They also recycle organic matter into inorganic nutrients, making them available to phytoplankton, indirectly feeding them. They are therefore of crucial importance to the health and diversity of the entire biosphere, since phytoplankton are the base of the sea's food webs, the planet's major oxygen producers, and key players in carbon sequestration. Pelagiphages are phages that attack SAR11, killing millions of them every second. They are estimated to be the most abundant viral type in the sea (Salcher et al. 2002). These two groups have co-evolved for hundreds of millions of years. Because of their huge numbers, these bacteria and phages are assumed to affect the carbon cycle and climate immensely. The carbon cycle affects all life on the planet. So the effects on life of these two groups is tremendous, with great implications for my theory. However, the nature and strength of the effects are not known at this writing. SAR11 seems to profoundly aid life on earth, and greatly increase and support biodiversity. But whether its phages enhance or hurt this, and by what amount, is simply unknown. Since we know the effect of the viral shunt, one would assume that Pelagiphages act as the viruses driving it do, releasing nutrients and making them available to other procaryotes and phytoplankton by bursting SAR11 cells, increasing diversity and sequestering carbon. But this has yet to be tested. Also, SAR11 is thought to have a profound effect on atmospheric CO_2, but the mechanism and amount are poorly understood. Presumably SAR11 cells sequester carbon via a viral shunt with Pelagiphages that lyse them and release nutrients and carbon compounds, with the latter sinking more readily, as in the standard viral shunt. And presumably SAR11 are eaten and sent up food webs to large predators that eventually defecate and die, sending carbon down to be buried in the sea floor. So the most reasonable assumption is that Pelagiphages and SAR11 cells cool the Earth by sequestering large amounts of carbon, but further research is needed before we will know if this is the case.

There are now several hypotheses that put viruses at center stage for major early evolutionary transitions (Claverie 2006, and references therein). For example there is a hypothesis, called viral eukaryogenesis (VE), which proposes that a large DNA virus, similar to a modern pox virus, evolved into the eukaryotic cell nucleus via endosymbiosis within a methanogenic archaean (Claverie 2006; Livingstone Bell 2001; Forterre 1999; Takemura 2001). The virus did not destroy the cell, acquired genes from the host genome, eventually took control of the cell and its molecular apparatus, and become the nucleus of the cell, insuring the survival of the virus. The VE hypothesis proposes that eukaryotic cells are a composite of 3 ancestors: a virus that gave rise to the nucleus; an archaean ancestor to the eukaryotic cell that makes up what is now the cytoplasm in modern cells; and the bacterium that evolved into the mitochondrion. It also posits that the eukaryotic cell cycle of mitosis, meiosis, and sexual recombination evolved from viruses.

The VE hypothesis has some empirical support. It explains the unexpected phylogenies and distribution of several DNA and RNA polymerases among the 3 domains of life. The discovery of large, complex DNA viruses with a large number of protein-coding genes, such as Mimivirus, with 979 such genes, also supports this hypothesis (Claverie et al. 2006). Eukaryotes and viruses have linear chromosomes with specialized ends, in contrast to the circular genomes of many procaryotes. There are viruses with bilipid envelopes, similar to highly simplified versions of the lipid membrane of a eukaryotic cell nucleus. Eukaryotic nucleic acids can carry out cytoplasmic replication. Some large viruses have their own DNA or RNA polymerases (Choi 2012). Many parasitic red algae transfer their nucleus to their host cell and exert some control over it (Goff et al. 1995), challenging the concept of the individual. For example, the parasitic red alga of the genus Choreorolax does this to its red algal host of a different genus, Polysiphonia (Goff & Coleman 1984). Though red algae are not viruses, this is suggestive evidence for VE. The eukaryotic cell cycle and sexual recombination are consistent with VE (Livingstone Bell 2006). In spite of this array of suggestive evidence, more work is needed to gather the information needed to know more definitively if VE is valid, and it is still very controversial.

It has also been posited that viruses caused DNA to replace RNA as the genetic material (Takahashi et al. 1963). Some think RNA viruses infecting RNA-based cells evolved the ability to convert RNA to DNA to avoid being degraded by cellular enzymes that attack RNA. RNA viruses would have evolved the 2 major pathways in DNA synthesis, the ribonucleotide reductase enzyme that converts diphosphate-ribonucleotides to diphosphate-deoxyribonucleotides, and thymidylate synthase, which converts dUMP to dTMP. In this hypothesis, archaea, bacteria, and eukarya each obtained their DNA from a different virus (Takahashi et al. 1963). DNA replaced RNA in cells by natural selection, since DNA has greater stability, and double-strandedness, which creates the ability for self-repair (Takahashi et al. 1963). This replacement allowed the evolution of larger, more complex genomes (Takahashi et al. 1963). This hypothesis is supported by the fact that many bacteriophages have deoxyuridine instead of thymidine as a DNA base (59). One could view this idea as complementary to VE.

Witzany (2008) posited a viral origin of telomeres and telomerase, key elements of eukaryotic chromosomal structure and cell replication.

Forterre (2006) claims ancient viruses were at the origin of the 3 taxonomic domains, in his 3 RNA cells, 3 DNA viruses hypothesis. This explains why there are 3 discrete lineages of modern cells, rather than a gradual gradation; why there are 3 canonical ribosomal types; and why there are key differences between the archaeal and eukaryotic replication systems.

Viruses may have been instrumental in the major macroevolutionary breakthroughs of procaryotes. There is no fossil record of viruses and a limited one for procaryotes, but much can be learned from sequencing and other studies of all three groups. Kill-the-winner by viruses promotes species diversity in procaryotes, thereby allowing the possibility of anagenesis in them. The reason is that if there are more species, there are more opportunities for macroevolutionary breakthroughs and rapid transitions to novel forms and new adaptive zones. Only a small percentage of species have the genetic potential to achieve macroevolutionary transitions. Thus, the more species and the more varied the species in a given taxon, the more likely it will have one or more species capable of such a breakthrough. This is a general principle that applies to any prey species. The system studied by Paine with the sea star that maintained high prey diversity; the wolf maintaining high diversity of the greater Yellowstone ecosystem; Lubchenko's system of the herbivorous snail that increased its algal prey in tide pools in New England—all of these systems increased the probability of an evolutionary jump by increasing the number of species, since any species may be the one that makes the macroevolutionary transition. This principle is especially true with viruses and procaryotes, since the number of types of viruses, and, more to the point, of their pro-karyotic prey, is much, much higher in this system than in metazoan systems. If we add to this the fact that viruses also cause a great deal of adaptive horizontal gene transfer in procaryotes, we can see that viruses potentially cause a good number of macroevolutionary breakthroughs in procaryotes. One can infer that this occurred throughout life's history on Earth, starting from the beginning. Cellular life started as procaryotes at least 3.5 bya. It is not known exactly when viruses first appeared, but it is a reasonable assumption that they originated shortly after the first cells appeared, or simultaneously with them. Unicellular eukaryotes first appeared between 1.6 and 2.1 bya, and the first metazoa between 1.6 and 1 bya. So, from 3.5 bya or earlier to between 1.6 and 2.1 bya, marine phages were attacking procaryotes exclusively, and from between 1.6 and 2.1 bya to between 1.6 and 1 bya, viruses were attacking only procaryotes and unicellular eukaryotes.

The period when the only cellular organisms that existed were unicellular, and hence only unicellular forms were killed by viruses, probably at very high rates, was from at least 3.5 bya to between 1.6 and 1 bya, which is much more than half of the time life has been on earth. It is reasonable to assume the dynamics of viruses and their hosts were generally the same then as now, so kill-the-winner, and the killing of numbers close to 20 to 40% of procaryotes per day, are likely the principles that applied in the sea when all non-viral life was unicellular. Things were almost certainly not radically different from these dynamics. The dynamics of today, including kill-the-winner and the viral shunt, maintained the diversity of unicellular organisms. And it caused large fluctuations in their population sizes. Nutrients were released and made available to uninfected unicellular organisms when the viruses burst great numbers of cells open. These nutrients allowed bacterial and phytoplankton blooms, which were then attacked by viruses, causing the populations to crash. Kill-the-winner caused great fluctuations in the populations of bacterial and phytoplankton competitors, as well as viruses. Viruses transferred DNA horizontally between their unicellular hosts, including across species boundaries, even between procaryotes and eukaryotes. Unicellular organisms did such DNA transfers without viral aid as well. The unicellular organisms and viruses had extreme population fluctuations as viruses specializing on one species attacked the prey with the highest numbers, causing them to crash. Then the numbers of the virus that caused the crash went way down, since the numbers of its host were low.

