ARGUS SETI NAAPO
North American AstroPhysical Observatory

North American AstroPhysical Observatory (NAAPO)

Cosmic Search: Issue 10
(Volume 3 Number 2; Spring (Apr., May, June) 1981)
[All Articles & Miscellaneous Items]

Webpage Table of Contents (Bookmarks)
(Internal links to items in this webpage)

[Note. Use Back button (or <Alt>+<Left Arrow>) to get back to this Table of Contents after you have clicked on a link and viewed the article.]

Codes Used Below:

P: Starting page of article in magazine; A: Author(s); T: Title of article

Space Travel and Life Beyond the Earth

By: E.J. Öpik

E.J. Öpik

Even in antiquity, at the age of mythological fantasies, there was understanding among the sages that the Earth is a globe and that beyond it there could be other inhabited bodies similar to our Earth. In these speculations, the Moon as a possible candidate for extra-terrestrial life came first. Thus, in his epic describing the creation of the world, Hesiod, the ancient Greek poet of the 8th century B.C., was guided by far-reaching analogy in saying that there, on the Moon—or Selene—are mountains, cities and temples. Although this saying was naive and contrary to modern knowledge—as we know, there is no life on the Moon—this bold suggestion shows deep vision and deserves our respect; it went against popular beliefs and myths of the time, by daringly maintaining that the Earth and the Moon are both celestial bodies, with similar properties. At present we know, indeed, that the difference is only one of size—a quantitative, not a qualitative one. Of course, there is no air or water on the Moon, while on Earth these life-sustaining substances abound; yet this seemingly qualitative difference is a direct consequence of a quantitative one: with its smaller mass and weaker gravitation, the Moon is unable to keep an atmosphere and cannot prevent it from dissipating into space.

When presented in the form of verses, such "unorthodox" views were accepted or tolerated by the audiences of antiquity. Otherwise, however, the wise men were not allowed to express freely their views against current prejudice or dogma: it was dangerous.

After a long period of hidden scientific progress during which astronomical truths were repeatedly uttered but suppressed or forgotten, the Copernican revolution of thought brought ultimately an understanding of the nature of the planets as bodies similar to our Earth. One went to the other extreme—as Hesiod did in antiquity—in accepting the habitability of all these bodies, with terrestrial conditions and forms of life, and with similar human-like inhabitants. Especially popular was the Moon in this respect, such as in the fantastic stories of Cyrano de Bergerac in the 18th century, and later on.

However, the subsequent progress in astronomy, physics, chemistry and the biological sciences soon caused disappointment in such "optimistic" speculations. It became obvious that the Moon is a lifeless body without an atmosphere where every exposed living being would die instantaneously. All those fantastic stories—about humans visiting the Moon, moving there freely around, unprotected and encountering "selenities" or the imaginary inhabitants of the Moon—have turned out to be even worse than mere fiction: the happenings so described are simply impossible. In comparison, Dean Swift's Gulliver's Travels are full of realism.

Despite this, because of our technical know-how, the Moon has now acquired new attractions which a desert spelling death could not otherwise offer. Travel to the Moon has now become a reality. American astronauts have been walking there, protected against the airless vacuum by space suits, as are the divers on Earth who carry their breathing apparatus with them under water. Russian robots, radio controlled automatic vehicles or "lunokhods" have been doing the same, in anticipation of carriers with human crews. At present such visits to the Moon are only in an experimental stage, serving the purposes of scientific exploration as well as of "technical reconnaissance". Yet in the future—we cannot foretell when—we expect that human habitations will be installed on the Moon, airtight cities under glass cover where plants are grown in the always available sunshine. During the lunar "day" of a fornight's [sic; "fortnight's"] duration the excessive heat must of course be checked by air conditioning, while during the extreme cold of the lunar night of same length some kind of storage heating will be needed. Water could be obtained chemically, with the aid of solar energy, from the hydrogen and oxygen content of lunar rocks and dust (as in the time of Moses from rocks of the Sinai desert). This could appear as a millionaire's paradise—but in the future, with the supreme technological achievements, all mankind could be millionaires by present standards! The changing aspects of weather, wind, rain or snow, could be a matter for artificial control, if for no practical purpose but to dispel the boredom of uniformity.

In the remote future the Moon could become in such a manner a place for emigration, after on our over-populated Earth every bit of land—and sea—being occupied, including all our deserts (which still are more attractive than the Moon!), polar tundras, and even the sea which can be covered with gigantic rafts carrying soil, gardens and fields. The area of the Moon equals some 40 million square kilometres, amounting to about 40 per cent of our continental area. When completely exploited by way of artificial methods, the Moon could feed and shelter a population of 10,000 million—21/2 times that of the present population of the Earth, being then about as densely populated as present China or the Netherlands.

Because of the lower gravity, as compared to their earthly motherland, these lunar inhabitants would feel 6 times lighter than here. Even the fattest man could swing himself up a tree with the speed of a monkey, or jump unharmed from the second floor of a house and run faster than a top marathon runner.

On the other hand, these lunar glass cities will be subject to the permanent danger of meteorites. Over the years a stony fragment from space could pierce the glass roof of a city, so that air would escape through the hole into the surrounding vacuum. The danger is similar so that for stratospheric aircraft with pressurized cabins when they move in thin atmospheric strata unfit for human breathing and when a hole or a crack in the fuselage could arise. To guard against such catastrophes, adjacent lunar cities must be separated from each other by airtight walls and doors, so that the effect of the meteorite could be confined to a small area. Also, one could imagine some balloons freely floating under the roof, with flat airtight valves on top which automatically would be carried by the air stream toward the hole (most holes will be small!), to close it until repairs can be made.

One could ask—does such emigration into space make sense? It might appear simpler to restrict the proliferation of the human race and stay in our old homeland—our Earth. To this one could point out that a lasting limitation of the birth rate, and especially on a voluntary basis, is not feasible. Prolificacy depends on heredity and tradition. In a population there will always be strains with a higher birth rate which do not want to be restricted; their number would increase faster than the rest of the population until they become dominant. Ultimately the logic of Nature will step in, and the three Horsemen of the Apocalypse—Famine, War and Plague—will take over control. Such forcible natural restrictions will inevitably be at work when the voluntary method fails. Until now this has been always Nature's way of population control, while the colonization of celestial bodies would greatly defer the critical phase of population growth for our Humanity.

A larger population, or a greater Humanity not only has the advantage of a greater technical and economic power (which is also a pre-requisite for the colonization of space); it also leads to a greater cultural and technological diversity. Geniuses are a relatively rare occurrence; the larger the population, the greater is their expected number. Although but single individuals, each of them is capable of influencing the entire population irrespective of its size. The cultural progress of humanity depends chiefly on the absolute number of geniuses, not so much on their relative number. Therefore one could surmise that the qualitative progress of a humanity depends on its size; larger populations should advance faster than the smaller ones because there would be more individual stimulants, each affecting the entirety of the population in contact with them. That is why one could assume that a more populous humanity would evolve technically and culturally faster than a less numerous one. One could expect therefore that, with the colonization of other members (planets) of the solar system, a more populous humanity would evolve faster towards perfection than a smaller one of the same quality—toward the imaginary goal of "demi-gods" and this simply because of a greater number of outstanding individuals, each capable of transmitting his creations to the entire Humanity.

It may be noted that theoretical research in this direction, culminating in conferences, is already proceeding. Sponsored by NASA and originated by Princeton (New Jersey) Physics Professor Gerard O'Neill, the project is concerned with placing artificial habitats for populations of millions in the Lagrangian Point "L5" on the lunar orbit, trailing behind the Moon at equal distance from Moon and Earth. Because of planetary perturbations, this position is somewhat unstable over long periods of time, but with very small amount of "steering" the space city can be kept there indefinitely, much easier than keeping a car on a road.

To be considered next after the Moon are the asteroids. The solar system contains a great number — hundreds of large and thousands of smaller size planetlets, from a few hundred to a few tens of kilometres in diameter. Of course they are without an atmosphere, lifeless like the Moon, but equally suitable for transforming them into celestial greenhouses by enclosing into glass shells. However, despite the large number, their total area is only about one-tenth of the lunar area, and the distances are some 1000 times greater, so that it would take about two years for a space vehicle to reach them, while a trip to the Moon would last but a few days. Therefore, colonization of the asteroids would only be of secondary importance, the Moon taking unquestionably the precedence. The asteroids could be chosen as domiciles by secluded groups of space settlers, thus creating greater variety in the future humanity of space in the shape of small nations or ethnic communities with their originality, as at present is also the case with the human population on Earth. The asteroids could also be used as intermediate stations or bases on more distant voyages: most of them are in the space beyond the orbit of Mars, half-way to Jupiter, the dominant planet and "Rosetta Stone"* (*The stone with simultaneous Egyptian and Greek inscriptions which furnished the clue to the Egyptian hieroglyphs.) of the solar system. These minor planets could be compared to the islands and archipelagoes of the Pacific, the stepping stones to the continent of Australia.

It may appear somewhat odd that in the proceeding, our first concern was for the small lifeless bodies of the solar system — the Moon and the asteroids. Yet because their surfaces are completely airless and lifeless, there is no locally established hostile environment except a dry desert surface covered with dust, sand and rocks. There is no need to fight the inimical surroundings — the environment can be created at will as desired when there is solar or nuclear energy and the advanced technical skill. The required know-how and material power will undoubtedly be available after thousands or millions of years of technical and moral progress — unless destructive instincts taking hold of the atomic bomb (the super-bomb) will sweep us off our planet.

Different is the situation with the larger bodies of the solar system, the "full size" planets. Except for Mercury, the smallest of them, the nearest to the Sun and devoid of any significant atmosphere, the other planets have their own atmosphere, climate and weather. This makes their visiting and colonization much more difficult than in the case of a completely lifeless empty desert surface in a vacuum. Of course, we need not reckon with hostile living beings within the boundaries of the solar system, and certainly not with intelligent species, attacking and fighting us humans; not even on Mars, the most popular of the planets and the object of so many fantastic suggestions and stories. A much greater real danger is presented by possible virulent microorganisms to which humans are not immune, and especially by their importation to Earth. Yet undoubtedly our modern medical science should be able to keep new epidemics under control — new diseases or bacterial mutations appear from time to time on Earth, too, and are successfully tackled. And, perhaps, H.G. Wells may be right in his fantastic story, "War of the Worlds," picturing an imaginary invasion of Martians equipped with ultra-superior weapons; the story tells that they succumed to the most common terrestrial bacteria for lack of immunity because they were not subject selectively to infection in the dry sunny and "healthy" Martian climate. We earthlings have been tried by all kinds of germs, and viruses of our common cold could affect the Martians as a deadly plague. Although those gigantic spiderlike Martians of Wells were but a creation of the writer's brain, his argument about germs and immunity appears to be quite plausible.

Our present information regarding Mars is sufficient to assert that, after the Moon, this planet could come next as a favourable and desirable seat of settlement for a humanity of the future. Setting aside all kind of wishful dreams about this planet, either based on insufficient knowledge or simply on fantasy, the situation is at present more or less clear.

There are no "canals" on Mars nor intelligent beings who purportedly have built them — not even in the past. The conditions for life to exist there are harsh if not quite forbidding. With the extreme scarcity of water, only available as thin vapour in the atomosphere, or as a snow deposit mixed with dry ice (carbon dioxide snow) at the poles, and with an atmosphere 100 times thinner than ours (as in our stratosphere 36 kilometers above the ground), some primitive life could still exist on Mars, such as algae, mosses and perhaps unicellular species of the animal kingdom. The climate is full of sunshine but cold with extreme diurnal and seasonal fluctuations, rising to 15 or 20°C (59-68 deg F) in daytime but falling to a Siberian winter low of - 60°C (- 76 deg F) each night even at the equator. On Earth there is nothing comparable to such extremes. There are no seas which, on Earth, were essential for the development of life from lower to higher forms: fish were the ancestors of our land animals, until their descendants could crawl out of the water. Even the very presence of any life on Mars is subject to doubt and requires direct confirmation. In all appearance there will be no challenge to the human settlers of Mars except the natural environment. The atmosphere consists mainly of carbonic acid gas (carbon dioxide) — same as arises from burning coal or is exhaled in breathing. The gas itself is not very poisonous except in large quantities (not as carbon monoxide) but is unfit for breathing. Oxygen is pratically absent from the Martian atmosphere. However, the actual composition of the Martian atmosphere is of little consequence for visitors from Earth: even if it were pure oxygen, when exposed in "open air" we would die there instantly, blood boiling into our lungs at the low atmospheric pressure. Therefore on Mars, as on the Moon, one should build airtight glass covered habitations, hermetically isolated from the free atmosphere. Oxygen could then be obtained electrochemically from the atmospheric dioxide, a much easier procedure than from the rocks on the Moon. The surface or settlement area of Mars is four times that of the Moon and considerably exceeds the area of terrestrial continents. The meteoritic hazard is there very much less than on the Moon because of the protection offered by the atmosphere, however thin it is. From all this one could infer that Mars may perhaps become the most important place of emigration for a future superhumanity. And this despite some setbacks — the large distance which would require 9 months for a one-way trip, and the considerable gravitational field which would make descent and separation much more difficult on Mars than on the Moon, but still easier than on Earth. Martian surface gravity, 21/2 times weaker than on Earth, is intermediate between that of our planet and the Moon.

Of the other planets Mercury, the first and closest to the Sun, is most similar to our Moon, lifeless and with an almost negligible atmosphere. Its size is also intermediate between Mars and the Moon. The surface, covered with craters as that of the Moon, could also be suitable for erecting the cosmic glass dwellings. The area of Mercury is about twice that of the lunar surface, and a trip to Mercury would take several months — not much shorter than one to Mars. Because of closeness to the Sun, Mercury receives about six times more solar heat per unit area than the Earth, so that the glass roofs of the cities should be protected against excessive heat by reflecting mirrors, or refrigerating machines working with solar radiation could be used for air conditioning and control of the climate. In the latter case there should be large external surfaces radiating the excess heat back to space, something which renders things on Mercury more complicated than on the Moon or Mars.

