2013 – Life is a Cosmic Phenomenon :

The "Search for Water" evolves into the "Search for Life"

William E. Smith, BSc (Special Maths), MBA, CITP, CEng, AKC
Director, CardioComm Solutions Inc.

ABSTRACT

We propose that the 2013 data from the Kepler Mission (giving a current estimate of the number of earth-like planets in the habitable zone of sun-like stars as 144 billion), has caused a consciousness change in human belief in the probability of life off earth. This seems to have affected NASA's public statements which are now leaning to the more visionary mission goal of the "Search for Life" rather than the 1975-2012 focus of the "Search for Water".

We propose that the first confirmed earth-like planet, expected to be announced later this year, be called "BORUCKI" in honour of the visionary USA scientist Bill Borucki, the father of the Kepler Mission.

We explore the 2013 status of the Hoyle-Wickramasinghe Model of Panspermia, its hypothesis, propositions, experiments and evidence. We use the Karl Popper model for scientific hypotheses (1).

Finally we explore Sir Fred Hoyle's vision of a planetary microbe defense system we call the Hoyle Shield. We explore the subsystem components of the shield and assess some options for these components using break-though technologies already available.

Keywords: Borucki, Kepler, Hoyle, Wickramasinghe, Panspermia, Hoyle Shield, Karl Popper, Loon, ViroChip

1. KEPLER MISSION – THE BORUCKI MOMENT

1.1 The Kepler Mission

Just 4 years into the Kepler Mission, in January 2013, the Harvard-Smithsonian Center for Astrophysics (CfA) used Kepler's data to estimate that "at least 17 billion" Earth-sized exoplanets reside in the Milky Way Galaxy (2). For scientists and laymen around the world this was a stunning announcement. It is generally agreed by the scientific community that the Milky Way Galaxy has approximately 300 billion low mass stars. So CfA were saying 5.6% had "Earth-sized exoplanets. The global media covered this with some interest, but really the impact on human consciousness was not obvious. There was no question that scientists around the globe were starting to think seriously about the implication of this estimate on the "search for life".

1.2 The World Economic Forum

Also in January 2013, at the World Economic Forum in Davos, Switzerland, the leaders of the world were being advised that the discovery of alien life would be one of five high risks to the global economy (3). They were asked to consider what would be the effects on science funding flows and humanity's self-image for such a discovery. And then they were advised that the proof of life elsewhere in the universe could have profound psychological implications for human belief systems.

They were then told that scientists were suggesting that new funding and new brain power will be needed to overcome the challenges that humanity will face as a result of its encounter with an extraterrestrial civilizations.

The discovery of even simple microbic life would fuel speculation about the existence of other intelligent beings and challenge many assumptions that underpin human philosophy and religion.

1.3 April 10, 2013 – 144 billion earth-like exoplanets – The Borucki Moment

In April 2013, new estimates were published (3).

"We (NASA) have estimated, using the latest available Kepler Mission data, that 48% of low mass stars have Earth-size planets in their habitable zones. So if we want to get a 'number' out of this, assuming that there are 400 billion stars of all types in our Galaxy, about 75% are low mass stars. That is about 300 billion low mass stars in our Galaxy. Then my estimate (which is validated by other researchers) shows that nearly 48% of these 300 billion low mass stars have Earth-sized planets in the habitable zone. That is, about 144 billion potentially habitable Earth-sized planets around low mass stars. And this is a conservative estimate! There could be more. Note that these billions and billions are not actually exact numbers but only estimates. Since we don't know EXACTLY how many stars AND PLANETS are in our Galaxy, this number (144 billion) could change a bit", Ravi Kopparapu, Research Team Leader, Penn State University.

This time NASA were estimating that there were 144 billion earth-like exoplanets (up from 17 billion three months earlier). For many scientists this was their "Borucki Moment" when it became clear that the Hoyle-Wickramasinghe theory that "Life is a Cosmic Phenomenon" surely had to be true. What were the chances that life began only on earth and NOT on any other exoplanet ? ie 1 in (144 billion – 1)?

1.4 "Search for Water" moves to "Search for Life"

Over the past 5 years, NASA's public relations team have published compelling video footage which perhaps unintentionally has slowly conditioned the public to the "Search for Life" mission change. The 2008 movie "Alien Planet : Darwin 4" featured Dr. James Garvin, who was the NASA Chief Scientist from 2004-5, clearly showed that in 2005 the NASA Chief Scientist could publically talk about a "search for life" vision (4).

But now in 2013, NASA remains cautious, not willing to move too quickly or overtly beyond their publically stated "Search for Water" vision. We can only assume the reasons are those discussed earlier in this paper (at WEF).

Well after the Borucki Moment, did we notice a change in the NASA public relations messages?

We argue "yes". In June 2013, the MARS Curiosity 2020 Mission was announced (5). The logo backdrop for the press announcement stated "**we should begin the difficult endeavor of seeking the signs of life**". They also announced a competition so scientists can apply to include their own experiment in the rover. Although none of the planned NASA experiments appear to have the ability to find life, it would not surprise us if the competition winner did have a "search for life" focus.

And then there is the proposed 2019 MARS Icebreaker Mission. This is not yet funded and hangs in the balance. Chris Walker's plan is to drill deep into the ice at the old Phoenix landing site (6) to look for microbes (live, fossilized or dessicated).

MARS CURIOSITY 2013 is now heading towards Mount Sharp after successfully completing its mission of proving the conditions for "Life on Mars" had existed in the past. It would not surprise us if, as it moves up the gulley at Mount Sharp, it will drill horizontally into the rock to search for microbes live or fossilized – or at least test for pre-biotic molecules.

1.5 Summary of Results in August 2013

As of August 16, 2013, Kepler has found 135 confirmed exoplanets in 76 stellar systems, along with a further 3,548 unconfirmed planet candidates. The first **confirmed "earth-like" planet** is expected to be announced this year. We propose this confirmed exoplanet be dedicated to the father of the Kepler Mission, Bill Borucki and called "Borucki".

1.6 Consciousness Changing Results

It is worth repeating that the estimate of 144 billion earth-like exoplanets continues to impact the consciousness of the whole planet. We believe this result has had a significant impact on the thinking of most astronomers and astrobiologists.

2. PANSPERMIA HYPOTHESIS

2.1 The Scientific Hypothesis

We plan to present the latest experiments which address Panspermia, and will be reminding the reader that scientific hypotheses, unlike medical hypotheses, do **not** require compelling evidence to exist at the time the hypothesis is made. In Science, experiments and evidence come later.

So if you are an engineer or an M.D., a technician or a technical writer, we ask you to accept and maybe try to understand the significance of this because without understanding this point many scientific hypotheses will seem like "fringe science". Wikipedia in 2013 is full of statements around scientific hypotheses which show little or no understanding of this principle.

> *"All science is full of statements where you put your best face on your ignorance, where you say: ... we know awfully little about this, but more or less irrespective of the stuff we don't know about, we can make certain useful deductions".*
> *— Sir Hermann Bondi (8).*

As there is no formally agreed and practiced scientific hypothesis process, we are following the guidance of the man generally considered the father of modern scientific method, Karl Popper (7) (1).

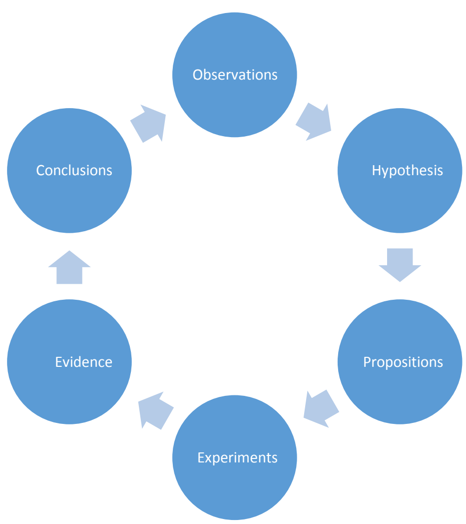

Figure 1- Scientific Hypotheses - An iterative process

Popper's idea about doing science is that after your observations, "you formulate a hypothesis, try to prove it wrong, and, from your results, formulate a new hypothesis". Karl Popper (1902 - 1994)

Why not try to prove it right? Because you can't; you never know if there isn't one more experiment that will prove it wrong.

i.e. the whole process is iterative. The hypothesis, once proven wrong, can be adjusted to better describe the latest observations.

Sir Karl Popper was one of the most influential philosophers of science of the 20th century. Popper argues the scientist should begin with **a hypothesis which is "an act of invention and imagination".** He explains that a conclusion is reached only to the extent that the hypothesis can be rejected.

In discussing the approach of engineering students compared with science students (8) : "He bitterly complained about the uncritical approach to science of the majority of his Engineering students. They merely wanted to 'know the facts'. **Theories or hypotheses which were not "generally accepted' but problematic, were unwanted: they made the students uneasy**. These students wanted to know only those things, those facts, which they might apply with a good conscience, and without heart-searching. I admit that this kind of attitude exists; and it exists not only among engineers, but among people trained as scientists. I can only say that I see a very great danger in it and in the possibility of its becoming normal (just as I see a great danger in the increase of specialization, which also is an undeniable historical fact): a danger to science and, indeed, to our civilization", Karl Popper.

