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The Chief Entities By: I. J. Good

For thousands of years people have speculated about the existence of *extraterrestrial* life. In ancient times it was thought to consist of gods and angels, whereas devils were thought to be *intraterrestrial*. Perhaps my own speculations have in some respects an ancient ring, but they are based on scientific rather than religious reasoning. Soon we might obtain some of the answers by direct observation, and then it will be too late to speculate.





"Angels were thought to be extraterrestrial"



"Whereas devils were thought to be intraterrestrial"

The problem of defining life has always been of philosophical interest, and on the whole there has been no problem in deciding whether a given entity is alive. But it may become more difficult in the future, owing to advances in cybernetics and biological engineering.

When speculating concerning extraterrestrial life, a definition is required even more. On earth, the possession of DNA as a controlling genetic chemical might be a reasonable defining property, since it occurs in all known lifeforms, but it would be geomorphic to insist on it for extraterrestrial life. Perhaps it would be better to say that a thing is living if its development depends on large molecules containing genetic codes.

A chemical definition of life might be too narrow, and some would feel that a more functional definition would be appropriate. Of the three "self" properties — self-repair, self-replication and self-preservation — the last seems the most important. If a thing is subjected to a great variety of dangers and overcomes them by a great variety of different acts, then it *might* qualify as a living thing; certainly it would qualify as an "org". (This term was coined in recent years and means an organism or organization.) Perhaps we should insist on both a genetic code and adaptive self-preservation in our definition of life.

It is difficult to agree that any cogwheel machine, however clever it might be, would qualify as living; could it be conscious and capable of feeling pleasure and pain? Maybe any sufficiently complicated information-handling system would be conscious even if it were purely mechanical. But many of us feel, as a metaphysical matter, that consciousness cannot have a purely mechanical basis and must depend on more than Newtonian physics.

Although a reference to consciousness as the main ingredient of life might be considered to be in bad taste by the high priests of materialism and irrelevant to the progress of science, it seems to me to be an issue that cannot be lightly sneezed upon; suppose we find that the back of the moon is inhabited by elaborate cogwheel machines or other orgs judged by us to be robots. If we regarded these orgs as dangerous to human colonization of the moon, we would be tempted to destroy most of them, keeping only a few in captivity for research purposes. We would do so with a much better conscience if we believed they were not conscious. We might do so anyway and learn to live with a bad conscience. Even if consciousness and real metaphysical pain are irrelevant to science, which is doubtful, they are at any rate relevant to ethics, including the ethics of interplanetary politics; but our galactic politics will probably be decided more by fear of retaliation than by ethics, until we reach cosmic maturity.

Ultraintelligent Machines

Real metaphysical consciousness might be relevant to science for the construction of the first ultraintelligent machine. By an "ultraintelligent" machine, I mean one that can do every intellectual feat better than any man. I am inclined to believe that such a machine will be constructed before the end of this century, using advanced electronic and optical techniques. I think the machine could be trained to become independent of its operator, but it is possible that it would not be properly motivated unless the operator remained in control.

The notion of an ultraintelligent machine will be relevant later on, so let us consider it in a little more detail. After the first ultraintelligent machine is built, the designs of far better and more economical ones can be handed over to the machine and its progeny, apart perhaps from some ethical guidance from a human committee. Clearly, there will then be an intelligence explosion. This will lead to extraordinarily rapid advances in medicine, space research, social science, and in every other branch of science. To say that a man *runs* like a machine is a compliment; before long it will be a compliment to say that he *thinks* like one.

It might be objected that machines cannot be expected to be creative. But creativity consists in putting ideas together in an unexpected manner, and once we have analyzed, perhaps linguistically, how ideas can be put together, we can begin putting pairs of ideas together in very large numbers by machine. If we can also solve the problem of testing whether the results are useful, then there will be no obstacle left. People put ideas together faster than is sometimes appreciated especially in the visual system, where it is done without effort. I believe an explanation will be found in the cell assembly and subassembly theories of the mind.

In order to consider how much intelligent life there might be in the universe it is necessary to remind ourselves of its size and some other of its features. First, let us get our distance scale in focus. We are about eight "light-minutes" from the sun — that is, about 150,000,000 kilometers — whereas Pluto, which is the farthest out of the known planets, is about forty times as far; and the nearest star is about 6,000 times as far away again. The diameter of our galaxy is about 20,000 times the distance to the nearest star; in fact it is about 80,000 light-years. The nearest full-size galaxy to our own is about a million light-years away; and the farthest one so far observed is a few thousand times as far away again; in fact its distance is believed to be a sizeable fraction of the radius of the whole "observable" universe.