The next planet, Venus, the second from the Sun and our sunward neighbour, the bright evening — or morning star, Vesper or Lucifer, is almost the size of the Earth and has a very thick atmosphere. Quite recently it had been the object of wistful dreams, pictured as an earthlike seat of life but with a warmer climate, or something of a garden of paradise. The evidence gradually acquired over the past decades has led to a great disappointment: not a paradise, but a virtual burning-hot, poisonous hell! There is definitely an atmosphere, even too much of it — 40 to 90 times denser than ours. Yet it is devoid of oxygen, its moisture content is extremely low, and it consists chiefly of carbon dioxide as on Mars but in several thousand times greater amounts. There is no liquid water on Venus, and its surface temperature, + 470°C or 880°F, is that of red-hot iron. The atmosphere is filled with dust or haze, shielding the surface which is invisible in ordinary light but can be explored by radar or radio (microwaves). Outwardly the haze presents itself as an impenetrable everpresent cloud layer, consisting — not of water droplets of ice crystals, but of hydrated sulphuric acid! No astronaut could ever land on this infernal hot and poisonous cauldron unless its climate and atmospheric composition could be transformed by injecting a whole oceanful of water (the indigenous water of Venus is not available, being probably locked in its near-surface unsaturated magma). This would create true clouds and purifying rain, clearing the atmosphere and lowering the temperature of the surface. The excessive amount of carbon dioxide could be removed through vegetation and oxygen set free as on Earth: however, even with abundant availability of water the process could take hundreds of millions of years to accomplish. It may be superfluous to say that such an imaginary project of improving Venus, the goddess of love, and transforming hell into paradise, must be virtually an impossible task even for a most advanced technological civilization. It is only a "mental experiment", to remain "on paper" forever as many other interesting but unreal projects. Venus is incorrigible!

The other, outer planets — Jupiter, Saturn, Uranus, Neptune and Pluto — are too far away, with very cold extended gaseous envelopes, partly "bottomless" or without a solid or liquid surface underneath. They are unsuitable for terrestrial type of life, nor can they be transformed properly, at least not within the foreseeable limits of human technology. Nevertheless, on Jupiter, in the depths of its bottomless atmosphere, some possibility of non-terrestrial type of life has been suggested. The basic substances of organic matter, such as ammonia and methane, are there present, and some biologists think that there, in the outer parts of the thick dense envelope to which some sunlight reaches, could float, swim or fly organisms which do not need water as a body liquid but are using liquid ammonia instead at temperatures well below the freezing point of water. In the deeper, denser and warmer but dark layers, there could float water-based organisms feeding on the detritus of organic matter sinking downwards from the upper layers in the same manner as some life is sustained in the deep dark waters and bottom of our oceans. However, from the standpoint of terrestrial life the conditions must there be very strange, and we will not further concern ourselves with them.

We have now finished with a review of our "nearest" surroundings called the "Solar System".

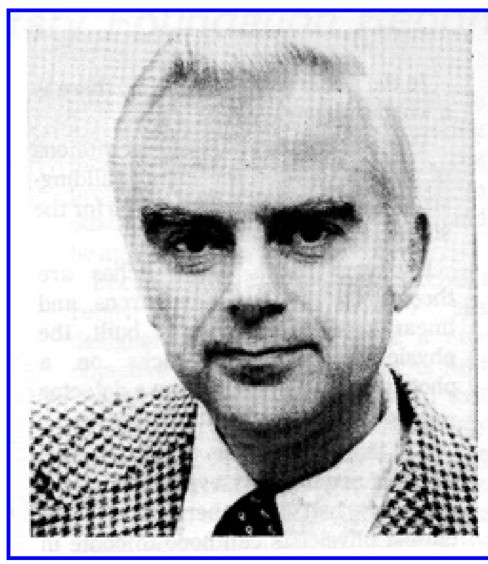
To be continued. In the next issue the author looks beyond the solar system to the stars.

E.J. Öpik

Ernst J. Öpik, an astronomer at the Armagh Observatory, North Ireland, has written numerous articles on life and intelligence in the universe. Dr. Öpik, who is now 88, was Editor of the Irish Astronomical Journal until last year. This article is based on a talk Dr. Öpik gave to the Estonian All-World Women's Club in New York, June 10, 1974, and is reprinted from volume 11 of the Irish Astronomical Journal with the author's permission.

Space Travel and Life Beyond the Earth

By: Frank D. Drake



Is intelligence a fluke? Are we the result of a series of remarkable unique events, the likes of which may never occur in the right order on any of the countless worlds in space? It's an important question, of course, not only because of its religious and philosophical implications, but because the answer strongly affects the plausibility of actions we take to detect intelligent life in space.

The lords of paleontology have not been cordial to SETI on this point. The records in the fossil-bearing rocks seem to show evolution to be a haphazard process, with a unpredictable twist here, another there, eventually leading to an extensive biota of complicated creatures of unpredictable anatomy and maybe, but very improbably, intelligence. However, some people have thought that evolution is not a random walk through the cosmic encyclopedia of possible life forms. They suspect that all of the twists and turns of evolution are like the random wavelets which go here and there across the face of the ocean. Throw in a cork and it bobs to and fro, now left, now right. But wait a while and it will always move overall in the same direction, the result of an invisible but dominant current. Could not the evolution of intelligence be so described? Could it not be that, indeed, nowhere in all of space and time will there be other creatures exactly like us; yet in most biotas there will be an intelligence like ours, the result of an unrecognized but powerful driving force in evolution.

Now there is evidence that this may be exactly what happens. Quietly, a careful, highly admired, paleontologist has made a study of the history of inelligence on earth. He is Dale Russell, of the National Museums of Canada, an expert on the creatures of the Mesozoic era, the age of reptiles including the great dinosaurs. He and others have achieved an important goal, a means of estimating the intelligence of a creature from its brain weight and body weight, both of which can be deduced sufficiently accurately from fossil remains. A relationship has been developed which tells how much brain mass a creature needs just to keep it alive and functioning like a mindless machine. Brain mass in excess of this can be devoted to intelligent activities. This thinking portion of brain is called "encephalization," a heady word if you will pardon me!

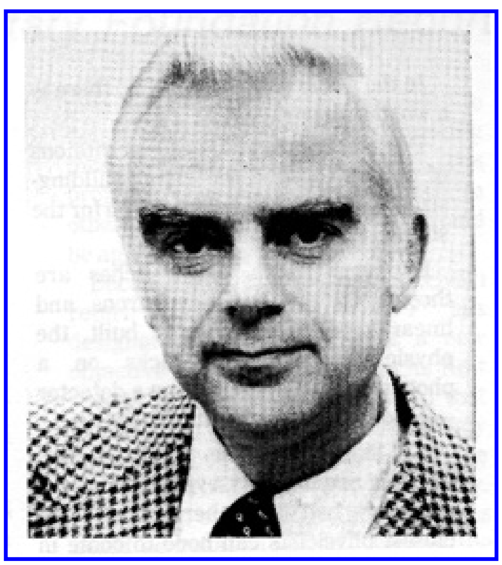
Russell has found, to his and others' surprise, that encephalization has increased at a remarkably uniform, steady rate for at least half a billion years. As reptiles, mammals, birds, and fish have experienced variations in their anatomy and their success as creatures, the "ripple on the sea," the level of intelligence has marched ahead like a well-trained army. The upward trend is visible in even the most recent past, and one can predict future levels in intelligence, providing that the actions of inelligence itself do no affect the rate of improvement either upward or downward. These studies seem to shout loudly that we can expect to find intelligence wherever intial circumstances and time have been sufficient.

An especially fascinating find is the discovery of some small dinosaurs with such large brains that they were on the verge of becoming intelligent. Saurornothoides, a resident of western Canada and Mongolia was a rather charming creature some four feet tall. It stood on two legs, and had hands with something like an opposable thumb. It could manipulate things with these hands, and was in a sense already a hunter-gatherer. It all sounds familiar, doesn't it? Saurornothoides was not quite smart enough to survive the cataclysm which wiped out every creature weighing more than about 50 pounds some 65 million years ago. That was the extinction of the dinosaurs, an event which wiped out many other creatures as well, and almost surely was caused by the dreadful climatic effects of the collision of a small asteroid with the earth. Had the asteroid waited just a few more billion years to strike the earth, Saurornothoides might have become truly intelligent. It might have found ways to survive a cataclysm. It might have become us, and we might have been small dinosaurs, all millions of years before our time.

Asteroids will smash into the earth again. We are probably smart enough to survive. But if we aren't, then just as it was 65 million years ago, there are candidates for the next intelligent species waiting in the wings.

A short time ago, a famous television newscaster asked me in an interview what the next intelligent species might be. He expected to hear the name of an exotic monkey or other primate, and that may well be the right answer. But I gave him another name, the name of creatures who are known to all of us, and who have demonstrated not only high intelligence (as anyone with a birdfeeder knows) but already the ability to prepare for long periods of adversity, even the coming of an asteroid. Squirrels! They are already up on two feet and using their hands with great dexterity. They even climb trees better than you or I! Give them a few million years and maybe the squirrels will be us.

The newscaster thought it was a joke and I doubt that you will ever see that part of the interview telecast. But it is not funny to the cosmos; the cosmos has no prejudices as to what form intelligence may take. We now know it gives every creature a real chance at it. The variety of intelligent creatures must be far beyond what we can imagine.



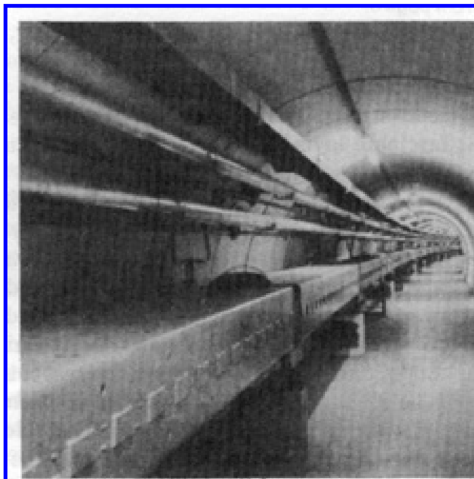
Dr. Frank D. Drake is Director of the National Astronomy and Ionosphere Center of Cornell University which includes the Arecibo Observatory. Dr. Drake is a member of the Editorial Board of **COSMIC SEARCH**.

What Makes Atoms Tick?

By: Earle Holland

In the world of basic physics, there is a wonderful paradox.

Physicists spend hundreds of millions of dollars to build the giant, building-sized machines needed to search for the smallest parts of nature.



Fermilab

But even when the switches are thrown on the huge cyclotrons and linear accelerators they've built, the physicists only see tracks on a photographic plate, clicks on a detector — proof of where a particle has been.

It's like finding the fossilized footprints of ancient man, evidence that our ancestors had been there. That's the closest physicists can hope to come in their search for the fundamental particles in nature.

Among these are "quarks." All of the particles that make up a class of hadrons — or so the theory goes — are composed of quarks, always thought to be in pairs or triplets. It's the way these combinations are formed, what charge they carry, how they interrelate, that is ultimately responsible for the diversity of the universe.

Scientists are fairly sure that the particles are there. But believing is much easier than proving. And keeping track of the variations of this new sub-sub-atomic world has become a science itself.

The quarks come in flavors, curiously labeled **up, down, strange, charmed,** and **bottom**. They come in colors, too — red and blue — but you wouldn't recognize them as colors. The labeling is purely arbitrary, assigned on the whim of the researchers who work with them.

The best known of the hadrons are protons and neutrons, but there are also pions, lambdas, and others. There's another class of fundamental particles called leptons. Physicists also ponder the relationships of positrons, bosons, mesons, gluons, muons, and neutrinos.

But it is the quarks that make up the nuclei in the atoms which make up the molecules which make up all that we are and all that we know.

It's a race among scientists, tinkerers at heart, who are rushing to take the atomic nucleus apart like an alarm clock to see if they understand what makes it tick.

Inside the Van de Graaf Laboratory at The Ohio State University Research Foundation, a team of physicists hurl sub-atomic particles together at nearly one-tenth the speed of light.

These microscopic collisions and the debris they leave offer clues to the composition of the atom and, more precisely, its nucleus.

"We take some energetic particle like a proton or a neutron and crash it into the nucleus," explains Hershel Hausman, Ohio State physics professor. "Something happens inside the nucleus and pieces come flying out.

"By studying these pieces, we try to reconstruct the nature of the particles that were inside that nucleus before we hit it, and understand how it is put together."

This is the thrust of nuclear and particle physics today. These infinitesimal projectiles hurled at atomic targets are yielding a cornucopia of different particles.

A key to understanding the universe is locked inside the atomic nucleus.

But physicists from Isaac Newton to Albert Einstein to their present-day descendants look for an orderly universe, one that's put together from simple parts. And a bushel basket of different particles tends to confuse this order.

So the theory exists that the fundamental particles are the basic building blocks and of these, the quarks seem the most basic. Quarks, so the theory says, exist in combinations, bound together by the "strong" force, one of four such fundamental forces governing the universe.

'Free quarks' shake current theories

But recent Stanford University experiments seem to dispute this. "Free quarks," those existing singly rather than in pairs or triplets, were observed. The finding is enough to shake the current understanding of how the nucleus is put together. But this work hasn't been duplicated to date.

"It's an incredibly difficult experiment to do," explains Richard Boyd, physics professor. Physicists are professional skeptics. Until we've seen this confirmed in another way, we're not very willing to accept it."

So physicists Boyd, Hausman, Timothy Donoghue, S. Leslie Blatt, Harold Suiter, and Larry Dries set about trying to verify the Stanford results and look for free quarks, this time using Ohio State's huge Van de Graaff generator in a way it never had been used before.

While the Van de Graaff generator has been used for nuclear physics for years, Boyd realized that the more than 15-year-old machine could be used as a detector of the free quarks — if they are there.

The generator normally serves as a source of particle beams for the physicists' experiments. To do this, gases are pumped into the top of the massive device where they are heated by radio frequency (RF) power. This causes collisions between the atoms; the bits and pieces from these collisions produce the particles. These are then accelerated to high speeds and form the beam.

Not able to disprove Stanford experiment

A huge magnet at the bottom of the generator bends the beam, filters out specific components, and then aims it at one of the seven major pieces of particle detection apparatus. "We did our experiment well in excess of the sensitivity needed to test the assertion of the Stanford experiment and we didn't find anything," Boyd explains.

