THE OBSERVER

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IS ANYONE THERE?

Alan Bridle

At least six groups of astronomers around the world are currently involved in using radio telescopes to listen for signs of intelligent life beyond the Earth. NASA is supporting design work for a huge installation - Project Cyclops - to detect radio transmissions from advanced civilizations on planets in distant star systems. Why do these experimenters suppose that there could be life 'out there' on which to eavesdrop with radio telescopes?

First of all, what is meant by 'life'? A Buddhist monk named Bankei was once publicly challenged to demonstrate a miracle by a rival whose leader had supposedly demonstrated many wonders. Faced with the challenge, Bankei simply said, "My miracle is that when I feel hungry I eat and when I feel thirsty I drink."

Bankei's 'miracle' is what distinguishes living from non-living matter. Left to itself, non-living matter always becomes steadily more disorganized as time passes. Abandoned buildings collapse into heaps of rubble, but rubble heaps never assemble themselves into buildings. Shiny cars rust into useless hulks, but the hulks in the wreckers' yards never spontaneously become new cars. Living matter, whether in a rose or a robin, an ant or an ape, you or me, is remarkably organized in the face of this seemingly implacable trend towards universal disorder. Life's most distinctive property is an ability to grow, repair or reproduce its peculiarly organized structures - at least for a limited time.

Living things achieve this by drawing well-ordered energy (food, sunlight) from their environment. This borrowed energy powers the processes which preserve, enlarge and reproduce the internal organization of living matter, then it is returned to the environment in a disordered state (waste products, heat). Life maintains itself as a temporary oasis of order in a chaotic world by actually increasing the rate of disordering of its environment.

There are some 350,000 different plant and 1,200,000 different animal species on Earth now. Different life-forms have adapted to extreme Arctic conditions, to the near-boiling waters of hot springs, to the thin air of the stratosphere, to the colossal pressures of the ocean deeps, to rain forests, to deserts and even to the high-radiation environments of nuclear power plants. We might therefore hope to gain some insight into the range of possible mechanisms for life, and the range of acceptable environments, by studying the life around us on Earth.

But it turns out that the wonderful variety of species on Earth is produced by the chemistry of carbon combining with only a few of the other 91 naturally-occurring chemical elements to form just a handful of basic raw materials (see Table, page 5). All Earth life from microscopic viruses to giant whales has essentially the same chemical basis. The organization of that basis into different life-forms is achieved by differences in the complex patterns of arrangement of just five molecular 'building-blocks' (the nucleotide bases) in what is known as the 'genetic code'. Our observations of millions of species turn out to amount to knowledge of only <u>one</u> example of life - carbon-compound-in-water life - and even astronomers should shrink from discussing a population of phenomena on the evidence of just one example!

The best we can do without lapsing immediately into pure speculation is to weigh the possibility that <u>L</u>ife <u>A</u>s <u>W</u>e <u>K</u>now <u>I</u>t (which I like to call LAWKI) might exist elsewhere. Our chances of finding <u>some</u> form of life beyond the Earth must actually be greater than those of finding LAWKI.

LAWKI needs a planetary environment with liquid water available, and functions best at transitions between solids, liquids and gases. Most astronomers consider it likely that such 'Earthlike' environments are abundant in the universe, but there is no direct evidence for this. None of the Sun's planets could be detected by present techniques if they circled another Sun at typical interstellar range. There have been claims that some nearby stars wobble across the sky as if under the gentle gravitational pull of unseen companions which could be planets. The most promising results have recently been challenged, however, and this evidence is presently very controversial. The main reason for optimism about the number of Earthlike environments is that planet formation is understood theoretically as a by-product of the formation of the slowly-rotating single

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stars which make up about one-third to one-half of the stellar population. Our own Solar System shows that not all planets are Earthlike but the regulating factor appears to be just distance from the star and it is therefore likely that many planetary systems would contain an Earthlike member.