The universe contains about 10¹¹ (100,000,000,000) galaxies and about 10²² stars all in immense space. But presumably most space travel by men, during the next fifty years, will be confined to the vicinity of our solar system. Even if a space-ship runs out of fuel and drifts out into the black depths of galactic space, it would take at least 10,000 years to get as far away as the nearest star. One might think, then, that interstellar travel is quite out of the question, but it should be remembered that technology started only a few hundred years ago, and even the human race is only twenty million years old according to the latest estimate. Interstellar travel might be quite easy for a civilization that is old by galactic standards.

Sherlock Holmes once remarked that if only one hypothesis fits the facts, then it must be true, however improbable it was initially. In this spirit some theories have been put forward for the origin of the solar system; for example, the origin was

attributed by Jeans and Jeffreys to the near passage to the sun of another star. This theory is initially improbable since the distances between the stars are so great and is no longer generally believed since the gaseous streamers would not condense into planets. An initially much more probable theory is that the sun and all the planets were formed by condensation of a rotating gaseous nebula. Holmes' principle is true but misleading in practice if the only theory you can think of is initially very improbable because the chances are you have simply overlooked something. Holmes himself never overlooked anything, at least that's Conan Doyle's story. At present, the nebular hypotheses are the most popular among professional astronomers.

It used to be thought that nearly all stars were isolated and that the sun was exceptional; but it is now known that about 80 percent of the stars in our vicinity are parts of multiple systems such as double stars, and at least one star has a nonluminous body going round it, as can be seen by variations in the linearity of its path. Now if a planet were associated with a double star it would be unlikely to be a suitable abode for life because the variations in temperature would be great; but the fact that there are so many double stars is indirect evidence for the existence of planetary systems around single stars. Moreover, one star has been noticed whose spectrum is what would be expected if it were surrounded by a gaseous nebula.

The current view is that in our galaxy alone there are probably at least a billion planetary systems. Moreover there is a magnetohydrodynamic theory of the origin of the solar system, due to Alfvén, which, if correct, would imply that most stars of the size of the sun would have similar planetary systems. This theory is not generally accepted since the magnetohydrodynamic equations are too difficult to work with. The fact that a simple rule, due to Titius and known as Bode's law, gives a good approximation to the relative distances of seven of the planets and of the mean distance of the asteroids from the sun is an indication that there is something rather natural about the origin of the solar system. One's first impression that the planets are spread around higgledy-piggledy appears to be incorrect.

Some fifty years ago it was frequently said that life is so fantastically unlikely that it could not have developed anywhere except on earth. In 1850 it was usually assumed that each species required a separate act of creation, and it was dangerous to deny it. The most common view among professional biologists today is that life is very likely to develop when the conditions are right and that no great coincidences are required. This view is further supported by the adaptability of life on earth under a variety of hostile conditions, an adaptability that is at first sight amazing.

Advanced Civilization

The development of life on earth exhibits a tendency to assume forms of greater and greater complexity. Let's call this the "Fourth Law of Thermodynamics", since the Second Law states that isolated physical systems tend to a state in which no work gets done. If a living organism is isolated, the best it can hope for is suspended animation, as in a deep freeze.

In virtue of the Fourth Law of Thermodynamics we can expect a reasonable proportion of planets in our galaxy, where large life-forms have developed, to possess advanced civilizations. (The life-forms presumably must be large, like humans, to have a prospect of great intelligence.) Nearly all the civilizations that have attained a level of technology as advanced as our own "civilization" will have done so many millions of years ago, since a million years is a very short time in comparison with the age of the galaxy.

If a civilization were 100,000,000 years ahead of our own uncivilization it would have invented the ultraintelligent machine about 100,000,000 years ago, unless it were prevented from doing so by a galactic police force. Within 1,000 years of this invention the technology would be unimaginable to us—let alone within 100,000,000 years. Among the inventions made within the first thousand years might well be methods of prolonging life almost indefinitely by the replacement and rejuvenation of parts; or the creation of ultraintelligent life-forms; or the construction of space-ships that could travel with a speed comparable to that of light. The ultraintelligent machines will also have helped to keep the peace and to stabilize the social system. They will create social problems but will also produce the solutions of those problems.

