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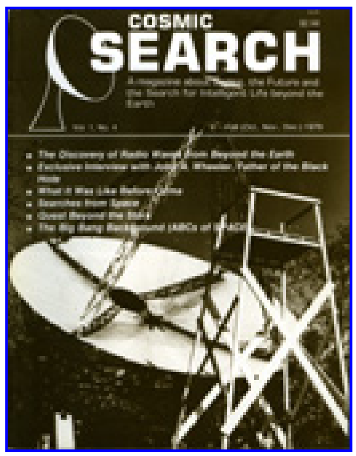

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The SEnTlnel

By: Robert S. Dixon

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New Evidence for Gravity Waves

The existence of gravity waves has been postulated by a number of physicists, but none have been unequivocally observed to date. However, recent observations of a binary pulsar system appear to show the existence of gravity waves.

Joseph Taylor and Lee Fowler of the University of Massachusetts and Peter McCulluch* (* Physics Today, May 1979.) of the University of Tasmania used the large Arecibo telescope, in Puerto Rico, to measure the orbital period of the pulsar, PSR 1913+16, which is orbiting around a normal star. They discovered that the pulsar and the star are revolving around each other more and more slowly. If the gravity wave theory holds, it can account for the slowing-down effect, since the binary system should be emitting energy in the form of gravity waves.

Gravity waves have been suggested as a means of interstellar communications, should we ever be able to understand them and generate them artificially.

Search for Pulsed Signals on Nearby Stars

A number of search programs have been carried out in recent years to find pulsars. Pulsars are natural astronomical objects that emit powerful radio bursts with extreme regularity. Pulsars pulse at different rates, from the millisecond range to a few seconds between pulses.

Sophisticated equipment and observing techniques have been developed to search for pulsars. It is reasonable to expect that intelligent signals might also be pulsed at a regular rate, similar to pulsars, so the existing pulsar search equipment would be well suited to search for intelligent signals.

R. Wielebinski and J. Seiradakis* (*International Scientific Radio Union meeting, Helsinki, Finland, August, 1978.), using the large 100-meter radio telescope at Bonn, West Germany, aimed the telescope at three nearby stars and searched for pulsed radio signals with periods in the range of 0.1 and 4 seconds. Each star was examined for up to one hour. No pulsed signals were detected within the capabilities of their instrumentation.

The experiment was not conclusive since only a few stars were observed, however, it did demonstrate that the techniques used for searching for pulsars might also be used in larger, more comprehensive searches for intelligent signals in the future.

ETI Pros and Cons Debated *

(*"Science Times," *N.Y. Times*, April 24, 1979.)

Michael Hart, Trinity University in San Antonio, Texas, says civilized life must be exceedingly rare in the universe and the example we have on the earth may even be unique. He bases his conclusion on an analysis he has made of hypothetical planets and the requirements for the development of a civilization like our own.

In an interview with the *New York Times* about Hart's results, Carl Sagan voiced disagreement, stating that he thought Hart sells short the adaptability of life to hostile conditions that may exist in any given corner of the universe.

Another astronomer who requested anonymity took a middle position. He replied, "Maybe there's something out there and maybe not. Your guess is as good as mine." Because of the lack of data, he felt that arguments pro and con were unproductive reminding him of the medieval scholarly debates about how many angels could dance on the head of a pin.

Search for Faster-than-light Particles

All particles that we know of (except neutrinos) travel *slower* than light. As you try to accelerate them up to the speed of light it becomes increasingly difficult, because the mass of the particle increases as the speed of light is approached. Might there be other particles that always move *faster* than the speed of light? This would tend to provide a symmetry which is often found in nature. By analogy with familiar particles we might expect that these faster-than-light particles would increase in mass as we tried to *slow them down* to the speed of light. Thus, a slower-than-light particle might never become a faster-than-light particle, nor vice versa, because their masses would become infinite at the velocity of light.

Particles that move slower than light are called *tardyons*; those that move at the speed of light are called *luxons*; and those that move faster than light are called *tachyons*. Tachyons have some interesting and unexpected properties, according to Jayant Narlikar* (*American Scientist, Sept./Oct. 1978), Tata Institute of Fundamental Research, Bombay, India, as summarized in the accompanying table.

Quantity	**Tardyons**	**Luxons**	**Tachyons**
Velocity:	Slower than light	Same as light	Faster than light
Mass:	Increases as particle speed increases to that of light	Always zero	Increases as particle speed decreases to that of light
Time travel:	Forward	Either way	Backward
Black hole size:	Increases	Indeterminate	Decreases

Tachyons have never been observed, but that may be because we do not know how to detect them. Narlikar has suggested two ways in which we might verify the existence of tachyons, or at least verify the symmetry idea that if slower-than-light particles exist, then faster-than-light particles must also exist. Narlikar proposes first that we search for Iuxons, that go backwards in time. These might be found coming from pulsars but this measurement would be difficult because the dispersion by the interstellar medium causes different frequencies to arrive at different times so the effect tends to be masked.