"We can't say that they were wrong. We were only able to span a restricted range. It's possible that the Stanford researchers could be seeing quarks outside our range.

"So we're not able to disprove them. On the other hand, we were able to reasonably, convincingly reject what may well be the most likely hypothesis" for the existence of free quarks, Boyd says.

But the point, Hausman adds, is that OSU physicists were able to use the Van de Graaff generator as a mass spectrometer that was two orders of magnitude more sensitive than would be required to detect the quarks.

Other tests for the Stanford effort

Other experiments are on the drawing board for the Ohio State team in hopes of understanding the Stanford work. To find the free quarks could upset modern particle theories.

"The Stanford result is so crucially important that, if it is right, we really want to know it as soon as possible," Boyd says.

The Van de Graaff generator is the largest of its type in the country. First built in 1963 with support from the National Science Foundation, it accelerates particles within the beam to energies of seven million volts, roughly one-tenth the speed of light.

"It's the black box from which we get our beams of particles to probe the nucleus," explains Donoghue.

Back in 1970, Donoghue and his research group made a unique addition to the Van de Graaff — equipment that focuses on a specific property of the proton beam.

While other major developments to do the same thing were underway at laboratories in this country and in Germany and Russia, only the Ohio State project was successful. "We did some very innovative things that made the project a success," Donoghue says.

An unexpected finding at OSU

This work has allowed the OSU team to pursue some very fundamental questions regarding the nucleus. Some of their studies have suggested that, in some nuclei, the very strong force between a pair of neutrons in the nucleus may be slightly different than the strong force between a pair of protons.

The finding implies that the two are not the same, as had been thought, and therefore the charge symmetry of nuclear forces may not be the same in all systems. "That is a very important result, if confirmed," Boyd says.

To understand our universe in all its vastness we need to understand the tiniest particles of which it is made.

In another group of experiments, Hausman investigated another kind of symmetry within nuclear interactions. That work produced information about a kind of nuclear structure — called a "doorway state" — that lasts only a billionth of a billionth of a second — a micro-instant long enough to provide a glimpse into the nucleus.

Work early last year brought Leslie Blatt and the other physicists an unexpected finding that physicists never thought existed and that may lead to a better understanding of one of nature's foremost powers — the "strong nuclear force" that binds together atomic nuclei.

Blatt detected the existence of a "second harmonic giant resonance," a new form of nuclear excitation. This new phenomenon can be described this way: A ringing bell radiates sound energy at one fundamental frequency. But it throws off energy at specific multiples of that initial frequency. These are called harmonics.

An atomic nucleus, like the bell, radiates energy when it is bombarded with positively charged particles, or protons. Instead of sound waves, the nucleus gives off gamma rays strongly at one specific frequency.

Secrets locked inside atomic nucleus

While harmonics in sound are quite common, scientists hadn't predicted them from the atomic nuclei. But this is precisely what Blatt's group found. "The original phenomenon — called the giant resonance — has been observed for some 30 years. Now we have discovered strong radiation at a second frequency approximately double that of this fundamental frequency," he says.

"And we suspect that the excited atomic nucleus may radiate in a harmonic pattern of several multiples of the fundamental frequency."

In a sense, the entire challenge now rests with the secrets locked inside the atomic nucleus. There lies the key to much understanding. A unique comparison can be made between the micro-universe of the atom and the macro-universe of space.

Boyd is looking at the precise chain of reactions that allow the burning of stars. The specific fusion process has long been a curiosity to physicists. For normal stars, the process is fairly well understood.

But for the newer oddities of the universe—the heavy neutron stars and the black holes that fascinate laymen and scientists alike—the process isn't that clearcut.

Because these objects are so dense, the nuclei of the individual atoms are fused together into one big nuclear mass. On the periphery of these stars, it's a different story.

In normal stars, Boyd says, the probability of collisions between nuclei and random particles allows for such meetings perhaps only once in, say, a million years. But in neutron stars, he adds, matter is so dense that collisions occur every few seconds.

In the laboratory, Boyd and others are looking at sections of the intricate nuclear process of fusion that takes place on the surface of stars, trying to understand the fueling of these stellar fires.

But other experiments lie ahead. The proton, a positively charged particle, has long been thought to be stable, immune to the radioactive decay of other particles. Boyd and Donoghue are planning an experiment that provides a fundamental test of the theory.

"It's still an open question whether protons are unstable or not. If, in fact, we find out that the proton is unstable and we can get a rough idea of its lifetime, then we can say that the theory which predicts that the proton is unstable has satisfied a crucial test of its validity.

"Proton lifetime experiments are perhaps the hottest experiments being done in physics today," Donoghue says.

Free quarks, proton decay, other possible fundamental particles—these are the treasures physicists are hoping to find. It's like peeling layer after layer on an onion, continually discovering something new each time.

And the layers are, perhaps, endless.

"What Makes Atoms Tick" is reprinted from "Quest" a quarterly publication of the Ohio State University.

Earle M. Holland is University Research Editor, Assistant Director of Communication Services and Editor of "OSU Quest" in the Office of Public Affairs of the Ohio State University. He holds a Bachelor's Degree in Journalism and Mass Communication from Auburn University (Alabama). He has received writing awards from such organizations as The Society for Technical Communication, The Associated Press and the Council for Advancement and Support of Education.

PERPETUAL INDEX

By: Editors

Vol. 1, No. 1, January 1979

Vol. 1, No. 2, March 1979

• "The Quest for Extraterrestrial Intelligence" by Carl Sagan
• "Circles of Stone and Circles of Steel" by Don Lago
• "Space Colonization and SETI": an interview with Gerard K. O'Neill
• "The Case for SETI" by Richard Berendzen
• "Generalized Life" by Jerome Rothstein
• "Man's Role in the Galaxy" by R.N. Bracewell

Vol. 1, No. 3, Summer 1979

• "Neutrinos for Interstellar Communication" by Jay M. Pasachoff and Marc L. Kutner
• "Extraterrestrial Politics" by Michael A.G. Michaud
• "Bio-Cosmology: A New NASA Thrust" by B.M. Oliver
• "Minds and Millenia: The Psychology of Interstellar Communication" by Michael A. Arbib
• "We Wait and Wonder" by John Kraus
• "Extraterrestrial Life: Where is Everybody?" by Jesco von Puttkamer

Vol. 1, No. 4, Fall 1979

• Forum: An interview with John A. Wheeler
• "My Brother Karl Jansky and his Discovery of Radio Waves from Beyond the Earth" by C.M. Jansky, Jr.
• "What It Was Like Before Ozma" by Louis Berman
• "A Hymn to Life in the Universe" by Don Lago
• "Quest Beyond the Stars: Are We Alone?" by Jesco von Puttkamer
• "The Possibility of SETI From Space" by Roy P. Basler

Vol. 2, No. 1, Serial No. 5, Winter 1980

• "The Grand Analogy: History of the Idea of Extraterrestrial Life" by Trudy Bell
• "It's a Nice Planet to Visit, but I Wouldn't Want to Live There" by Virginia Trimble
• FORUM: Billingham on NASA and the Exploration of Space
• "A Strange Radiation from Above" by John Kraus
• "Strategies for the Search for Life in the Universe: A Joint Session of the International Astronomical Union" by Michael Papagiannis
• "Towards a Cosmic Language" by Hans Freudenthal

Vol. 2, No, 2, Serial No. 6, Spring 1980

• "The Aliens in Our Oceans: Dolphins as Analogs" by Bruce E. Fleury
• "Marconi" by George H. Brown
• "The Chief Entities" by I.J. Good
• "Communication with Extraterrestrial Intelligence" (Munich conference) by Jill Tarter
• "Life in the Universe" (Paris conference) by Jill Tarter
• "Where Are They" (Maryland conference) by Virginia Trimble
• "Space Industrialization: Opportunity for Space Science" by G. Harry Stine
• "In the Time Machine" by Don Lago
• "Allocating the Radio Spectrum" (Geneva conference) by Vernon Pankonin

Vol. 2, No. 3, Serial 7, Summer 1980

• "Putting Our Best Signal Forward" by Leonard David
• "A Speculation on the Influence of Biological Immortality on SETI" by Frank D. Drake

• "Diana Waves Back: The First Moon Bounce" by John Kraus
• "Confronting Political Realities" by Marcia S. Smith
• "Strategies of Searching for Extra-Terrestrial Intelligence" by Nikolai Kardashev
• "Science Communication in the Mass Media" by Joan Lurie

Vol. 2, No. 4, Serial 8, Year End 1980

• "The Recognition of Alien Biospheres" by James E. Lovelock
• "Strategies of Searching for Extra-Terrestrial Intelligence (Part Two) by Nikolai Kardashev
• "SETI" by Frank D. Drake
• "Why is Scientific Writing Unintelligible?" by Sharon Dunwoody
• "Technical Development and Colonization as Factors in the Long-Term Variation in Limits to Growth" by Brian A. Tinsley
• "In Search of Extrasolar Planets" (EPF Report) by George Gatewood

Vol. 3, No. 1, Serial 9, Winter 1981

• "SETI and the Spectral Classification of Stars" by John Bahng
• "Not As We Know It" by Isaac Asimov
• "In Which Klingons Became Chimeras" by Frank Drake
• "Universal Chemical Evolution" by Robert Rubin
• "ETI in the Classroom" by Philip Barnhart

College Courses on "Life in the Universe"

By: Editors

College courses on "Life in the Universe" are becoming increasingly popular. Although dealing mainly with astronomy, many of the courses include much interdisiplinary material from such diverse areas as biology, medicine, psychology, physiology, semantics and communication.

We would like to include additional institutions. Please send information to Prof. John Kraus, Ohio State University Radio Observatory, 2015 Neil Ave., Columbus, Ohio 43210. Years given, attendance, a syllabus (if available) and other information will be appreciated.

In previous issues we have listed 29 colleges or universities offering or planning to offer courses. We list here two more instutions: The State University of New York at Albany and the New School for Social Research at New York, N.Y.

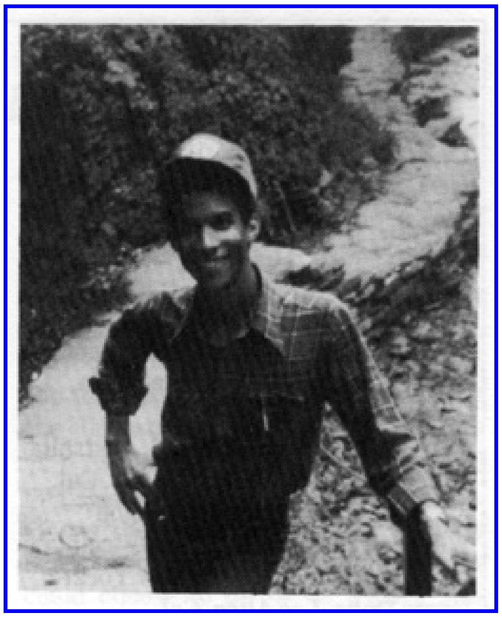
Institution: The State University of New York at Albany.
Instructor: Dr. Robert R. Creegan, professor of Philosophy.
Title: Borders of Science. (Phi 440 Q: a Jr.-Sr. Philosophy Course.)
Content: Some theory of perception and of reasoning, elementary astronomy topics, interstellar communication, UFO reports and theories, energy fields of the person, both normal and possible paranormal.
References: Kraus, "Our Cosmic Universe"; "The Cyclops Report," NASA; and "The Seti Report," NASA; Page and Sagan, "UFOs, a Scientific Debate", Creegan, "the Magic of Truth."
Year given: Once per semester since 1972.
Enrollment: Minimum 70, Maximum 200.

Institution: The New School for Social Research, New York, N.Y. 10011.
Instructor: Jeff Robbins.
Title: Other Minds/Other Stars
Content: Primary aim is to establish a more cosmic point of view from which we may better perceive our universe, ourselves, our past and conceivable futures, as one path among many possibilities.

References: Shklovskii & Sagan, "Intelligent Life in the Universe"; **COSMIC SEARCH**; Sullivan, "We are Not Alone"; Macvey, "Interstellar Travel"; Ridpath, "Messages From The Stars"; Lunan, "Interstellar Contract"; Sagan & Page, "UFO'S, A Scientific Debate"; Sagan, CETI; Jonas, "Other Senses/Other Worlds"; Patterson, "Evolution"; Brand, "Space Colonies"; Leakey & Lewin, "Origins"; Berendzen, "Life Beyond Earth & The Mind of Man"; Gribben, "White Holes."
Years given: 1979, 1980 (Spring Semesters)
Enrollment: 39 (1979), 40 (1980)

The Next Best Thing to Being There

By: William R. Dodson



This past year, as a summer student at the Kitt Peak National Observatory, I happened upon a rather interesting lunch-time discussion which the other summer students were having. It seems that they were wondering what the American public, since this was a national observatory we were all working at, was gaining from the research that was going on there. "What," one of the students asked, "would we tell some little old lady who, while being shown around the facility, asked one of us why she was paying x number of dollars a year for astronomy research, and what was she, as a consumer, getting out of the deal?"

We were all silent for a few moments, each trying to imagine what he would say to the woman. "Well," one of the students hesistantly began, "if astronomers didn't study the sun, as an example, we wouldn't have the understanding that we do today of, let's say, radio interference — or even weather; both short range, as in tomorrow's forecast, and long range, as in three hundred years ago and three hundred years from now."

We all smiled at the answer, but none of us said anything. It wasn't the most outstanding answer in the world, we all silently agreed, but it was an answer nonetheless. "But what about the other stars?" entertained one of the other students, thoughtfully. "Why do we study, for instance, the spectrum of Betelgeuse?"

"That's easy," interjected the student who had answered the question first, "we study the other stars so that we can better understand our star so that we can better understand the effects that our star has on our planet." He sat, staring at the others, awaiting their response.

"Hmmm," another student said, "so what about black holes and quasars and neutron stars and extraterrestrial intelligences and other wonderful things like that. Why do astronomers bother with those? They have no direct effect on our little sun. And even if, say, we did find that we had to alter some theories and realized that in another four billion years our sun was really going to turn into a black hole, instead of going the red giant then white dwarf route, what in the world could we do about it? Warn the public and then attempt to find a way to keep it from doing so? "He eyed each of us reprovingly, daring us to find his argument at fault.

