

Living Proto-Cells Made in Space

By Peter Fotis Kapnistos (copyright 2008)

In early 2001, scientists at NASA Ames Research Center in California's Silicon Valley reported a breakthrough discovery that had major implications for future astrobiology missions. Duplicating the harsh conditions of cold interstellar space in their laboratory, they produced "membranous structures" that mimic primitive cells found in all living things.

Using simple, everyday chemicals, researchers from Ames' Astrochemistry Laboratory and the Department of Chemistry and Biochemistry at the University of California, Santa Cruz, created, for the first time, so-called "proto-cells."

Although not alive, they were similar to the membranous structures found in all life forms. In a key report published in *Proceedings of the National Academy of Sciences*, the NASA scientists explained how they had recreated the cold vacuum conditions found in space, irradiating a series of simple ices with the ultraviolet radiation found everywhere. They created solid materials or "*amphiphiles*," which, when immersed in water, spontaneously produced bubbles of membranous soap-like structures that had internal and external layers.

Scientists could not yet prove whether life began as naked RNA or as genetic material encapsulated in membranes. But at some point, membranes became very important.

By the mid-1990s, Membrane or *M-Theory* had gradually grown into a new mathematical construct of theoretical physics. In *String Theory*, a membrane (or "brane") is a spatially extended mathematical concept of higher dimensional objects. String theory uses one-dimensional extended objects (*filaments*) called "strings" instead of point particles. A membrane is a matrix or "container of strings" wrapped on various cycles.

"All life as we know it on Earth uses membrane structures to separate and protect the chemistry involved in the life process from the outside," said Dr. Jason Dworkin of the SETI Institute, the paper's lead author and a team member. "All known biology uses membranes to capture and generate cellular energy."

The Ames research scientists claimed that the molecules needed to make a cell's membrane are found all over space. The transfer by comets, meteorites, and interplanetary dust of corresponding organic compounds from interstellar space could have started life on Earth.

In contrast to current thinking, this new work showed that the early chemical steps considered vital for the origin of life do not require an already-formed planet with warm ponds. Instead, the chemical sequences seem to take place in deep space long before planet formation occurs.

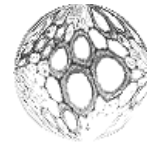
"This discovery implies that life could be everywhere in the universe," said Dr. Louis Allamandola, the Astrochemistry Laboratory group leader. "This process happens all the time in the dense molecular clouds of space."¹

"The formation of these biologically interesting compounds by irradiating simple interstellar ices shows that some of the organics falling to Earth in meteorites and interplanetary dust might have been born in the coldest regions of interstellar space," Allamandola said. "The delivery of these compounds could well have been critical to the origin of life on Earth."

In the spring of 2001, the BBC News acknowledged that comets might have seeded life on Earth. More than seventy varieties of amino acids had already been found in meteorites and some in interstellar dust and gas clouds. This was the beginning of a new field of science.

By simulating a high-velocity comet collision with the Earth, a team of scientists showed that organic molecules hitch-hiking aboard a comet could have survived an impact and seeded life on Earth.

Jennifer Blank of the University of California, Berkeley, and her colleagues shot a can-sized bullet on to a coin-sized metal target containing a droplet of water mixed with amino acids, the building blocks of proteins. The test was designed to simulate the type of impact that would have been frequent during Earth's early history, some four billion years ago, when rocky, icy debris in our Solar system accumulated to form planets.



¹ "Scientists Find Clues That Life Began in Deep Space." *SPACEDAILY.COM*. Jan. 29, 2001.

It was observed that not only did a good fraction of the amino acids survive the collision; many had been polymerized into chains of two, three and four amino acids, so-called “peptides,” the first stage of building proteins. What’s more, freezing the target to mimic an icy comet actually increased the survival rate of the amino acids.

“This impact scenario provides the three ingredients believed necessary for life: liquid water, organic material, and energy,” she told the BBC, and indicated that her work was only the beginning of a new field of science.²

In 2001, researchers from the University of Naples reported they found “live” extraterrestrial bacteria inside a meteorite. Geologist Bruno D’Argenio and molecular biologist Giuseppe Geraci claimed the bacteria were jammed inside the crystal structure of minerals, but were revived when a sample of the rock was placed in a culture medium. They said the bacteria were not terrestrial and that their DNA is unlike any on Earth.³

After a heated debate, they presented a report on May 11, 2001, identifying it as the first evidence of extraterrestrial life documented in its genetic and morphological properties. Some of the bacteria they discovered were inside meteorites estimated to be over 4.5 billion years old, and were determined to be related to modern *Bacillus subtilis* and *Bacillus pumilus* bacteria on Earth, but appeared to be a different strain.