Narlikar's second suggestion is that careful measurements of black holes be made over a period of time. Black holes are surrounded by spherical *event horizons*, through which matter can enter, but never leave. Since no light can leave, we can never see what is happening inside a black hole. The size of a black hole is determined by convention to be the size of its event horizon. When tardyons fall into a black hole, the black hole's size increases, but when tachyons fall into a black hole, its size should decrease. If we were to discover a black hole whose size is decreasing, we can infer the existence of tachyons. Although the size of a black hole cannot be measured directly, we might infer it from measurements of a double star system where one of the pair is a black hole.

If tachyons exist, the time delays required for interstellar communications could be drastically reduced. Two-way exchanges of information might be possible, rather than the one-way monologues envisioned today.

Does the Universe Always Run Downhill? *

(* Malcolm W. Browne, *N.Y. Times*, May 29, 1979)

Everyone is intuitively aware of the tendency for things to become disorganized. For example, if you take a deck of playing cards, neatly organized by color and suit, and throw it up into the air, you can be sure that when the cards come down they will no longer be neatly organized. Or take a bottle of oxygen and a bottle of nitrogen and connect them together with a hose. Soon you will have two bottles of mixed-up oxygen and nitrogen. Or take a universe filled with galaxies and stars. Wait a long time and the galaxies will separate and the stars eventually burn out.

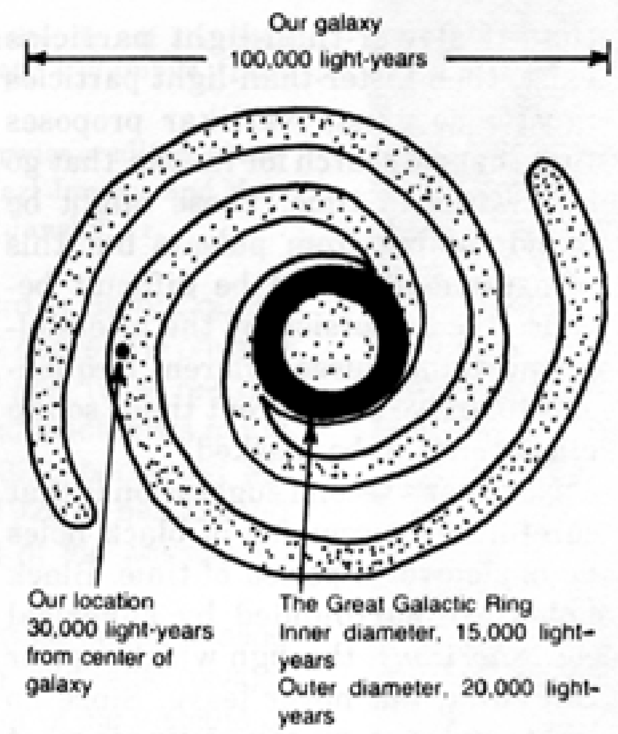
This tendency is referred to by scientists as the Second Law of Thermodynamics. It predicts that eventually everything will run down and stop. On the other hand, we know that there are exceptions to this law. Bricks can be put together to make buildings. Oxygen can be separated from nitrogen. All it takes is purposeful work. Life is the great exception to the Second Law. Living creatures can make the universe run uphill, by creating order out of disorder. Life itself appears to evolve into more and more complex creatures. How is it that life is able to prevail against the ever-present Second Law? This paradox has concerned scientists for some time.

In 1977 Ilya Prigogine, a Belgian chemist, won the Nobel prize for discovering an explanation to this paradox. He discovered certain classes of natural chemical and physical reactions which run uphill by forcing something else in their neighborhood to run downhill faster than it normally would. These reactions create new structures that are more complex than the sum of their constituents. On the average, the Second Law may still be satisfied, but it doesn't matter. It's like paddling a canoe upstream. You make progress by pushing the water downstream faster. There is so much water that your paddling doesn't make a significant difference to the river, but you still make it to your destination.

Prigogine has formulated a theory to explain this effect and has applied it successfully in other fields, including something as down-to-earth as preventing traffic jams. His theory makes the future of the universe much more optimistic than predicted by the Second Law. Maybe we are the ones who will have to stop the universe from running down.