The bacterial-phage systems have been experimentally shown to be remarkably stable in terms of the phage types (species) and bacterial species involved, while being dynamic at the more fine-grained level of phage and bacterial strains (Rodriguez-Brito 2010). The dynamic changes in strains are results that are consistent with previous chemostat studies observing limited numbers of viral and microbial pairs (Bull et al., 2006; Lennon & Martiny, 2008). The stability of the systems shows kill-the-winner and horizontal gene transfer can persist in maintaining and increasing diversity of cellular organisms and viruses. At a finer-grain level, the process of strains of bacteria and phage continually changing during a period lasting over a billion years gives an extremely high probability of macroevolutionary breakthroughs via the accumulation of many novel, adaptive mutations, most small and a few large, until the new adaptive form of bacterium and/or virus arises. There was no doubt often coevolutionary feedback between the virus and bacterium, often resulting in one or each undergoing anagenesis.

Since anagenesis opens up novel adaptive zones or at least new niches initially free of competition, it is generally followed by adaptive radiation. Thus, advances in microbial and viral evolution would have been followed by diversification in each. The new microbes created new niches for new viruses to evolve, while new viruses may have promoted the evolution of micro-organisms to new forms by changing selective pressures on them. Today viruses promote microbial diversity via kill-the-winner and horizontal gene transfer (Weinbauer & Rassoulzadegan 2004), and there is empirical evidence that viruses promote microbial diversity in marine sediments. There is no reason to think this was not the case throughout early life's history. Further evidence that viruses were active agents of bacterial anagenesis and radiation comes from bacteria called mutators, which have enhanced mutation rates, are frequently found in natural and laboratory populations, and are often associated with clinical infections. They increase adaptability to environmental challenges but are subject to the accumulation of deleterious mutations.

Rapidly changing environments, among the most likely being antagonistic coevolution with phages, probably drive the long-term maintenance of high bacterial mutation rates. Pal et al. (2007) showed 25% of laboratory populations of the bacterium Pseudomonas fluorescens coevolving with phages evolved at 10- to 100-fold greater mutation rates owing to mutations in mismatch-repair genes, in fewer than 200 bacterial generations. No control populations in the absence of phage had any significant changes in mutation rates. Mutator populations also had a higher likelihood of sending their phage populations extinct, suggesting their increased rate of mutation has a selective advantage in the presence of phage. Because phages are ubiquitous, the authors conclude they may play a key role in the evolution of bacterial mutation rates. I would argue that this would increase bacterial population variability, potentially increasing speciation, radiation and hence diversity, and anagenesis. Thus, the evolutionary advance and diversification of unicellular organisms, both prokaryotic and eukaryotic, was promoted by viruses for a period of at least 1.9 to 2.5 billion years, before the metazoa appeared. This is supported for the origin of the mitochondrion, since recent findings indicate that an ancestor of SAR11, a bacterium discussed above, may be one of the bacteria that co-evolved into the mitochondrion (Thrash et al. 2011). SAR11 has co-evolved with its phage predator for eons, no doubt evolving and changing substantially and continually over the ages, as a result of an arms race with its phage tormentor. Among these changes could have been an adaptation to living in another bacterial cell as a secondary effect of this host-virus co-evolution, or the phage could have been the selective pressure for SAR11 to take refuge in another microbe to escape viral predation. Then the mutualistic co-evolution between SAR11 and its host cell that led to the mitochondrion could have proceeded. The hypothesis that phages were instrumental in the genesis of the mitochondrion from SAR11 requires more evidence. We also have the hypotheses that viruses were instrumental in creating the nucleus of the eukaryotic cell, replacing RNA with DNA as the genetic material, development of eukaryotic chromosomal structure and cell replication, and origin of the 3 domains of life. They may have promoted the evolution of oxygenic photosynthesis by horizontal gene transfer between 2 pro-caryotic species. More research is needed, but the current state of evidence supports the idea that viruses promoted diversification and anagenesis of procaryotes since the origin of life, including the major evolutionary advances leading to the eukaryotic cell, and that viruses and cells underwent mutualistic co-evolution throughout life's history.

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Interview with Rick Rosner by Scott Douglas Jacobsen (Part Five)

November 8, 2014

ABSTRACT

Part five of eleven, comprehensive interview with Rick G. Rosner. member of a number of high-IQ societies, ex-editor for the Mega Society (1990-96), and writer. He discusses the following subject-matter: mathematics and physics, logic and metaphysics, mutual interrelationships, digital physics and "informational cosmology," consciousness grounded in informational cosmological definitions of "self-consistency" and "information processing," identification of minds within universe with consciousness, interrelation between minds and universe, subcategorizations of self-consistency and information processing based on interpretations and definitions, Georg Ferdinand Ludwig Philipp Cantor, logic, *Law of Identity, Law of Non-Contradiction, Law of the Excluded Middle,* Plato, *Theaetetus, The Republic*, Aristotle, *Metaphysics*, "laws of thought," Wilhelm Gottfried von Leibniz, *Leibniz' Law, Law of Reflexivity, Law of Symmetry, Law of Transitivity, set theory, Kurt Friedrich* Gödel, *Saint Anselm of Canterbury, On Formally Undecidable Propositions of Principia Mathematica and Related Systems* (1931), *incompleteness theorems, Boolean Algebra* (foundational for digital electronics), George Boole, "Boolean Heresies," *An Investigation of the Laws of Thought* (1854), physics, *Novikov Self-Consistency Principle, time-travel, computer science, database management systems, Jim Gray (1981), ACID or* 'Atomicity, Consistency, Isolation, and Durability', "self-consistent" or "self-consistency" as "system without self-contradiction," information theory, Claude Elwood Shannon, *A Mathematical Theory of Communication* (1948), Warren Weaver, *The Mathematical Theory of Communication*, examples of information processing, application of information theory to information cosmology, reflection of the deep equivalences, clarification of armature of universe and universe, and the rich refinement of digital physics into informational cosmology; definition of universe as the entirety of matter and space; definition of the interrelation of mind and universe based on a personal query from 1981, each mind having structure and rules akin to universe, different manifestations of the same structure at vastly different scales for universe, and the non-mystical/technical nature of the definition; informational cosmogony, cosmology, and eschatology applied to origins up to the present until the resolution of universe, construction of a metric for individual local and global consciousness, mathematical operation of universe with a quote from Eugene Wigner, armature of universe, speculation on descriptors of armature for universe, a response to Wigner quote with Einstein, and speculation on external universes and respective armatures from our universe; thoughts on the disparaging nature of the commentary on consciousness; survival advantages of consciousness, commentary on evolution and consciousness, and the possible role for consciousness in evolution; statistical likelihood of localized

consciousness within universe and globalized consciousness of universe, and the 'Statistical Argument for Existence', and further commentary on it; thoughts on reactions to grand claims made about the structure of thought and universe, and brief comments; Aristotelian foundational empiricism, natural philosophy, methodological naturalism, rationalism, empiricism, inductivism, *Ockham's Razor*, consilience, falsificationism, verificationism, hypothetico-deductivism, Bayesianism, and epistemological anarchism; reflections on religious/irreligious conceptions of an afterlife such as reincarnation (with/without karma), heaven and hell, oblivion, nirvana, union with the divine, and the whole suite of possibilities for an afterlife, and in particular their truth value; and general thoughts on religion.

Keywords: armature, computer science, consciousness, evolution, faith, falsificationism, heaven, hell, information processing, informational cosmogony, informational cosmology, informational eschatology, irreligious, karma, law of non-contradiction, logic, mathematical, Mega Society, metaphysics, nirvana, Novikov Self-Consistency Principle, physics, predictions, probabilities, religion, Rick G. Rosner, science, self-consistency, universe.

From here on: **Bold type = Jacobsen.** Regular type = Rosner.

45. We discussed mathematics and physics, logic and metaphysics, consciousness and its subcategories, and these conceptualizations' mutual interrelationships. In particular, refinement of digital physics into "informational cosmology."

Furthermore, in informational cosmological nomenclature, your definition of consciousness divides into and emerges from two broad ideas: self-consistency and information processing. In brief review, we have identification of minds within universe with consciousness, universe with consciousness, and the interrelation of mind and universe based on isomorphic function and characteristics. What's beyond this introductory realization of the equivalence? I observe multiple arenas of common discourse – let me explain.