In 2004, scientists from Cardiff University revealed that if comets hitting the Earth could cause ecological disasters, including extinctions of species and climate change, they could also disperse Earth-life to the most distant parts of the Galaxy.

Professor Chandra Wickramasinghe and Dr Max Wallis, of the Cardiff Centre for Astrobiology, and Professor Bill Napier, an astronomer at Armagh Observatory, discussed these ideas in two papers to the Royal Astronomical Society. They said the “splash-back” from a large comet impact could throw material containing micro-organisms out of the planet’s atmosphere, strengthening the “panspermia” hypothesis that Professor Wickramasinghe and Fred Hoyle had been refining since 1974.

It was known that when comets impact the Earth, boulders and organic debris might be thrown from the Earth into space. Professor Napier found that collisions with interplanetary dust would erode the ejected boulders into smaller bits and that these tiny, life-bearing fragments could be driven out of the solar system by the pressure of sunlight in a few years.

The solar system could, therefore, be surrounded by an expanding ‘biodisc,’ 30 or more light years across, of dormant microbes preserved inside tiny rock fragments. In the course of Earth history there may have been a few dozen close encounters with star-forming nebulae, during which microbes might be injected directly into young planetary systems.

If planets capable of sustaining life are sufficiently common in the Galaxy, the Cardiff based scientists conclude that this mechanism could have infected over 10,000 million of them during the lifetime of our Galaxy.⁴

Dr Wallis and Professor Wickramasinghe identified another possible delivery method. They pointed out that fertile Earth ejecta on impact would bury themselves in the radiation-shielded surface layers of icy comets. A band of such comets, the Edgeworth-Kuiper belt, is located beyond the planetary system. This belt slowly leaks comets into interstellar space, some of which will ultimately reach proto-planetary discs and star forming nebulae. There they are broken up by collisions and erosion, releasing trapped micro-organisms and seeding the emergent planetary systems.



By putting forward the theory of an expanding “BioDisc,” Napier, Wallis, and Wickramasinghe also framed a setting that allows life to be expressed in the same way as a “conservation law.” The loss of organic material leaking out of the BioDisc due to planetary seeding is kept in relative equilibrium with the capture of micro-organisms returning back to the BioDisc from rock structures and fertile fragments ejected into space.

² David Whitehouse, “Comets could have seeded life on Earth.” *BBC News*. April 5, 2001.

³ Debora MacKenzie, “Are they aliens or just humble earthlings?” *New Scientist*. May 19, 2001.

⁴ “Comets spread Earth-life around galaxy, say scientists.” *Cardiff University*. Feb 11, 2004.

A buildup and dispersal mechanism to circulate a steady amount of organic material throughout the BioDisc could be analogous to a macro-metabolic process. Vast regions of corresponding BioDisc clusters in grids that interconnect adjacent galaxies could conceivably preserve a fixed organic balance all over the Universe. Such a cosmic recycling route or transmigration of organic molecules implies Conservation of Biosynthesis:

Like mass and energy, the total sum of life in the Universe cannot be created or destroyed. It can only be changed from one form to another.

The Earth's *biosphere* supposedly is a large-scale ecological system or zone of the planet where life's cycles arise. But every year, "thousands of tons" of cometary dust, organic debris and larger fragments fall to Earth from outer space.⁵ Beginning in the late 1960s, US military intelligence monitored and photographed comets and other objects exploding in the upper atmosphere "as big as thirty to fifty meters in diameter." Close to a hundred and fifty such comet-like objects were detected from 1975 to 1992, about eight per year. That information was kept classified until 1993-1994. When life on Earth first emerged four billion years ago, the number of comets approaching the Sun was hundreds or thousands of times greater than it is today. Therefore, if fertile BioDiscs do encircle typical star systems, they are perhaps the closest residues between stars, and can swap organic molecules by means of incoming and outgoing comets. Consequently, an even larger grid of BioDisc groups might be clustered throughout the entire Galaxy.