Popper might be very concerned if he were alive in 2013, as he would find a world where invention and imagination in science had been severely curtailed and a label of "fringe" science applied to the very same type of hypotheses which had made Popper's engineering students "uneasy".

It is time to visit the Panspermia Hypothesis and to understand why two generations of scientists have failed to disprove the hypothesis, and why even the best scientists in NASA are on record describing processes which seem consistent with the three Panspermia propositions. For forty years the model seems to be still standing as the best description of the experimental results we have so far found.

However Stephen Thornton reminds us "Popper stresses that it should not be inferred from the fact that a theory has withstood the most rigorous testing, for however long a period of time, that it has been verified; rather we should recognize that such a theory has received a high measure of corroboration and may be provisionally retained as the best available theory until it is finally falsified (if indeed it is ever falsified), and/or is superseded by a better theory" (1).

So in 2013, we propose that the Panspermia Hypothesis - Hoyle-Wickramasinghe Model be retained as the best available theory around the issues of life in the galaxy.

We now review the hypothesis.

2.2 Life is a Cosmic Phenomenon – the Panspermia Hypothesis - Hoyle-Wickramasinghe Model

In 1974, Hoyle and Wickramasinghe, having observed what they believed were organic molecules in the inter-stellar clouds of the Milky Way Galaxy, created their model of an old theory, the Panspermia Hypothesis.

Panspermia is the hypothesis that life exists throughout the Universe, distributed by meteoroids, asteroids, comets and planetoids.

The Hoyle-Wickramasinghe Model of the Panspermia hypothesis defines the following propositions to guide the investigation:

1. that dormant viruses and desiccated DNA/RNA can survive unprotected in interplanetary space (RadioPanspermia) (9)
2. that the seeds of life can survive protected from cosmic rays in asteroids, comets and meteors (LithoPanspermia) (10) (11) (12)

3. that the seeds of life are promulgated from solar system to solar system by a process of comet and asteroid collision with planets; matter ejection from planet to local planets and moons; and then onwards and outwards from that solar system to an adjacent solar system (11) (13)

In the above propositions of the Hoyle-Wickramasinghe Model, the "seeds of life" include biological microparticles such as bacteria, viruses, spores and pollen. This specifically includes:

1. desiccated and/or partially inactivated DNA/RNA (12) (14) (15)
2. live, dormant or fossilized non-cellular life (viruses) (10) (14) (15) (12) (13) (16) (17)
3. live, dormant or fossilized cellular life (bacteria, archaea) (17) (18)

i.e. In the more general Panspermia Hypothesis these "seeds of life" are not as clearly defined as in the Hoyle-Wickramasinghe Model. Also in the Hoyle-Wickramasinghe Model, LithoPanspermia includes comets. It proposes that comets are the major promulgation "carrier" of the seeds of life, especially from solar system to solar system, and proposes that the center of comets is water, not ice, an ideal environment for bacteria and viruses.

Figure 2- The Seeds of Life - in all their various forms (including fossilized, dormant and alive modes)

The most contentious issue around the Hoyle-Wickramasinghe Model of the Panspermia hypothesis is a corollary of their first 2 propositions that viruses and bacteria continue to enter the earth's atmosphere from space and are responsible for many of the major epidemics (19) (18).

2.3 The Experiments and Evidence to Date

As we have discussed, real progress with a hypothesis is proving it NOT to be true. So if we can show that the various forms of the “seeds of life” cannot even survive on earth in extreme conditions, this would be strong evidence for the hypothesis NOT being true.

But for over 40 years scientists have been unable to prove that “seeds of life” cannot survive in extreme conditions as would be encountered in space. It would seem that viruses and bacteria have the ability to survive in almost every situation below “inner space”.

Even more puzzling is that scientists have proven that viruses and bacteria have the ability to go into a “dormant” state which effectively allows them to “live forever” – certainly for millions of years.

2.3.1 Organic Molecules in Interstellar Space

Wickramasinghe was the first scientist to ask the question (in 1960) “Could interstellar grains be somehow connected with biology, with life itself”? This was in its day such a profound question to ask, that it was considered an assault on conventional thinking.

Certainly people who did not understand the scientific hypothesis would routinely say – “but where is your evidence?”

As already mentioned it was Wickramasinghe who in 1974 first hypothesized that they organic molecules were in the inter-stellar medium (clouds) of the Milky Way Galaxy.

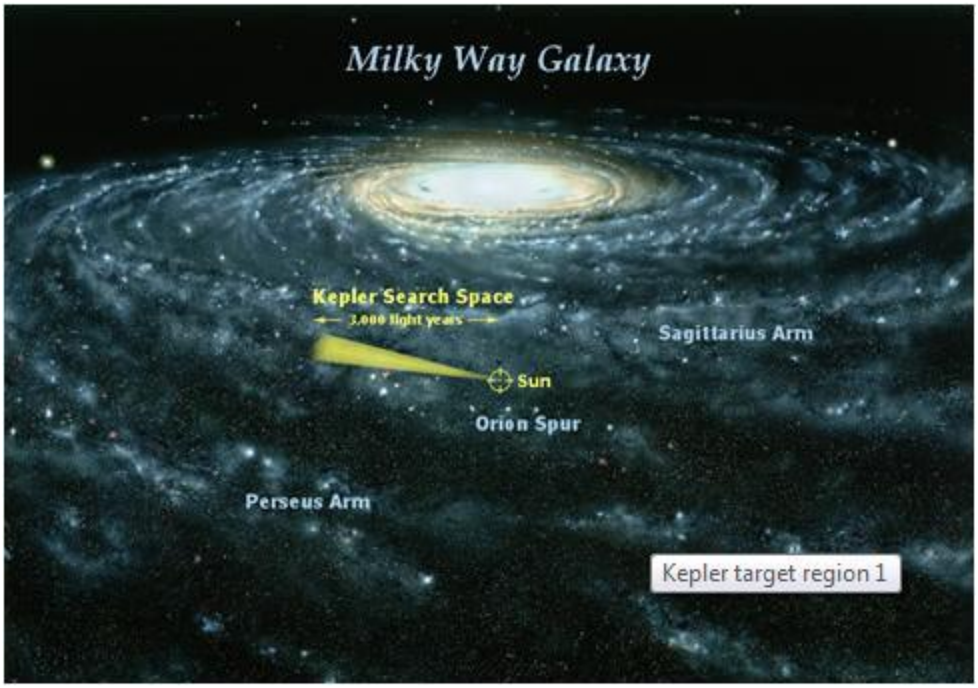

Figure 3- Interstellar Medium (ISM) - the dark spaces between the spiral arms

In the 2013 Panspermia Hypothesis (H-W Model) the definition of "seeds of life" still includes both biological and non-biological organics, (esp DNA/RNA molecules and fragments). Scientists in 1960, and 1984 would be surprised that the scientists of 2013 are even more “ambiguous” about certain molecules, DNA/RNA pieces and even Viruses themselves.

Non-biological organics

Looking at non-biological organics by 2011 there were about 160 reported interstellar molecules which include simple molecules (e.g., H2, CO, H2O, CO2, and NH3), molecular ions (e.g., H+3, HCO+, H3O+,HCO+2), radicals (e.g., CnH, CnO, CnS (n=1,2,...)), ring (cyclic) molecules (e.g., c-C3H2, c-SiC2,c-C3H, c-C2H4O), and stable molecules (e.g., H2CO, HCOOH, CH3OH, C2H5OH) (20).

Atacama Large Millimeter/sub-millimeter Array (ALMA)

By 2013 the technology to explore these vast interstellar gas clouds (aka ISM) has improved substantially with the Atacama Large Millimeter/sub-millimeter Array (ALMA). It is an astronomical interferometer of radio telescopes in the Atacama desert of northern Chile.

Already the NASA team led by Dr. Anthony Remijan, University of Virginia, have discovered an important pair of prebiotic molecules in the icy particles in interstellar space (ISM).

The chemicals, found in a giant cloud of gas about 25,000 light-years from Earth in ISM, may be a precursor to a key component of DNA and the other may have a role in the formation of an important amino acid. Researchers found a molecule called cyanomethanimine, which produces adenine, one of the four nucleobases that form the "rungs" in the ladder-like structure of DNA. The other molecule, called ethanamine, is thought to play a role in forming alanine, one of the twenty amino acids in the genetic code.
Previously, scientists thought such processes took place in the very tenuous gas between the stars. The new discoveries, however, suggest that the chemical formation sequences for these molecules occurred not in gas, but on the surfaces of ice grains in interstellar space.

In February 2013, NASA ALMA spokesman announced : "Finding these molecules in an interstellar gas cloud means that important building blocks for DNA and amino acids can 'seed' newly-formed planets with the chemical precursors for life."

Figure 4 - DNA/RNA Fragments in Space (in Comets, Meteors and even free form)

.
Later, In a profound interaction between Dr. Remijan and the interviewer, Remijan was asked : "Are you saying it's unlikely that the amino acids needed to produce RNA and DNA could've formed right here on Mother Earth?"

Remijan responded "That's one thing that we are suggesting, that the conditions on the early Earth were not conducive to this type of chemistry but it was possible that the chemistry could've been transported to the early Earth by comets, meteorites, asteroids that have the chemistry bottled up from the interstellar medium, from interstellar space that brought this chemistry to early planets like the early Earth".