Again, we were all silent. Foreheads furrowed and palms sweaty, we each tried to find a way out of our dilemma. "It seems to me, then," one other student said (I was the only one in the group who hadn't spoken), "that we'd give our nice old lady a sort of utilitarian answer. Something like, 'we study the universe to get a better idea of how we stand in it and how it affects us in our everyday lives here on Earth.'" He, too, looked at us all, awaiting some kind of response. "Well, what do you all think?" he asked, expectedly.

We all nodded in affirmation. That seemed to be the best answer of the day, and an answer that one would give to another who knew very little about Astronomy.

COSMIC SEARCH AWARD WINNER

This article is a **Cosmic Search** Award winner. Previous award winners were Don Lago's "Circles of Stone and Circles of Steel" in the March 1979 issue and Bruce E. Fleury's "The Aliens in Our Oceans: Dolphins as Analogs" in the Spring 1980 issue.

So, after having more or less agreed on a not-so-satisfactory answer, we merely sat there in our chairs, saying nothing, and staring at our empty lunch sacks. Luckily, it was the end of the lunch break, which meant that we all had to get back to work — which we did, and rather quickly at that, I might add; for, if the end hadn't come by then, we would have all been crushed by that thick silence which weighed so heavily upon each of us. A silence not born from the lack of anything to say, but a silence created in each of our minds and hearts from the feeling that there was something much more basic, much more fundamental, and much more profound than our postulated answer to the nice old lady.

So I went back to work in an extremely muddled state of mind, a state which I was determined to remedy before my summer sojourn came to an end. That night, then, I decided to take a very long walk beneath the beautiful, diamond inlaid night sky that is Arizona's. That night, I decided to come to a conclusion — which I did.

One of the first loves of my life are the stars. Some love music, others love paintings, and still others love cars. I love the stars. The stars are humankind's next frontier. It is there, not here on this miniscule plot of land on which we were born, that we, as one, will grow from a spoiled, unkempt child into a wiser, more thoughtful, more caring adult.

Call it a 'Manifest Destiny', if you like — I believe it as such. I believe that humankind was meant to go out among the stars, to mingle with them, to call them brother or sister, to laugh with them, to cry with them.

We were not meant to play beneath just one sun, we were meant to run and sing and dance beneath many other suns — each sun just as different and varying as the many races which live on this, our prima domus.

But I do not believe myself to be the only person to feel this way. There are others, I know; because I have seen — we all have seen — the long and winding lines in and around movie theatres showing some space opera — whether it be the very newest or the very oldest. Most of us have seen the large crowds gathered at the doors of planetariums giving visual lectures on, for instance, "Einstein's Universe". And not too few of us have helped some young person to the eyepiece of a large telescope and heard him or her gasp in awe at the sheer beauty of the heavens.

But most dear to me is a conversation which I overheard in a donut shop in Tucson that same summer. It was between three women, who were, I'd judge, to be in their late sixties. They sat at the far end of the lunch counter while I sat but a few paces from them.

"Yes, I remember that night real well," a small woman with silver and white hair said. "I had just watched them get out of the ship and walk around a little, then I decided to go and wash the dishes."

She took a sip from her white porcelain coffe cup while the other women looked on expectantly. She continued, "I walked to the kitchen sink, which was full of dishes, and looked out the window — the window being just above the sink. And out there, I saw the moon, which was just as big as could be. And I said to myself, 'How about that, there are actually men out there walking around. Isn't that something'. I never thought I'd ever see such a thing in my lifetime —"

"Yeah," one of the other women interrupted, "I know what you mean. We can't say any longer '...as impossible as flying to the moon' or 'the man in the moon' or 'the moon is made of green cheese' or anything like that. But, in spite of all that, it really is something."

"Yeah," the third woman nodded in agreement. And it was then that I left the little donut shop, a thick fog of euphoria keeping me from thinking clearly. If I was sure that they wouldn't have called the police on me, I would have hugged every one of those ladies and given each a big kiss.

And then there is Norman Mailer's, **Of a Fire on the Moon**, a personal recounting of the Apollo 11 moon landing mission.

In it — himself, for all practical purposes, a layman — he relates the almost religous experiences which he felt while studying the different phases of the space program.

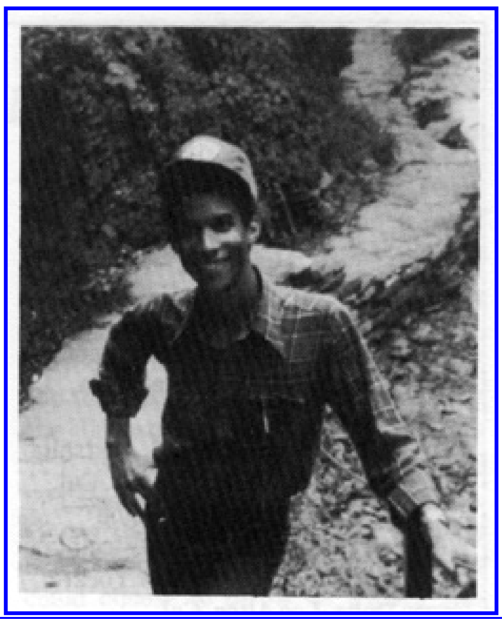
But most precious is his conclusion, in reasoning out the motives behind humankind's desire to venture into space.

I contend, however, that this "first revelation of the real intent of History", which Mr. Mailer speaks of, does not find its roots in the flight of Apollo 11, but that this first revelation was born thousands of years ago — when humankind first turned its eyes to the heavens and began wondering what lay out there among the myriad pinpoints of flickering light; when humankind, for lack of a means to break the grip which its mother, Earth, had upon it, first resolved to find its place in the cosmos; when humankind, that ever-curious, always searching race of beings, first vowed to discover if it was alone in the universe or merely one of a vast cosmic community stretching from star's end to star's end.

Astronomy, then, is the quest for these answers; but it is also more, much more. It is the tool through which each and every one of us travels through the cosmos to discover the answers to those questions which have gnawed at our souls for millennia. For most persons, these questions are, as Mr. Mailer puts it, "in the depths of the unconscious along with everything else most vital for the preservation of life". For others, these questions are among the most important things in their lives. But, whether it be myself, the three women in the donut shop, Norman Mailer, or our postulated nice old lady, these questions are there, in all of us, and we would all like nothing better than the answers to them.

Although we are no longer bound by gravity's chains, we still have a long way to go before we will be able to freely frolic among the stars, to actually see and touch those things and beings which are awaiting our interstellar debut.

So, until that time does arrive, we are now only able to watch, listen — and wonder; **for Astronomy, that vehicle of the mind which enables us all to roam the universe, is the next best thing to being there.**



William R. Dodson III is a sophomore physics major at Cornell University where he plans to continue for a Ph.D. degree in physics and a career in astronomical research. Ultimately he would like to do some popular science writing.

Born 19 years ago in Colorado Springs, Colorado, he had lived in all parts of the United States including Hawaii and Alaska during his father's tour of duty with the U.S. Air Force. As his prize-winning article "The Next Best Thing to Being There" suggests, William Dodson is a highly idealistic person. This is his first published article. We hope it is the first of many more.

Letters:

By: Editors

Letters are always welcome but owing to the volume it is not possible to acknowledge all of them. Also due to space limitations we reserve the right where necessary to condense or edit the contents. Letters may be addressed to: Editorial Dept., **COSMIC SEARCH**, P.O. Box 293, Delaware, Ohio 43015.

In his recent **COSMIC SEARCH** article, **In Which Klingons Became Chimeras**, Frank Drake puts forward conclusive common-sense evidence that the United States will not embark on a program of interstellar colonization in the near future.

Dr. Drake's further conclusion that there are no intersteller empires, far from demonstrating the fallacy of Star Trekitis, serves merely to demonstrate a sad case of Saganism, the condition wherein university professors and radio astronomers become convinced that the entire universe is populated by other university professors and radio astronomers.

If current human technology is the pinnicle [sic; "pinnicle" should be "pinnacle"] of possible technology; if no further basic scientific breakthroughs will ever be made anywhere in the universe, then Dr. Drake's conclusions are probably correct. However, even something as trivial as a good fusion reactor makes interstellar travel a reasonable, if somewhat expensive, long-term operation. There are several excellent, logical reasons for interstellar colonization (Klingon groups might go just to get away from other Klingons) and many irrational ones. If there are a large number of technical civilizations, the odds are that many of them will find such reasons persuasive. Far more reasonable explanations for the absence of aliens on Earth are that we aren't on good travel routes or that advancing technology so alters the nature of technical civilizations that empire building (if it occurs) is a short-lived phase (cosmicly speaking). Dr. Drake's comments on radio and CETI bring to mind the nineteenth century astronomers who speculated that the reports of flashes observed on Mars might be explosions set off by an intelligent, advanced race trying to signal us. After all, what other method could an advanced technology use to communicate across interplanetary distances?

Tom Van Horne
Columbus, Ohio

•

The article "Why Is Scientific Writing Unintelligible?" in a recent COSMIC SEARCH reminds me of an allied question: Why are scientific books and magazines so expensive? There seem to be four basic reasons for this: (1) Low circulation. (2) Scientific and mathematics books are generally made to endure. Hence, they are usually hardbacks, printed on high-quality paper, which are costly. (3) The special symbols needed for physics, chemistry, astronomy, and math require high prices. (4) Since the text must be as free of mistakes and misprints as possible, exacting proof-reading is required.

John Fadum
Boca Raton, Florida

•

In COSMIC SEARCH (Serial no. 6) you solicit opinion regarding the "Flag of Earth". In my opinion it is an excellent idea; however, the moon is one-quarter earth's diameter. The flag shows it less than one-fifth.

Good luck with this wonderful magazine.

Jerry T. Searey
Las Vegas, Nevada

The SEnTinel

By: Robert S. Dixon

Detecting Stellar Garbage Dumps

As our civilization continues to move into the "throwaway" era, the waste products of our technology become more and more troublesome. Chemicals and plastics are thrown away, only to crop up again elsewhere in some potentially dangerous form. We are running out of safe places to "throw" things.

The worst example of this problem is in dealing with atomic waste products. There are the materials left over from the operation of nuclear reactors. They are highly radioactive and last virtually forever. Currently, we store them in deep mines and at the bottom of the ocean, hoping perhaps that if we put them out of sight and forget about them they will just go away. But sooner or later they will return to haunt us in some unforeseen way. Even if they don't, our spiraling use of nuclear reactors will eventually produce so much waste that even hiding it may not help.

Dumping radioactive wastes into the sun could signal our presence throughout the galaxy.

It has been suggested that we throw these nuclear wastes into space somewhere. There are lots of places in the solar system where these wastes could be placed into stable orbits around the sun or planets. NASA did a study of this possibility in 1978 and found it to be feasible. Of course, this is just a more advanced form of hiding it where it can't be seen. As our journeys througout the solar system become more frequent, it would become increasingly bothersome to avoid certain "contaminated" zones where radioactive wastes were silently orbiting. And as long as they existed, they would be available for misuse by terrorists and other nefarious groups.

The best solution seems to be to throw them into the Sun. Then there is no question about their ever coming out again, and the Sun is so huge and hot that everything would be diluted and disintegrated to the point that we could forget about it forever. The energy required to send significant amounts of material to the Sun is large, since you essentially have to accelarate backward, along the Earth's orbit, to nullify the Earth's velocity, before you can actually "fall" into the Sun. Nevertheless, it is possible and might eventually become mandatory. Perhaps the residual radiactivity in the waste material could even be harnessed to provide the energy needed to do the job. That would be particularly appealing — letting the garbage carry itself to the dump. Such a crude one-way rocket need not carry any shielding or be concered about fuel efficiency, and its navigational system only needs to be good enough to hit the Sun (and avoid Venus and Mercury on the way in!)

Now an interesting question arises. Suppose a civilization did dump its radioactive wastes into its star for a long time. Would this have any effect on the star that might be observable from a great distance? In other words, could we detect a civilization by finding its garbage dump. Intriguingly, the answer is yes.

Daniel Whitmire and David Wright of the University of Southwestern Louisiana have investigated this exact question and described their results in the April, 1980, issue of the journal Icarus. They find that if between one and ten percent of the Earth's supply of uranium were converted into waste products and thrown into a suitable star, it would produce clearly observable anomalies in the optical spectrum of that star. Specifically the emission lines of the rare element Praseodymium would become significantly stronger than normal. This effect would be detectable by optical telescopes from as far away as the star could be seen. Furthermore, the effect would last for a billion years after the dumping stopped, so it might be observed long after the civilization itself had perished. In that regard, this is the cheapest method yet devised for letting other civilizations know they are there, since the star does most of the work in sending out the message.

There are a few complications in choosing a suitable star, however. The star must be of a type that does not have a strong internal mixing action. It is critical that the atomic wastes thrown into the star remain near the surface, and not get diluted throughout the interior of the star. This restricts the choice of stars and rules out the Sun as a candidate. Nevertheless, stars of this type are very numerous, and are among those considered most likely to harbor life. Furthermore, a civilization could choose to throw its wastes into some suitable neighboring star, rather than into its own, to take advantage of this "free message" capability. The energy required to send wastes to nearby stars is, amazingly enough, less than that required to send them to the Sun, but the time and navigational requirements are much greater.

Whitmire and Wright suggest that we should begin a search for these kinds of anomalies in all the suitable stars we know of. If any are found, then those stars should be subjected to intensive study at all wavelengths, particularly those commonly suggested for radio communications with other civilizations.

Private Space Probe

A newly formed non-profit organization is taking reservations for private messages to be sent into deep space sometime in 1982. The organization named EARTH/SPACE INNOVATIONS will place the messages in a privately-financed spacecraft dubbed PROBE ONE. The idea is to send messages which might eventually be intercepted by life elsewhere and inform it about us.

Messages with photographs, or drawings, will be accepted on a first come first served basis over the next year. The information will be microfilmed and loaded aboard the spacecraft along with special microfilm reading equipment and translation materials.

What kind of messages will be sent? It is hoped that much of the material will be the result of classroom projects from schools, scouts, clubs and space buffs. Plans call for a spacecraft launch sometime in 1982 although the exact date and location have not been set. To send a message, or obtain additional information write: Earth/Space Innovations, Van Etten, NY 14889.