Both optical and radio astronomy show that the elements needed for LAWKI (see Table) are abundant in the universe, so there is no shortage of the raw materials for LAWKI elsewhere. But having the ingredients does not guarantee that the cake will be baked. Even on an Earthlike planet with the appropriate chemistry, should we necessarily expect to find LAWKI?

Here we are at a crossroads in this discussion. How did the crucial organizing patterns of nucleotide bases appear on Earth? Could that process, or its equivalent, have occurred anywhere else? Laboratory experiments have shown that fragments of LAWKI's chemistry can be produced by normal, essentially random chemical processes in simulations of the primeval environment of Earth. Some of the complexity of the genetic code in today's organisms may strictly be unnecessary; faced with environmental challenges, self-copying molecules responsible for patterning simple organisms have been shown to shed large parts of their structure without losing their ability to copy themselves. The fossil record also suggests that early Earth life was simple and that complexity evolved over billions of years. This all suggests that the first self-reproducing life-patterning carbon-based molecules could have been simple ones that arose randomly and mindlessly in the Earth environment long ago.

No chemical experiment has created LAWKI of any kind in the laboratory. Even if one does, it will not prove that life <u>did</u> appear in that way on Earth. Experiments performed now can only show paths by which life <u>might</u> have arisen in the past. Alternative paths will always be arguable; for example, special adjustment of Earth's chemistry by a supernatural (divine) being, or accidental 'seeding' of the Earth with life-patterns from the sandwich lunch of some visiting astronaut. On any of these pictures, there is some possibility that LAWKI will exist elsewhere.

The tantalizing uncertainty of the above discussion stimulates searches for LAWKI beyond the Earth. The exploration of the Solar System has yet to find evidence for life - the lunar samples were sterile, but we will soon have data from the Viking spacecraft on the surface of Mars. With time, money and continued interest the exploration of other nearby planets could follow. But if the appearance of the life-patterning molecules hinges on some sufficiently rare process, the nearest examples of LAWKI could be beyond the range of travel using our present technology.

They need not, however, be beyond the range of our present radio technology. If we equip the world's biggest radio telescope (the 1000-ft reflector at Arecibo) with its most powerful radar transmitter, it can broadcast a signal detectable by its 'twin' equipped with the most sensitive available receiver at a range of several thousand light years. Within such a range there could be millions of potential homes for LAWKI. If LAWKI with only our own technical capabilities existed on some of these sites, we could become aware of their existence through radio contact now. In practice, their detection would present a formidable problem of searching at the right radio frequency in the right direction at the right time.

But the Sun is not an old star and Earth is not an old planet. We and our environment are recent arrivals on the cosmic scene in astronomical time. Even if LAWKI always needed billions of years to reach our technical level, advanced forms of LAWKI could have been blundering into radio contact with one another for billions of years before Earth existed. So long as technological prowess does not inevitably bring destruction, many contacts between LAWKI in different locations could already have been made. The chances of contact are greatest between forms of LAWKI that achieve long-term social stability. Contact via radiated signals would also be most likely at radio wavelengths, because these are where interstellar space is most transparent and where there is minimum natural 'noise' to compete with artificial transmissions.

If earlier contacts between stable advanced LAWKI had been fruitful, new arrivals like us might no longer face the difficult task of detecting feeble, unintentional transmissions from other young societies. Older forms of LAWKI might generate strong signals designed for easy detectability by fledgling

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civilizations. The possibility that such 'beacon signals' might be picked up with present radio telescopes has stimulated the current round of listening experiments.

Listeners for beacon signals do not expect quick success. The search must cover many possibilities. Beacons may not be located in star systems but at strategic locations elsewhere. The signals will be most easily distinguished from natural signals if they are sharply localized in frequency, but then we must find the frequency. The present experiments all use sensitive equipment that exists for 'regular' astronomical purposes at potentially distinctive beacon frequencies. A popular choice is the 21-cm hydrogen line, which is the most distinctive radio spectral line of the most abundant chemical element in the universe. One of my own experiments uses the 1.35-cm water line, the closest spectral line of a biologically significant molecule to the waveband of minimum natural noise. Most of the experiments are surveying samples of nearby single stars that are likely to have planets, and all so far appear to have met with silence.

