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ARE SPACE VOYAGES POSSIBLE

By

I Lin

FOREIGN TECHNOLOGY DIVISION

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By: I Lin

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ARE SPACE VOYAGES POSSIBLE?

I. Lin

There has been an increasing interest for man to fly out of the solar system, into the immense space of the universe, and to explore the mystery and evolution of heavenly bodies and the origin of life, and to search for life similar to the human race on earth. What kind of difficulties and problems will be encountered? What are the solutions?...

* * *

The reader might think that these two questions had been answered positively twenty years ago. Why waste any more space here? What we propose to discuss now ~~is the real~~ are actual ~~cosmic travel~~ space voyages, rather than ~~the~~ space flights within the solar system, already a reality. Flying away from the solar system, into the world of the fixed stars is what we mean by ~~travel in the universe~~ space travel or simply "astronautics" ~~cosmic travel~~.

The present status of space flights

In 1957, the successful launching of ~~the~~ an artificial earth satellite marked the beginning of the space flight era. Since then, the human race has, many times, ascended to heaven and turned the thousand year old myth of Chang O's flight to the moon into a reality. The mysteries of Mars are being revealed and the door to Venus opened. It will not be long before human beings set foot on the soil of Mars, and the long march toward the enormous Jupiter and Saturn at a billion kilometers away has begun. Neptune and Uranus, far away near the edge of the solar system, may soon welcome the first visitors from planet Earth.... Although the distances of travel are getting farther and farther away, they are still within the "sky" of the solar system. The moon is 380,000 kilometers from Earth, an arm's stretch compared to the millions of kilometers of Mars and Venus. On the other hand, Mars and Venus are really our next door neighbors if one thinks about Pluto, 60 billion kilometers away at the edge of the "sky." All we can do in the twentieth century will be roaming in the solar system, 12 billion kilometers across. The solar system "sky" is enormously large when it is compared to the "Earth," a mere 13,000 kilometers in diameter. But, when the solar system is compared with the universe, it is at best only a speck of sand in the ocean, ~~at best~~, since the ocean has a boundary while the universe is infinite.

The reader probably knows that, on the Earth's surface, when an object's speed reaches 7.9 km/sec, the first ~~universal speed~~ space velocity, it becomes an Earth satellite. Upon reaching the second ~~universal speed~~ space velocity, or, 11.2 km/sec, the object will escape from Earth and become an artificial planet of the sun. It will finally break away from the attraction of the sun at the third ~~universal speed~~ space velocity, 16.7 km/sec, and fly beyond the "sky." With today's space technology, flights beyond the solar system pose no problem, in fact, since 1972, there have been several Jupiter and Saturn explorers, which will reach the third ~~universal speed~~ space velocity and leave the solar system in ~~1984~~ 1983 and forever disappear into the infinite universe. The planet explorer launched Spetember, 1977, will approach Jupiter next year, fly around Saturn in 1981, and head for Uranus. Bidding farewell to Neptune and crossing the ~~"sky line,"~~ "boundary line of the sky" the orbit of Pluto, it will be beyond the solar system. Most interestingly, this explorer carries a ~~record~~ recording which contains greeting messages ~~said~~ spoken in some 60 languages and calling sounds of more than one hundred birds and animals. While roaming in the galaxy, the explorer will keep playing the record in hope of meeting some appreciative humans or beings in the universe.

However, flying out of the solar system is not ~~equal to cosmic flight~~. ~~Cosmic travels~~ refer to flights with a certain fixed star or star system as the destination and a certain flight mission, not the aimless wandering around in the universe.

Searching for new worlds

As we all know, the three fundamental questions modern science is facing today are the evolution of stars, the origin of life and the elementary particles. ~~Universe~~ travel will provide a wealth of vivid data on the evolution of stars and the origin of life. The hope for ~~searching~~ life within the solar system is slim indeed; even Mars, the most hopeful case, may have some most primitive life form at the best. This naturally leads to an increasing interest ~~of life~~ searching outside the solar system. The universe is full of fixed stars like the sun and planet system like ours. If the conditions on some planets are similar to those on our Earth, life may have originated on them and life forms similar to human beings, or even more advanced forms may have appeared through evolution. Even if other human beings are not found, the understanding of life and evolution on other planets will greatly enrich our understanding of the origin of life. Thus, the major mission of the cosmic travels we are facing is to search for "new worlds" similar to the sun and the Earth in the vast realm of fixed stars.