ABCs of Space

By: John Kraus

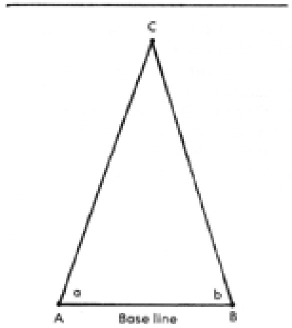
Spanning Space

Plumbing the Depths of the Cosmos

When you read of the distance to the Moon, or Mars or a remote galaxy, have you ever wondered how these distances were measured? You can't do it with a ruler or tape line or pace it off so other methods must be used.

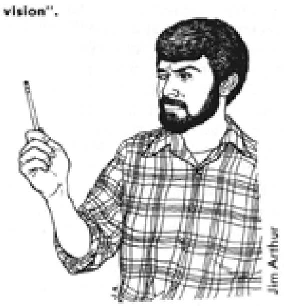
One of the most basic techniques for distance measurement is called triangulation. Knowing the length of one side of a triangle (the base-line) and of two angles you can determine the lengths of the other two sides. Special instruments are commonly used to measure the angles but even without them a person continually determines distances by using both eyes as a triangulation system, the distance between the eyes being the base-line.

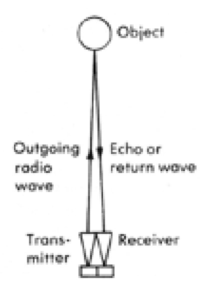
Triangulation with two eyes works well for judging the distances of nearby objects but for determining the distances of remote objects larger base-lines are needed. The larger the base-line the larger the distance that can be measured. Indeed, with a big enough base-line the distance to astronomical objects can be determined.



Distance by triangulation. From the base-line distance (AB) and the angles (a and b) the long sides of the triangle can be determined by a scale drawing (as here) or by trigonometry.

Triangulation by stereo-vision. The pencil appears to jump back and forth when viewed first with one eye and then the other. Bringing the pencil closer increases the span of the jumps. The eyes with the brain "measure" the distance by triangulation although we generally speak of it as "depth of perception" or "binocular" or "stereo-vision".

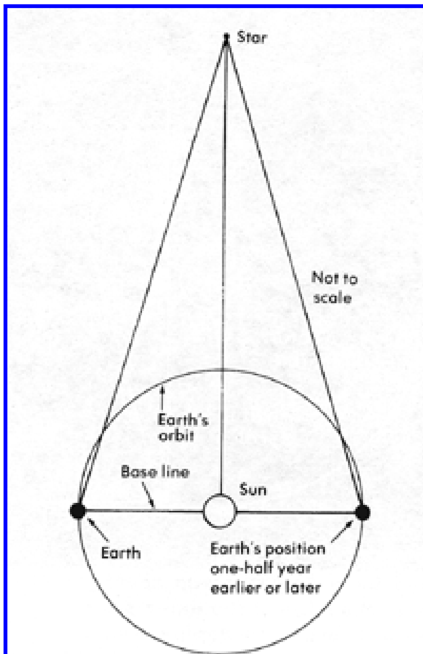




With radar, distances are measured by timing the delay of an echo. The longer the delay the greater the distance. This method is so accurate the distance to a point on the moon can be measured within a few centimeters.

For example, with an intercontinental base-line, the distances to the moon and planets have been measured. However, even with the earth's full diameter for the base-line, the method is inadequate for measuring the distance of even the nearest star (4 light-years) because the angles become so nearly 90° that even the most precise instruments won't do.

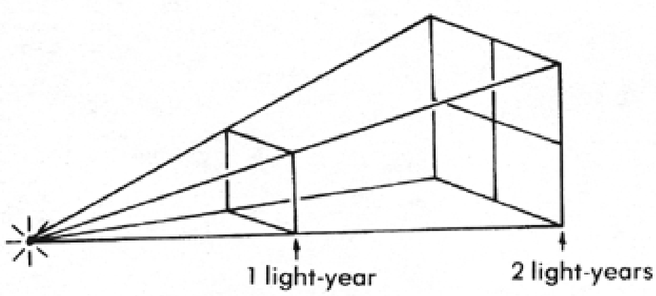
With the advent of RADAR (an acronym for Radio Direction And Range) another method of distance measurement involving time delays became available following W.W.II. With radar a pulse of radio waves is sent out and the time for the echo to return from an object is measured. Multiplying the echo time by the wave velocity gives the distance. [1] [1. In symbols, $\mathbf{R}=\mathbf{vt}/2$, where **R** is the distance (in kilometers), **v** is the velocity of the radio wave (equal to 300,000 kilometers per second) and **t** is the delay time for the echo (in seconds).] This method is so accurate that the distance from the earth to a point on the Moon can be measured with a precision of a few centimeters. The distances to some of the inner planets of the solar system have also been measured by radar but the long time delays (hours) and weak echoes make radar marginal for the remote planets. However, with radio-equipped probes, such as Voyager 1 and 2, the method can reach further since when the probe "hears" the pulse sent from the earth it can send back an **amplified** echo.



The distance to stars out to about 300 light-years has been measured by triangulation using the diameter of the earth's orbit as the base-line.

To stretch triangulation beyond the solar system, the diameter of the earth's orbit has been used as a base-line. With this base-line the distances to stars have been measured out to about 300 light-years. [2] [2. A **light-year** is the distance light travels in a year. It is equal to 10 million billion meters (10^{16} meters).]

For still greater distances the fundamental fact that the brightness of a star decreases as the square of the distance has been applied. Thus, at twice the distance, a star will be one-quarter as bright. So if we know how many watts a star radiates then a measurement of its brightness can tell us how far away it is. [3] [3. In symbols, $\mathbf{R}=\sqrt{(\mathbf{W}/4\pi\mathbf{B})}$, where **R** is the distance (in meters), **W** is the power or wattage (in watts) and **B** is the brightness (in watts per square meter). √ is the square root operator.]



The brightness of a star decreases as the square of its distance. Thus, all of its light passing through the square at 1 light-year distance is spread out over 4 squares at 2 light-years making it one-quarter as bright as it is at 1 light-year. It follows that a star's brightness can give information as to its distance.

Stars have been grouped by their spectra [4] (and other means) into different classes and the wattage levels for the classes determined, at least approximately, by triangulation measurements of some of the nearer members of each class. The distances of other members of a class, too distant for triangulation, can then be inferred from their brightness. [4. The light from a star passed through a prism produces a **spectrum** or rainbow of colors and lines indicating the temperature and chemical composition of the star. See **COSMIC SEARCH**, Summer 1970 (Serial No. 3) page 37 and Winter 1981 (Serial No. 9) Page. 4.]

A particular star class that has proven especially useful for distance determinations is the **Cephied variable** [sic; "Cephied" should be "Cepheid"] group. These stars dim or brighten cyclicly with periods of days or weeks.

We can't span space with a ruler but mankind has developed an impressive kit of tools which can.

About 1908, in studying some of these stars in the Magellanic clouds (small nearby galaxies), Henrietta Leavitt of Harvard University noted that the brighter ones pulsed more slowly than the fainter ones. Since all were at roughly the same distance this meant that the slowly varying Cephieds [sic; "Cepheid"] were intrinsically more powerful than the more rapidly varying ones. A determination of the wattage of one of the Cephieds [sic; "Cepheid"] then served to calibrate all of them as standard wattage stars so that the (average) wattage of any of them is known if its period is known. Thus, a slowly varying Cephied [sic; "Cepheid"] variable which appears faint must be far away like a powerful lighthouse at a great distance.

Subsequently, Harlow Shapley of Harvard used the brightness of Cephied [sic; "Cepheid"] variable stars in our own galaxy to establish our galaxy's diameter as 100,000 light-years with our solar system over half-way to the edge. 5 [5. See **COSMIC SEARCH**, Winter 1981 (Serial No. 9) page 20.]

Then in the 1920s, Edwin Hubble, a lawyer turned astronomer, used the Mt. Wilson 2.5-meter telescope, the largest then in existence, to resolve some of the nearer external galaxies into stars and among then he found Cephied [sic; "Cepheid"] variables. Using these he established the distance of some of these galaxies at a million or more light-years.

Hubble with Milton Humason, his observing assistant, also photographed spectra of these galaxies. They noted that the light from the galaxies was shifted to longer wavelengths by an amount which increased with the distance of the galaxy. This shift to longer or redder wavelengths, called a redshift, implied that the galaxies were receding from us with a velocity which increased in proportion to their distance and this led Hubble to conclude that we live in an expanding universe. 6 [6. The **redshift** is thought to be produced by the Doppler effect, a phenomenon which we often experience audibly as the decrease in pitch (increase in wavelength) of the horn of a truck or locomotive that is moving away from us. See **COSMIC SEARCH**, Fall 1979, (Serial No. 4) page 25.]

Henrietta Leavitt of Harvard found that the wattage of Cephied variable stars was related to their period.

Harlow Shapley of Harvard used Leavitt's Cephieds to establish the size of our galaxy and our place within it.

Edwin Hubble of Mt. Wilson used Leavitt's Cephieds to span the gap to the galaxies and discovered that they were receding from us. He concluded that we live in an expanding universe.

Going backwards in time, like running a movie film of the universe in reverse, the expansion appears to have started about 15 billion years ago with a titanic explosion called the Big Bang. Assuming that all objects in the universe partake of the expansion, a measurement of any object's redshift can tell us how far it is. [7] [7. The redshift gives the velocity and the velocity the distance. In symbols, **R**=**vT**, where **R** is the distance (in meters), **v** is the velocity (in meters per second) and **T** is the age of the universe (in seconds). See **COSMIC SEARCH**, Spring 1980 (Serial No. 6) page 32 and Summer, 1980 (Serial No. 7) page 22; also **OUR COSMIC UNIVERSE** by John Kraus, Cygnus-Quasar Books, 1980, Pages 59 and 182.] In this manner, distances have been deduced for quasars almost to the "edge" of the universe. [8] [8. The term "edge of the universe" is metaphorical. More properly it is a celestial horizon or observational limit.] The most distant known object is quasar OQ172 at 91 percent of the way to the "edge". The most distant galaxies Hubble measured are only a few percent of the way and the most distant known galaxies are about 60 percent of the way. A galaxy is a huge aggregation of 100s of billions of stars. Many astronomers believe that a quasar is a galaxy with an extra-powerful nucleus but so far away that it appears only as a starlike point of light. Hence, the name QUASAR for QUASi-stellAR object, an object which looks like a star but isn't.

Astronomical distances can be measured by triangulation, radar, brightness, redshift, expansion and hopefully soon by radep.

The more remote an object, the farther back in time we observe it. Thus, the look-back time for quasar OQ172 is almost 14 billion years in a 15 billion-year-old universe.

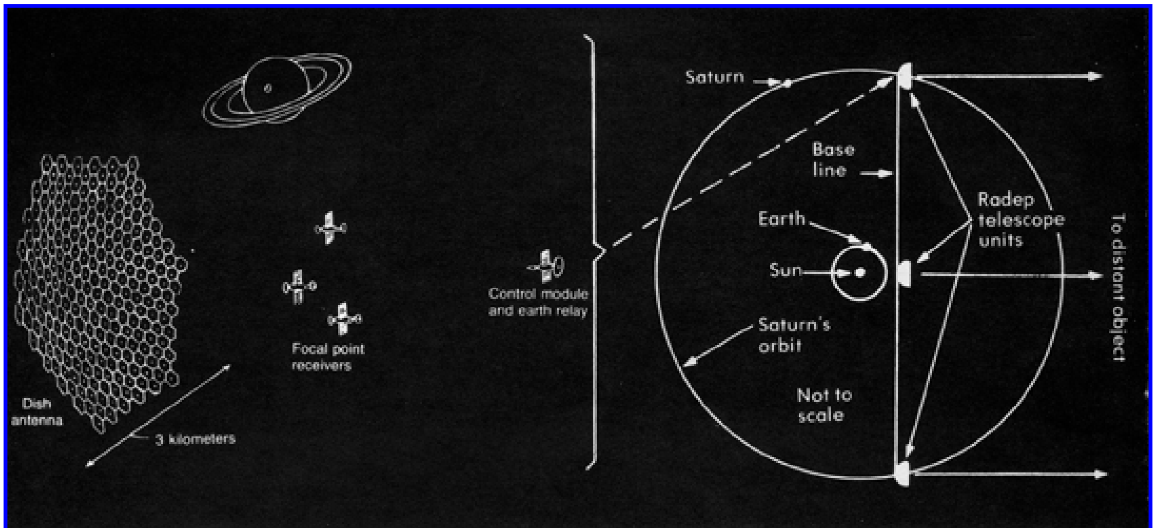
So it is that with many steps involving triangulation, brightness, redshift and expansion, the distances to the planets, the stars, the galaxies and the quasars have been spanned and measured. And now comes a new technique, RADEP for RAdio DEPth, which gives promise for measuring all astronomical distances with one technique.

Although radep is a form of triangulation, it works on the principle that the response pattern of a radio telescope antenna can be affected by the distance of the radio source being observed. Thus, if the distance of the source to the edges of the telescope differs by a fraction of a wavelength from the center of the telescope the pattern is different. When a point source is at more than a certain critical distance, the pattern is always the same. At less than this critical distance the pattern is not only different but changes with distance. [9] [9. In the esoteric language of antenna designers, it is said that beyond the critical distance the source is in the far-field or Fraunhofer region of the telescope antenna while inside the critical distance it is in the near-field or Fresnel region. For a one-eighth wavelength path difference we have in symbols, $\mathbf{R}=\mathbf{L}^2/\lambda$, where **R** is the critical distance, **L** is the transverse size of the telescope and λ is the wavelength (all dimensions in same units). See, for example, **ANTENNAS** by John Kraus, McGraw-Hill, 1950, pages 117 and 448.]