The gaping holes in our understanding of the development of LAWKI here on Earth may contain hidden factors which guarantee failure of such experiments. LAWKI may not spend very long experimenting with technology. Advanced LAWKI might achieve contact by means that we cannot presently envisage. The odds in favor of success in present experiments are very small, but we do not know they are zero. They become zero only if we do not try.

TABLE

MAIN CHEMICAL CONSTITUENTS OF LAWKI

COMPONENT	FUNCTION	COMPOSITION
Water	Universal Solvent	Hydrogen, Oxygen
Carbohydrates	Energy Source	Hydrogen, Oxygen, Carbon
Fats	Energy Storage	Hydrogen, Oxygen, Carbon
Adenosine Phosphates (ADP, ATP)	Energy Transfer	Hydrogen, Oxygen, Carbon, Nitrogen, Phosphorus
Proteins	Structural; Facilitate Chemical Reactions	Hydrogen, Oxygen, Carbon, Nitrogen, Phosphorus, Sulphur
Nucleic Acids (DNA, RNA)	Patterns for Protein Synthesis	Hydrogen, Oxygen, Carbon, Nitrogen, Phosphorus-- Organized into 5 Nucleotide "Building Blocks"

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THE REEK OF THE PENN CENTRAL*

G. S. "Big Daddy" Shostak

The Penn Central Railroad--mention it at any social gathering and you're sure to get wry smiles and synical remarks. It is a catch phrase guaranteed to elicit derisive laughter, much in the way that baldness is, or the cities of New Jersey. We use humor to defend ourselves against the hopelessness of such large-scale pervasive problems. And thereby avoid dealing with the situation.

For the past six months I've been dealing with the problems of the Penn Central, and in this article I shall attempt to explicate some of the reasons behind, and future of, the world's largest bankruptcy.

Well, we all know why the Penn Central went under: corrupt management and late, filthy trains, right? Wrong. It's true that the top executives of the nation's biggest railroad were less than inspired (I note in passing that many of them were Virginia lawyers), and it's also true that the passenger service was not particularly commodious. But these failings, although conspicuous to Mr. and Mrs. Front Porch, were hardly the first-order terms in the bankruptcy equation. To begin with, PC carried about 40% of the nation's rail passengers, including substantial commuter operations in Philadelphia, Boston and New York. And for every dollar paid in fares by the unfortunates who rode its trains, the PC was incurring about two dollars in costs. The resultant loss was a couple of hundred million dollars annually. Despite what you may think, cleaning up the trains would have incurred more costs, without much change in revenues. A well-run passenger service, while socially desirable, is not guaranteed to be profitable. If you have doubts, consider the railways of Europe and Japan, all of which operate at enormous deficits. And they don't have an Interstate Highway system to compete against.

Furthermore, the PC is situated in the North, the part of the country which had the bad luck to win the Civil War. As a result, railway lines were built to every town and village, something which the South couldn't afford to do. A hundred years later, the shift of industry out of the Northeast and the invention of the truck made many of these "branch" lines unprofitable. Nevertheless, the Government, via its antediluvian agent, the Interstate Commerce Commission, only occasionally would allow abandonment of such lines.

Then there's the labor problem. Ride behind the fireman on a locomotive headed for New York. You'll note that the only control on his side of the cab is the windshield wiper. And you can bet his salary is more than yours. The railroad industry is burdened by 140 years of labor entrenchment.

To all this you might add the fact that the U. S. Government has actively subsidized all of the railroads' competitors: truckers, barge lines and airlines. The rails didn't get a nickel.

