Searching for Signals from Civilizations Spreading Life Among the Galaxies

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Abstract

If life which has evolved to intelligent forms is not unique to Earth, why have we never detected unambiguous signs of extraterrestrial intelligence? We have been looking for the wrong kind of signals and expecting spaceships that will never arrive. Any practical intergalactic transportation system whose purpose is to spread life around the universe will consist of very tiny unpowered capsules carrying seeds of single cell organisms designed to establish life on barren planets. The same system would serve for communication of genetic updates, messages about life and its possibilities, coded in a language understood best by its intended recipients. No systematic search has been made for such particles. Intergalactic capsules of intelligent origin should be detectable with existing technology. Some scientists think life on Earth grew from an external seed; if we detect particles which seem to be of unnatural origin, we will want to capture them intact so we can analyze their contents. Someday we may want to construct an intergalactic transportation system ourselves. The most probable means by which we will find proof for the existence of ETI will be by searching for particles on or near Earth that can be clearly identified as intergalactic seeds produced by intelligent life.

Practical intergalactic transportation of life

ANY CIVILIZATION WHICH wants to colonize planets in its own galaxy or in nearby galaxies is confronted with the practical limits of physics and engineering. Exploration or colonization of nearby planets by manned or robotic spacecraft may be feasible, and may be a reasonable goal. However, assuming our present understanding of the laws of physics is reasonably correct and complete, interstellar travel by intelligent life may always be extremely difficult. Exploration of regions outside the home galaxy by any means is even more difficult, if not practically impossible. No civilization which seriously considers colonizing distant planets will accept the risk of putting all its resources into a few giant spaceships carrying colonists to an uncertain fate. And who would want to go? Few sane adventurers would commit generations of descendants to the confines of a mechanical world in hopes of someday finding a primitive planet suitable for life, when those who survive the trip attempt to rebuild a self-sustaining advanced civilization like the one their predecessors left behind. Intelligent life is, for the most part, confined to the planets where it has evolved.

Scientific searches for extraterrestrial intelligence (ETI) have focused on attempts to detect radio signals that have characteristics typical of intelligent signals. We assume that technologically advanced civilizations will construct radio or optical beacons that we can detect, or that they will produce detectable signals as a by-product of everyday life. If there are no space traveling social creatures, there are no interstellar civilizations, and no need for the kinds of communications systems that we could detect with our best radio receivers. Normal signals generated by inhabited planets like our own are not detectable beyond the immediate stellar neighborhood. So unless intelligent life has arisen on a planet very close to us, we are not likely to detect any radio emissions from any intelligent source. Would any civilization want to advertise its presence with a radio or optical signal powerful enough to be detected over intergalactic distances? Would we want to build such a beacon? Only if we had a very important message to send. But it would probably not be the first project pursued by a civilization that wants to establish its place in the universe.

If we assume that there are compelling reasons for wanting to spread life itself around the universe, we should also assume there will be competition to determine the future of life and its role in the evolution of the universe. One strategy for spreading life which has favorable competitive advantages is to broadcast seeds of colonizing organisms throughout a galaxy so that any emerging planet is likely to be seeded with life just when it is ready to support it. Each seed would contain genetic mechanisms to establish a simple form of life in conditions thought to be typical on new planets. The simplest way of getting the seeds into distant galaxies is to launch them at full speed from a machine built in space (or on a moon or nearby planet without an atmosphere), aiming them at the target galaxies, at regions of active star formation where suitable planets might be present when the seeds arrive. Individual seeds, or a group of seeds coding different strategies, would be packaged in a capsule durable enough to survive the long high velocity trip though space. The capsule would protect the seeds from radiation and minor collisions, and shield them from heat during entry through a planetary atmosphere, but would provide no propulsion or active support except for releasing the seed intact in the atmosphere or at the surface of the planet. Only a tiny fraction of the seeds launched would arrive safely at planets ready for life.