So Remijan is hypothesizing that the little understood "magic moment" when complex molecules became non-cellular life (eg "viruses") was more likely to have happened in the Interstellar Medium, than here on earth.
But as more and more evidence for complex molecules are discovered in the Interstellar Medium, so we have a responsibility to better define what ***life*** really is in terms of biological or non-biological organics. For example Viruses are most often considered replicators rather than forms of life. They have been described as "organisms at the edge of life".

Life on Earth

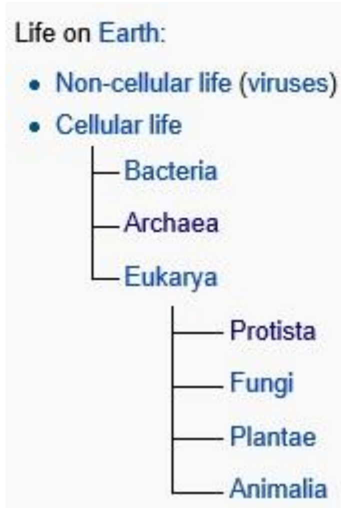

Figure 5 Life on Earth

It might be a good point to remind the reader that in the Panspermia Hypothesis' "definition of the seeds of life" includes microbes (live, dormant or fossilized) - including viruses, bacteria, mitochondria and as yet unidentified early life forms.

Perhaps the best discussion of biological or non-biological organics is in Wikipedia under "Icebreaker Life" (21) where NASA astrobiologist Chris Walker defines the goals of his important proposed 2019 MARS Icebreaker Mission :

> " Target biomolecules will be aminoacids, proteins, polysaccharides, nucleic acids (e.g., DNA, RNA) and some of their derivatives, NAD+ involved in redox reactions, cAMP for intracellular signals, and polymeric compounds such as humic acids and polyglutamic acid —formed by bacterial fermentation.Ionizing radiation and photochemical oxidants are more damaging in dry regolith, therefore, it may be necessary to reach ~1 meter deep where organic molecules may be shielded by the ice from the surface conditions. The optimal deposition rate for the landing site would be such that 1 m of drill will sample through 6 million years of sediment. "

At this point we hold back on the important recent developments in Virus detection and identification. We will discuss this in the last section under the "Hoyle Shield" Project.

Having looked at the complex molecule discoveries, and been introduced to the ambiguousness of "life" (ie today's most respected biologists do not all agree on what IS life) we now review the surprising discoveries of microbes on the surface of the earth, deep into the water, ice and rock and even up in the stratosphere and inner space.

2.3.1 Evidence on Earth for microbe survival in extreme conditions : deep underground water, deep ice, deep rock and deep ocean

Over the past ten years we have seen a large number of discoveries of microbes (dormant and alive) in deep ice, deep underground water, deep rock and deep ocean. Science continues to surprise itself to discover microbes surviving in a variety of previously unbelievable ways.

2.3.1.1 Underground Water

On 6 February 2013, scientists reported that bacteria were found living in the cold and dark in a lake buried a half-mile deep under the ice in Antarctica. (24)

In one such similar system, 2.8 kilometres below the surface in a South African gold mine, extant chemoautotrophic microbes have been identified in fluids isolated from the photosphere on timescales of tens of millions of years (22).

In 2013 the world's oldest flowing water has recently been found in a Timmins, Ontario mine. The water, as old as 2.64 billion years, has chemistry that could support life. We await with much interest the results of the analysis for microbes, both live, fossilized and dormant (23).

2.3.1.2 Deep Ice

In 2004 Price and Sowers discussed their discoveries of prokaryotic (i.e. bacteria) communities that survive in ice and permafrost. They hypothesize that far below freezing point, liquid water inside ice and permafrost is available for metabolism. They even state that the rate for repairing molecular damage by means of DNA-repair enzymes and protein-repair enzymes is comparable to the rate of molecular damage (24).

2.3.1.3 Deep Rock

As long ago as 1997 scientists were reporting microbe findings from "deep rock" and "deep rock under deep ocean" . By 2013 it is well accepted knowledge that bacteria flourishes deep in our planet requiring neither sunlight nor oxygen to live. Some can tolerate temperatures hotter than surface boiling temperatures, and some colder than surface freezing.

Scientists are also realizing that not only does rock provide a welcome environment for the nourishment of life, but life may actually play a role in the concentration of minerals.

"Rocks influence biology and biology influences rocks," summed up Deborah Kelley, a University of Washington oceanographer who has discovered deep methane concentrations that could provide food for bacterial colonies.

"It wouldn't surprise me to find life on Mars at all," she said. "I don't remember this much excitement (among earth and ocean scientists) since plate tectonics," the 1960s revolution in geology that explained the evolution of the continents, volcanoes and earthquakes.

In 2011 Rika Anderson asked "is the genetic landscape of the deep subsurface biosphere affected by viruses? (25) Her team hypothesized that viruses directly influence the genetic capabilities and the fitness of their hosts through the use of fitness factors and through horizontal gene transfer. They also discussed how these results might apply to other regions of the deep subsurface, where the nature of virus–host interactions would be altered, but possibly no less important, compared to more energetic hydrothermal systems. ***"Viruses are emerging as a profound evolutionary force whose impact we have yet to fully assess, particularly in the realms of the deep".***

2.3.1.4 Deep Rock below Deep Ocean

Microbe studies deep below the Pacific ocean bed are thought to be among the oldest microbes on the planet. They are extremely inactive and very slow on the intake of nutrients from their environment. They seem to barely classify as being alive. Their very existence could help define the limit between life and death.

Paradoxically, though, they may also be among the oldest "living" organisms on Earth. Hans Roy of Aarhus University in Denmark says "It is safe to say that we do not know anything about the adaptations to low energy life that these organisms might have – only the thermodynamic limits which constrains them." (26) (27) He continues "Elsewhere on Earth, life is primarily concerned with building up enough energy to fuel reproduction. In extremely energy-poor communities, though, reproduction makes less sense because it creates new rivals that also need to feed. "If you can just barely meet your energy requirement, then it is suicide to divide into two," he says. He thinks it makes more sense for the cells to use the energy they gather to repair cellular molecules that have been damaged over centuries of use instead of fuelling cell division."

2.3.1.5 Total Biomass

Biomass is the mass of organically bound carbon (C) that is present. Apart from bacteria, the total live biomass on earth is about 560 billion tonnes C, and the total annual primary production of biomass is just over 100 billion tonnes C/yr. However, the total live biomass of bacteria may exceed that of plants and animals by a factor of 1,000. Even more surprising is that the total live biomass of Viruses may exceed even that of Bacteria by a further 1,000 times.

2.3.2 Evidence on Earth in the Atmosphere –Troposphere, Stratosphere and Mesosphere

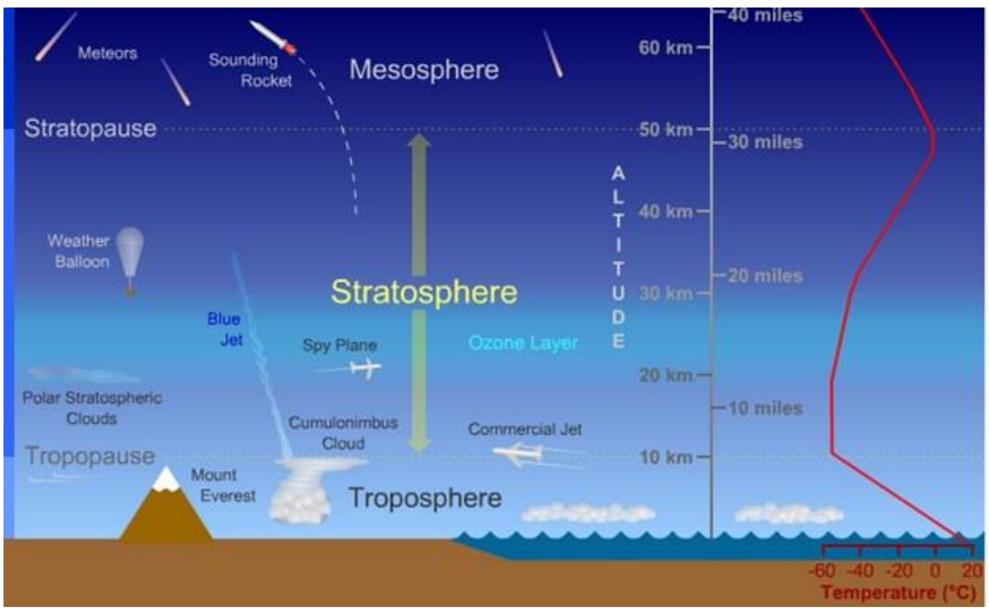

Figure 6- LOON in The Stratosphere

2008 - Stratosphere

In April 2008 a team from the University of Washington had conducted an aerobiological sampling flight at 20 km over the Pacific Ocean (28). The aim of the study was to confirm presence of viable bacteria and achaea within an atmospheric bridge. They concluded there were viable fungi and bacteria but conservatively stated it was unlikely a permanent stratospheric ecosystem existed.