In 1994, computer scientist Len Adleman of the University of Southern California showed that DNA could be used to solve a mathematical problem. It was the first known instance of the successful use of DNA to compute an "algorithm." Several scientists predicted that computing with the molecular structure of genes could sooner or later take the place of silicon-based machines.

Using nanotechnology in 2001, computer scientists in Israel developed the world's first biological computer. Ehud Shapiro, research director at the Weizmann Institute of Science, invented a simple mathematical computing machine. It used two naturally occurring enzymes that manipulated DNA as its hardware. The biological computer was so small that billions could fit in a drop of water.⁶



In 2003, information technologists led by Pak Chung Wong, of the Pacific Northwest National Laboratory in Washington State, showed that a message encoded as artificial DNA can be stored within the genomes of multiplying bacteria and then accurately retrieved.

The scientists took the words of the song *It's a Small World* and translated it into a code based on the four "letters" of DNA. They then created artificial DNA strands recording different parts of the song. These DNA messages, each about 150 bases long, were inserted into bacteria such as *E. coli* and *Deinococcus radiodurans*. The beginning and end of each inserted message had special DNA tags devised by the scientists. These "sentinels" stopped the bacteria from identifying the message as an invading virus and destroying it, according to Wong.

"The magic of the sentinel is that it protects the information, so that even after a hundred bacterial generations we were able to retrieve the exact message," said Wong. "Once the DNA message is in bacteria, it is protected and can survive." And as a milliliter of liquid can contain up to a billion bacteria, the potential capacity of such a memory system is enormous.⁷

In 2007, microbes were modified for data storage with a technique developed at Keio University Institute for Advanced Biosciences and Keio University Shonan Fujisawa Campus. Artificial DNA with encoded information was added to the genome of common bacteria, thus preserving the data. According to researchers, up to 100 bits of data can be attached to each organism. The scientists successfully encoded and attached the phrase "e=mc² 1905" to the DNA of *bacillus subtilis*, a common soil bacteria.⁸

The bacillus itself creates new copies of the data every time it reproduces itself, thus making it an ideal archival storage system. *Bacillus subtilis* also creates extra copies of the data (multiple backup copies), inserting it in different places in its genome, further safeguarding the data.

In 2008, a research team from the biology and the mathematics departments of Davidson College, North Carolina and Missouri Western State University, added genes to *E. coli* bacteria, creating bacterial computers able to crack a standard mathematical puzzle.

⁵ William J. Broad, "Earth is Target for Space Rocks at Higher Rate than Thought," *The New York Times*. January 7, 1997.

⁶ Tim McDonald, "Nanotech: A Billion Computers in a Drop of Water." *NewsFactor Network*. December 5, 2001.

⁷ Natasha McDowell, "Data stored in multiplying bacteria." *NewScientist.com*. Jan 8, 2003.

⁸ Bill Christensen, "New Technique Stores Data in Bacteria." *Live Science*. March 10, 2007.

By genetically altering bacteria, the US researchers created living computers to solve a classic puzzle known as the burnt pancake problem. (The aim is to stack pancakes properly in the fewest number of flips.) The findings of the study confirmed that computing in living cells is feasible. It would shape a number of applications including data storage and genetic engineering.

“The system offers several potential advantages over conventional computers,” said lead researcher, Karmella Haynes. “A single flask can hold billions of bacteria, each of which could potentially contain several copies of the DNA used for computing. These ‘bacterial computers’ could act in parallel with each other, meaning that solutions could potentially be reached quicker than with conventional computers, using less space and at a lower cost.” In addition to parallelism, bacterial computing also has the potential to utilize repair mechanisms and, of course, can evolve after repeated use.⁹

How much data can be stored in an expanding BioDisc of dormant microbes many light years across? For such an outsized system to detect and respond to complex conditions, a variety of different molecules would have to be used as signals.

Could a BioDisc use natural markers to instruct microbes in corresponding loops to “write,” “read” and modify chemical messages between them? Could it breed self-organization?

The signal-processing procedures of writing and erasing cellular information are “enzymatic functions” that would make available a wide range of communication possibilities between dormant microbes in a natural BioDisc.

Some scientists at present directly wonder if carbonaceous life could have been invented by a non-carbonaceous “intelligence.” They reflect on the properties of silicon as opposed to ordinary carbon chemistry.