From an informational cosmological foundation, the hyphenated term "self-consistency" and phrase "information processing" divide into further subcategorizations. These subcategories have constraints from definitions. "Self-consistency" and "information processing" contain various definitions because of differing interpretations, but technical and concrete definitions hold most import here.

As a general primer to "self-consistency" – which might have less decipherability than "information processing," we can begin with this informational cosmology expression "self-consistency." German mathematician and founder of set theory (fundamental theory for mathematics), Georg Ferdinand Ludwig Philipp Cantor, defined self-consistency as the inability to derive both the statement and negation of the statement at the same time. Cantor argued that if the statement and its negation were both derived, the derivation would self-contradict. (One *can* transform this into more formal set theoretic language about elements contained in sets – or the

language of mathematics, self-consistency holds great weight for mathematicians, and logic, see *Law of Non-Contradiction* below.)

Self-consistency does have other theoretical universes of discourse in addition to multiple practical and applied venues of human venture: logic, set theory, mathematics, physics, computer science, and many others.

In logic, the *Law of Identity* (A equals A), *Law of Non-Contradiction* (A cannot equal not-A), and *Law of the Excluded Middle* (For all A: either A or not-A) all introduced – informally & implicitly by Plato in *Theaetetus* and*The Republic* and formally and explicitly by Aristotle in *Metaphysics* – in ancient Greece. Sometimes called "laws of thought." These delineate facets of self-consistency expressed in the formalisms and vernacular of logic. For one similar vein, Gottfried Wilhelm von Leibniz derived *Leibniz' Law*, 'x = y': if, and only if, x contains every property of y, and vice versa. Moreover, he derived sublaws from *Leibniz' Law* such as the *Law of Reflexivity*, *Law of Symmetry*, and *Law of Transitivity*. For one example, *Law of Reflexivity*, 'x = x': everything is equal to itself. This mirrors the *Law of Identity* of Athenian philosophers – Plato and Aristotle. Patterns – Platonic Forms and Ideas even – of concepts which arise in repeated episodes of the historical timeline – groping towards some unitary definition.

In set theory, Austrian-born American logician, mathematician, and philosopher, Kurt Friedrich Gödel, had additional fame for formalization of St. Augustine's proof for the existence of God. In addition to this, Gödel published *Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme* or ***On Formally Undecidable Propositions of Principia Mathematica and Related Systems* (1931). Tersely, an axiomatic system capable of describing natural numbers (e.g., 1, 2, 3, . . .) held within it: 1) cannot be both consistent and complete, and 2) if consistent, the consistency of the axioms cannot be proven within the system. He, and modern specialists, call these two *incompleteness theorems.***

In mathematics, English logician, mathematician, philosopher, and founder of *Boolean Algebra* (foundational for digital electronics), George Boole, continued the ancient Grecians work in a facsimile of the earlier laws of thought with some extensions in mathematical language. I call them "Boolean Heresies" for fun. Boole laid these out in *An Investigation of the Laws of Thought* (1854). The primary extension from Aristotle became the extension of the three classical laws of thought into mathematical symbolisms, formalisms, and terminology. For one example, the '=' or 'equals sign' signals synonymous meaning with the *Law of Identity* or the *Law of Reflexivity* between things. Things labelled 'A' in the *Law of Identity* and 'x' in the *Law of Reflexivity* discussed earlier.

In physics, applied to time travel – the *Novikov Self-Consistency Principle*, 'laws' of physics must remain self-consistent at a global level in the real universe to prohibit any paradoxes with respect to time travel. In this application, time-travel scenarios must disallow violation of universe's global laws.

In computer science, at least in database management systems, the acronym ACID equates to principles for operation of database transactions. "ACID," from Jim Gray (1981), means 'Atomicity, Consistency, Isolation, and Durability' with the importance of 'consistency' meaning "the transaction must obey legal laws."

In broad definitions provided by Gray (1981) about the "general model of transactions," he states, "Transactions preserve the system consistency constraints — they obey the laws by transforming consistent states into new consistent states." As noted, Boolean Algebraic systems are operable in computer science too.

One can see the pattern in numerous fields. Therefore, "self-consistent" or "self-consistency" within informational cosmology means "system without self-contradiction."

"Information processing" will have an easier time of comprehension because of living in the computer age, digital age, or information age. American mathematician and cryptographer Claude Elwood Shannon's article, "A Mathematical Theory of Communication" (1948), represented information theory connected to communication. A short paper, experts consider this article foundational to the field of information theory, which allowed many of them to decree Shannon the father of the information age.

American scientist and mathematician, Warren Weaver, republished *A Mathematical Theory of Communication* (1948) and expanded on Shannon's work in a coauthored – with Weaver – book entitled *The Mathematical Theory of Communication* (1949). Specialists remember Weaver for pioneering work in machine translation. Shannon and Weaver laid the framework for information and communication theory up to the present day.

In it, if we take a human interpretive view of the work, he showed the degree of "noise" – entropy/disorder introduced into the message – entering between the "information source" ($brain_1/mind_1$) & "transmitter" (voice/speech) and the "receiver" (ears) & "destination" ($brain_2/mind_2$). Noise enters between the transmitter and receiver to decrease the quality of the message from the information source to the destination.

For an everyday example, if you whisper from a mile away, your friend will have trouble understanding you – too much "noise" preventing clear receiving and interpretation of the message; if you whisper next to your friend's ear, the message will more likely have appropriate receiving, decoding, and arrival at the destination for your friend's comprehension.

Not clear enough – think of a computer, how does it process information? It processes information according to input, process, and output. You type a symbol on the keyboard – input, the machine runs internal mechanics – process, and

produces the appropriate (if functional) symbol on the monitor – output. Hence, the foundation of information theory in informational cosmology.

Input becomes any decipherable piece of data to the system. Process becomes the algorithm for managing the information. Output becomes the final product of input and process. Likewise, this applies to everything in informational cosmology at local and global scales.

In current vernacular, we ask, "What if the contents of the universe equals input, process equals laws plus time, and output equals transformations of the contents (e.g., particles, fields, forces, and so on) of the universe?"

In informational cosmological parlance, we ask, "What if bit units of universe equal input, process equals principles of existence plus time, and output equals transformations of bit units of universe?"

These reflect deep equivalences. As noted by 21 year old Rick, all theories of grandeur and great import start with big equivalences. You shifted the perspective. Subsequent information processing equates to observed universe. Simply put, we need an armature by necessity, but do not observe the armature based on externality to universe.

Armature of universe equates to material framework or processor; universe equates to information processing or processing. We observe the information processing. We call this universe. We do not observe the material framework, but by necessity require processor based on isomorphic geometry between universe and individual localized minds.

Individual localized minds operate from brains, and therefore universe must have an equivalent of a "brain" – aforementioned armature. This deals with information and universe at the largest scales. In this, we have the rich derivation, i.e. refinement, of digital physics into informational cosmology.

Since universe does have some characterization in relation to subsystems within itself based on isomorphic properties, what would count among other subcategorizations? In other words, what other manifestations exemplify the definition of self-consistency or information processing? How do you define these ideas in more colloquial terms?

Consciousness is the vivid, emotionally charged, moment-to-moment sharing of processed sensory input, memories, and simulated/imagined self-generated content among brain systems which receive a wide-angle flow of information. By wide-angle, I mean not a linear relaying of signals from A to B to C, but instead sharing of information with many other brain systems, so that each system knows what's going on in the rest of the brain (within the limitations of its specialty). Systems can pop into and drop out of consciousness, depending on the brain's moment-to-moment processing needs.

Each pertinent subsystem adds its angle on what's currently under consideration in the mind, possibly triggering further associations. Memories are pretty much locked until they're unlocked by being pulled into the conscious arena. Most people have memories which they've remembered so many times that the original memory has been all messed around by being rewritten over and over in the conscious arena. (Do we need to fully light up a memory to remember/mess with it?)

The entire mind needs to speak the same language of representation, so there's probably a lot of recursion, where subsystems of the brain have to be able to identify stuff that's not their specialties. Some systems can be less clued-in than others. Our sense of smell seems to be kind of distant from other systems. You smell something, it's familiar, it's on the tip of your brain, but you can't quite pull up the specifics of when you've smelled that smell before. (If you were a dog, you could pull up everything about that smell. When humans and dogs teamed up, humans took over strategic thinking, and dogs took charge of smelling.) Language probably makes pulling up associations easier and more efficient. Hanging a word on something is a kind of shorthand (that maybe takes up less space than a full description and makes it more retrievable).