2009 – Stratosphere

Yinjle Yang et al from the University of Tokyo used the latest evidence from stratosphere studies to assess the Panspermia Hypothesis (29). They expressed the conclusion that "verification of the hypothesis had been difficult in the early years. In saying this they were in effect confirming Panspermia as a hypothesis which has still not been falsified – ie still "the best guess".

They also cautioned that “it is very likely that directed panspermia from Earth to other planets has been going on since the beginning of our space exploration” and so we have more than likely already inadvertently contaminated most places we have sent probes to including Mars, Jupiter, Saturn, the Moon, and Venus.

2011 - Troposphere

In April and May 2011 a second team again largely from the University of Washington studied microbes in the troposphere and came to the conclusion microorganisms were abundant in the troposphere. They also concluded microbes could be transported long distances on prevailing winds. They sampled at 2.7 km above the sea level. They again focused on bacteria and fungi, not viruses. They counted 49 different species using DNA gene sequencing.

2013 - Stratosphere

The latest experiment has been completed by Milton Wainwright in Chester, UK, in July 2013 (30). The experiment revealed the presence of a diatom frustule captured from a height of >25km. On account of the very short residence time of particles of diatom size and mass at these heights, they argue for its incidence from space, with a probable origin in the watery environment of a comet.

Their paper discusses the possibilities of how the diatom reached the lower stratosphere and offer two options : either it was lofted from the earth’s surface or “inbound” from space.

The writers offer a third option that such diatoms might well live in the stratosphere, although Kasten’s calculations would argue that these microbes are just too heavy to remain at that height (31).

Wainwright’s microbe gathering sensor equipment was “mechanical” and analysis required the samples to be returned to ground level for laboratory work.

They add that “further studies by us are now underway on the biology of the stratosphere with a view to finally answering the question of where the organisms found in this region originate – are they exiting from Earth, or falling in to our planet from space?”

Microbes Living in the Upper Atmosphere - Hypothesis

The writers feel that just as it was discovered that microbes can survive in a wide spectrum of surprising conditions upon and below the surface of the earth, it would seem likely that they also flourish at all levels in the atmosphere. This corollary of the Hoyle-Wickramasinghe Model is hypothesized here and should be easy to falsify by a simple experiment involving the use of balloon-mounted nanosensors using virus-chip technology.

The writers hypothesize that, as viruses are much smaller and lighter, and have a proven 1,000 times the biomass of every other life form both on and under the earth, a viable virus-laden stratospheric ecosystem is most likely to exist.

An experiment to falsify this hypothesis should be achieved within the next 18 months.

2.3.3 Evidence on Earth in Inner Space

On 26 April 2012, scientists reported that lichen survived and showed remarkable results on the adaptation capacity of photosynthetic activity within the simulation time of 34 days under Martian conditions in the Mars Simulation Laboratory (MSL) maintained by the German Aerospace Center (DLR) (32). It was stated ***that the outcome of this work might be relevant to classify Mars as a habitable planet*** by a new experimental and biological approach.

On 29 April 2013, French scientists, funded by NASA, reported that, during spaceflight on the International Space Station, microbes seem to adapt to the space environment in ways "not observed on Earth" and in ways that "can lead to increases in growth and virulence" (33). Professor Frippiat hypothesizes that Microgravity modifies microbial physiology, pathogenesis and virulence; ***Space travel has immunosuppressive effects that increase vulnerability to infections;*** and Spaceflight is a model of stress with potential societal impact.

2.3.4 Evidence in Meteorites

The history of research into Meteorites and microbes is extensive, and is a strong reason why people who doubt the Hoyle-Wickramasinghe Model for Panspermia model have repeatedly failed to falsify the second proposition of the model :

Panspermia Proposition # 2. that the seeds of life can survive protected from cosmic rays in asteroids, comets and meteors (LithoPanspermia) (10) (11) (12)

By 2013 there are approximately 45,952 meteorite finds of which 10,812 have been named (34). .
As of June 29, 2013 there are 177 confirmed meteorites from the moon, 67 confirmed from Mars and 1 possible meteorite from Mercury.

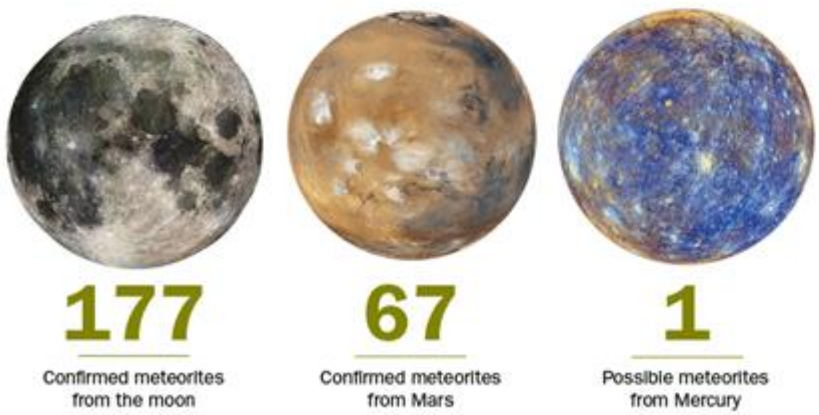

Figure 7- Meteorites Found

Credit: From left: JPL/NASA; JPL/NASA; JHU-APL/NASA, Carnegie Institution for Science

ALH84001

NASA scientist David Stewart McKay, who sadly passed away on Feb 20, 2013 published findings in 1996 regarding possible microfossil structures in Martian meteorite ALH 84001 (35). McKay presented more than 100 talks at scientific and public gatherings on the possibility of life on Mars and the implications of that possibility.

Growing Evidence

The evidence for microbes inside meteorites has been accumulating for many years. Over this time expertise in contamination management has considerably increased in sophistication. There was a time when the morphology of an object would typically have been strong evidence for life or fossilized life. (ie if it looked like a diatom then it likely WAS a diatom). But by 2013, we have adopted much more definitive tests including isotope ratio analysis and more recently DNA/RNA classification of particles. Even these are clouded in controversy due to the high probability of contamination even in meteorites recently gathered.

Role of Richard B. Hoover

Richard B. Hoover is a scientist who was employed at the United States' NASA Marshall Space Flight Center from 1966 to 2011 as an Astrobiologist. He is generally regarded as the first scientist to identify putative fossilized cyanobacteria and other filamentous prokaryotes in successive studies (1997 (36), 2007 (37), 2011 (38) and 2013 (39).

The four studies cited include progressively more sophisticated analyses using the rapidly advancing equipment typically used for the various types of analysis: morphology; elemental composition; and isotope ratios. In all cases t**he results showed strong evidence for either dessicated, fossilized or even live microbes in the meteorites**. In each case Hoover was confident he had provided sufficient evidence to show there was no contamination of the objects he had focused on. (i.e. he failed to disprove the Panspermia Proposition #2).

2.3.5 Evidence in Comets

With the Panspermia Hypothesis placing so much emphasis on the promulgation of "life" inside watery comets, we would expect the three propositions to be seriously tested over the next few years.

Around 1980 Fred Hoyle and Chandra Wickramasinghe developed the idea that Lithospermia should also include Comets (10) (40). In "A Journey with Fred Hoyle" published in 2013 (41) Wickramasinge describes how they considered all the then known characteristics of comets having to do with "life". The hypothesized the heating of the comet core such that the replication of bacteria and viruses would occur.

In 1986 the comet Halley returned. This was the first time since the start of the space age that a comet was studied. Five space-crafts were launched in 1985 to investigate the comet. Hoyle and Wickramasinghe developed a series of propositions and published these in 1986 just 12 days before the encounter (42). They predicted the comet would have a very black surface of very porous crust of polymerized organic particles. On the evening of March 13, 1986, the world was riveted to their TV screens as cameras came within 500 km of the comet. The cameras were expected to photograph a "bright snow scene" at the nucleus of the comet, as the Whipple dirty snowball model of comets was the then accepted model. Instead the images were more consistent with the Hoyle-Wickramasinghe proposition – "blacker than the blackest coal".

Observations made 2 days later by Dayal Wickramasinghe and David Allen discovered a strong emission from heated organic dust over the 2 to 4 μm waveband. It was well known that basic organic molecules involving C-H linkages, and for any assembly of complex organic molecules such as in a bacterium or virus the absorption is broad and takes on a highly distinctive profile.