Hoyle and Wickramashinghe once noted, “For swift calculation, and perhaps for thinking too, a siliceous form of life could be greatly our superior.”¹⁰ On the other hand, the originally shapeless lifecloud of moderns panspermia theory gradually accumulated into the structure of an expanding BioDisc with a diameter of many light years, formed by the pressure of sunlight driving out myriad grains of life-bearing microbes into space.

In view of the fact that modern science is currently able to create living bacterial computers that will potentially be much faster and more secure than conventional computers, a fertile BioDisc surrounding our solar system could be conceived of as a “living supercomputer” and the natural storage disc of life’s genetic database.

In the 1960s, a small number of software engineers developed the idea that the Universe runs on a grid of “cellular automata” and stirred up feelings of God commanding the ultimate biological supercomputer.¹¹ **If a higher level of intelligence does in fact control the laws of nature, it would perhaps not be feasible for it to shape carbonaceous life without an immense amount of calculation.**

An expanding BioDisc could also function as a microbial fuel cell. In 2008, Bruce Rittman, director of Arizona State University’s Bionodesign Institute, found a way to use bacteria to make electricity.¹² Since discarded biomass contains stored energy, Rittman’s bacteria experiments successfully converted the energy value to electricity. A BioDisc might similarly generate electrical energy using its organic fuels. An electrified fluid that carries ions and electrons is a “plasma” or ionized gas. According to information theory, *plasma particle codes* can give the best computing performance.

In 2005, Dr. Ehud Keinan of Israel and a team of associates developed a biological computer composed entirely of DNA molecules and enzymes built on a “gold-coated chip.” A noted member of Keinan’s team was Professor Ehud Shapiro, who announced the newest version of his original biomolecular computer, which was 50 times faster than its predecessor. It could read DNA as data and also used it for fuel.¹³

Massively parallel processing within a natural BioDisc would depend on the coordinated performance of microbes, based on the transfer of genetic material from one bacterium to another. It would involve quantities of DNA well beyond our Earthly capacity, undergoing chemical reactions in parallel and solving problems so complex as to stupefy conventional computers.

In 1981, the bio-organic chemist Anatol Eberhard referred to bacterial communication systems as “quorum sensing.” The bioluminescence bacterium *Vibrio fischeri* was discovered to glow only when large

⁹ “New Meaning For The Term ‘Computer Bug’: Genetically Altered Bacteria For Data Storage.” *ScienceDaily*. May 21, 2008.

¹⁰ Hoyle, F. & Wickramashinghe, C. *Evolution from Space* (1981).

¹¹ Kevin Kelly, “God Is the Machine.” *Wired*. Dec. 2002.

¹² “Bacteria used to power fuel cell.” *UPI*. Jan. 4, 2008.

¹³ “Technion Scientists Develop Biological Computer on Chip.” *Technion*. Oct. 27, 2005.

numbers of the organism were present. Eberhard found that the accumulation of signalling molecules enable a lone cell to sense the “cell density” or number of bacteria in its own colony. He thought that an undiscovered activator molecule or “autoinducer” was the hidden cause. In the 1990s, Gordon Stewart, a young molecular biologist from the University of Nottingham, engineered bacteria to emit light and arrived at one of the most valuable discoveries in microbiology. He found that bacterial cells “talk” to each other using small diffusible signalling molecules. Stewart determined that microbes communicate with one another by releasing and sensing chemicals called “pheromones.”

This is the basis of quorum sensing.¹⁴ It enables bacteria to regulate gene expression in a population-dependent manner. According to a BBC report, scientists established that microbes are not deaf, dumb, and blind, but perfectly capable of communicating with one another:

Alternatively, there are some microbes that have “realized” that they would get things done more efficiently if they were to work with one another, than if they were to work alone. These microbes co-ordinate themselves so that they carry out certain activities only when there are enough organisms to operate.