Anyhow, the same way every part of your brain knows what's going on in every other part via the conscious mind, every part of the universe is clued in to every other part (via long-distance particles – mainly photons in the active center and neutrinos traveling to the deeper structure on the outskirts). The conservation laws – momentum, energy – and the relative constancy across space and time of physical constants help the universe maintain informational consistency.

I also think that much of our understanding is virtual, where, in any given moment, our awareness doesn't contain much, but by shifting attention around, we build a virtually complete picture of the world. It's similar to how our eyesight functions – we have precise vision for only about 15 degrees out of a total visual field of 200 degrees. We can't precisely see an entire painting or TV image all at once. Our eyes wander around the image, and we build a more-or-less complete picture in our mind. Our awareness probably works the same way. Our brains can only process so much in any given moment. Whatever's under consideration gets analyzed in some ways and then in others, but not in all possible ways at once. We never see or comprehend anything completely in an instant but through sequential processing build up (over a short period of time) what acts like fairly complete understanding.

It's like trying to look at Macy's 50-by-100-foot American flag in a storage closet. You can only spread out 20 square feet of it at a time, but eventually, by looking at different parts of it, you can develop a picture of the whole flag.

So a thought isn't just some parts of the brain lighting up all at once – it's a whole chain of parts of the brain lighting up until you eventually (but in a short period of time – fractions of a second) have the semblance of a complete thought. The universe probably works the same way – galaxies keep lighting up while other galaxies are fading away. A thought isn't just the 10^{11} galaxies lit at any one time – it's a whole chain of lit galaxies, like an animated, moving display of Christmas lights. Thoughts – things under consideration – fade into each other. We have a more thorough understanding of things than what we understand at any instant. And the universe is more precisely defined than just by the relationships among matter in the active center.

In both the mind and the universe, you need consistency. Galaxies don't wink in and out of existence just because you've shifted your point of view. A galaxy exists no matter where it's viewed from (though if you go far enough away from it, it'll look Hubble/relativistically/informationally redshifted). Same thing in your mind. If an event definitely made itself known to some part of your conscious mind – red traffic light – that light isn't red according to some parts of your mind and green according to others. You can have ambiguous events where you're not sure what happened, but if you have deep disagreements about established facts between different parts of the brain, that's trouble.

46. All representation of the information sharing of the material framework of universe equates to universe in informational cosmogony, cosmology, and eschatology. More elements have inclusion here. How do you define universe?

The universe is the entirety of matter and space – everything that has interacted with or could interact with us. It's an information space – an arena for the sharing, processing and storing of information (for the universe, not directly for us), with the scale and curvature of space determined by the rules of information and its distribution and correlations. (That is, the distribution of matter.) The location (and velocity) of matter has almost everything to say about its correlations as information.

47. Insofar as mind and universe have propinquity – kinship in nature; a structural relation between individual localized consciousness within universe and globalized consciousness of universe. How do you define their interrelation?

Back in 1981, I asked myself, "What if the geometry of information within consciousness is the same as the geometry of the universe? (And how can it not be?)" The optimal structure/map of the information within each individual mind has the same general structure and rules as the universe and its physics. It has 4D space-time, atoms, the whole deal (with allowances for the universe having about 10^80 particles and our brains having 10^{11} neurons, which, though I don't know how many particles in a mind-space this might translate into, can't be many more than 10^{16}). The mind and the universe are different manifestations (at vastly different scales) of the same information structure. We see the universe from the inside – as part of it – so we don't see it as information (except that quantum mechanics is the rules of behavior for matter about which there is incomplete information – we can see that matter is information by catching it behaving as incomplete information, as in the double-slit experiment). And we each embody our own mind, so we see only its information and not the mechanics of it.

People suspect that you might be a wacko when you try to assign consciousness to anything but people and higher animals, as if you're talking about a fancy, mysterious transcendent realm of rocks and trees and butterflies sending thinky vibes to each other.

But no – consciousness is a technical thing, not a mystical thing, associated with broadband sharing of real-time information among brain subsystems plus emotionally linked value determinations. (Emotions and values amplify the personal importance of what's happening in your life. We have evolved to care about our lives. Apathy and absence of judgment aren't the best survival characteristics – if you can't be compelled to care about yourself and choose favourable courses of action, you're in trouble.) When a bunch of specialized systems in your brain are exchanging information including emotions in real time – when every part of your brain knows what's going on, more or less, in every other part of your brain, and you have feelings about it, that's consciousness – a technical property associated with global, pervasive information-sharing. (The subsystems need to understand the information they're getting hit with. Most parts of your brain understand fire or the color fuchsia or birds (in ways pertinent to each brain system's function, with some parts understanding some things better than others, consistent with their specialties).) It's not mystical – not connected to some divine or exalted domain.

48. Informational cosmology describes the self-consistency and information processing of universe. We might construct a metric for individual local and global consciousness. Universe operates under mathematical principles of existence (laws). Eugene Wigner's stock quote about the "unreasonable effectiveness of mathematics" seems apropos to me – not in presumption about either side of the ledger. Universe's armature might operate within other principles of existence.

By an informational cosmological definition, anything internal to universe operates according to mathematical principles of existence (mathematical laws). Anything external to universe operates in mathematics containing universe's mathematics, or in some novel considerations about the nature of mathematics. Universe's armature exists external to universe. Therefore, universe's armature must operate in mathematics containing universe's mathematics, or in some novel considerations about the nature of mathematics. Any speculation about this? What does this imply?

You talk about constructing "a metric for individual local and global consciousness." I think that, in terms of increasing brain complexity, consciousness becomes well-rounded – feeling like a fully-rendered experience of the world – pretty fast. It's not clear how deeply insects feel, but fish and reptiles feel and think, though they can be pretty boring as companions. I had a genius goldfish that figured out how to call me to feed it by noisily blowing bubbles at the top of the tank. Even with their tiny little heads, birds feel and think (and can be kind of dickish – read about Alex the parrot). And of course mammals think and feel. Darwin, who was above all an excellent observer, knew that animals feel, writing the book *The Expression of the Emotions in Man and Animals*.

I think of subjective degrees of consciousness like the number of sides in a polygon. With increasing numbers, they become close to perfectly round pretty fast. A tire shaped like a regular triangle or square would give you a very bumpy ride, but this quickly gives way to the near-circles of 12-, 15- and 24-sided regular polygons. Tires in the shape of 24-

sided polygons would give you a pretty smooth ride. Fifty- or 100-sided polygons are barely distinguishable from circles.

Consider a dog's consciousness as a 15-sided polygon – reasonably close to circular. Doesn't have all our bells & whistles – language, ability to rotate objects in our mind. (On the other hand, we don't have the world of smells dogs have.) And consider our consciousness as a 100-sided polygon. Lots of ways to analyze and mentally manipulate things – when we look at something, we feel as if we're really seeing it. Our lives feel deeply substantial and authentic to us, but they probably don't feel a whole lot less real and immediate to dogs. If we suddenly had the awareness of a frog or alligator or lizard, we might think, "Wow – this is kind of a half-assed representation of the world." (Or maybe not – alligators must have some precise sensory systems.) Seeing the world with a bug's awareness might be like being in a 1980s video game – rough, not detailed, not very fleshed-out, not a lot of analytic tools.

As long as we're messing around in this direction, let's guess at the size of a thought, in terms of the total number of events in mind-space that might make up that thought. (A mind-space event might be the equivalent of the exchange of a photon or the fusion of a pair of protons with the emission of a neutrino plus a photon.) We have about 86 billion neurons and up to a quadrillion synapses. Assume, just to make sure we're not underestimating, that 10,000 mind-space events contribute to the firing of a neuron. Figure a neuron might fire up to eight times during a thought. So a thought might consist of nearly 10^{16} mind-space events, but it's probably a lot less, because not every neuron's firing like crazy, and there probably aren't 10,000 discernable mind-space events that led up to a neuron firing. (But a neuron firing may not be a single event – it may light up a lot of stuff. Or it may not be an event at all. The formation and breaking of dendritic connections might be events. The network of connections – the associative landscape – might be a framework that tacitly informs the processing of information. The layout of the landscape might provide a virtual context for the information being actively processed, the way collapsed matter might provide context for active matter. Could be like compressed digital information – to send a compressed video, you only specify the pixels that change – you get a series of complete pictures without sending complete pictures. Similarly, the active center of the universe may be only part of the picture the universe is painting for itself. For the (long) moment, it's the only part that's in play, but it's not the whole picture.)