So you see, bad management only exacerbated an already untenable situation, and those who were aware of that situation were not surprised when in 1972 the Penn Central filed for bankruptcy. Since that time the railroad has managed to continue operating only by deferring maintenance of track and payments to creditors, shifting the passenger burden onto Amtrak, and asking Congress for "loans".

Where do we go from here? Well, we could pull up the tracks and use them for the VLA, but the result of that action would be a shutdown of such firms as General Motors, U. S. Steel and Consolidated Edison. Plus a doubling of the number of trucks bearing down on you on Route 29. Railroad service in the Northeast is essential, so we can forget about paving over the tracks just so Bill Meredith can have a bike path to Boston.

Faced with the demise of the PC (and six other small railroads in the Northeast), Congress created the U. S. Railway Association. This group was promptly charged with divining a plan to reorganize the bankrupts in such a way that they would once again be profitable. The idea is to avoid nationalization and its attendant quagmire of public funding and political pressures (consider the Postal Service). A preliminary plan has been published, and it essentially proposes the same reorganization scheme that the railroads themselves would pursue were they permitted.

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*The PC is operated by the Penn Central Transportation Corp. under grants from the American taxpayer.

In particular, the plan requires (1) greater compensation from Amtrak for passenger service provided by the railroads, (2) the abandonment of thousands of miles of branch lines, (3) renegotiation of the labor contracts, and (4) government loans (to the tune of about $5 billion) to finance repair of the property. Will it happen? Well, only approximately. There is strong political opposition to each of these measures, and the resulting legal battles promise to keep attorneys and politicians exercised for years to come.

Perhaps you wonder how the author, schooled in the lore of radio astronomy, fits into this picture. (Then again, perhaps you don't.) Well, G. S. S. inhabits a small cubicle in downtown Philadelphia and helps in the development of a computer simulation model of the railroad. Presumably this model will allow rational evaluation of the various reorganization plans without the necessity of spending a lot of money. Additionally, as a result of a dubious reputation for having "nimble lips" and the ability to write complete English sentences, I am often asked to give presentations to various groups of vice presidents. Indeed, I had dinner with the number one man in the PC this week, and promptly assaulted him with my ideas for improving service while he attempted to digest an inferior eggplant parmigiana. Unfortunately, this gentleman, while intelligent, is a lawyer, and doesn't know a spike from a slumbercoach. Picture, if you will, the long-term consequences for NRAO should that organization be headed by a businessman rather than a scientist.

Is it interesting? Well, it was. Frankly, I miss the excitement and independence of astronomy, so my tenure here may be short. Nonetheless the railroad is exceptional among man's devices; it is more than simply a crudely fashioned object of utility. It transcends itself, and often manages to touch us emotionally, taunting us with promises of melancholy freedom. Imagine for a moment standing in an open vestibule on the night train to New York. The bleak industrial landscape of New Jersey slides by in the dark as steel wheels clang and chatter on the rails. A cold wind, tainted by dust and steam, assaults your face as you strain to watch the signals sequence along the right-of-way. I would be lying if I said the goosebumps are less now than before.

Southern Railway's train #8 coming into CV

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COFFEE TOPICS

After about ten years of retirement an old Green Bank institution has been resurrected. Roughly once a week a very informal discussion session is organized around the afternoon coffee break in the Cafeteria. This idea dates back to the days of our first director, Otto Struve, but fell into disuse in the mid 60's.

The topic is usually astronomy, and the discussion is usually centered around a visiting observer, but we're open to all sorts of suggestions. For example, rumor has it that there is a scientist coming to the valley to study cave bats. Somebody like this would be a refreshing break from the normal coffee banter.

Anyone is welcome, and if you're interested, keep an eye on the electronics bulletin board or the one outside Dr. Howard's office. We'll try to post a notice at least a day in advance. Again, feel free to suggest speakers or far-out topics of interest.

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