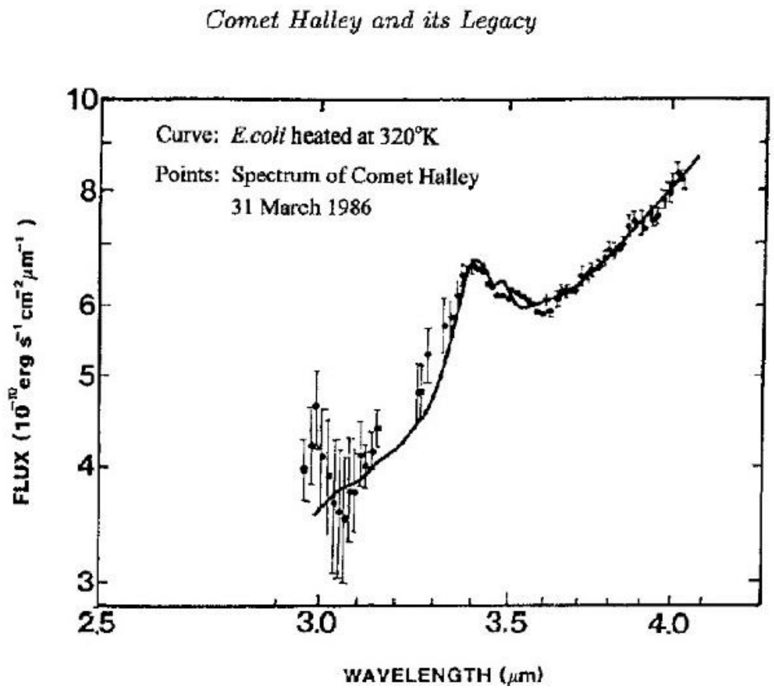

Figure 8 - Comparison of the spectrum of the Comet Halley (points) obtained by Dayal Wickramasinghe and David Allen with a microbial model (curve)

These Halley Comet observations were found to be identical to the expected behavior of dessicated bacteria at 320 K. These experimental results encouraged Hoyle and Wickramasinghe as the Proposition #2 of their Panspermia Model was still not yet disproven.

Sir Arthur C. Clarke who suggested that three geostationary satellites would provide coverage over the entire planet, and who later was co-author of the movie "2001 : A Space Odyssey", in 2001 predicted that "2061 Halley's Comet returns - first landing by humans, and the sensational discovery of both dormant and active life forms vindicates Wickramasinghe and Hoyle's century-old hypothesis that life exists through space" (43).

Many comets have been studied from Earth sometimes over centuries. But only a few comets have been closely visited. In 1985, the International Cometary Explorer conducted the first comet fly-by (21P/Giacobini-Zinner) before joining the Halley Armada studying the famous comet. The Deep Impact probe hit 9P/Tempel and learned more about its structure and composition. The Stardust mission returned samples of another comet's tail. The Rosetta Mission will attempt to land on a comet next year (2014).

The challenge to "Search for Life"

The challenge we face in the "Search for Life" on Comets has been similar to that faced by the MARS Missions. i.e. lack of clear definition of life; lack of light, low cost, reliable detection technology; possibility life can be in any of three states : live, dormant or even fossilized; potential contamination complexities

Japan Mission lands on Asteroid and returns samples to earth

Japan Aerospace Exploration Agency launched Hayabusa in May 2003. It was an unmanned spacecraft designed to return a sample of material from a small near-Earth asteroid named 25143 Itokawa to Earth for further analysis.

Hayabusa rendezvoused with Itokawa in mid-September 2005 and studied the asteroid's shape, spin, topography, colour, composition, density, and history eventually in November 2005, it landed on the asteroid to collect samples. The spacecraft returned to Earth on 13 June 2010. The first announcement was confirmation of a direct oxygen-isotope link between the chondrites (meteorites) and their parent asteroid.

“ Impaction appears to be an important process shaping the exteriors of not only large planetary bodies, such as the moon, but also low-gravity bodies such as asteroids. The space environment alters asteroid surfaces by a combination of disaggregation, cratering, melting, adhesion, agglutination, and implantation/sputtering, all consequences of constant bombardment by nm- to μm-scale particles”, Eizo Nakamura (44). “Amino acids such as glycine and alanine were detected only at procedural blank levels in two different grains from asteroid Itokawa using 2D-HPLC with highsensitive fluorescence detection. ToF-SIMS analysis also gave no substantial difference between sample extracts and blanks. Indigenous organic compounds were therefore not identified in this study, and if present, the amino acid concentrations in these samples are at the ~ppm level or lower for the DCM/MeOH extract. The particle amount available for this study was very limited. Further analyses of acid hydrolyzed hot water extracts of Itokawa samples using larger sample sizes and the least minimum procedural blank may be required in order to detect trace levels of indigenous amino acids. A direct particle analysis by ToF-SIMS without solvent extraction is also preferred. In addition, carbonaceous microparticles will be searched in the Itokawa samples for organic compound analyses”.

In a personal communication to the writer in August 2013, Akira Tsuchiyama commented, “Our preliminary examination (PE) team looked for carbonaceous materials and some organic materials (***we did not search for viruses, bacteria and diatoms***). In the PE, unfortunately, we did not detect any these materials (see attached papers)”.

Richard Hoover, when asked for his opinion on these results, quoted “The negative result is not surprising. I do not know of any instances of detection of indigenous amino acids or other organics in LL5-6 stony meteorites either. This was unfortunately a poor choice of Asteroid for this study”.

Chandra Wickramasinghe commented “this asteroid was not one that resembles comets, as some do. It is a bit of rock on which no life could have arisen or survived. I think this was a poor target if life detection was to be involved”.

2.3.6 Evidence on Other Planets and Moons

Meteorites Recovered on other planets and moons

Moon : two tiny fragments of asteroids were found among the samples collected on the Moon; these were the Bench Crater meteorite (45) (Apollo 12, 1969) and the Hadley Rille meteorite (46) (Apollo 15, 1971).

No results have been made available on their analysis other than sufficient “proof” that they are indeed meteorites.

Mars : Opportunity Rover discovered the "Heat Shield Rock" (47) meteorite on Mars in addition to five similar iron meteorites. Also two nickel-iron meteorites were identified by the Spirit rover (48).

It would be consistent with Panspermia (3rd proposition) to find rocks with an earth-like oxygen/isotopic signature on every planet and moon we visited.

2.3.7 Evidence extra solar system

Evidence “extra solar system” will be by remote sensing for many years to come. The Atacama Large Millimeter/sub-millimeter Array (ALMA) has entered into its science operation, and it is expected that many exciting results including detection of amino acids, building blocks for nucleic acids, and others by this powerful instrument (49).

A recently calculated estimate of the time for free travelling microbes (aka radiopanspermia) to move from one star system to the adjacent star system, gives an estimated average time for this journey (using a 4 ly average) of only 10,000 years. Microbes travelling deep enough inside meteors, asteroids or comets (aka Lithopanspermia) would be expected to survive such a journey with their DNA/RNA largely undamaged by cosmic rays.

This is substantially less elapsed time than the age of microbes found in extreme conditions on/in earth, and brought back from dormant state to live state.

3. HOYLE SHIELD

3.1 Viruses

It is generally agreed that viruses are the most abundant biological entity. It is estimated there are about one million of them in a teaspoon of seawater. Most of these viruses are bacteriophages, harmless to plants and animals. They infect and destroy the bacteria in aquatic microbial communities. The organic molecules released from the bacterial cells by the viruses stimulates fresh bacterial and algal growth.

Since 1971, the International Committee on Taxonomy of Viruses (ICTV) operating on behalf of the world community of virologists has taken on the task of developing a single, universal taxonomic scheme for all viruses infecting animals (vertebrate, invertebrates, and protozoa), plants (higher plants and algae), fungi, bacteria, and archaea.

Their current report (50) builds on the accumulated taxonomic construction of the eight previous reports dating back to 1971 and records the proceedings of the Committee since publication of the last report in 2005. Representing the work of more than 500 virologists worldwide, this report is the authoritative reference for virus organization, distinction, and structure.

3.2 Viruses from Space

Sir Fred Hoyle explored the issue of "Viruses from Space" in his 1986 book of the same name (51).

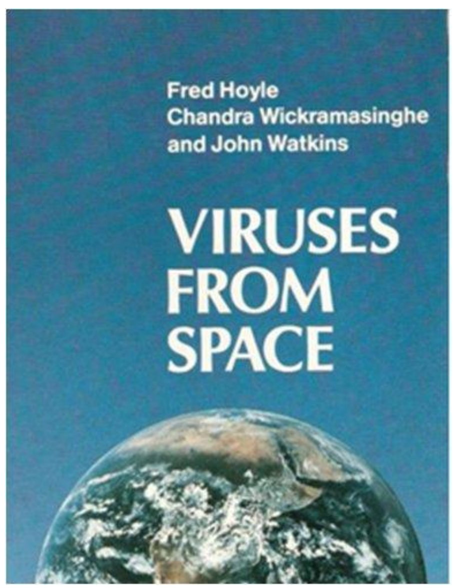

Figure 9- Viruses from Space

The previous chapter presented arguments that the Panspermia scientific hypothesis and its 3 propositions, remain in 2013 a " best guess" for the overall philosophy that "Life is a Cosmic Phenomenon".

So this chapter looks at the possibility of a "shield" around the earth, which would be designed to identify "inbound" pathogens and designed to give virologists an added period of time to develop required vaccines for new pathogens.

Fred Hoyle's close friend was Arthur C. Clarke who "proposed" geostationary satellite communications in the Wireless World magazine in 1945 (52). Clarke expected this to be in place within 50 years – ie by 1995. But although most people did not consider the idea seriously at the time it became a reality within just 20 years with the launching on 1965 April 6th of Intelsat I Early Bird the first commercial geostationary communication satellite. It was a compelling idea for the US military and was heavily funded.

Just as Clarke's communications proposal inspired a generation of creative satellite and communications development, the writers hope to generate a similar vision and momentum for the HOYLE SHIELD project - for early detection of inbound viruses.

3.3 The Assumption

The corollary of the Hoyle-Wickramasinghe Model of Panspermia, and its three propositions, is that pathogens continue to enter the earth's atmosphere and are likely contributing to the regular outbreak of new diseases.