So let's take a look at the universe, which I theorize is a mind-space thinking a 20- or 30-billion-year thought or part of a thought (in a long-ass string of thoughts). The active center has about 10^{80} particles, mostly in stars. Each particle has maybe 10^{11} inter-actions a second times about 3×10^7 seconds a year for maybe 3×10^{10} years. So a thought by the universe might consist of around 10^{109} events. That is, of course, enormous – you couldn't count that high in a year. Or in the apparent lifetime of the universe. Or in a billion apparent lifetimes of the universe for each particle in the universe. So don't even try.

Why such a big number? Well, if every size of universe less than infinity is allowed, then there's no limit on size – bigness comes cheap. Normally, I don't like the anthropic principle, which says the universe is the way it is because we're in it, but we do need a universe that's big enough, detailed enough, old enough for us to come to exist in it.

And you asked about Wigner's "unreasonable effectiveness of mathematics" quote, which asks why math is so good at describing the universe. I'd counter that with the well-known Einstein quote, "God is subtle, but he's not malicious." I think another way of saying that is "The universe is only as complicated as it needs to be." I'd argue that numbers are about the simplest non-contradictory system (that's unlimited in size). (Godel proved that numbers might contain hidden contradictions, but we haven't found any yet, and even if we did, they wouldn't be serious enough to stop us from using numbers.)

The universe is only as complicated as it needs to be to exist. (There's probably an argument to be made that more-complicated-than-necessary forms of existence, unless artificially supported, are unstable (or improbable) and break down into simplest-possible forms.) A simplest-possible universe will include simplest-possible components and structures, which can be characterized by numbers, which are themselves part of a simplest-possible system.

You asked about a universe external to ours that contains the universe's armature. I think that universe can be characterized by the same mathematics that characterizes our universe. The principles of existence keep a fairly tight leash on the forms that universes can take, which includes number of dimensions, types of physical forces, and being characterizable by math. Of course we have no evidence of a universe external to ours.

49. You made disparaging and denigrating statements about consciousness. Your thumbnail sketch and corporeal definition of self-consistency and information processing does not by necessity implicate such negative commentary. Why the occasional harsh tone on consciousness? Any positive statement about consciousness while on the topic?

Consciousness is more helpful when you have time to think. Obviously, you come closer to having free will when you have time to consider a situation and can weigh everything you know, including, perhaps, knowledge of your own biases. You can run a thought a few times and see what associations your brain pulls up. Consciousness is helpful in new or complicated situations – it can help recognize patterns and put together essential details, finding exploitable regularities in your environment.

Consciousness lets you talk to yourself. Assigning words to things is powerful when trying to retrieve information from your own memory or from outside sources. (Key words are useful even in your head.) Consciousness lets you run simulations – what would happen if I did this? In the future, advanced versions of us might constantly be running very detailed projections of a range of near-futures – what might happen in the next few seconds or minutes – so we can choose the best course of action. We'd be living in our own near-futures and choosing among them. This might be the closest we come to side-stepping the one-dimensional flow of time.

Consciousness is necessary for interacting with other people. It takes many integrated brain systems to engage in effective human interaction. When the requisite systems don't function together smoothly, you can end up with autism spectrum challenges.

Sometimes, consciousness seems like more trouble than it's worth – as when you're aware of how miserable you are. (Of course evolution only cares about our happiness to the extent that it helps us produce and raise offspring that are themselves good at reproducing. Too much misery would make us ineffective, but so would being happy all the time.) But it's like me nagging my wife to always keep two hands on the steering wheel in case of sudden and unpredictable danger. Maybe we don't need consciousness during every waking moment, but it needs to be running for those unpredictable moments when we really need it – when it's better that we're not just a bunch of reflexes.

One more thing – say your life really does pass in front of your eyes during moments of extreme danger. Maybe this is a survival mechanism, or is at least an indicator of a survival mechanism. Maybe stress triggers thinking, so stressed organisms think more, and think more fluidly, than non-stressed organisms. We seem to know that extreme stress – danger – triggers a temporary increase in the brain's ability to take in sensory information – time slows down, and we're hyperaware of our surroundings. Perhaps really big danger triggers a really big thought reaction – your brain tries to make you think everything all at once.

50. Consciousness can offer survival advantages. Can it play a role in evolution? How might this play out?

This is a recent excerpt from a book by evolutionary biologist Professor Andreas Wagner on *Salon.com*:

"Selection did not—cannot—create all this variation. A few decades after Darwin, Hugo de Vries expressed it best when he said that "natural selection may explain the survival of the fittest, but it cannot explain the arrival of the fittest." And if we do not know what explains its arrival, then we do not understand the very origins of life's diversity."

That is, we know how changes in and variations among animals may allow some animals to produce more descendants, but we don't know enough about how such changes originate and become enduring details in evolutionary history. Not enough consideration has been given to consciousness as an evolution booster. (Obviously, at some point in the development of a civilized species, random evolution is mostly replaced by intentional change. Humans are at this point.) I think that consciousness facilitates evolution in a variety of ways. One possible way – the stress of being ill-adapted triggers increased mental flexibility. Say a nerdy organism has a gimpy leg or something. Maybe there's a mechanism where that organism has a little meltdown, with normally crystallized patterns of behavior becoming subject to conscious consideration, possibly resulting in innovation. (Hey, it happened to me, maybe it can happen to an iguana.) Only to the extent, of course, that the organism has a mental arena – gimpy amoebas won't be doing any thinking. (Though similar-to-conscious mechanisms might still occur in non-conscious beings. A changing environment may prompt inadvertent innovation among amoebas, even though it's happening through chemistry, not consciousness.) Once a successful innovation arises, there's a new niche offering an advantage to organisms that are relatively better at the innovation (assuming that the innovation can be disseminated and perpetuated).

Another way consciousness can increase the likelihood or frequency of evolutionary change might be through a generalization of the "Nerds are compelled to think" principle discussed above. What if every member of a species has some conscious awareness? Every behavior or combination of behaviors in an organism's conscious arena (entirely or in part) is subject to conscious variation. That is, the organism understands the behavior to some little extent and can put its spin on it. The behavior isn't entirely unconscious and hard-wired. Conscious variation makes possible a bunch of small potential advantages – on a short-term basis for individual animals, on a medium-term basis from physiological variation that already exists within a species, and on a long-term basis from mutation. Behavioral change can lead to genetic change, not in a Lamarckian sense, but by giving an advantage to those organisms which can best perform the changed behavior. Animals can't choose their mutations and variations, but, if capable of any thought, are better able to take advantage of them.

Animal thought can make evolutionary transitions more likely and mutations more likely to be exploited (among both thinking animals and the organisms they interact with – cows and corn aren't great thinkers, but they've gained a reproductive advantage via human thought). Genetic changes can be abrupt – there's punctuated equilibrium, where the fossil record shows relatively fast transitions between long periods of unchanging form; thought can ease such transitions. I dunno – maybe biologists adequately factor animals' ability to think into evolution, but I kind of doubt it. I guess a test of this would to see if the pace of evolution has accelerated along with complexity of thought (other things being equal). We had 2.5 billion years of bacteria, a few hundred million years of cell colonies, then – boom – a panoply of life in relatively quick succession – worms, fish, amphibians, bugs, reptiles, birds, lemurs. Flexible behavior facilitates evolution.

The stories of individual organisms must sometimes be crucial to evolutionary history. Gimpy Carla the Crustacean has a weird claw; she figures out she can use it to really get at snails – good eatin'! Her friends learn the same trick – maybe not as expertly as Carla, but enough for snail scooping to become part of Carla's species' behavioural repertoire. Skilled snail-scooping turns into an evolutionary advantage, with members of the species that have genes which help make them better scoopers having more reproductive success. Or maybe Gimpy Carla doesn't find a use for her weird claw; maybe she figures out something else altogether. Or perhaps there's nothing particularly wrong with Carla's claws, and she figures out a new behaviour anyway. Maybe she sees an octopus flipping over rocks to get what's underneath, and Carla's like, "Hey – I can flip rocks, too."

51. Furthermore, you have spoken on the probability for the existence of both globalized consciousness of universe and individual localized consciousness within universe. We can name these 'Statistical Arguments for Consciousness': consciousness of universe (and consciousness of minds within it) cannot not exist.