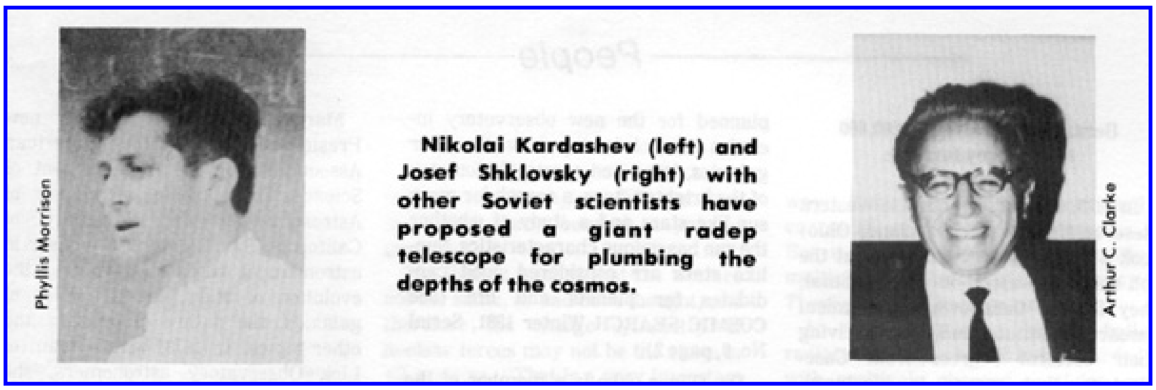
The farther away an object, the farther back in time we observe it. With quasar 00172, we are looking back almost 14 billion years into the history of our 15 billion-year-old universe.

For radep measurements of astronomical distances, the radio telescope must be in space in order to avoid atmospheric effects and to permit building a telescope of sufficient size. A group of Soviet scientists, including Nikolai Kardashev and Josef Shklovsky, have proposed an interferometer radep telescope of three units, two deployed near the orbit of Saturn with the third near the earth. [10] [10. Report PR-373, Academy of Sciences USSR, Space Research Institute, Moscow, 1977.

Note: Other characteristics of objects, such as size, can also be used to gauge distance. Thus, galaxies of a given class which appear small should, on the average, be farther than those which appear larger. Although size might also be used for judging the distance of stars of a given class, it is not generally feasible to do this because, except for a few of the nearest largest stars, their diameter is not measurable, their images appearing only as points of light.] Operating at centimeter wavelengths, this radep array has the potential, in principle, of measuring the distance of celestial objects all the way to the "edge" of the universe. A new astronomical era will be opened when radep can be employed to determine the distances of the quasars to see if they agree with those now quoted on the basis of our present multi-step procedure involving triangulation, brightness, redshift and expansion.



Radep interferometer telescope proposed by a Soviet group could measure the distance of objects all the way to the edge of the universe. Three units, each like the one shown at the left, would be deployed in space, two near the orbit of Saturn and one near the earth.



Nikolai Kardashev (left) and Josef Shklovsky (right) with other Soviet scientists have proposed a giant radep telescope for plumbing the depths of the cosmos.

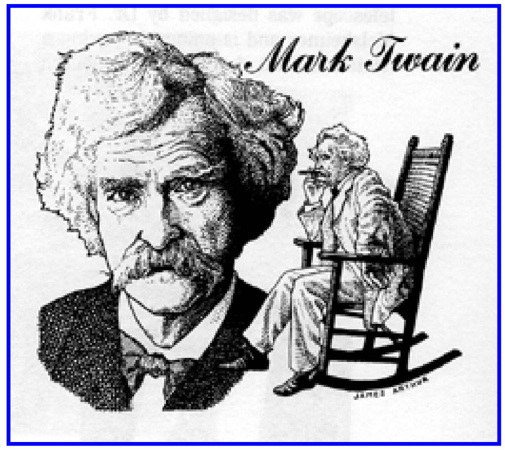
Although we can't span space with rulers or tape lines, mankind over the years has developed an impressive kit of tools which can.

ASTRONOMICAL DISTANCE MEASURING TECHNIQUES

To:	Techniques:
Moon, Sun and planets of solar system	Triangulation with base-line on the earth. Radar.
Nearest stars	Triangulation using diameter of earth's orbit as base-line. Star brightness. Radep.
More distant stars	Star brightness. Radep.
Nearest galaxies	Star brightness. Galaxy size. Radep.
More distant galaxies and quasars	Galaxy size and brightness. Red shift and expansion. Radep.

In Review:
Mark Twain in Space

By: Editors



A book about 75 years old seems like an unlikely subject for a review. But Mark Twain's short novel, **Extract from Captain Stormfield's Visit to Heaven**, deserves mention, first because it is so prescient and so much fun to read, and second because it is so little known and seems to be ignored in many collections of the great humorist's works.

The book begins, "Well, when I had been dead about thirty years I began to get a little anxious." After sailing along through space those thirty years, old Captain Stormfield came upon a comet and raced it. For the race he altered his course a point or two, but lost out when the comet's captain dumped millions of kazarks of brimstone, wiping out several constellations, and pulled away "like an express train passing a handcar."

Finally, Stormfield spied bright lights ahead, like a fiery furnace. "I guess I've arrived," he said to himself, "and at the wrong place, just as I expected." But the lights turned out to be golden gates. He had gotten to Heaven. But at the wrong gate.

Asked to tell where he came from Stormfield mentioned San Francisco, then California and then the United States but all without any recognition by the angel at the gate. Finally, Stormfield blurted out "I'm from the world." "Which world?" he was asked. "There's millions of them."

That statement, written three-quarters of a century ago shows that Mark Twain was pretty smart in his old age.

John Merrill Weed

People

By: John Kraus

Bernard Oliver Grants $200,000 to Monterey Institute

In 1973, six students at Case-Western Reserve University (Cleveland, Ohio) took a unique tack. Realizing that the job outlook in astronomy was dismal, they formed their own astronomical research institute and, on receiving their doctoral degrees from Case-Western, they moved to Monterey, California, where they found full-time employment in the area doing teaching and computer programming. But they devoted their combined spare-time efforts to their first love, astronomy, and to the implementation of their desire to actively participate in the exploration of the universe. Their organization, the Monterey Institute for Research in Astronomy (MIRA), acquired an observatory site, gifts of equipment and a group of several hundred "Friends of the Institute."

Recently, Bernard Oliver, Vice President for Research and Development of Hewlett-Packard of Palo Alto, California, made a $200,000 grant to assist MIRA to build an observatory. The grant is contingent on MIRA raising another $200,000 to match Oliver's gift. However, Dr. Oliver is making an advance of $44,000 regardless of the outcome of the matching.

Bernard Oliver

The telescope for MIRA's new observatory is equipped with a 91 centimeter mirror made originally for Princeton University's Project Stratoscope and being loaned by Princeton to the observatory. The telescope was designed by Dr. Frank Melsheimer and is unique in having a friction instead of gear drive. Research planned for the new observatory includes a search for supernovas in other galaxies, improved spectrophotometry of the brighter stars, a search for more sun-like stars and a study of whether the sun has unique characteristics. Sun-like stars are considered good candidates for planets and life (see **COSMIC SEARCH** Winter 1981, Serial No. 9, page 2).

Dr. Oliver, who is a member of the Editorial Board of **COSMIC SEARCH**, told us that he made the grant because he was impressed with the MIRA group and the progress they had made on their telescope and the automation they had provided, making it very well suited for their proposed plan to study stars in the solar neighborhood and acquire better statistics on those that may be good SETI candidates.

The MIRA core group consists of 10 persons, six of whom came from Case-Western. These six, who obtained Ph.D. degrees in astronomy from Case-Western (between 1973 and 1975) are Craig Chester, Cynthia and Nelson Irvine, Albert Merville, Hazel Ross and Bruce Weaver. Their philosophy that, if federal support for astronomy is peaking out, at least for the present, it is reasonable to think of doing astronomy as it was done prior to World War II. After all, the Yerkes, the Mt. Wilson and Mt. Palomar Observatories were built by private gifts. Since World War II, with increased costs, particularly for large facilities, federal support has become important but private support is still vital.

John Quincy Adams, 6th President of the United States, remarked that the culture of a nation can be judged by the condition of its astronomical observatories. Although other U.S. presidents have not shown similar devotion to culture, former President Avila Comacho of Mexico established the great Tonanzintla Observatory with his own personal funds.

The MIRA project is a refreshing, exciting example of the great public interest in astronomy, the queen of the sciences, which makes us one with the cosmos.

Persons interested in more information, or in becoming Friends of MIRA, should write to MIRA, Bin 568, Carmel Valley, California 93924 or telephone 408-375-3220.

•

Margaret Burbidge is the new President-Elect of the American Association for the Advancement of Science. Dr. Burbidge, Professor of Astronomy at the University of California, San Diego, is a pioneer in astronomical research involving the evolution of stars, the dynamics of galaxies, the nature of quasars and other topics. In 1973, with a team of Lick Observatory astronomers, she established the redshift of the quasar OQ172 making it the most distant known object in the universe at 91 percent of the distance to the "edge" or observational limit of the universe.

•

The Reverend Theodore Hesburgh, President of the University of Notre Dame has been honored by the naming of an asteroid orbiting between Mars and Jupiter as "Asteroid Hesburgh-1952". The naming was suggested by Professor Frank Edmundson of Indiana University to thank Dr. Hesburgh for his valuable services to astronomy during his membership of the National Science Board from 1954 to 1966. Dr. Hesburgh is a member of the Editorial Board of **COSMIC SEARCH**.

•

Johns Hopkins University has been selected as the site for the new Space Telescope Science Institute. Plans call for the new Space Telescope with 2.4 meter mirror to be put into low orbit by the Space Shuttle in 1985. Above the earth's atmosphere, the new telescope will afford astronomers a much clearer view of the cosmos than possible from even the best mountain sites. The observational data acquired by the telescope will be transmitted from orbit to a NASA station in New Mexico, then relayed by the high-orbit Comsat to NASA's Goddard Space Flight Center at Greenbelt, Maryland, and finally relayed by land line to the Telescope Institute at John Hopkins in Baltimore, Maryland, where the data will be displayed, recorded and analyzed.

The new institute will be operated by the Association of Universities for Research in Astronomy (AURA) under contract with NASA. The institute is to have a staff of about 40 astronomers with a support group of one hundred persons. It is anticipated that several hundred astronomers from many different institutions will visit the institute each year in order to observe with the new telescope.

•

A **Master List of Nonstellar Optical Astronomical Objects** compiled by **Robert S. Dixon** and **George Sonneborn** of the Ohio State University Radio Observatory has been selected by Choice magazine as one of the Outstanding Academic Books of the year. This list makes available pertinent information in easy-to-read format on 185,000 nebulas, galaxies, clusters and other non-stellar objects which was formerly scattered throughout the astronomical literature in nearly 300 catalogs published in many different countries. Dr. Dixon is Co-Editor of **COSMIC SEARCH**.

•

The **National Aviation/Space Education Convention** will be held during National Space Week '81, July 13 to 20, in Seattle, Washington. For further information contact the American Society for Aerospace Education, 1750 Pennsylvania Ave., N.W., Suite 1303, Washington, DC, 20006. (Tel. 202-347-5187).

JK

In Search of Planets

The Extrasolar Planetary Foundation Report

By: George Gatewood

The first system with more than sufficient power to discover the planets of other stars is now under construction at the Allegheny Observatory of the University of Pittsburgh. This Observatory will employ a new electronic detector on its 76 centimeter aperture Thaw photographic refractor. Expected to become operational this fall, the system will be able to glean more directional information in one hour than the previous system could obtain during an entire year of photography.

Unfortunately, the new detector and the Thaw refractor are less than a perfect match, the detector having more potential than the telescope's 67 year old objective lens. Careful analysis has shown that this mismatch can be overcome by replacing the objective. The group at Allegheny, working with scientists at the University of Arizona's Optical Center, have determined that a lens focusing red light would give the new system at least 3 times as much precision and more than 5.5 times its current sensitivity to intrinsically faint nearby stars. Combined, the new electronic detector and the red light lens would give the Allegheny group the ability to detect Jupiter-like planets orbiting more than 100 neighboring stars. The projected cost of the lens is $97,000. In other words, the additional cost would be approximately $1,000 per star.

Because of its unusual potential return per dollar, the EPF has designated the acquisition of a new objective for this telescope as its first special project. We are informed that $32,000 from private funds has already been set aside for this project by the observatory. This leaves us $65,000 shy. It has been estimated that the new lens could be installed within 1 year of the date the glass is ordered.

We at the EPF believe that this is the best way to bring the first really powerful planet detection system on line quickly and efficiently. If you would like to join our effort to get this project going, please write the Extrasolar Planetary Foundation, Observatory Station, Pittsburgh, Pennsylvania 15214. Your cumulative patronage can go a long way towards this goal. Thanks.

George Gatewood, Chairman
Extrasolar Planetary Foundation.

The Nature of Extraterrestrial Communication

By: Robert E. Kuttner

It is certain that many of the basic premises governing our understanding of the nature of communication will have to be modified if effective means of detecting extraterrestrial intelligence are to be developed. Only the first steps have been taken and these have been necessarily primitive. The immense distances separating stars and the many years a signal must travel have made it clear that ordinary give-and-take communication such as occurs between individuals is impossible. Life forms that live less than a century would regard the exchange of a single sentence in that interval as something different from personal or even non-personal conversation. It is evident that the content of any communication must be pertinent to the purposes of entire civilizations.

Our logic dictates that messages must be informative and convey useful facts. The initial goal would be to announce to postulated civilizations the fact of our existence. This purpose would not be very valid for older alien cultures long aware of each other. Once a critical technological barrier has been passed that includes the means of engaging in interstellar communication, it would be obvious that this development permits its masters to discover whatever they must know to control their space environment.

The inherent tendency to optimize technology almost automatically leads to convergent evolution and therefore to equivalent capabilities. Among peer cultures, little profit can be expected from contact designed to promote intellectual crossfertilization. An apt analogy is that of a long-married couple who have grown so close over the years that they anticipate each others' thoughts and make verbal comments solely as routine courtesies. When a teacup breaks, it is certain the partner has heard it. When a supernova flares, it is safe to assume neighbor civilizations have spotted it also.