Not only are microbes able to tell each other where they are and co-ordinate their survival, they can even call out to each other for the purpose of “congregating.” In other words, migrating cells can track down one another. Isolated cells of *Dictyostelium discoideum*, for example, live independently of each other but can also aggregate or clump together to form a larger self-directed body:

If you were trying to get everybody together, the obvious thing for you to do would be to tell those people in which direction they should move to get to you, or the increasingly big group you are gathering. Dictyostelium does this by briefly secreting a pheromone called cyclic AMP (cAMP). Any other members of its species that happen to be around to catch this signal will fire off a bolt of cAMP in response, and simultaneously produce pseudopodia on the side closest to the source, taking one step in that direction. Detection of this second wave will result in the secretion of a third wave of cAMP accompanied by another step in the direction of the source of the pheromone, and so on.¹⁵

Quorum sensing can function as a decision-making process. The “swarm mentality” of various populations, which individually are rather simple and unaware, can perform cooperatively without leadership to make complicated choices that turn out to be best for the population on the whole. Scientists describe such a system as “self-organizing.”

Complex behavior may be coordinated by relatively simple interactions. Quorum sensing can occur within a single bacterial species as well as between diverse species, and can regulate a multitude of different processes, fundamentally serving as a communication network.

In 2006, Yuichi Hiratsuka and his colleagues used a species of bacteria called *Mycoplasma mobile* to push the rotor in the first motor powered by bacteria.

A new motor designed by scientists from Japan offers the best of both worlds: the living and the non-living. The group built a hybrid micromachine that is powered by gliding bacteria which travels on an inorganic silicon track and pushes a silicon dioxide rotor. The combination takes advantage of the precise engineering of synthetic devices along with the efficient energy conversion and potential for self-repair of biological systems.¹⁶

The *Mycoplasma* bacteria moved through the entrance of circular tracks in a little device that allowed the bacteria to clump together and push rotors. Once the bacteria reached the circular tracks, the rotors began to move at speeds of up to 2.6 revolutions per minute. The scientists estimated that only a few cells are needed to drive motion.

Mycoplasma is just one example of micro-organisms with interesting and potentially useful properties, according to Hiratsuka. *Chlamydomonas* swim toward light (phototaxis), and *Dictyostelium* amoeba crawl toward a specific chemical substance (chemotaxis). Hiratsuka said micro-robots driven by biological motors could move around and do mechanical work in the micrometer world.

The work of scientists Uenoyama and Miyata gave details of *Mycoplasma* “ghosts,” which are not alive due to partial membrane dissolution, but still demonstrate gliding movements. Consequently, even dormant microbes in space could possibly supply micro-mechanical power. As a reliable website once observed, “microbes were the first to invent rotary motion.”

¹⁴ A *quorum* is a minimum number of members needed to constitute a meeting.

¹⁵ “Small Talk in the Microbial World.” *BBC*. June 13, 2003.

¹⁶ Lisa Zyga, “New motor first to be powered by living bacteria.” *PhysOrg.com*. Oct. 12, 2006.

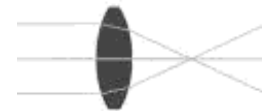
In 2005, researchers at the University of California, San Francisco and the University of Texas announced in the journal *Nature* that they had created “photographs” of themselves by programming *E. coli* bacteria to make pictures in much the same way film produces images.

Chris Voigt was the senior author of the bacteria-as-film report. It was the result of an attempt in synthetic biology to create a genetically engineered cell that lays dormant until a laser is shined on it.

Voigt and colleagues took from algae light-sensitive genes that emit black compounds and spliced them into a batch of *E. coli* bacteria. The organisms were then spread on a petri dish that resembles a cookie sheet and placed in an incubator. A high-powered projector cast photographic images of the researchers through a hole on top of the incubator, exposing some of the bacteria to light.

The result: Ghostly images like traditional black-and-white photographs of the researchers responsible for the invention, at a resolution Voigt said was about 100 megapixels, or 10 times sharper than high-end printers.¹⁷

Synthetic biologists trying to create complex systems that function like computers discovered that bacteria can act as photographic film, producing a visual image. In this respect, the possible storage of data on a natural BioDisc could prove to be relevant to the fine-tuning of *gravitational lensing*. A gravitational lens is formed when the light from a distant, bright source is “bent” around a massive object. According to general relativity, mass warps space-time to create gravitational fields and bends light as a result. This theory was confirmed in 1919 during a solar eclipse, when Arthur Eddington noticed that the light from stars passing close to the Sun was slightly bent, and the stars appeared somewhat out of position. Albert Einstein realized that astronomical objects could also bend light and that under the correct conditions we should observe multiple images of a single source, called a gravitational lens or sometimes a “gravitational mirage.” In 1937, Fritz Zwicky calculated the set of circumstances where a galaxy could act as a lens. Dennis Walsh, Bob Carswell, and Ray Weymann accidentally discovered the first gravitational lens in 1979 using the Kitt Peak National Observatory telescope. It became known as the “Twin Quasar” because it gave the impression of two identical quasars. In 2003, Craig Wiegert of the University of Chicago’s Enrico Fermi Institute explored the possibility that quasars are “gravitationally microlensed.” He wanted to discover if a gravitational lens system could allow the Universe to imitate a telescope:



Microlensing can be considered a variant of strong lensing, in which the gravitational deflection due to a compact object produces multiple images of a background source that are too close to be resolved, yielding effectively a single magnified image.¹⁸

In 2008, Physicists Tommaso Treu and Raphael Gavazzi of the University of California, Santa Barbara made an impressive astronomical discovery — a form of gravitational lensing called a “double Einstein ring.” This phenomenon had never been observed before.

The discovery was made using the Hubble Space Telescope and the Sloan Lens Advanced Camera for Surveys program.¹⁹ NASA’s Hubble Space Telescope revealed a pair of glowing rings, one nestled inside the other like a bull’s-eye pattern. The double-ring pattern is caused by the complex bending of light from two distant galaxies strung directly behind a foreground massive galaxy, like three beads on a string.

At first glance, gravitational lenses were compared to rather odd telescopes or potential tools for observing the stars. But at present there is fresh interest. Unlike an optical (e.g. glass) lens, maximum bending occurs closest to the center of a gravitational lens. Minimum bending occurs furthest from it. Consequently, a gravitational lens has no single focal point, but a “focal line” instead. Some of the light rays escaping from the solar system in a straight line could thus be deflected at the solar wind shock front (or tidal radius). At the locality of that focal line, a background source in alignment would be projected as a ring (referred to as an Einstein ring), or as multiple images.

As a result, the possibility may well exist that gravitational lenses can also be strong “projectors” capable of casting information over huge chemical surfaces along focal lines, while illuminating interstellar ice grains to produce amino acids.



¹⁷ Paul Elias, “Bacteria Used as Photo Film.” *Associated Press*. Nov. 24, 2005.

¹⁸ Craig C. Wiegert, “Constraining Compact Dark Matter with Quasar Equivalent Widths from the Sloan Digital Sky Survey Early Data Release.” July 28, 2003.

¹⁹ “Hubble Finds Double Einstein Ring.” *ScienceDaily*. Jan. 12, 2008.

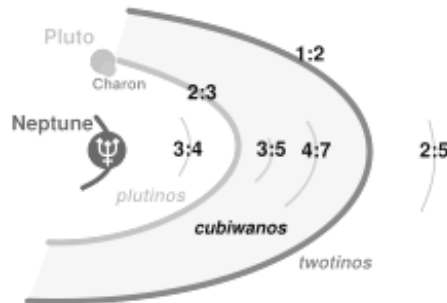
If gravitational lensing can render “mirage” descriptions on a BioDisc of dormant microbes, perhaps this process could be illustrated in analogy to the optical burning of data on a biological computer disc. Gravitational lenses affect all types of electromagnetic radiation. A gravitational lens doesn’t merely bend light rays. With strong lensing phenomena it may also vary the path direction (and possibly also the charge) of other elementary particles:

The Sun could do this too, raising the possibility that it could work as a telescope capable of picking out details on distant planets. Light from bodies behind the Sun could be brought to a focus at a point 550 astronomical units (AU) in front of it. That’s 550 times the distance between Earth and the Sun. At that distance or beyond, an object immediately behind the Sun would be magnified 100 million times or more.

Claudio Maccone, a retired scientist for Italian satellite manufacturer Alenia Spazio, has calculated that a modest 12-metre-wide space antenna sitting at 550 AU could resolve features as small as 80 kilometres across on Alpha Centauri, one of our nearest stars.

The idea has several drawbacks, however. It would only be able to make observations along one particular line of sight - that connecting the antenna to the Sun. So examining a new object would require launching a new telescope. It would also take a spacecraft at least 55 years to reach 550 AU, so the object to be put under the cosmological microscope would have to be very important indeed.²⁰

In laser physics, a hologram reproduces a three-dimensional “visual image” of a reconstructed wavefront. However, a gravitationally microlensed projection could possibly reconstruct even more electromagnetic aspects of a wavefront. Gravitational deflection may also have some effect on the spectra of interstellar grains necessary for the origin of life.



