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Space Travel and Life Beyond the Earth

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Continued from the last issue in which Dr. Öpik discussed the conditions for life in the solar system.

Let us enquire whether the next step, this very long one, could be directed towards the stars—the so-called "fixed" stars which actually are not fixed at all but move even faster than the planets; because of the enormous distances we do not notice much of these motions which can be detected only by accurate measurements. The stars are other suns, and many of them are far-away other solar systems. There undoubtedly are other planets, some lifeless, some carrying life—relatively few of the latter kind as can also be judged from what we know about our Solar System. Yet their distances are enormous to which, among other things, testifies their feeble apparent brightness when it is realized that, seen from an equally close distance, a star could equal, or even appear 10 to 100 times brighter than our Sun. The speed of light is 300,000 kilometers per second, 10,000 times faster than the motion of the Earth in its orbit or the velocity of an interplanetary vehicle; while this in turn could be a hundred times faster than the fastest jet planes. Yet despite its enormous speed, it takes $4\frac{1}{2}$ years for light to cover the distance from the nearest star, and about 300 years from a star chosen at random among the thousands seen in the dark sky at night. At the actual speed of our space vehicles it would take 40,000 years to reach the nearest star, and three million years to reach an average sun seen by the naked eye as a faint scintillating starlet. Man has always been tempted by far-away places, yet those distances are utterly prohibitive. Despite the thirst for knowledge and its philosophical lore (while no practical purposes could be served by a space journey of so long duration), hardly such a voyage will ever be undertaken. The journey could be made either in a state of artificial lethargic sleep, provided that medical science will ever tackle such a proposition; or by successive generations—hundreds of thousands of them, covering a span in time equal to that from our earliest Stone Age, over the entire prehistory and history of mankind until the Present. On Earth, during such a span of time, there appeared and disappeared entire races, nations and empires—how could ever survive and persist in its aims over a hundred thousand generations a tiny isolated human group lost in the immensities of space and time? Visits to the stars in such a manner are virtually

impossible and unthinkable. Moreover, those scientific and philosophical aims which are underlying the plans would interest only the initiators of the expedition and, perhaps, their immediate descendants. Prospects of receiving an answer after one hundred thousand or a million years would hardly be conducive to such an expedition, and especially because its ultimate failure would be certain.

Could the speed of the space vehicles be accelerated and the time of travel thus shortened? The maximum physically possible speed is that of light, ten thousand times faster than the "normal" velocity of interplanetary vehicles. With such a speed a return journey to the nearest star would take 9 years. However, this nearest star, Alpha Centauri, may not be a very attractive goal; it is a double star which would not tolerate life-bearing planets within its domain; in the presence of those two suns the motion of a planet would be very complicated, with the mutual distances varying in the extreme, so that uniformity of a global planetary climate could not be maintained—lethal heat and deepest cold in succession blotting out all traces of life. Also, most of the planets of such a binary system would move on unstable orbits, being either ultimately ejected from the system, colliding between themselves, or swallowed by a sun (as is the fate of comets and other stray bodies in the Solar System). If we were in search of extraterrestrial life, thousands of stellar systems would have to be tried before one is found, at distances requiring centuries to be covered even at the speed of light. The outlook is entirely hopeless; humanity must content itself with its own Solar System, as must those other humanities lost somewhere in the depths of space in permanent isolation.

To make a material body move with the full velocity of light is impossible because it would require an infinite amount of energy. Even at near this velocity the energy per unit mass (initial or "rest mass") could by far exceed all sources of nuclear energy. Yet despite the seemingly virtual impossibility of attaining such high velocities, there are extraordinarily interesting outlooks connected with it, so that even scientists are repeatedly tempted to consider, theoretically at least, the consequences of locomotion at such ultimate velocities, and to search for loopholes to overcome the apparent technical near-impossibility.

Consciousness remains the ultimate mystery even though it is through it that we perceive the cosmos around us.

One of the consequences of motion with a velocity approaching that of light, according to Einstein's Theory of Relativity, is a foreshortening of time which in the departed vehicle advances slower than the body left behind, so that when the vehicle's velocity equals 0.995 that of light, a tenfold foreshortening takes place and a return trip to a star 50 light years away, recorded from Earth as of 100 years duration, would be recorded as only 10 years of life by the passengers in the vehicle. This strange fact is not simply a mere mathematical conclusion, but is confirmed by experiments in atomic physics where moving atoms represent the vehicles, their vibrations measuring time. The foreshortening is the greater the closer the velocity is to that of light.

Curiously, such foreshortening of time has been envisaged in some fairy tales. There is the story of Rip van Winkle; or Andersen's tale of Swamp King's Daughter, where the heroine is allowed to spend but one day in paradise with her deceased beloved and, returning to Earth, discovers that 1000 years have passed.