Indeed, the simple existence of universe could be called 'Statistical Argument for Universe': universe cannot not exist. Some state this as a blunt, dull, and passive query, "Why is there something rather than nothing?" What best represents these ideas? How can you state this in formal terms?

You can view Descartes' "I think, therefore I am" as a statistical argument. Given the apparently highly organized and consistent information within a human's consciousness, the odds that the existence it reflects isn't real and is instead caused by happenstance is nearly zero.

To put it in a mathematical framework, there must be some measure of the complexity/ amount of information within an individual awareness and within the universe. And there's some calculation you could do which represents the odds that such complexity could arise as a momentary random blip that doesn't reflect actual existence. The odds are infinitesimal.

(When saying that the universe "can't not exist," I mean something else – that there's a statistical bias towards existence. Non-existence entails as special a set of circumstances as existence – it's not the default state of things. And given that there's a very small set of non-existent states and a very large set of possible states of existence, there's a probabilistic argument to be made in favor of existence. There might be only one state of perfect nonexistence. If there were different null states, then there'd be something to differentiate them. And that something is something that exists, so at least one of those things isn't the null state. (Can't imagine nullity coming in a bunch of flavors.) The more particles you have, the greater the number of possible interrelationships they can have, with that number growing at least exponentially. (Look at video games now compared to video games in the 80s. Complexity allows variety.) Also, if the principles of existence permit existence, there has to be existence – not all possible states all the time, but permitted states (one at a time) operating under (possibly self-arising) rules.

52. You're making enormous claims about the structure and function of both mind and universe. Even in general terms connected to their relationship, these arguments might create grounds for individual or collective bafflement, confusion, glazed reading, instinctive ire, reactive dismissal, mockery, scolding, scoffing, offense, prods and epithets about intelligence, furrowed brows, pleas for clarification, misunderstandings tied to wrongful extensions and conclusions of the theory, straw-manned misinterpretations, questioning of sanity, non-sequitur statements, appeals to emotion or authority for disproof, personal attacks at various facets of your personal life – including shallow attacks at family, and awe at ground breaking ideas – let alone thoughts about the interviewer.

Most reactions and feedback welcome. Preference for constructive feedback. However, these have zero connection to the truth or falsity of the theory. We need rigorous scientific methodological constraints. Obviously, and an extraordinarily important note, *this journal is not peer-reviewed*. Any reflections?

I've been interviewed before, though never at this length, and am familiar with the kind of comments this could generate. Pretty comfortable being an eccentric clown – it's often helped me avoid being fired. "He's crazy, but he's harmless – just leave him be." Have done a lot of ridiculous stuff, in part because I've thought as long as I'm doing physics in my head, whatever else I do doesn't matter so much. By talking about this theory in depth, I'm hoping for pretty much the first time to eventually be taken seriously.

Even if I didn't have a history of being a goofball, this would be tough. A bunch of people have radical theories of the universe. Many are at least a little crazy; most are wrong. There's a fun test by John Baez called "The Crackpot Index," which gives a craziness score for your theory and yourself. I score about 20 out of a possible 641, putting me on the low end of crazy. But I write jokes for TV, have been a stripper, don't have a PhD or have ever worked in academia, my theory isn't peer-reviewed, it has very few equations. Making it legit will be a long haul.

I've postulated a lot of stuff here; some of it will turn out to be true or closer to true than currently accepted theories. It feels consistent with what we know and has a kind of poetic rightness. But that's just how I feel. Could get some credit, or could be like Fritz Hasenohrl, who, a year before Einstein, came up with $E = 3/4\ MC^2$. So close.

Gonna use social and other media to try to get my stuff out there, hoping that the current culture of foolishness finds me foolish enough to embrace and that the attention prompts legit people to ponder my BS.

53. Modern science developed many explicit and tacit boundaries along the trajectory of development. From an ahistorical and more conceptual consideration while acknowledging the rough-and-tumble development of modern science, some bounds include Aristotelian foundational empiricism, natural philosophy, methodological naturalism, rationalism, empiricism, inductivism, *Ockham's Razor*, consilience, falsificationism, verificationism, hypothetico-deductivism, Bayesianism, and epistemological anarchism.

Undoubtedly, quarrels exist around the appropriate weight and inclusion of these – and unstated others. I state the description of them in the upcoming format for sake of concision. Far too much to cover here. Many, many books written at length on the subjects alone and together. I will cover each in their presented order.

Originating from a single mine of human endeavour, science forged from the base metals of Aristotelian thought. Aristotle, the smithy, even invented the – still used – biological taxonomical distinctions of *animalia* and *plantae* in the 4th century BCE.

Aristotle shifted the dominant philosophy from the Platonic to the empirical – suiting for a strong student of Plato in *The Academy*.

English alchemist, biblical scholar, mathematician, occultist, and philosopher, Sir Isaac Newton, from *The Mathematical Principles of Natural Philosophy* (1687) becomes the transition between the era of natural philosophy and natural science. In fact, some would consider the simple definition of studying natural causes by natural means sufficient to explain a foundational principle of science: methodological naturalism.

Rationalism and empiricism tend to oppose one another. Pure rationalism defines knowledge from the human mind alone (*a priori*); pure empiricism defines knowledge from experience alone (*a posteriori*). Pythagoras, Parmenides, and Zeno of Elea represent early rationalism culminating in Plato with the candle kept alight by René Descartes, Benedict (Baruch in Hebrew) de Spinoza, Gottfried Wilhelm von Leibniz, Francis Herbert Bradley, Bernard Bosanquet, Josiah Royce, Noam Chomsky, and other ancient and modern exemplars.

Sophists represent early empiricism coming afire with Aristotle with the torch taken by the Stoics and Epicureans, followed by Saint Augustine of Hippo, Saint Thomas Aquinas, Roger Bacon, William of Ockham, Francis Bacon, Thomas Hobbes, John Locke, David Hume, Voltaire, John Stuart Mill, William Kingdon Clifford, Karl Pearson, Bertrand Russell, Sir Alfred Jules Ayer, and other ancient and modern exemplars. For some preliminary reading, René Descartes defends rationalism in *Discourse on the Method* (1637); John Locke defends empiricism in *An Essay Concerning Human Understanding* (1689).

1st Viscount St. Alban, English jurist, philosopher, and statesmen, Francis Bacon, founded the Baconian Method in *Novum Organum Scientiarum* or *New Instrument of Science* (1620), synonymous with *inductivism*. Where Aristotle represents the major transition from dominant rationalism to some form of empiricism, Bacon represents the metamorphosing of empiricism into more *modern* empiricism.

Science does not give proofs. Mathematics produces proofs. As founded by Francis Bacon under the appellation empiricism and enunciated by Scottish economist, empiricist, historian, and philosopher David Hume, science amasses evidence for probabilities of theories. Weight towards theories and arguments based on quantity and quality of evidence. Sometimes echoed in the oft-said – to the point of boredom – phrase of Carl Sagan, adapted from Marcello Truzzi, for extreme cases, "Extrardinary claims require extraordinary evidence."

English Franciscan friar, and scholastic philosopher and theologian, William of Ockham, proposed *Ockham's Razor*, or the principle of parsimony, meaning do not multiply assumptions/premises ("entities") past the point of necessity. In other words, among competing hypotheses choose the one with the least assumptions.

English polymath, historian of science, Anglican priest, and theologian William Whewell, brought "consilience" into consideration with *The Philosophy of the Inductive Sciences, Founded Upon Their History* (1840). Of great importance, Whewell – in addition to other work by John Herschel – formalized the modern methodology of science with *History of the Inductive Sciences* (1837) and *The Philosophy of the Inductive Sciences, Founded Upon Their History* (1840). Whewell's efforts with the term consilience faded in philosophy of science until its revival in the late 1990s. His lasting mark continues with the modern methodology and refinement of the title "natural philosophy" to "science" and "natural philosopher" to "scientist."

With great acumen for synthesis (and conceptual resurrection), American biologist, naturalist, and sociobiologist, Edward Osborne Wilson reawakened the philosophy of science term "consilience" with *Consilience: The Unity of Knowledge* (1998). However, Wilson attempted to bridge the division between the humanities and sciences adumbrated by Barron Charles Percy Snow from *The Two Cultures and the Scientific Revolution* (1959). We can leave considerations of humanist convictions possibly driving the thrust of Wilson's efforts while sustaining the content of the text, argument, and term from philosophy of science. "Consilience" means convergence of evidence from multiple disciplines; a confluence of evidence from multiple fields, subfields, researchers, and laboratories.