The first seed establishing life on a planet would capture the planet for its form of life, if it could defend itself against later arrivals. Seeds arriving after the first organism is widely established would simply be eaten. More sophisticated attacks could be defended with the types of antiviral and antibacterial defenses which are built into the organisms we are familiar with. We should take the evolution of life on Earth as our model for how a raw planet must be transformed and made hospitable for more advanced forms of life. Given a deeper understanding of the general model of evolution we are familiar with, we should not be surprised if even a small genetic message could be designed cleverly enough to program the general course of evolution on a planet, if not all its details.

This strategy for intergalactic transmission of life is similar to what has been called "directed panspermia." Kelvin[1] and Helmholtz[2] suggested that life arrived on Earth via meteorites. Arhennius[3] suggested that an exploding star could propel living organisms from its planets into space, and that bacterial spores could survive long trips through space, propelled by radiation pressure to fertilize distant planets, a scenario he called "panspermia." Hoyle and Wickramasinghe[4,5] suggested that spore-like organisms originated in or reproduced in interstellar clouds and were protected from radiation inside comets, fertilizing planets by impact. Crick and

Orgel[6] coined the term "directed panspermia" to mean intentionally introducing genetic material into space to colonize the rest of the galaxy. The idea that life arrived on Earth after evolution elsewhere is seen as a reasonable explanation for the mystery of the origin of life on Earth. The evidence suggests that all things now living on Earth evolved from a single cell organism containing a set of complex mechanisms selected by its situation and suited for its survival, which generated all the mechanisms, forms, and structures essential to the evolution of all the complex multicell organisms which have followed, including us. We see no traces of evolution, of variation and selection, in many of the basic cellular mechanisms and structures essential to all life. They seem to have sprung fully formed from pre-living chemistry; it is as if there could be only one possible structure for life, and it was built in from the beginning. The idea that life has been designed is very strong. The question has always been, who or what designed it, and how. Neither answer previously considered (God or chance/evolution) is satisfactory. We should consider the possibility that life arrived here with a set of instructions and a tool kit for its future needs, designed by intelligent beings inside our universe.

Identifying seed bearing particles of intelligent origin

Positive identification of seed particles broadcast by intelligent life will very likely require capture of particles for analysis. If particles are captured nearly intact, those of intelligent origin should be easy to identify, from the microengineered capsule components and possibly familiar genetic components inside. If particles are captured by impact, or after they have passed through Earth's atmosphere, positive identification is more problematic, although distinguishing characteristics may be observable in the chemical composition or in the composition of the particle debris. Construction of a device to capture tiny high velocity particles in space is probably a very expensive project. The kind of device needed will probably become more clear after candidate particles are detected by other means.

An initial guess at the characteristics of particles carrying intergalactic seeds:

Size: 1-100 micron diameter
Velocity: up to 50% of the speed of light
Density: higher density than natural cosmic dust
Direction: signals originate from an area within the boundaries of a galaxy
Structure: "engineered" external structure "seed" ,"genetic"or "microengineered" internal structure
Penetration: deep penetration through atmosphere, possibly to surface
Other: emission and velocity profile during atmospheric entry characteristic of an ablating or insulating capsule

The first step in identifying candidate particles is to determine whether any particles with characteristics expected of intelligently engineered seeds, and outside the range of naturally occurring particles, can be detected with existing detectors or collection systems. It may be possible to identify candidate particles with existing radar and cosmic ray detectors capable of accurately measuring velocity and direction of travel for microparticles entering the Earth's atmosphere. Dust samples collected from the upper atmosphere and orbital impact collections can be searched for unusual, unnatural particles. Antarctic meteorite collection programs might be expanded to look for unusual microparticles. New ground based cosmic ray detectors and orbiting cosmic ray detectors being planned could be modified to allow discriminating between events caused by cosmic ray primary particles, which always travel at relativistic velocities, and high mass particles entering the atmosphere at less than relativistic velocities.