These guesses are too optimistic in at least one respect, since many of these civilizations will have allowed the Second Law of Thermodynamics to win out against the Fourth Law, either through internal strife or because the civilizations became redundant after inventing their ultraintelligent machines. A certain fraction of advanced civilizations will have failed to achieve a planetary government and

will therefore of course have annihilated themselves. But there must be a reasonable fraction, say 10 percent at least, where a planetary government was evolved. Of these, some will have become too corrupt to bother about their descendants, and will have used up the natural resources of their planets within a few centuries. But again a reasonable fraction, say at least 10 percent, will be sufficiently forward-looking to avoid this, especially as the individuals will be long-lived. In most cases, ultraintelligent machines will have been built within say a century of the widespread use of electronics and lasers. The collection of ultraintelligent machines would soon have achieved the status of an oracle and its advice would have been accepted even by the most stupid of politicians. Thus united planetary governments would have become established.

It therefore seems safe to assume that a small but by no means negligible proportion of advanced civilizations will have survived. Since there were probably thousands of millions of advanced civilizations in our galaxy, even a small proportion of survivors would be a large number. And even if there had originally been only 1,000, a figure far lower than most scientists who have considered the matter recently have suggested, probably at least one of them would have survived.

A race of beings, each of whom is almost immortal, would be prepared to plan millions of years ahead and would have been able to colonize the entire galaxy. It would not be necessary for any one being to travel more than a few light years in order that the entire galaxy should be explored. Pioneers from distinct civilizations might have come into conflict, but by now these conflicts would have been resolved, and a stable United Worlds Organization must have been established. Strong evidence for this is the fact that we ourselves have not yet been annihilated by extraterrestrial entities. They probably have evolved an instinct of peace-ability as well as a police force. It is already known that the aggressiveness of monkeys can be controlled by means of electrodes placed in a certain part of their cerebral cortices, so presumably aggressiveness can be controlled even in homo self-styled "sapiens".

In our vicinity the average distance between stars is about ten light years. Near the center of the galaxy it is only about one light year. Hence the population density near the center is presumably about a thousand $(10 \times 10 \times 10)$ times what it is in our vicinity. (Not 10; space is three-dimensional.) Moreover there might have been a great deal of migration to the center in order to be in the heart of things, just as

there is a tendency on earth for people to migrate towards large cities.

There is little reason to suppose that all the Top Beings would be of the same species. Even if they were all descended from the same species in the first place, they would have had hundreds of millions of years in which to differentiate into a great variety of species and genera if these terms are not too geomorphic—by the processes of natural selection and



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artificial selection. So we can assume, with reasonable confidence, that the United Worlds Organization is sympathetic to all forms of life. Perhaps it would be better to talk about the Chief Entities rather than the Top Beings, since they might be machines, or a hybrid between machines and living beings, "biomachines" as it were. Perhaps biomachines would be more sympathetic to all forms of life than purely biological things would be. A biomachine would probably not be much concerned about the color or even the shape of other biomachines.

If we assume that the universe is populated like this, the next question is: "how would the universe be colonized?" Space travel might be extremely boring, so civilizations could either send out complete villages in very large space-ships, or they could put fertilized ova into deep freeze and then space-ships of moderate size would be adequate. When the ship arrives at a suitable habitat their ultraintelligent machines could thaw out the ova, incubate them, bring them up and educate them. If it were not for the fact of evolution on earth, we could conjecture that Adam and Eve were Top Beings, at any rate before the fall! As it is, it is somewhat more likely that Christ was a Top Being.

It is not essential that all the Chief Entities should live on planets; many of them might live in artificially constructed space stations for some of the time. And these stations would be useful for relaying radio, laser, or other communications. Some of their space-craft might be very small, and be inhabited by pico-micro-miniaturized ultraintelligent machines. An advantage of small space-craft is that they could land on strange planets, such as our earth, and could take off again with a small expenditure of energy.

What experiments should we perform to detect the presence of the Chief Entities? Some radio listening has been tried on a wavelength of 21 centimeters, which happens to be suitable for interstellar communication. These experiments are more pertinent for communication with advanced civilizations as such rather than with the Chief Entities. The Chief Entities will make their presence known when they see fit.

The Galactic Zoo

What then are the Chief Entities waiting for? We have agreed that they have not occupied the earth because they are lovers of peace. Then why don't they announce their existence in order to encourage peace on earth? Perhaps we are part of the galactic zoo and are good material for doctoral theses. If they were to intervene it would bias their statistics. But we should not complain, since it is better to live on a preserve than in a jungle.