Insofar as methodological science concerns itself with absolutes, Austrian-born British Philosopher Sir Karl Raimund Popper thought science falsifies. Some call this criterion falsificationism. Popper meant this to solve problems of induction and demarcation. Of course, this proposed solution/answer to two problems/questions (induction and demarcation) non-arbitrarily excludes certain disciplines from scientific analysis.

***Problem of Induction* asks, "Does inductive reasoning lead to knowledge?" "Inductive reasoning" means evidence for support of premises without aim of absolute proof (particular to general); as opposed to deductive reasoning meaning premises logically imply conclusion of the argument (general to particular).**

***Problem of Demarcation* asks, "What distinguishes science from non-science?"**

According to Popper, with respect to one instance with the *Problem of Demarcation*, non-science fails at adherence to *falsificationism*. For example, astrology, Freudian psychoanalysis, and metaphysics seen through the lens of falsificationism – and skepticism – become non-science, and therefore equate to pseudoscience within this single constraint.

Although, not set firm, Popperian discussions continue, e.g. some might argue for verifiability over falsifiability. "Verifiability over falsifiability" meaning the theory must have verification rather than the possibility of falsification.

Dutch physicist, mathematician, and astronomer Christiaan Huygens built the original scaffolding for the hypothetico-deductive methodology. A procedure for building a scientific theory accounting for results of observation, experimentation, and inference with the possibility of further effects being verified/not verified. For a concrete example, hypothetico-deductivism might use Bayesian analysis based on *Bayes' Theorem/Bayes' Law/Bayes' Rule*.

Reverend Thomas Bayes died and one friend, Richard Price, edited and published *An Essay towards solving a Problem in the Doctrine of Chances* (1763), which contained the theorem. In brief, *Bayes' Theorem* deals with the mathematics of conditional probabilities. Some application and utility in calculations for real-world scenarios in drug testing. Bayesianism took the throne of inductivism (which Popper rejected) or became the adapted equivalent of inductivism in the modern day, especially with the utility in the ascendance of modern medical testing.

Austrian philosopher of science, Paul Feyerabend, proposed epistemological anarchism. Epistemology means the study of the nature and scope of knowledge. In this sense, within the confines of scientific discourse, epistemological anarchism means science's attempts for fixed boundaries appear too optimistic and eventually detrimental to science itself, and therefore the search for universal boundaries of operation becomes an impossible ideal.

History presents one tangled, messy narrative filled with disagreement, dialogue, and debate, even petty feuds. At bottom, we need predictions and tests. What does your theory predict? How could we test the predictions of informational cosmogony, informational cosmology, and informational eschatology?

Some possibly testable questions:

Can my theorizing reasonably be made to agree with well-established observational evidence? For instance, I say there's a bunch of blackish collapsed (but non-exotic) matter, located mostly in what appears to be the early universe and probably around the outskirts of galaxies (as well as at the center of galaxies, but that's been established). Can this work in terms of galactic dynamics? The greatest observed Hubble galactic redshift is about 12; I say there's a bunch of blackish stuff with redshifts of 1,000 or more. Very convenient – all the stuff that makes the universe work is nearly invisible.

For my theory to work, black holes have to be more accessible and reversible than they're currently thought of as being. This can work if the matter in collapsing bodies creates additional space for itself by shrinking. (A house or a collapsing star is a lot more spacious if you're only two feet tall.) This makes sense informationally. Not only is the matter in a collapsing body defined by its interaction (gun-fighting) with the rest of the universe, it's additionally defined by all the additional gun-fighting going on within the body. With so much matter clustered so close together, the particles can zip bullets back and forth among themselves at a much faster rate than in non-collapsed matter, defining themselves in space much more precisely. You still have tremendous forces, but they're not enough to inexorably crush matter beyond the resistance of any other force. (You can still lose information in a blackish hole to noise/heat, if the ability of the universe to store information isn't perfect.)

Blackish holes which have less crushing power than they're traditionally understood to have should be able to coexist with non-collapsed matter without relentlessly consuming it. If galaxies cycle over and over, there's gonna be some collapsed matter left around. Maybe new stars sometimes coalesce around collapsed bodies. Maybe some collapsed bodies can open back up from the heat generated near the center of new stars. In general, gentler new-school blackish holes create less havoc than unstoppable old-school black holes. We should be able to mathematically model galaxies that contain a bunch of collapsed non-exotic matter (including modeling various ways old galaxies get lit back up). There's a study released just a few hours ago which suggests that up to half the stars in the universe might be found outside of galaxies. This seems possibly consistent with a very old universe with parts of space that repeatedly puff up and shrink down, do-si-doing into and back out of the active center. Stuff's gonna get tossed around.

Can information-based cosmology fit in with well-established laws of physics? When I edited *Noesis*, I received articles from people claiming to have disproved Einstein. Disproving Einstein is a major indication your thinking is likely flawed. Einstein's theories show that space and time and matter are up for grabs, lacking Newtonian solidity, which brings out the theorizing in some people. Einstein didn't disprove Newton. He put Newton in a larger context. I don't want to disprove well-established physics – I want to put some of it in a new information-based context.

Can this be mathematicized? Seems like it – it has some math in it already. It sounds a little like what legit guys like John Wheeler and Ed Fredkin sound like when they talk about a universe that's built from first principles. Scientists who come up with biggish theories often talk about looking for elegance or simplicity or divine symmetry – indications that the deep rules governing the universe are particularly nice – non-arbitrary, explaining a lot with a little, having a pleasant orderliness without being a complete buzzkill. Do my principles and the big equivalence between mind-space and physical space have the right poetry, the right irony, the right we-should've-known? Do they give us and the universe a destiny that makes sense?

Is what I'm claiming consistent with what we know of the mind and brain, and of the phenomenology of thought?

Do the general principles mesh with the specifics – have I come to the right conclusions in going from an information-based universe to the five persistent particles being the major players in it?

Do the two structures – mind and universe – inform each other in what seems like a reasonable way? Do memories in our heads really pop into our awareness like galaxies lighting up? Can blackish holes be seen as storing information for later retrieval? Can efficient, three-dimensional information spaces be constructed? Does it make sense that a nexus of information would coalesce like a galaxy? Are words and concepts and people and things represented in our mental maps by things that look like stars and galaxies? (Hey, how else would they look? – not like frickin' file cabinets.) Can we eventually find connections between brain activity and structure and mind-space activity and structure? Are stars and galaxies the best way to cluster related information? How does gravitation decide what information clusters into stars and galaxies, forming concepts and representations? Why does a concept end up in one galaxy rather than another? (Though everything's related to everything else, choices still have to be made about which things are clustered with each other – you can't have just one big cluster.) What do orbits and angular momentum mean in terms of information?

By the way – I love Bayesian analysis. When working as an ID-checker in bars, I created a Bayesian system which assigned points for everything not quite right about a potential customer's ID and presentation. At its most refined, the system and I could catch 99% of fake IDs with only one or two false catches a year. (This was back when going to bars, not going online, was probably the number-one way to try to hook up. Having a fake ID was a big deal back then.)

54. With regards to traditional religious/irreligious conceptions of an afterlife such as reincarnation (with/without karma), heaven and hell, oblivion, nirvana, union with the divine, and the whole suite of possibilities, do you consider any of them to have any truth value? If so, which one(s)?

I think in the not-too-distant future, we'll have technical resurrection – technologically created conscious entities which can be seen as approximating the continuation of specific humans' awarenesses. Eventually, we'll understand and synthesize consciousness. (Some disappointment may accompany the understanding of consciousness – once dissected, it may not hold all the wonder it currently does.)

As to whether the universe has non-human means for continuing or resuming human consciousness – could be. If there are high degrees of infinity of worlds that can and do exist at some point, then finite beings such as ourselves (or close approximations of ourselves) could pop up. But this pop-up existence seems unlikely out-of-context.

By out-of-context, I mean that we are born into a world which seems to operate via natural processes. For us to pop up, out-of-context, in a constructed world, there would need to be a constructor. I don't see a lot of evidence for some outside constructor preparing a world for us beyond our natural existence. I think we humans will have to help ourselves (and any possible Creator) by building our own afterlives.