These comments do not exhaust every motive that might stimulate contact but they cover most of them. Transfer of information satisfies curiosity. But curiosity is like an itch: once it is scratched it ceases to excite attention. Peer civilizations may not have compelling reasons to be interested in alien industrial arts. We do not ask the Russians how to build steel mills. Our communications serve chiefly diplomatic purposes. Convergent technologies which have reached the peak of scientific attainment have no need to copy details. The engineering departments of Ford, Toyota, and Volkswagon can still learn from their competitors but not on any major feature of automobile construction.

The self-image of humans can generate a large list of reasons why alien contact is a natural if not inevitable future event. Without such conceits, however, these reasons are reduced to their proper and therefore very human proportions. Our society needs lawyers and diplomats to regulate internal and foreign relations. To extrapolate these encumbrances on advanced civilizations is surely unwarranted if by advanced we imply the ability to coexist with nuclear technology long enough to accomplish space travel.

Likewise, the aesthetic impulse we value so much may be merely a human peculiarity and even if shared it may be insufficient to foster extraterrestrial contact. When we claim art and music to be universal we are really saying we hope it is at least global. Emotional hunger for symbolic communication is quite restricted. Asiatic music has only recently arrived at our record shops and African sculpture has scarcely penetrated our department store galleries. Until Beethoven is welcomed by the bulk of the Hindu proletariat or the Eskimo hunters in the Canadian arctic, broadcasting symphonies to the galaxy can hardly be viewed as instinctive. The "Music of the Spheres" may remain electronic static forever.

Other points require examination. Our notions as to what constitutes intelligent life have to be redefined. This continues to be a vacillating concept. Inaccuracies on the matter can pose problems on what to look for and how to attempt communication. A few generations ago Man was considered to be the pinnacle of creation, a unique entity specially formed by a supernatural act. Following the Darwinian revolution, Man was demoted to "man" by establishing a link to the animal kingdom. The very same school of anthropology that joined man to the primate family then separated him from his cousins by virtue of his superior brain and his supposedly unique language skills. The transformation of ape into Super-Ape did not endure for long. The psychological literature of the past decade is replete with articles of apes educated to communicate by keyboards, colored geometric tokens, and the standard deaf-and-dumb sign language. Man differs from ape only in degree according to the current consensus. Can a species which has redefined itself three times in less than two centuries be trusted to anticipate the form of alien life and the mode of its communication?

Until insects educate us to appreciate their viewpoints, we may be wasting our time searching for intelligence in the galactic wilderness.

The answer to this question appears to be an unflattering negative. Writers invoking the "Grand Analogy" concept accept the fact of human life on earth as validating the existence of other life on distant worlds. The framing of this concept is flawed from the very beginning in a highly revealing manner. There are two and not one "Grand Analogies" of intelligent life. The insect kingdom has provided excellent samples of urban civilizations that escape the attention of those versatile authors who are most anxious to depict favorable odds for the Cosmic Search. The difficulty resides in defining intelligence. Ants build cities, keep aphid herds, garden fungus, store food, fight wars, take slaves, have nurse, soldier, and worker castes, and communicate by odor. They do this by instinct, a kind of frozen intelligence. Ants have existed for scores of millions of years. They are so successful they have no reason to "think". Having found the best way to survive, there is no premium on innovation. Is this not an endpoint of biological evolution?

Ant society resembles the postulated high civilizations possessing self-repairing and therefore stagnant-technology. **Our world is dynamic because it is imperfect.** For us, change is progressive. But when maximum efficiency is approached, the demand for creative thinking which promotes more change is vastly diminished. Change can only be counter-productive. Those who climb beyond the mountain top are going downhill. Much the same applies to interrelationships between the individuals of a million year-old culture. Centralized and computerized behavior is almost a certainty. To our eyes this would be robot automatism as in ant colonies. Yet the value of intelligence is that it allows flexible responses in a changing world. When the environment is exactly controlled and predictable, then intelligence may be sacrificed for the advantages of electronic computer instincts. There is ample space for philosophical argument on this issue but humans carry a full cargo of prejudices. Until insects can educate us to appreciate their viewpoint, we may waste our efforts searching for Oxford and Harvard professors in the galactic wilderness.

Communicating with ants is not the only barrier. We have difficulty in our first transmission with the Arecibo radio telescope. A coded message describing the location of earth and the state of technology of its dominant mammalian species may get safely across the void to the target star cluster, but it did not cross the Atlantic ocean successfully. The message was printed in reverse by NATURE (vol. 253, Jan. 24, 1975; page 230), the most widely-circulated British scientific journal. Whether this was an editorial oversight or a printed error is not pertinent. The crucial fact is the failure to get a symbolic cosmic pictogram correctly replicated by scholars who speak a mutually comprehensible language and who share our culture. If the best laid plans of mice and men go astray, can we expect more from aliens?

Our energies might be better employed in detecting alien messages than in sending out our own. Even this task does not warrant an optimistic appraisal. What constitutes a suitable medium for communication is a decision aliens might not share with us. And we should not suppose that sophisticated extraterrestrials have a consuming desire to educate or uplift backward planets. The zeal to study protonuclear planetary cultures would be eroded after possible thousands of similar contacts. When Columbus journeyed to this hemisphere, he was indeed eager to converse with the Carib Indians. However, this model historical encounter is a poor guide. Columbus suffered from the vain belief that he reached the Asian land mass and he hoped to learn the quickest road to the rich trade centers of Sind or Cathay. Even this special case teaches that 99 percent of communication was not directed at the inhabitants. The bulk of the letters and messages were aimed at Spanish, Portuguese, Italian and other European kings, diplomats, navigators, mapmakers, missionaries, and academics. A parallel should be expected. If aliens discover earth, it is overwhelmingly more likely that their messages to other aliens would fill the ether rather than our newspaper columns.

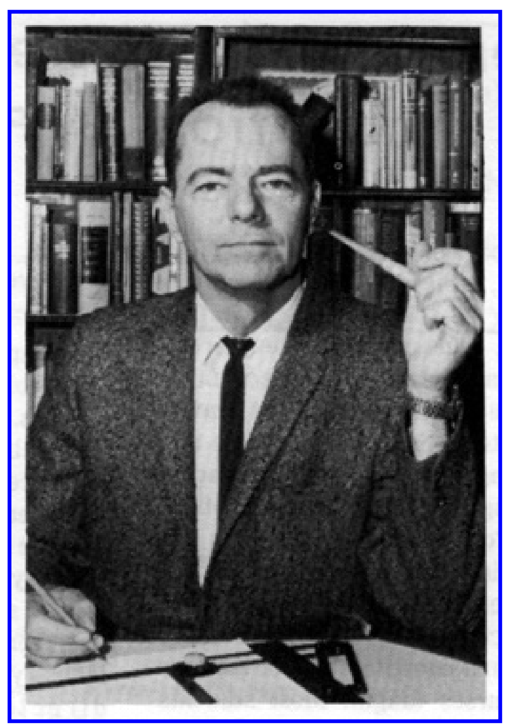
The realization that aliens have other priorities is a step forward. The escape from dogmatic passivity improves our chances of recognizing the evidences of alien activities pointed at other receiving stations. Driftwood containing iron nails washed ashore along the arctic coast long before the first Spanish ship sailed in search of the New World. A modern philosopher could have reconstructed many facets of European civilization from a single nail. We may ask ourselves if we too are blind to precious clues strewn like debris around our telescopes. Space civilizations radiate immense energies as a by product of their technologies. Computer-linked sensors must automatically monitor such emissions as a means of regulating the flow of activity. To us, the detection of these signals would represent static, electronic debris washed ashore from the cosmic ocean, and yet this noise itself could be a message. We must grow ears before we learn to speak.

Robert E. Kuttner is Chief of the Surgical Research Laboratory of the Veterans Administration Medical Center at North Chicago and Associate Professor of Surgery Research, University Health Sciences, Chicago Medical School. He is engaged in research on the body's response to shock and stress.

Born in Queens, New York, in 1927, he received his Ph.D. degree in zoology from the University of Connecticut in 1959. Prior to coming to Chicago he had extensive research experience at a number of medical schools. Dr. Kuttner has edited a book on anthropology and he has written about one hundred scientific articles. His special interests include linguistics, evolution, and human biology-psychology as related to "extraterrestrial behavior".

Intra-terrestrial Intelligence

By: W. Albert Rhodes

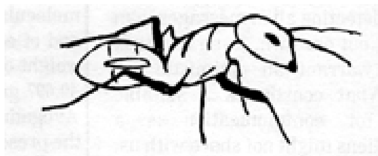


Today we diligently seek contact with extra-terrestrial civilizations. I wonder what the response would be if someone announced such a civilization might exist right here on this planet. I can hear the editor now, "Oh no, not another one of those!" What if I announced such beings actually exist and they possess inconceivably massive brains but that a panel of experts has determined that their lives are governed only by primitive instincts? It was decided a brain of those ridiculous proportions would be incapable of functioning because the signal impulses between cells would be short-circuited since they are probably bathed in a salty electrolyte. Indeed, it was decided the mass we call a brain — only because it is in the creature's head — is not a brain at all but probably only a nutrient storage chamber while the creature's seat of primitive intelligence is elsewhere.

Who am I? Why, I'm an ant. We call ourselves Red Harvesters. The civilization we are investigating is called the human race. Its members are indeed primitive. Each time we go forth to harvest, they go out of their way to step on us or poison us. Our dislike for them is monumental. We bite and sting them every chance we get.

End of simile

I am one of the humans described in the simile. For the past 40 years I have owned and operated a pet Harvester colony at a remote corner of my property. I have observed and experimented with the little creatures and at times caused them much consternation. Others before my time have done likewise. On many occassions [sic; "occassions" should be "occasions"] I have transported one to my desk — keeping it in a small bottle until it calmed down — then turned it loose on a piece of white paper. They all behaved the same — walking very slowly in a small area. I would contact it with a hair placed in a pin-vise. Touched on the head, each would alternately tap the hair slowly with its antenna. Touched on the thorax side it would open its pincers and turn its head — slowly like a dog — toward the hair. But, it wouldn't seize it. It seemed more curious than frightened or angry. The slow deliberate movements are in contrast to anger and fright. Further experiments revealed the insect's response was more animal-like than insect. The following experiments show why I question instinct as being the answer to behavior.



• Place a Harvester on a spread newspaper. It turns to travel toward its original direction. Rotate again and the ant turns again toward its original direction. Will we say this is because the sun's position provides this orientation? How does it accomplish this with a June sun almost directly overhead? How does it do this under a completely overcast sky?

• It is mid-day in a blistering Arizona desert sun. Harvesters have carved a highway through tinder dry weeds 40 meters from headquarters to where I placed a pile of grain, on a gravel driveway about 10 meters from the shade of side vegetation. Noon is approaching and no self-respecting Harvester will be caught in that furnace without some protection — even if it be the shade of a pebble. If they are caught in the heat, they rest in shady areas until later, then resume their journey. About 40 centimeters to one side of the highway — out in the open — is a small dense green weed. Harvesters coming and going make a right angle to its shade. How did they know it was there? Instinct or eyeball?

• While in the shade a Harvester releases its seed, preens, then picks it up and resumes — again at right angles back to the highway.

• With a stop watch in one hand and a propane torch in the other I become a shameful assassin and exterminate a few near the grain pile. I start the watch and retreat to a glass legged platform next to the colony's ground entrance 40 meters away. Harvesters are streaming in with seeds and back for more.

Atop the platform, 5 to 6 minutes pass. Quite suddenly the outstreaming begins to diminish. By 10 minutes, none are going onto the highway. Those with seeds continue to stream in until the highway is vacant. As a double-check, the heads of several were dotted with yellow water base paint. Trips away from the nest ceased before any tracers arrived. How was the signal transmitted to arrive ahead of those first arriving from the scene of the disaster?

• Literature dismisses sight as an element of orientation because of being "tiny and crude". Why then does the Harvester work only during daylight hours (exclusive of the scorching hours)? After dark and all night the highway has zero traffic. Only within a few centimeters of the nest entrance is there any activity and very slow at that. If the Harvester's eyes are so crude why is light required for distant activity — even on overcast days?

• At a later date when traffic is again high, watching this time from the grain end and repeating with the torch, I noticed those running from the scene transferring information to those approaching. Those in turn retreated and transferred to others. Such information is transferred within a fraction of a second to two seconds by either a brief touching of antennas or a single or half orbit around each other, while in contact. What is their means for instant contact communication?

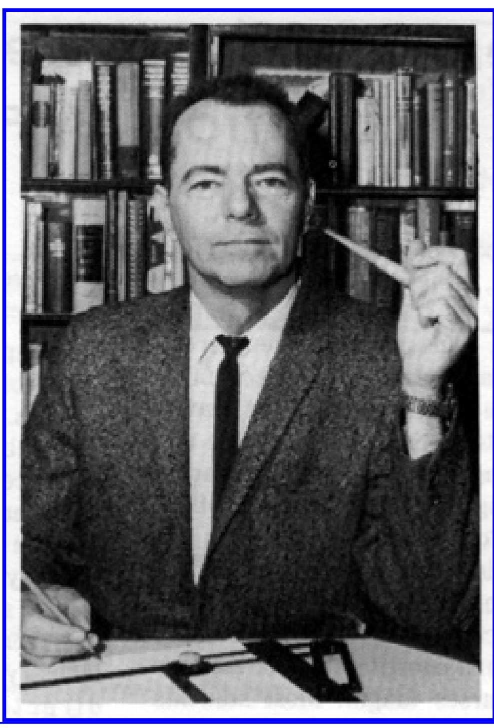
I have observed this procedure progress back to where they are all streaming toward home. This kind of information travels considerably slower than does the information relayed back to stop the column during the 6 to 10 minutes immediately following the torching. There appear to be two modes of communication: (a) Direct transfer and (b) Remote transfer. Sound familiar?

We take for granted that such life-forms are guided by instinct. How do we know it is instinct? Mainly because — once out of the egg the creature appears already fully educated? Or is this the case? How do we know alien planetary life doesn't come already programmed from the egg? We don't, but if true would such conditions pre-empt scientific investigation with a mental block? Are we doing this to the ant and other social insects?

Could it be possible that such insects have intelligence comparable to higher animals but instead of existing on a cellular level exist on a molecular level? The cranial dimensions of the Harvester are 3 by 3 millimeters by 1.5 millimeters thick. Since transit time for internal signals depend on distance might we assume that thought processes would be so rapid that a lot of information may be passed on to another by a mere touch? In view of solid-state technology transit times vs. active element dimensions this seems likely.