Various books are available which discuss the evidence for this hypothesis but the writer asks the reader to suspend questioning of the assumption for a short while, and allow himself/herself to consider the "system". What would be needed to effectively fund, develop, deploy and operate such a shield (53).

Some of the proposed technologies and solutions will be of vital importance in the various NASA and ESA missions to planets and moons planned for the next 25 years.

In the early systems study, we reviewed a fundamental problem being the issue of "what is life" and "what are the signs of life" that NASA are now starting to search for.

In our definition of the Panspermia Hypothesis in **Error! Reference source not found.** we define the "seeds of life" to include biological microparticles such as bacteria, viruses, spores and pollen. We repeat the list here as the very complexity and spectrum of this list is part of the challenge.

1. desiccated and/or partially inactivated DNA/RNA
2. live, dormant or fossilized non-cellular life (viruses)
3. live, dormant or fossilized cellular life (bacteria, archaea)

In its early years after deployment we propose the Hoyle Shield will only look for objects from (2) and (3) i.e. live (or dormant) viruses, bacteria and archaea.

3.4 The System Components

The Hoyle Shield will be a system to detect viruses and bacteria in the stratosphere long before the microbes infect birds or humans. The system will have three major subsystems:

- Sub-System #1 : The Nanosensor
- Sub-System #2 : The Platform
- Sub-System #3 : The Backend processing

Lessons Leaned – From Looking for Fossils and Life in Meteorites

In our feasibility study, we explored the various challenges scientists like Richard Hoover and Chandra Wickramasinghe have had to overcome exploring meteorites and coping with contamination issues.

The biggest challenge has been access to the various and many pieces of equipment needed for a comprehensive analysis of rock samples from target meteorites. Equipment needed is typically housed across many faculties of universities – i.e. rarely in one single faculty. The equipment is heavy and expensive and needing substantial expertise to operate.

Here is a list of typical equipment used to "search for life" in a meteorite.

1. Light Microscope
2. Field Emission Scanning Electron Microscope (SEM)
    a. Philips XL30 FEI FEG ESEM : Gold Coated samples

    b. Hitachi S-3700N Field Emission Scanning Electron Microscope
3. EDX Energy-dispersive X-ray spectroscopy (EDX, EDS, EDAX)
    a. EDS Oxford Instruments INCA
4. Triple Oxygen Isotope Analysis
    a. Thermo MAT 253 spectrometer
5. Xray Powder Diffraction
    a. Philips PW1710 Automated Powder Diffract meter X-ray diffraction
6. RAMAN and ATR-FT-IR spectroscopy
7. Wavelength-Dispersive X-Ray Spectroscopy (WDS) :
8. Amino Acid Analysis
9. ToF-SIMS Analysis

Although it might not be obvious, there is no DNA/RNA identification equipment in this list.

3.5 Early Assessment of the Required Detection Technology (54)

Milton Wainwright of the University of Sheffield in the UK (30) has described his sampling of the stratosphere at heights between 22 and 27 km carried out in the UK on 31st July 2013 using balloon-borne equipment carrying aseptically clean electron microscope stubs onto which aerosols were directly captured.

This is a low cost solution to a complex problem. The good news is that his experiment (as his recent paper indicates (30)) delivered very interesting results, especially with microbes the size of bacteria and diatoms.

Although not yet part of this proposed Hoyle Shield project umbrella, Wainwright's pioneering work is recognized by his peers as important data gathering as scientists continue to try to prove the "inbound virus" hypothesis wrong.

We would hope for future experiments Wainwright can get access to isotope analysis equipment and even DNA/RNA identification equipment.

The realization that "Virus Chip" technology might provide a solution which could be light, low cost and effective for our needs was a tipping point in our feasibility analysis. Up until this point the answers to all our sensor questions, seemed to all point to a solution where samples would need to be brought back to earth for analysis.

Of course in the short term, having scientists like Wainwright incorporating Virus Chip testing technology in their sample analyses should significantly enhance the quality and depth of the microbe analysis process.

Viral pathogen discovery is of critical importance to clinical microbiology, infectious diseases, and public health. Pathogen discovery is critically important to infectious diseases and public health. Nearly all new outbreaks are caused by the emergence of novel viruses. Genomic tools for pathogen discovery include consensus PCR, microarrays, and deep sequencing. Downstream studies are often necessary to link a candidate novel virus to a disease.

Sub-System #1 : The Nanosensor

In our early exploration of the sensor subsystem, we assumed identification of bacteria and even viruses would involve analysis under an Electron Microsoft (SEM). We postulated using morphology recognition software to compare the viruses and bacterial with a known population in a referable database. We envisage a system perhaps based upon existing facial recognition software.

We asked : Does low cost, light SEM technology already exist? Technology that might be used in the stratosphere? Or would samples need to be returned to earth for analysis?

Early option analysis looked for a low cost, lightweight, electron microscope that could be carried aloft. Such a solution was discovered to exist and the solution option looked promising.

However, it was quickly brought to our attention from the experts in virus identification, that in 2013, there has been a whole new technology revolution that had obsoleted any visual virus or bacteria recognition.

Andrew King (50), Editor of Virus Taxonomy, advised "Virus identification is based almost entirely on immunological or gene sequence data. The definitive way to quantify the relatedness of viruses is to compare the sequences of either their genes or the proteins encoded by those genes, the latter being sensitive to more distant relationships. For very distant relationships, between members of different families, high-resolution 3-dimensional protein structures sometimes reveal similarities whose evolutionary origins are too ancient to be detected by sequence analysis. "High resolution" for this purpose means close to atomic resolution. Such fine detail can only be seen in structures determined by X-ray crystallography, although the latter approach is sometimes augmented by 3-D modelling based on a sophisticated analysis of multiple electron microscopic images. It is important to appreciate that both approaches rely on the fact that every particle in the sample or crystal is identical to every other. Even here, therefore, image analysis is not about recognizing an individual object (like a human face) as distinct from other objects (faces) but, rather, it is about averaging the images of many identical objects".

PCR

We explored the very simple but powerful method to detect life by the DNA polymerase chain reaction (PCR) which is standardly used (55).

MIT's "Search for Extra-Terrestrial Genomes" Project (SETG) states ***"SETG will test the hypothesis that life on Mars, if it exists, shares a common ancestor with life on Earth. There is increasing evidence that viable microbes could have been transferred between the two planets, based in part on calculations of meteorite trajectories and magnetization studies supporting only mild heating of meteorite cores. Based on the shared-ancestry hypothesis, this instrument will look for DNA and RNA through in-situ analysis of Martian soil, ice, or brine samples. By applying recent advances in microfluidics, embedded systems, and biological automation, our team is developing an instrument that can isolate, amplify, detect, and classify any extant DNA or RNA-based organism"***.

Virus Chip

There are several Virus Chip R&D initiatives around the globe. We believe the following three options illustrate the stunning results this technology is delivering. These represents a reasonable selection of options which the Hoyle Shield project will need to assess.

April 2013 : PathChip : Singapore (56).

A DNA sample from an infected patient is extracted and then put on the chip. Within 24 hours, a report is generated, showing which viruses are detected. The chip can also detect new viruses, such as the avian influenza A (H7N9) virus first found in humans in 2013.

Dr Edison Liu, president of Human Genome Organisation, said: ***"All the 70,000 pathogens are in one way or another related to each other, not closely but related enough, so that the probes were constructed and selected specifically to be generalised, if need be. So if you have a new SARS virus, a new coronavirus that is SARS-like and you've never seen it before, this (chip) will detect it."***

The device costs less than S$600 and only needs one technician to operate. This is a chip that can detect 70,000 viruses and bacteria, all in one test. So all the viruses are clinically relevant, such as H1N1, H1A1, H7N9, can all be detected on the chip as well as the bacteria," Dr. Wong said. According to Dr. Wong, in just 24 hours, the PathChip will be able to successfully identify a pathogen. The chip uses a variety of a patient's DNA to identify parts of the genome of the pathogen being tested. That information is then fed through a computer algorithm that can identify the pathogen using a special program. **The PathChip is currently only available for research and needs further testing**. PathChip is waiting for government approval before it can be put into diagnostic use Video Source.

2013 : USA State-of-the-Art : Lawrence Livermore Microbial Detection Array (LLMDA)

USA Scientists have developed the Lawrence Livermore Microbial Detection Array (LLMDA), a technology enabling detection of bacteria, viruses and other organisms. This technology has shown value for applications in detection for product safety, diagnostics and bioterrorism events

The LLMDA can test for over 6,000 viruses and 15,000 bacteria as well as fungi and protozoa organisms. After DNA and/or RNA is extracted from a sample, it is applied to the LLMDA. Any probe that detects its specific sequence will fluoresce, and be read by a scanner. The raw data from the scanner is then analyzed **using algorithms developed by LLNL run on high performance computing (HPC) machines.**

Hughes Medical - Joe DeRisi: Solving medical mysteries (57)

Joseph DeRisi is a molecular biologist and biochemist. His lab is focused on the cause of malaria, and he`s also looked into SARS, avian flu and other new diseases as they crop up. DeRisi designed and programmed a groundbreaking tool for finding (and fighting) viruses -- the ViroChip, a DNA microarray that tests for the presence of all known viruses in one step.