Possible detection of intergalactic seeds by cosmic ray detectors

Micron-sized particles traveling near the speed of light would look like extremely high energy cosmic rays to some ground-based detectors. Several high energy cosmic ray observatories use detectors which analyze the "air shower" produced when a cosmic ray interacts with the Earth's upper atmosphere; the primary particle (a single proton or an atomic nucleus) loses energy by producing a cascade of secondary particles which can be observed directly (muons) or which produce fluorescence measured by an array of sensitive photodetectors on the ground. High energy events which don't fit current cosmic ray models have been observed at two such detectors.[7, 8, 9, 10, 11] The Fly's Eye air shower cosmic ray detector in Utah has recorded one event at 3.2×10^{20} eV, the highest energy cosmic ray ever detected. The primary particles for cosmic rays above $\sim 5 \times 10^{18}$ eV are assumed to be protons accelerated by extra-galactic sources. (12,13) According to the accepted propagation model, the interaction of the cosmic microwave background with nucleons at that energy implies a source distance less than ~30Mpc away.[8] No apparent source has been identified within 50 Mpc in the direction from which that particle arrived; active radio galaxies, considered the only likely sources for particles of such high energy, are more than 100 Mpc away.[14] Because this event is so unusual, entirely new physical mechanisms have been invoked in an attempt to explain it; it has been suggested that the primary particles were the product of the decay of a higher energy particle from "topological defects left over from early universe phase transitions caused by the spontaneous breaking of symmetries..." which occur within the required distance.[7]

It is possible that the detector recorded a relativistic seed packet entering our atmosphere. The geometry and operation of the Fly's Eye air shower detector does not exclude the possibility that the 3.2×10^{20} eV event was caused by a particle the size of cosmic dust traveling at relativistic speeds[8], but also does not allow the actual velocity or composition of the primary particle to be determined. We would not expect natural cosmic dust to have such high velocity or penetrate as deeply into the atmosphere as this particle apparently did. A seed bearing capsule designed to deliver its cargo intact to the surface of a planet would have exactly these characteristics.

Determining the composition and origin of the highest energy cosmic rays (above 10^{20} eV) is an area of intense research interest. They are thought to originate from high energy sources far outside our galaxy, yet natural mechanisms limit the propagation distance of such high energy elementary particles or nuclei to much shorter range, but no likely sources have been identified close enough to our galaxy. These events are assumed to be of natural origin, but new physical theories and exotic production mechanisms are required to explain them.

Seed bearing particles produced by engineered systems, traveling at less than relativistic velocities, may have approximately the same energy as the highest energy cosmic ray events. Determining the composition and origin of these events requires higher detection rates and larger detectors. Several improved detectors are currently being designed. The Pierre Auger cosmic ray observatory is being designed specifically to accurately determine the energy spectrum and direction of arrival of the highest energy cosmic ray events.[15] An orbiting cosmic ray detector with improved sensitivity is also being considered.[16] Modifications which will allow discriminating between natural and intelligent origin of these events should be considered.

Detection of high velocity micrometeorites by radar

High frequency bistatic radar systems are now being used to measure atmospheric trajectories, and orbital parameters, for meteors down to 100 microns in diameter.[17,18] A larger fraction than expected have velocities above 100 km/s, which is above the limit for heliocentric orbits, indicating origin outside our solar system.[19] Similar radar systems could be designed to watch for smaller particles traveling up to the speed of light. Radar events could be used to trigger optical systems for collection of atmospheric entry emission spectra, and tracking systems that could more accurately determine the direction of arrival.

Summary

Detection of convincing evidence for extraterrestrial life would be a significant event in human history. Efforts to detect signs of intelligent life should be directed by the kind of signals which intelligent life is most likely to produce, given the constraints of physical reality. Activities designed to spread life throughout the universe may not seem like reasonable behavior to us now, but as we learn more about life and its possibilities, it may seem like the most reasonable way we can participate in the evolution of life across the universe. The discovery of intergalactic seeds produced by intelligent life would immediately change our view of the origin and purpose of life on earth, and improve our expectations for the future of life in this universe.

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