Existence of the Great Galactic Ring

A gamma-ray telescope onboard the NASA Small Astronomy Satellite, SAS-2, has mapped the sky's gamma-ray emission (gamma rays are similar to radio waves, except their frequency is much higher). Floyd Stecker* (*American Scientist, Sept/Oct. 1979) of NASA's Goddard Space Flight Center, Greenbelt, Md., analyzed the map and found that a majority of gamma rays are emitted from a circular ring within our own galaxy. The ring is concentric with the center of the galaxy and has inner and outer diameters of 15,000 and 20,000 light years, respectively. (See accompanying sketch).



The Great Galactic Ring

Combining this new information with previous data, Stecker concludes that the ring is a veritable hotbox of activity. It appears to be the "galactic nursery" where most of the large and bright stars are being born. Since these stars burn up relatively quickly, this ring is also the "galactic fireworks factory" where these stars become supernovae. These supernovae often leave behind rhythmically-ticking pulsars, so the ring might also be referred to as the "galactic clockworks".

The ring would not appear to be a likely location for intelligent civilizations because of the short-lived stars and supernovas occurring there. On the other hand, the supernovas are spewing out the heavy elements necessary for the formation of life in other parts of the galaxy. We can take comfort from the fact that our sun is well outside the Great Galactic Ring.

Supernovas are not so common out here in the galactic boondocks.

Scientists Study Virus for Ancient Messages *

(*Walter Sullivan, *N.Y. Times*, May 7, 1979.)

Two Japanese scientists, Hiromitsu Yokoo and Tairo Oshima, have investigated the genetic structure of the virus, PhiX-174, and believe it to contain a message planted there billions of years ago by some advanced civilization. Yokoo and Oshima chose PhiX-174 because it is one of the simplest known viruses and hence easier to decode.

Each different life form on the Earth has a different genetic code, which may be written out as a long string of letters representing the chemical components of its DNA (deoxyribonucleic acid). Even for something as simple as a virus, the string is thousands of letters long. By comparison, a bacterium code requires millions of letters and the higher plant and animal codes are almost hopelessly long. A given code tends to persist for generations. A popular scenario in the formation of life on the earth is that "seeds" were planted here long long ago, from which all life eventually developed. If this were the case, Yokoo and Oshima believe it might not be unreasonable for the seed makers to use part of the original genetic code to send some form of message, knowing that it would be passed onward through time until someone would eventually comprehend it.

Thus far, the scientists have not been able to decipher the code, but their research is continuing.

Another Search for Extrasolar Planets

A new technique for finding planets associated with other stars is being employed in a search program underway at the University of Arizona. The technique is being used by K. Serkowski to measure the backward and forward movement of a star as seen by observers on earth.

As a planet and star revolve about their common center of mass, the motion of the star will produce a doppler shift in its spectral lines. If any periodic doppler shifts are detected, the existence of planets can be inferred. This technique differs from that of Gatewood (described in **COSMIC SEARCH**, Summer, 1979) since Gatewood's measurements involved side-to-side motion of the star.

Size Constraints on Living Organisms *

(*Contributed by John H. Fadum)

Although the shapes and sizes of living organisms can vary enormously, there are constraints—both local (caused by environmental factors such as gravity) and global (caused by physiochemical laws) which seem to be universal.

While there is no example of extraterrestrial life now known, the possibilities and probabilities are sufficient to guarantee a spirited discussion in any group consisting of astronomers, biologists, physicists, and chemists.

Since it may be possible to have organisms smaller than earth viri, when a creature shrinks much below the molecular level, the *Uncertainty Principle* begins to dominate. (Under certain conditions, of course, the Uncertainty Principle is a major factor even for much larger objects.) But is there a maximum size limit? Certainly for planet-bound creatures there is the obvious fact that the larger the creature is, the heavier it will be. Even in the nearly-weightless state of water, the living organisms cannot be indefinitely large-though creatures of the sea can be much larger and more massive than landlubbers. The Great Whales, for example, are far bigger than the biggest dinosaur ever was.

There could conceivably be "energy creatures" or other beings living in empty space between the stars, as has been hypothesized by many science fiction writers; but these creatures have another constraint to contend with (as was pointed out by Arthur C. Clarke in his essay "God and Einstein"): a really large creature would have the speed-of-light time lag to contend with. If a creature of this sort sensed a danger/food/weather signal at one end, it would not have time to evoke the appropriate response at the other end, if it were more than a few tenths of a light-second long. Even if the reaction time were instantaneous, like that of a living geon (as discussed in J. A. Wheeler's *Geometrodynamics*, Academic Press, 1963), the creature would still have to be small by astronomical standards, or be very sluggish.

Note: The size constraints on organisms have been discussed in a very entertaining, although limited way, by J. B. S. Haldane in his article "On Being the Right Size." ("The World of Mathematics", Vol. 2, Simon and Shuster, 1956).

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