Would such head dimensions if placed at one focal point of a high resolution spherical reflector with an appropriate sensing element placed at second focal position produce ant noise? Due to proximity, processes inside the ant's head might provide energies equivalent to that received from some celestial sources. I realize voltages required for solid state integrated circuits are many order of magnitudes greater than we can expect from an ant brain, but improvements might be possible.

I would like to extend an invitation for someone to join me in making suggestions, proposing antenna and low-noise amplifier designs and finally share the results with me. My laboratory would be adequate and most of the hardware and time would require no outside funding to proceed. It is indeed exhilarating to anticipate what might be discovered. Forty years experience in applied physics will offer an advantage.



William A. Rhodes is a problem-solving research physicist and inventor residing in Phoenix, Arizona. He holds over 30 patents covering a wide variety of inventions. The titles of a few of the patents are: "Steering Control for Aircraft", "Shearing Device for Bone-Holding Pins", "Beryllium Extraction Process", "Solar Turbine", "Body Fluid Transfusion Method", "Muffler for 2-cycle Engines" and "Unidirectional Horizontal Seismometer".

Science and Engineering Education

By: Philip H. Abelson

In comparison with other advanced countries, **the United States is becoming a nation of scientific illiterates**. Our principal commercial and military rivals have recognized that future superiority will rest heavily on competence in applied science and engineering, and they are preparing their young people for the world of the future. For example, in Japan instruction in science begins in the first grade. From the third through the ninth grades, science and mathematics are required and constitute two of the four major courses taught. Most students who intend to go on to universities continue to take science and mathematics courses in upper secondary schools. Their curriculum includes differential and integral calculus and probability and statistics.

Conspicuous examples of American achievements, such as Nobel Prizes or pictures from the Voyager spacecraft serve to blind the public to the fact that a problem exists here. Acutally, the nobel laureates and the engineers responsible for Voyager are products of an earlier era. During their formative years (the 1940's and 1950's) a different attitude, one more favorable to science and engineering, prevailed in America. Around 1965 the environment for science and engineering began to deteriorate, and while Nobel Prizes still come, our superiority in technology has about vanished.

A recent report on "Science and Engineering Education for the 1980's and Beyond" from the National Science Foundation and the Department of Education provides some sobering comments. At a time when the world faces an enormous need for engineers, the United States lags behind Japan, West Germany, and the Soviet Union in the number of engineering graduates per capita. The contrast is especially marked with respect to Japan, where engineering enjoys high prestige and the total number of degrees granted to engineers annually has surpassed that in the United States. In Japan 20 percent of all baccalaureate and about 40 percent of all master's degrees are granted to engineers. This compares with about 5 percent for each of these degree levels in the United States. Moreover, many of the U.S. graduates are foreign nationals.

In Japan an engineering degree is a favorable route to business and social success. The report states that in Japan "only about 50 percent of the engineers produced each year ... enter the engineering profession. The others become civil servants and managers in industry. Around one-half of the senior civil service hold degrees in engineering or related subjects ... In industry, about 50 percent of all directors have engineering qualifications."

The educational situation in Germany is similar to that in Japan, with emphasis on science and mathematics in primary and secondary schools. "The overall picture in Germany is one of a very high level of science and mathematics literacy among college graduates as well as strong science/mathematics understanding among the general population."

In the Soviet Union students are exposed to an intense mathematics and science curriculum. Algebra and geometry are taught in the sixth and seventh grades, and additional mathematics, including calculus, is part of the high school curriculum. All youngsters are required to complete 5 years of physics and 4 years of chemistry. About five times as many Soviet students as Americans go on to engineering training. The inefficiencies of the Soviet system dissipate much of this advantage, but one can scarely feel comfortable about the contrast in educational level between the military forces of the U.S.S.R. and the United States.

Our present policy is moving us toward becoming a colonial supplier of raw materials and food to more advanced countries and is placing us in a position of increasing peril. Unfortunately, there is no crisis to alert the public. The one positive factor operating at this time is a strong demand for engineering graduates, which is driving up salaries. Overcoming scientific illiteracy will take decades.

This editorial appeared in SCIENCE, Vol. 210, page 965, 28 November 1980 and is reprinted by permission. The editorial is Copyright 1980

by the American Association for the Advancement of Science.

Philip H. Abelson is editor of SCIENCE, the weekly publication of the American Association for the Advancement of Science, a position he has held for 19 years. Born in Tacoma, Washington, in 1913, he received his B.S. in 1933 and M.S. in 1935 from Washington State College and his Ph.D. from the University of California in 1939. During W.W. II he was physicist with the Naval Research Laboratory and subsequently was with the Carnegie Institution becoming its President in 1971. A recipient of many awards and honors Dr. Abelson's special interest is in physical chemistry. He has written many scientific articles and is author of the book "Energy for Tomorrow" (1975).

Miscellaneous Items

Webpage Table of Contents (Bookmarks)

(Internal links to categories of items in this webpage)

Information About the Publication
(Editorial Board, Editors, Table of Contents)

COSMIC SEARCH ®

A magazine about Space, the Future and the Search for Intelligent Life beyond the Earth presented in a popular, responsible manner

Spring (Apr., May, June) 1981
Vol. 3, No. 2
Serial No. 10

ISSN 0161-8555

CODEN: COSEDN

Editors, and Others Involved in the Publication

About COSMIC SEARCH

Opinions expressed by persons writing in **COSMIC SEARCH** are their own and do not necessarily reflect the opinions of the editorial staff.

Subscription price: $10 for 4 issues in U.S. (and possessions), $13 elsewhere. Single copies: $2.50 in U.S. (and possessions), $3 elsewhere.

Address subscriptions and all other correspondence to: Radio Observatory, Box 293, Delaware, Ohio 43015.

Second-class postage is paid at Delaware, Ohio, and at additional mailing offices.

Note to subscribers: The last digits of the top line of your address label indicate the last issue of your subscription.

Front Cover

The Space Telescope (Photo courtesy NASA). See page 18 (the article entitled "People").

Table of Contents (in magazine)

Photo Credits:

Henrietta Leavitt (Shopley, Harlow, "Through Rugged Ways to the Stars," N.Y., Charles Scribner's Sons, 1969). Harlow

Shapley (American Institute of Physics. Niels Bohr Library. Shopley Collection).

THANK YOU!

COSMIC SEARCH expresses sincere thanks to the following donors who are helping to make sure that the story of SETI and mankind's future continue to be told in an interesting and factual way.

Planetary Donors

Robert J. Allen, Blythdale, Missouri
George Austin, M.D., Loma Linda, Cal.
Jane L. Brooks, Adelaide, S. Australia
Vera Buescher, Mountain View, Cal.
Jack Craig, Oregon City, Oregon
William E. Dorion, McLean, Virginia
Amahl S. Drake, Ithaca, New York
Harry Duke, Los Altos, Cal.
Nancy F. Eberbach, Ann Arbor, Mich.
Hale P. Faris, San Jose, Cal.
B. Fredricksen, White Bear Lake, Minn.
Richard and Maria Gauthier, North Bay, Ontario
Paul J. Hurn, Seven Mile, Ohio
James C. Killman, Sherman, Texas
David M. Laida, Sierra Vista, Arizona
Nelson Lecklikner, Novata, Cal.
John L. Mohr, San Antonio, Texas
Arthur J. Morgan, New York, N. Y.
A. V. Shaver, Winchester, Virginia
Paul Simmons, Sheboygan, Wis.
Eric W. Six, Iowa City, Iowa
John B. Theiss, Tucson, Arizona
Dennis Wildfogel, Pomona, N.J.
One Anonymous

Stellar Donors

Keith Conrad, Toledo, Ohio
George L. Douglass, II, Reno, Nev.
John Fadum, Boca Raton, Florida
David C. Halley, Colonial Hts., Vir.
Virginia Shaver, Winchester, Vir.
Paul Simmons, Sheboygan, Wis.
John Teetor, Marion, Ohio
C.L. Turnage, Camarillo, California

Cosmic Donors

Two anonymous

COSMIC SEARCH, published by a non-profit scientific-educational organization, has been granted tax-exempt status by the Internal Revenue Service, so contributions are tax-deductible (but subscriptions are not). On a combination donation-subscription or donation-renewal, the amount over and above the magazine cost is tax deductible. For example, if a donor sends $30 (qualifying as a "Planetary Donor") and includes a two-year subscription at $18, the $12 difference is tax-deductible.

Donation categories are as follows:

Planetary: $30 per year

Stellar: $100 per year
Galactic: $500 per year
Cosmic: $1000 per year

Contributions, however, will be gratefully accepted in any amount. Checks should be made payable to Cosmic Quest, Inc., P.O. Box 293, Delaware, Ohio 43015.

COSMIC SEARCH AWARDS

For best papers on SETI

Category 1. Undergraduate students
Category 2. Graduate students
Category 3. Anyone else under 30 years of age

Papers may be on any aspect of the Search for Extra-Terrestrial Intelligence (SETI). Papers must be double-spaced typewritten with one inch margins on 81/z by 11 inch bond paper and less than 2000 words in length. Any illustrations must be clearly executed.

Authors of best papers will be given a **COSMIC SEARCH AWARD** of $100 and the paper will be published in **COSMIC SEARCH**. Authors should include their full address and telephone number. Authors should enclose a self-addressed stamped envelope if they wish to have their manuscripts returned.

Manuscripts may be submitted at any time. Their review is a continuous, on-going process. Each article received is reviewed by a special committee and if judged worthy, either in its original form or after revisions, will be given a **COSMIC SEARCH AWARD**. The opinion of the committee is final.

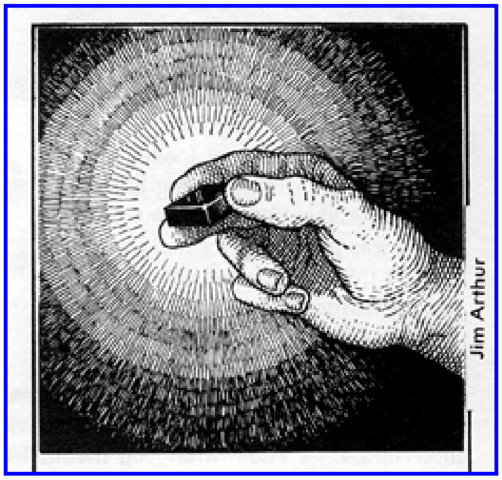
A contestant may submit and have under review only one manuscript at a time and be eligible for only one **COSMIC SEARCH AWARD** in one category. However, it is possible for one person to achieve **COSMIC SEARCH AWARDS** sequentially in each of the three categories.

Address **COSMIC SEARCH AWARD** Committee, Radio Observatory, P.O. Box 293, Delaware, Ohio 43015.

A Message to Humanity

A puzzle for computer buffs

[This puzzle was found on page 12 in the magazine, with hints found on page 21 and the answers found on page 24. Try to solve this puzzle without looking at the Hints and the Answers found here immediately below the puzzle.]



Suppose a friendly extraterrestrial presents us with a message to humanity in the form of a 20-gram piece of carborundum (silicon carbide). It looks like a palm-sized version of the monolith from "2001." The message is encoded in the lattice of the crystal; each carbon atom represents a zero, each silicon atom a one. The number 2001, for example, is represented by the sequence SiSiSiSiSiCSiCCCSi.

From the above data calculate:
(1) the number of bits of information in the message,
(2) the time necessary to read the message if it can be read at 10 megabits per second,
(3) the number of computer tapes necessary to store the message if each tape is 730 meters long and stores 1600 bytes per inch (8 bits = 1 byte), and
(4) the cost of these tapes if each one is $25.

This problem is from John Ball, a radio astronomer at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. Some hints are on page 21. [See immediately below, but DON'T LOOK!

A Message to Humanity — Hints

These are hints to help solve the problem on page 12. A gram-mole of any substance contains Avogadro's number (6.0225 x 10^{23}) of molecules. The molecular weight of silicon is 28.086, and of carbon 12.011; so the molecular weight of silicon carbide is 40.097. Thus 40.097 grams of silicon carbide contain Avogadro's number of molecules. But the prescription in the problem records two bits in each molecule.

The answers are on page 24. [See immediately below, but again DON'T LOOK!

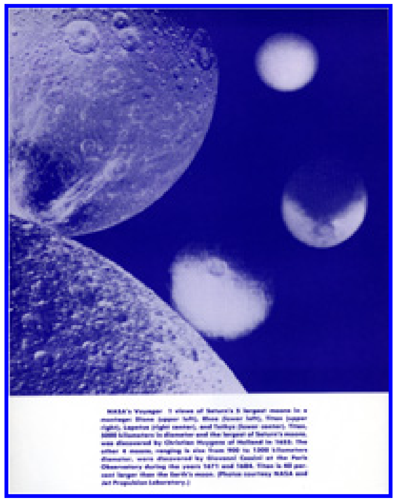
A Message to Humanity — Answers

These are answers to the problem on page 12. (1) 6 x 1023 bits. (2) 1.9 x 109 years (That is almost half the age of Earth.) (3) 1.6 x 1015 tapes (That is about 400,000 tapes for each person on Earth.) (4) $40,000,000,000,000,000.

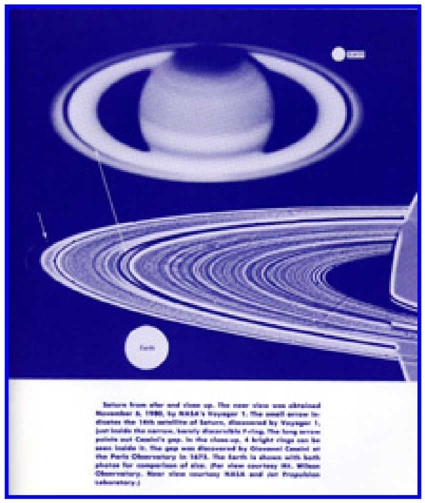
Miscellaneous Photos

The following photos (found on the inside front cover and inside back cover) are not directly associated with any article.

Inside Front Cover Photo



Inside Back Cover Photo



[HOME]

Designed by Jerry Ehman.
Last modified: September 9, 2006.