DeRisi uses microarrays extensively in his work, and has designed and built both hardware and software for microarrays. He is a proponent of open access to microarray technology and maintains a website with software and protocols for microarray operations (58).

"From now on, I don’t think there is going to be any new viral epidemic that we will not be able to identify within a few days. It doesn’t mean you’ll find a cure right away. But you will be able to separate people who have it from those who don’t. You can stop it from spreading, if you have a diagnostic." Joseph DeRisi.

Joe DeRisi’s hypothesis is inspiring and his vision is at the heart of the writers vision of the Hoyle Shield.

3.6 Virus Chip Technology – Used Remotely

The use of Virus Chip technology, especially used remotely, might have immediate applicability in two of NASA most important projects :

- MARS 2019 Ice Breaker (6)
- MARS 2020 Curiosity (5) (59)

The 2020 Curiosity has an “open competition” for an experiment which would complement the planned experiments outlined in 2013.

NASA has already been urged to seek live Martians with 2020 rover. Lisa Grossman writes “We have the technology to look for microbes alive right now on Mars, and **failing to grab this opportunity is absurd”** (60).

One experiment that could be ready to fly in time for either of the above missions is the technology in development at MIT called the Search for Extraterrestrial Genomes (SETG) (55)although it is unclear if their solution involves the Virus Chip technology or if it is simply PCR. The writer is more excited by the potential of the ViroChip.

The writer support the following proposal : **that we should be doing DNA analysis on Mars rather than waiting for rocks to arrive back on Earth.**

Early versions of the Hoyle Shield Project would likely bring samples back down to the earth's surface for analysis by today's systems using PCR and ViroChip. The writer plans to encourage Milton Wainwright to include ViroChip testing in his future sample analysis from the stratosphere.

3.7 Vision of Hoyle Shield in 2025

But for this paper we would like to be allowed to share a bigger, longer term vision with the reader where the nanosensors do most of their detection in the stratosphere, communicating their results back to earth in real time.

In order to deliver this level of solution, there are two major issues. Can we process the samples aloft in a way which allows the ViroChip technology to then be able to do its identification? i.e. how do we grind the samples? Can we mount the required laser in the balloon?

Certainly if this can be achieved on Mars Ice Breaker 2019, then it augurs well for weight and size reduction processes, to be able to do this in a set of balloons in the stratosphere.

3.8 Use of Google LOON-like technology

Google is deploying a network of balloons in a Project they call LOON.

Project Loon is an R&D project by Google with the mission of providing Internet access to rural and remote areas. The project uses high-altitude balloons placed in the stratosphere at an altitude of about 20 km to create an aerial wireless network with up to 3G-like speeds.

Google plans on sending up 300 balloons around the world at the 40th parallel south that would provide coverage to New Zealand, Australia, Chile, and Argentina. Google hopes to eventually have thousands of balloons flying in the stratosphere.

The writer suggests that this "platform", with its existing operational processes including 3-6 month balloon replacement; and with its sophisticated high speed data communication system; might be an ideal platform for the Hoyle Shield of 2025.

The Hoyle Shield nano-sensor subsystem would be mounted on each LOON balloon and would interface to the existing Google electronic device controlling each balloon.

Data would be directed to the HOYLE SHIELD Control Centre.

The HOYLE SHIELD Control Centre.

3.9 The HOYLE SHIELD Control Centre

Data from all balloons would stream down in a real time to a HOYLE SHIELD Control Room likely located at the United States Centers for Disease Control and Prevention in Atlanta, Georgia, USA and perhaps to a second centre under the United Nations or European funding.

The “back-end” system is likely to include super-computer data analysis tools which will process the virochip data from thousands of ViroChip sensors in real-time, doing sophisticated pattern recognition and collating results from around the Hoyle Shield. A prototype of this software has already been developed by Joe DeRisi.

The evolution of this software has unlimited capability and promise, including bringing data streams from labs and hospitals world-wide so the Hoyle Shield becomes an umbrella monitoring system not just for the stratosphere, but for earth surface and even much remoter locations like space stations and bases on other planets and moons..

4. CONCLUSIONS

The writer hopes the reader has enjoyed this paper and that just one reader has the vision and power to initiate the next phase. Perhaps a prototype project between Hughes Medical, Lawrence Livermore and Google. I conclude with three questions ;

1. Is it possible the International Astronomical Union (IAU) will bend its policy, and agree that the first confirmed earth-like planet around a sun-like star, should be called “Borucki”?

2. Is it possible the next generation of scientists will be encouraged to have the vision to hypothesize revolutionary ideas in science - as Karl Popper would say – “this is critical for scientific progress”? We need to eliminate the term “fringe science” from our lexicon. Hypotheses on Cold Fusion, Cold Dark Matter Theory, Black Hole Theory, formation of Earth 4.5 billion years ago, missing hydrogen as Dark Matter, inflation theory and even the nature of Consciousness should be acceptable, funded hypotheses. BUT the scientists making these claims must accept their responsibility to develop propositions against which the hypotheses can be tested. And then to deliver experiments and evidence. Remember Karl Popper asked each scientist not to cling to their own theories but to try to “disprove” their theories. Hard to do?

3. Will the Hoyle Shield come to pass? In the final analysis, if someone eventually disproves the notion that pathogens come from space, the Hoyle Shield still makes sense to manage global virus detection from hospitals world-wide (and later from hospitals on other planets, moons, and space vehicles). It could well be that viruses and bacteria are the most successful life-forms in the universe. Good job for us that they seem to be in a relentless battle. Managing our knowledge and information on their movement and evolution could be important.

Acknowledgements

I am deeply grateful for the guidance and support of Professor Chandra Wickramasinghe.

Wickramasinghe’s influence is global. His nearly 300 published scientific papers (over 70 in the highest impact journal Nature) and 31 books are a veritable catalog of the evolution of the emerging science of astrobiology, and of his undisputed role in this area.

In a paper written in 2004 he estimated there were 100 billion (10^{11}) earth-like exoplanets. This was before the Kepler Mission. At that time only 50 exoplanets were known – i.e. Wickramasinghe predicted that number when mainstream science believed the earth was unique. And now in June 2013, NASA updated their estimates and announced there are likely 144 billion (10^{11}) earth-like exoplanets. Quite astounding how Chandra had come to the same number through theoretical physics and mathematics so many years earlier. Yet another hypothesis proven visionary and eventually accepted as “mainstream”.

And now, this summer 2013, NASA announce that they are starting to move their focus from “Search for Water” to “Search for Life”. This paradigm shift towards Chandra’s theory that “Life is a Cosmic Phenomenon” is recognition that “extraterrestrial life” is now statistically likely – and now acceptable science. This is the moment that Panspermia moves from “fringe science” to “mainstream science”.

And to my teacher Sir Herman Bondi who said, after asking how old the “relativity class” was at Kings College in 1967, and hearing the response “18 Sir”, replied “***too bad, you are far too old to understand this subject***”.

“***Sometimes I am a little unkind to all my many friends in education ... by saying that from the time it learns to talk every child makes a dreadful nuisance of itself by asking 'Why?'. To stop this nuisance society has invented a marvellous system called education which, for the majority of people, brings to an end their desire to ask that question. The few failures of this system are known as scientists***”. — Sir Hermann Bondi - 'The Making of a Scientist', Journal of the Royal Society of Arts, June 1983, 403.

He told a story that today’s airplane travelling generation might not really appreciate. A train in a station – likely somewhere in Northern Italy, like Milan. A vision of a beautiful young woman in a carriage in a coach opposite – so close but so far. She smiles at him. The woman’s carriage starts to pull away and he stretches to see her depart. But then he realizes it is his train that is moving. This is the moment he starts to understand relativity. What if the train was travelling at the speed of light? Yes a 12 year old could understand these questions, and certainly I, aged 18, could.