To determine how light behaves at a BioDisc’s focal line, we need to work out where the BioDisc boundary is located in space. On the surface, it consists of tiny, life-bearing dust fragments driven out of the solar system by the pressure of sunlight.

Our BioDisc material may have originated from ejecta splashed back to an expanding accretion disc or icy build-up of fragments in the so-called Edgeworth-Kuiper Belt. In the 1940s and 50s, Kenneth Edgeworth and Gerard Kuiper established the existence of a *comet-belt* or enormous mass of small material on the cold outskirts of the solar system. The Kuiper belt consists of objects in relatively stable orbits beyond the reach of Neptune.

Farther out to be encountered is the “scattered disc,” an area of the solar system that is still not precisely mapped. The innermost portion of the scattered disc overlaps with the Kuiper belt, but its outer limits extend much farther away from the Sun. The boundary between the Kuiper belt and the scattered disc is blurred. Many astronomers see the scattered disc not as a separate population but as an outer region of the Kuiper belt.



In 1932, the Estonian astronomer Ernst Opik suggested that long-period comets originated in an orbiting cloud at the outermost edge of the solar system. In 1950, the Dutch astronomer Jan Hendrik Oort revived the idea. It is now thought that the scattered disc might be supplying the so-called “Oort Cloud” with material. A third of the scattered disc’s population is likely to end up in the Oort Cloud after 2.5 billion years.

Directly beyond the outermost edge, the gravitational field of the Milky Way produces a tidal force. The point at which the Sun’s gravity yields its influence to the strong galactic tide is called the “tidal truncation radius.” It marks the outer boundary of the Oort Cloud.

²⁰ Mark Anderson, “Interstellar space, and step on it!” *New Scientist*, Jan. 5, 2007.

Our fertile BioDisc is naturally set above the far and wide vicinity of the solar system's outer edge, the region where the hot solar wind smashes into the cold interstellar medium.

The "termination shock" is a part of the "heliosphere" or magnetic bubble where the supersonic solar wind slows to subsonic speed as it merges with the interstellar medium. The Sun's magnetic bubble is not entirely spherical, but indented inward at the southern hemisphere. The "heliosheath" is the area of agitated plasma between the shock front and the interstellar medium.

In 2007, the twin *STEREO* spacecraft detected that "neutral atoms" come from the shock front and the heliosheath, where the Sun plunges through the interstellar medium. The ions heated in the termination shock become neutral by exchanging their charge with the cold neutral atoms in the interstellar medium. The ions reverse direction along the shock front as if unaffected by magnetic fields and flow back to the Sun again.²¹

The termination shock is one of the last unexplored regions of the heliosphere. It could provide us with significant details into the workings of our solar BioDisc, since we know that high velocity impacts and their shock fronts can create amino acids in laboratory experiments.

If amino acids stream into the termination shock front, they could polymerize through these impacts into chains of peptides that build proteins. The rapid exchange of charge and the sudden reversal of direction by ions in the termination shock front could also offer indications as to how ice grains in space produce amphiphiles and proto-cell membranes.

Beyond the Sun's magnetic bubble are the molecular clouds of interstellar space. These dense clouds are thousands of light years across. The gas and dust of interstellar clouds serve as natural material to build amino acids.

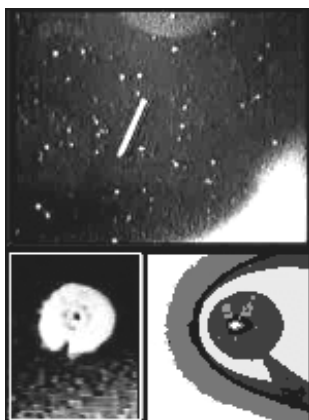
In December of 1996, NASA's *STS75* "Tether" mission stumbled over some puzzling illusions. A satellite was deployed from the US space shuttle at the end of a conducting cable or tether 20 km (12.5 miles) long.

The idea was to let the shuttle drag the tether across the Earth's magnetic field, producing half of a dynamo circuit. The return current from the shuttle to the dynamo load would flow in the Earth's ionosphere.