There can be little doubt that we have been under regular observation ever since we started using radio. We are in a very interesting and unusual condition, since we are going to build an ultraintelligent machine within the next few decades. Soon after we have done so, the Chief Entities will be forced to announce their presence since we are otherwise liable to become obstreperous. The Chief Entities will have excellent judgment concerning our probable future behaviour, partly because of their unimaginably great intelligence, and partly because of their vast experience of other emergent civilizations. By their experience alone they might know that it is unwise to announce their presence unambiguously to primitive cultures: to do so might undermine our existing motivations for working and lead to chaos. They might be waiting for the ultraintelligent machines to take over, especially if they

themselves are machines!

On the face of it, the Chief Entities have an acute problem of communication between themselves, because light and radio signals travel very slowly; one message between two planetary systems would take years. A centralized galactic government would be exceedingly unwieldy if its communications took thousands of years. Thousands of years are not much compared with the age of the galaxy, but if we were left to our own devices for such a time there is no knowing what crimes we might commit in the name of high ideals and undefined abstractions; the real motivation is the unconscious lust for power on the parts of the politicians. Accordingly we can reasonably presume that the galactic government is highly decentralized. It is ancient enough to have developed a fixed but viable constitution, copies of which would be widely distributed. I have assumed for the moment that no informative signals can travel faster than light, as has been generally believed since the acceptance of the Special Theory of Relativity. But there are more things in the universe and in the galaxy than were dreamed of in Einstein's philosophy.

At all times in the history of science a large fraction of professional scientists, in their collective arrogance, have strongly believed that we were close to the whole truth and nothing but the truth concerning the fundamental laws of nature. (Collective arrogance is a kind of trade union activity, is commoner than personal arrogance, is generally considered to be less noxious, but is more so.) Laplace, for example, thought the entire future could in principle be predicted if we knew the positions and velocities of all particles of matter. This form of billiard-ball materialism is now hotly denied by most quantum-mechanical physicists. The "miracles" that have occurred since Laplace's time, some of which were not even predicted in science fiction, let alone by the professors who wished to be respected for their common-sense administrative ability, include (i) radio and, in particular, transatlantic radio which was declared impossible in a court of law by a professor of physics when it was first claimed by Marconi; (ii) the clock paradox that if you take a round trip with nearly the speed of light you return younger than those who stayed behind; (iii) atomic energy, whose economic use was declared impossible by Rutherford himself; (iv) lasers ("death-rays" were predicted even in bad science fiction); and (v) satellite communication, predicted by Arthur Clarke in 1945, although the British Astronomer Royal said space travel was impossible a few years later.

We *might* be close to the whole truth in physics, but to believe this with much confidence is entirely unjustifiable. Although quantum mechanics is a very successful theory, its implications are more fantastic than any self-consistent science fiction, and in fact quantum mechanics is probably self-contradictory and therefore strictly wrong. Moreover, there are many simple and important unsolved problems which could eventually be classified under physics; for example, the nature of quasars, why the proton is so much heavier than the electron, the nature of consciousness, and whether telepathy, or instantaneous thought transmission, is possible.

Let us then reconsider the possibility of signalling faster than light. This is not strictly ruled out by the Special Theory of Relativity as is often thought. What this theory implies is that if a signal travels faster than light to one observer, then there will be other observers for whom it travels backwards in time. But several eminent physicists and mathematicians have quite seriously suggested this apparently paradoxical possibility, mostly but not entirely for subatomic phenomena. There is, for example, the Stückelberg-Feynman idea that a positron can be regarded as an electron moving backwards in time. In Gödel's modification of relativity theory, a speed of 72 percent of the speed of light is enough to produce backward time travel. The apparent paradoxes of backward time can be resolved in terms of the branching-universe theory, but I shall not go into details here.

Any evidence for precognition, or knowledge of events before they happen, would be evidence that signals can travel backwards in time. Perhaps the best evidence is not yet scientific because it depends on highly critical emotional situations which can hardly be repeated in a controlled manner. Any evidence for telepathy is weak. But one thing is fairly certain. If telepathy is possible, the Chief Entities would have perfected it by now and I would guess that all the best life in the universe would be now living in a state of integrated consciousness. The consciousness of a man is apparently a consequence of close communication between many entities: we tend to forget that a neuron is an animal that lives in the head.

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HOME

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