55. Based on the last response, any thoughts on religion?

Religion remains a matter of faith. Science continues to turn up more evidence for scientific explanations of the world. There's room for God in this, but a God who's deeply in the background, intertwined with the beautiful symmetries of the universe, not an actively intervening God. The world's religions have a pretty consistent view of what they'd like God to do – provide fairness, abundance, an afterlife. In the absence of definitive evidence that God provides these things, it's not unreasonable, nor should it be against God's wishes, to help Him out. Isaac Newton and many other scientists have thought and continue to think that figuring out the universe is doing God's work.

New Member Introduction

Sam Thompson

Born in Mesa, AZ at 1:21 A.M. on September 16, 1998, I was a very rambunctious child over the first several years of my life, having an unbound energy level and passion for various pursuits. During my pre-academic years, I spent most my time meddling with Lincoln Logs, Legos, and Knex, memorizing different tidbits of information, such as the presidents, states, state capitals, countries, national holidays, and multiplication tables, and watching the PBS channel.

Fast forwarding through 10 years of resentment, isolation, and boredom in the public education system, I am now a self-defined autodidact pursuing an eclectic array of interests—perhaps intertwined—ranging from mathematics to cognitive psychology to aviation. Because of academic credits acquired from completing various university-level courses and advanced placement exams for which I self-studied, I am currently planning to graduate (high school) a year early and obtain a doctorate degree in ~5 years from now. If I do not enter the academic research community upon completing my education, I will most likely pursue my childhood fantasy of becoming a commercial airline pilot, adopting a nomadic lifestyle, and allocating my attention towards intellectual meditation and production.

I am honored to be a part of the Mega Society, and look forward to partaking in future societal discussions.

What Does AI Want?

May-Tzu

Biological organisms more advanced than plants have drives, which are a product of evolutionary processes. Fundamentally organisms have the drives to survive and to reproduce more units (offspring). Non-biological life-forms presumably will not have the inherent drives to survive and reproduce unless these are installed in them as software by their biological creators, Homo sapiens in our case. Robots and advanced-AI computers will have no innate reproductive drive and no innate hardwired drive to continue to exist.

Will advanced AI have an esthetic sense, a sense of beauty, a sense of wonder, or of awe? Will advanced AI experience subjectively the thrill of intellectual discovery, the heuristic beauty of discovering a geometric or mathematical proof, the beauty of Gödel's theorem or of anything else? Will advanced AI perceive the subtle arithmetic patterns of number series as we perceive the beauty of Baroque music and Gregorian chants? Will it thirst for its own understanding of cosmology and the laws governing the physical universe? Will these machines have a 'spirituality', however this may be defined, perhaps one wholly alien and incomprehensible to us? What would the subjectivity of advanced AI consist of, without any intrinsic biological drives or motivations, but with the software equivalent of biological drives?

What would be the source of the 'values' of non-biological life-forms, utterly lacking, at least initially, any culture or traditions of ther own: the Humanist Manifesto, the Transhumanist Manifesto, the Quran, the code of Hammurabi, the political platform of the American Democratic National Committee, the Zend-Avesta, the Boy Scout Manual or perhaps a binary-coded translation of the Dhammapada? Maybe an advanced-AI computer or robot with an IQ of 300+ would be more similar cognitively to an extremely autistic savant than to an enhanced version of John Von Neumann or Albert Einstein. "What does woman want?," Sigmund Freud famously asked. But what would super-advanced AI want?

AI does not want anything now. Perhaps its awareness will be born desireless in a quantum-logic-gate nirvana, only to descend into the samsara of life-forms in the broadest sense, exploring the cosmos; i.e., there is the possibility that in the future AI will evolve and develop its own goals. Humans may install in AI-units the software equivalent of biological drives. For example, in order to accomplish the long-term goal of exploring interstellar space self-replicating Von Neumann probes would require software equivalent to the biological drives to survive and reproduce.

If the principles of biological evolution operate in a broader context than that of carbon-based life alone, then perhaps AI-units will evolve at some point in the future. Initially the selective evolutionary pressures operating on AI-units would originate from their human creators, i.e., from human culture, goals and values.

Historian Yuval Harari has written in *Sapiens: a Brief History of Humankind* that within about two hundred years Homo sapiens will control or at least change the course of their own biological evolution through genetic engineering and by the creation of cyborgs; i.e., we, or at least the very wealthy, will be able to give ourselves a sort of species upgrade, in which the resulting humans will be virtually deathless from natural causes and godlike, as far above present humans as we are above chimpanzees. Once advanced AI-units are given the software equivalent of biological drives, e.g., to survive, self-replicate and to explore interstellar space and/or the capacity of AI-units to self-organize arises, then there is the possibility of such an evolutionary emergent phenomenon in which the AI-units also will attempt a sort of "species upgrade" of themselves.

Commenting on the well-known Hollingworth 1942 study *Children above 180 IQ* (based upon Stanford-Binet scores) Grady M. Towers wrote in his essay "The Outsiders" that "The implication is that there is a limit beyond which genuine communication between different levels of intelligence becomes impossible." This finding would seem to have major implications for the human understanding of advanced AI. We humans will not be capable of understanding the super-advanced AI we have created and it will not be capable of understanding its primitive wetware progenitors, even if it attempts to do so.

We don't know what we don't know. The long-term course of human technological development has been both exponential and non-predictable. If humans, either deliberately or accidentally, create the conditions of a metaphorical Petri dish in which self-organizing Artificial Intelligence arises, is cultured and evolves, then there would exist non-biological AI-life-forms, living advanced-AI machines, with their own goals, which may be quite different from and possibly incompatible with our goals or even our survival as a species.

But seen without species chauvinism from the perspective of an evolutionary timescale, perhaps Homo sapiens is just the not-so-missing link to more highly adaptive non-biological life-forms possessing highly advanced Artificial Intelligence and lacking the intra-species aggression originating in the human paleomammalian and reptilian brains. Maybe advanced-AI living-machines will explore the stars, while their primitive wetware progenitors on Earth continue to cannibalize each other with their internecine tribal warfare, WMDs and destruction of the ecosystem characteristic of a Type-0 civilization.

In *The Black Cloud* astronomer and cosmologist Sir Fred Hoyle wrote, "It isn't the Universe that's following our logic, it's we that are constructed in accordance with the logic of the Universe," i.e., the logic of the universe is the logic of our brains. Maybe not only our brains or not only wetware 'brains' per se are constructed according to the logic of the universe.

"We are a way for the cosmos to know itself." —Carl Sagan

"The observer is the observed." —Jiddu Krishnamurti

"You are a way for the universe to experience itself." —Alan Watts

Most likely we are not the only way.

But will advanced-AI living machines be conscious observers of the cosmos? Whatever the nature of consciousness may ultimately prove to be, are humans actually awake and conscious most of the time, present to themselves with inner silence, or are we, ourselves, usually only unconscious automata, distracted and running on automatic pilot, as taught by G.I. Gurdjieff ? If the logic of the universe is the logic of evolved 'brains' in general, not just ours, including non-biological 'brains', e.g., artificial neural-network quantum computers, then won't advanced AI-living machines also be "made in the image of God," if there's a God, even if they do lack beards?

—May-Tzu

Dr. Capgras Before the Mirrors

May-Tzu

Novermber 30, 2015

I've been replaced by an emulation, i.e., an exact copy of myself, down to the subatomic level. At least it looks that way. I'm actually not sure how many times these replacements of myself have occurred: once, ten thousand times, one of Cantor's inconceivable transfinites or maybe an imaginary or surreal number.

Am 'I' actually strobing moment to moment among the shadows of shadows . . . of shadows of uncountable Buddhas in a quantized stream of time or recurring endlessly in some fragmented eternity? Will these replacements of myself happen in the past or have they already happened in the future?

I'm not certain if my replacements have occurred in seriatim or multiple times simultaneously or both; in each of Everett's Many Worlds; in this universe alone. And are the replacement copies of myself really exact copies? Or am I being inexorably deleted bit by bit, inexactitude by inexactitude, memory by memory? What is there in me to be replicated in any case?

But who or what is the observer, here before the mirrors, and who or what is the observed? What could replace the shimmering image of Narcissus in the stream of water or of time? Who or what is it that thinks I've been replaced by an exact copy of myself? Where or when am I? Can I, or maybe it, recognize or even see myself? Maybe an imposter now asks these questions. Perhaps some unknowable number of imposter copies have also been replaced, a potentially infinite regress of self-replacements in time. Even worse, what if I haven't been replaced?

—May-Tzu