The objective of the experiment was to produce electrical power in space. Unfortunately, a small amount of air leaked out of some pinholes in the tether. The high voltage electric pressure of the tether (about 3500 volts) converted the air into plasma as it bubbled out of the holes.

The tether suddenly broke and its end twisted away into space. As the broken cord lashed out from the shuttle, the plasma made electric contact with the ionosphere. A swarm of bright vibrating "bubbles" suddenly filled the dark sky:

"What are we looking at?" the anxious voice of Houston Control inquires of astronaut Franklin Chang-Diaz. On the television screen there was a white line, the extended tether, surrounded by an ever-increasing number of fuzzy, circular shapes. Some were small but others were huge. The large ones afforded a better assessment of the shape and revealed a hole in the center and a "notch," sometimes two, on the peripheral edge. This notch seems to appear in different locations on different shapes, eliminating the possibility of a video lens or camera iris artifact.²²



"There's a little bit of debris that kind of flies with us," the astronaut replied. Houston Control took it for granted that the round shapes were ice crystals illuminated by sunlight.

But on close inspection the bits and pieces appeared to flutter like hot pancakes. The central hole was also expanding and contracting. If the shapes were in fact due to sunlight on ice, were they *proof* of the NASA Ames Research 2001 claim that irradiating simple ice grains with ultraviolet radiation can create membranous layered structures? Some of the "discs" photographed behind the tether seemed to be in the vicinity of two to three miles in diameter. They appeared and vanished within a narrow line of sight. A few scientists later joked about sky critters.

But there could be an extra explanation. The bubbly forms were not noticeable before the tether broke. The agitated plasma energy released by the broken cable evidently led to the influx of surrounding shapes. Could

²¹ "STEREO craft examine solar system's invisible frontier." *UNIVERSITY OF CALIFORNIA-BERKELEY*. July 2, 2008.

²² Gary Vey, "The Tether Incident: Alien Encounter?" *Viewzone.com*. 2007-2008.

they have been gravitationally microlensed *projections* at the locality of a focal line, possibly stimulated by the 20 km long tether circuit in the ionosphere?

The multiple southern-notched images of a round body of light could mean that a single source in alignment was being projected onto icy stratum in the expected shape of Einstein rings along a narrow focal line interval. In any case, until 2007 it remained more or less unrecognized that a gravitational mirage of our solar system's notched or indented heliosphere could be distinctly projected into an electrified area of frozen space:

NASA's Voyager 2 spacecraft has found that our solar system is not round but is "dented" by the local interstellar magnetic field of deep space, space experts said. The data was gathered by the craft on its 30-year journey into the edge of the solar system when it crossed into a sweeping region called the termination shock, they said.

It showed that the southern hemisphere of the solar system's heliosphere is being pushed in or "dented."²³

Perhaps the dented rings that appeared in the *STS75* mission were gravitational deflections of our solar system's heliosphere or magnetic bubble, projected along a focal line into a narrow interval of frozen ice grains enveloped in a conductive field.

But that's not to say the objects were purely optical tricks. Ultraviolet light striking amino acids in ice crystals can form layered sheet-like tissues in space. A gravitationally microlensed projection could conceivably reconstruct solidity, heat, humidity, and other physical aspects of real objects.



Dormant microbes in icy emulsions can additionally act as photographic film to display visual images. The photos that Chris Voigt and his colleagues made of themselves from their bacteria-to-film tests in 2005 boasted a high resolution of about 100 megapixels.

How much data can be stored in an expanding BioDisc of dormant microbes many light years across? In a parallel living system individual nodes sense a population of other nodes with similar data to report. Microbial computers have extraordinary potential for enhancing the brainpower of self-organizing networks.

After formatting computer discs for nearly half a century, scientists realized that our natural world regulates a perfect "disc operating system" beyond anything we could invent or design. Bacteria can physically store and transmit genetic information throughout a far-reaching biological network. Perhaps our solar system rotates inside the magnetic bubble of an active supercomputer surrounded by a fertile BioDisc full of DNA instructions in a nascent database of dormant microbes.



(NOVEMBER 2008) PETER FOT K KAPNISTOS, ICARIAN SEA, GR, 83300.

²³ Mark Lawin, "Voyager 2 finds solar system's shape is 'dented'" *Reuters*. Dec. 10, 2007.