Despite such tempting prospects of a "time machine", there is a great obstacle which renders the project virtually impossible. The mass of the accelerated vehicle increases in the same ratio as time is shortened. Thus, even with the modest ratio of 10 to 1 as in the above example, each gram of the vehicle must be given 9 grams extra; now, according to Relativity theory and experiment, mass is equivalent to energy; it is actually the greatest concentration of energy we know, so that the extra grams of mass need a supply of energy equal to that of 1200 grams of a hydrogen bomb, or about ten times more of a "conventional" atomic bomb! If the rocket accelerator of the vehicle could use the strongest existing explosive, that of hydrogen fusion in the hydrogen bomb, acceleration to an 8-fold foreshortening of time would require an expenditure even of this super-fuel equal to 10^{37} times the mass of the vehicle (1 with 37 zeroes). At this rate, for one ton of the vehicle the amount of hydrogen to be spent should equal the mass of 10,000 million suns or almost that of the entire Galaxy.

Theoretically there could exist even a more powerful explosive or fuel than the hydrogen of the bomb: the mass of matter itself which, when converted into radiation, yields 128 times more energy than fusion of hydrogen. Mass is thus the ultimate possible source of energy, a source of which we have no idea how to tap it. One way would be to have a store of "antimatter" which, in contact with matter, annihilates completely. However, only single particles of atomic dimensions have

been observed in the laboratory, and these annihilate instantaneously in contact with matter. To store antimatter is just as practicable (and infinitely more dangerous) than to store gunpowder in a burning fireplace. But even if storage were possible, to reach the desired "modest" time-foreshortening ratio of only 8, an amount of antimatter 3000 times the mass of the vehicle should be spent.

A sophism in Relativity, pertaining that the vehicle leaving the Earth, and the Earth left behind at an equal relative velocity are in equivalent states and should, therefore, have the same measure of time, is invalid: it is not velocity, but acceleration which pumps energy and mass into the vehicle; the vehicle is solely accelerated and the passengers would actually feel the acceleration as do those in an accelerated car, and not the by-standers watching it from the roadside.

To summarize—interstellar travel, visiting the stars or expecting visitors from the stellar universe, is at present not possible. We, as well as the inhabitants of other planetary systems, may be forever isolated in this respect.

This statement refers to material things having a finite rest mass, i.e. a mass even when they are not moving. Only an object which lacks a rest mass can be made to move with the velocity near that of light, because a zero increased so many times still remains a zero. Are there such objects?

Actually, light itself moves with the ultimate velocity whence its name. The waves of radiation, the photons, have no rest mass, only energy (and a kinetic mass appropriate to the energy). Therefore, time inside a photon stands still—at exactly the velocity of light the foreshortening is absolute. When measured by their "internal time" (if such a notion is permissible), the photons can traverse the entire Universe in an instant of their own time, although in our measure the time between the emission of a photon and its absorption by a body somewhere on the outskirts of the Universe would amount to thousands of millions of years or to anything short of infinity.

The analogy of the timeless photon could suggest possibilities for grasping (not solving) the greatest mystery of our experience — that of our consciousness, or our "soul". Its nature is not accessible to physical experiment, it is not subject to the laws of physics, to measurements or timing: it is immaterial. Being immaterial and massless, it could be timeless as the photon, moving with the speed of light in an

instant (by its own timing) through the immensities of space. As a mere suggestion for an insoluble mystery — could it be that the immortal soul, the individual unit of consciousness, would move through the infinities of space and time, after leaving one body, to find another and cooperate with it, like the absorbed photon transmitting its energy when absorbed? We do not know; the nature of consciousness, of the soul remains the ultimate mystery, despite the fact that consciousness to us is the only incontestable reality, through which we perceive the world around us.



Dr. Öpik has written numerous articles on life and intelligence in the universe. Recently he reviewed his monograph "The Sun", published in 1919 and noted how much of our basic concepts of cosmic evolution have persisted despite new observational facts, and how little has changed. The age of the Earth in 1919 was underestimated at a few hundred million years, while that of the stars reckoned in thousands of millions. The prophetic suggestion of immense energy sources in stellar interiors was a forerunner of modern concepts of nuclear energy sources. The outmoded representation of stellar spectral types as a continuous evolutionary sequence is no longer valid, as well as the description of solar evolution by continuous "cooling" and dimming. This must now be replaced by a future brief heating up, ultimately followed by a real cooling—a collapse into the white dwarf stage to which the offered description of a frozen end of the world could still apply.

The monograph was written at Moscow Observatory during the privation year of 1919. There was no fuel, and ink was frozen hard on the writer's desk. In the biting cold and with a dim electric light available, the writing was done in pencil, in bed under a blanket—a foretaste of a freezing dying world of the future.

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