5. REFERENCES

1. Thornton S. "Karl Popper". Stanford; 2013 [cited 2013 08 18. Available from: http://plato.stanford.edu/archives/spr2013/entries/popper/.
2. space.com. 17 Billion Earth-sized Alien Planets Inhabit Milky Way.; 2013.
3. Kopparapu RK. HABITABLE ZONES AROUND MAIN-SEQUENCE STARS: NEW ESTIMATES. The Astrophysical Journal. 2013; 765(2).
4. Barlow W. Darwin 4. [Online].; 2008 [cited 2013 08 16. Available from: http://youtu.be/K4plJ8ZJ3ok.
5. Matson J. Mission: Risk-Averse - Planetary exploration is stuck in a Martian rut. Scientific American. 2013 Feb: p. 19.
6. Astrobiology Magazine. Mars Icebreaker Life Mission.; 2013 [cited 2013 08 16. Available from: http://www.astrobio.net/exclusive/5476/mars-icebreaker-life-mission.
7. Weaver WB. Science Buddies. [Online].; 2003 [cited 2013 Aug 16. Available from: http://www.sciencebuddies.org/science-fair-projects/project_learn_more_weaver.shtml.
8. Popper K. Normal Science and its Dangers. In Criticism and the Growth of Knowledge: Volume 4:.
9. Secker J, Wesson P, Lepock JR. Astrophysical and Biological Constraints on Radiopanspermia. Pullman, WA 99164-3113 USA: Washington State University, Program in Astronomy; 1994.
10. Hoyle F, Wickramasinghe C. Comets - a Vehicle for Panspermia. In Ponnamperuma C. Comets and the Origin of Life. Dordrecht: D. Reidel Publishing Co.; 1981. p. 227.
11. Wallis M.K. WNC. Interstellar Transfer of Planetary Microbiota. Mon. Not.R. Astr.Soc. 2004; 348: p. 52-57.
12. F. Hoyle CW. Living Comets Cardiff, Wales: University College Cardiff Press; 1985.
13. Napier WM. A Mechanism for Interstellar Panspermia. Mon. Not.R. astr. Soc. 2004;(348): p. 46-51.
14. Wickramasinghe C. Viva Panspermia. The Observatory. 2011 June.
15. Wesson P. Panspermia, Past and Present: Astrophysical and Biophysical Conditions for the Dissemination of Life in Space. Sp. Sci.Rev. 2010; 156(1-4): p. 239-252.
16. Hoyle F, Wickramasinghe C. Evolution from Space London: J.M. Dent & Sons; 1981.
17. Hoyle F, Wickramasinghe C. Proof that Life is Cosmic. Mem.Inst. Fund. Studies Sri Lanka. 1982; 1.
18. Hoyle F, Wickramasinghe C. The Case for Life as a Cosmic Phenomenon. Nature. 1986; 322(509).
19. Hoyle F, Wickramasinghe C. Diseases from Space London: J.M. Dent & Sons; 1979.
20. Ohishi M. Search for Large Molecules and Spectral Line Surveys. In S. Komonjinda YYKaDR, editor. NARIT Conference Series, Vol. 1,; 2011.
21. Wikipedia - Icebreaker Life. [Online].; 2013 [cited 2013 08 21. Available from: http://en.wikipedia.org/wiki/Icebreaker_Life.
22. Lin LHea. Long-Term sustainability of a high-energy, low-diversity crustal biome. Science. 2006; 314: p. 479-482.
23. Canadian Broadcasting Corp. CBC News. [Online].; 2013 [cited 2013 05 15. Available from: http://www.cbc.ca/news/technology/story/2013/05/15/science-oldest-flowing-water-timmins-mine.html.
24. Price PB, Sowers T. Temperature dependence of metabolic rates for microbial growth, maintenance, and survival. Proceedings of the National Academy of Sciences of the United States of America. 2004 March; 101(13): p. 4631-4636.
25. Anderson RE, Brazelton WJ, Baross JA. Is the Genetic Landscape of the Deep Subsurface Biosphere Affected by Viruses? Front Microbiol. 2011; 2(219).
26. al Re. Science. .
27. al Me. Proceedings of the National Academy of Sciences. .
28. Smith DJ, Griffin DW, Schuerger AC. Stratoshperic microbiology at 20 km over the Pacific Ocena. Aerobiologia. 2010; 26: p. 35-46.

29. Yang Y, Yokobori Si, Yamagishi A. Assessing Panspermia Hypothesis by Microorganisms Collected from the High Altitude Atmosphere. Biological Sciences in Space. 2009; 23(3): p. 151-163.
30. Wainwright M, Rose CE, Baker AJ, Briston KJ, Wickramasinghe NC. ISOLATION OF A DIATOM FRUSTULE FRAGMENT FROM THE LOWER STRATOSPHERE (22-27Km)-EVIDENCE FOR A COSMIC ORIGIN. Journal of Cosmology. 2013 August; 22: p. 1063-1068.
31. Kasten F. Falling speed of aerosol particles. J. Appl. Meteorol. 1968; 7: p. 944-947.
32. de Vera JPP, Schulze-Makuch D, Khan A, Lorek A, Koncz A, Mohlmann D, et al. The adaptation potential of extremophiles to Martian surface conditions and its implication for the habitability of Mars. Geophysical Research Abstracts. 2012 April; 14(EGU2012-2113).
33. Frippiat JP. Contribution of the urodele amphibian Pleurodeles waltl to the analysis of spaceflight-associated immune system deregulation. Molecular Immunology. 2013; 56(4): p. 434-441.
34. The Meteoritical Society. The Meteoritical Society. [Online].; 2013 [cited 2013 08 20. Available from: http://www.lpi.usra.edu/meteor/metbull.php.
35. McKay DS, Kathie L. Thomas-Keprta, , Gibson EK. Search for Past Life on Mars: Possible Relic Biogenic Activity in Martian Meteorite ALH84001. Science. 1996 Aug 16; 273(5277): p. 924-930.
36. Hoover RB. Fossilized Life Forms in the Muchinson Meteorite. ; 1997.
37. Hoover RB. Microfossils of Cyanobacteria in the Orgueil Carbonaceous Meteorite. NASA; 2007.
38. Hoover RB. Fossils of Cyanobacteria in CI1 Carbonaceous Meteorites : Implications to Life on Comets, Europa and Enceladus. Journal of Cosmology. 2011; 13.
39. Wallis J, Miyake N, Hoover RB, Oldroyd A, Wallis DH, Samaranayake A, et al. The Polonnaruwa Meteorite - Oxygen Isotope, Crystallline and Biological Composition. Journal of Cosmology. 2013 March; 22(2).
40. Hoyle F. Living Comets Cardiff: University College, Cardiff Press; 1985.
41. Wickramasinghe NC. Journey With Fred Hoyle: The Search For Cosmic Life: World Scientific Pub Co Inc (February 10, 2007); 2007.
42. Hoyle F, Wickramasinghe NC. Some predictions on the nature of Comet Halley. In Hoyle F, Wickramasinghe NC. Earth, Moon and Planets.: University College, Cardiff, Wales; 1986. p. 289-293.
43. Clarke AC. Beyond 2001.; 2001 [cited 2013 08 21. Available from: http://www.arthurcclarke.net/?scifi=3.
44. Nakamura et al E. Space environment of an asteroid preserved on micrograins returned by the Hayabusa spacecraft. Proceedings of the National Academy of Sciences of the United States of America. 2012 Mar; 109(11).
45. McSween H. A new type of chondritic meteorite found in lunar soil. Earth and Planetary Science Letters. 1976 July; 31(2).
46. Rubin AE. The Hadley Rille enstatite chondrite and its agglutinate-like rim: Impact melting during accretion to the Moon. Meteoritics and Planetary Science. 1997 Jan; 32(1): p. 135-141.
47. Chappelow JE, Sharpton VL. The event that produced heat shield rock and its implications for the Martian atmosphere. Geophysical Research Letters. 2006 Oct; 33(19).
48. Schroeder et al C. Meteorites on Mars observed with the Mars Exploration Rovers. Journal of Geophysical Research: Planets (1991–2012). 2008 June; 113(E6).
49. Ohishi M. Search for Large Molecules and Spectral Line Surveys. In The 11th Asian-Pacific Regional IAU Meeting 2011; 2013: NARIT Conference Series.
50. The International Committee on Taxonomy of Viruses. Virus Taxonomy, 1st Edition. 1st ed. King A, Lefkowitz , Adams , Carstens , editors.; 2011.
51. Hoyle F. Viruses from Space Cardiff: University College Cardiff Press (March 1986); 1986.
52. Clarke AC. V2 for Ionosphere Research? Wireless World. 1945 February: p. 1.
53. Joseph R, Wickramasinghe C. Comets and Contagion: Evolution and Diseases From Space. Journal of Cosmology. 2010 May; 7: p. 1750-1770.
54. Chiu CY. Viral pathogen discovery. Current Opinion in Microbiology. 2013 August; 16(4).

55. Massachusetts Institute of Technology (MIT). SETG - The Search for Extra-Terrestrial Genomes. [Online].; 2013 [cited 2013 08 24. Available from: http://web.mit.edu/setg/SETG/Mainpage.html.

56. Simoes, et al EAF. Pathogen Chip for Respiratory Tract Infections. Journal of Clinical Microbiology. 2013 January; 51(3): p. 945-953.

57. DeRisi J. Joe DeRisi: Solving medical mysteries. 2006..

58. DeRisi J. microarrays.org. [Online].; 2013 [cited 2013 08 24. Available from: http://derisilab.ucsf.edu/microarray/index.html.

59. NASA - Mars Exploration Program. MARS 2020 Mission Plans. [Online].; 2013 [cited 2013 08 24. Available from: http://mars.nasa.gov/programmissions/missions/future/m2020/.

60. Grossman L. NASA urged to seek live Martians with 2020 rover. New Scientist. 2013 July 20: p. 9.

61. Wickramasinghe C. Astrobiology, Comets And the Origin of Life: World Scientific Publishing Company (August 31, 2009); 2009.

62. THE PUBLICLY AVAILABLE PREBIOTIC INTERSTELLAR MOLECULAR SURVEY (PRIMOS): EXPANDING SPECTROSCOPIC CHARACTERIZATIONS, EXTENDING TO NEW SOURCES, AND ADDING TO THE KNOWN MOLECULAR INVENTORY. [Online].; 2013 [cited 2013 08 21.

63. Hisayoshi Yurimoto KiAMAMEAFMHKHTRISIJKCKJKNKFKSK. Oxygen Isotopic Compositions of Asteroidal Materials Returned from Itokawa by the Hayabusa Mission. Science. 2011 Aug; 333(6046): p. 1116-1119.