Some might feel that if we can fly out of the enormous solar system, it only takes ~~some more gas~~ to reach other fixed stars. Things are not that simple. If we can compare the transition ~~of flying on Earth~~ to ~~flying out of the Earth and in the solar system~~ with climbing ~~a tall~~

to the top of a tall building, then, it takes the courage and determination of climbing ~~the~~ to the peak of Mt. Everest ~~peak~~ to make the transition from flights ~~inside~~ within the solar system to real ~~cosmic~~ space travel~~s~~.

<u>What is so difficult about ~~cosmic~~ space travel?</u>

The difficulty lies in the fact that fixed stars are just too far from us. The distance to fixed stars belittles 10,000 kilometers as a distance unit, even the astronomical unit (the average Earth to Sun distance or 150 million kilometers) is too small. The distances to stars are usually expressed in units of light-years, the distance travelled by light in one year. Since light travels 300,000 kilometers per second, one light=year is approximately 9500 billion kilometers. The nearest star to the Earth, α -Centaur (Nanmen 2), is 4.3 light-years away, or 40,000 billion kilometers, 7000 times the distance to Pluto. Like the ancient Chinese poem: "Liu Long thought the Pong Mountain is so far away, now they are separated by ten thousand Pong Mountains."

If we imagine a ping pong ball sitting at the middle of the Tien An Men Square to be the sun, then the Earth is a grain of sand, 0.3 mm in diameter and 4 m from the ping pong ball. The entire solar system will be the size of the Square and the nearest star is 1000 kilometers away.

Let us then look at the familiar bright stars in our galaxy. The brightest star in the sky is Sirius, the fifth nearest star and 8.6 light-years from us. The brightest star in the northern sky, the Vega, is ~~20~~ 26 light-years away. The other bright stars are Nanho 3 (11.4 light-years), Altair (Hoko 2, 16.3 light-years), Arcturus (36 light-years), Wuch'e 2 (45 light-years), Huasu 5 (68 light-years) Tsansu ~~1~~ 4 (650 light-years), and Tientsin 4 (1600 light-years).

Consider the present planet explorer capable of achieving the third space velocity ~~universal speed~~. For ~~After~~ the explorer to escape~~s~~ the gravitational attraction of the sun, the traveling speed of the explorer in space must reach ~~the universe will be the velocity of the sun.~~ solar escape velocity. This velocity is different relative to various fixed stars but it is about 30 km/sec on average and 100 km/sec at the most. Even with the maximum speed of 100 km/sec, it will take tens of thousands years to reach the nearest star. Therefore, to realize space ~~cosmic~~ travel, the speed must be raised substantially, not by factors of 10 or 100, but raised a ~~by~~ thousand times ~~folds~~, or ten thousand times to a speed of several tens of thousands kilometers per second, close to the speed of light. For example, at the speed of 30,000 km/sec, one tenth the speed of light, it takes 43 years to reach α -Centaur. If the speed is raised to 100,000 km/sec, of 1/3 the speed of light, it still takes 13 years to reach α -Centaur.

<u>The line-up of destination stars</u>

Within ~~the~~ 20 light-year distance from the sun, there are 59 star systems all together. Among them, 41 stars are single stars, 15 are binaries and 3 are triplets. For instance, α -Centaur consists of 3 stars, the A, B, and neighbor star. Do these stars have planets? and how many planets? Since they are so far away, only 8 planets have been discovered so far. The first destination of our space voyage ~~cosmic travel~~, as expected, is the nearest star similar to our sun. If the size, mass, spectrum and luminosity of the star are similar to those of the sun, then, it is likely that the star will have a planet system and life exists on its planets.

Just like the first astronomical object explored by human beings is their neighbor, the moon; the first star outside the solar system will be the nearest neighbor α -Centaur. The A and B stars are close together, with a spearation of only 34 astronomical units, the neighbor star is 2400 AU closer to us than the A, B stars. Since these three stars move with the same speed in the same direction, astronomers regard them as one star. The α -Centaur is chosen not only because it is the nearest star but also because its A star is quite similar to the sun in size, mass and luminosity, and therefore, a greater probability for the existance of life.

At a distance of 6 light years from the sun, there is a grade 10 star, invisible to the naked eye, called Barnard. This star first drew some attention because of its large displacement every year (called self-travel in astronomy), the star is approaching us at a line of sight velocity of 108 km/sec. The diameter of Barnard is 1/7 that of the sun and its mass is 38% solar mass; the surface temperature is only 3300^{o} (compared to 6000^{o} of the sun). This relatively dim star belongs to the red dwarf variety. Astronomical observations have revealed that it has three planets, and since it is the next nearest star, a logical second candidate for ~~cosmic~~ space travel destination. People are already doing preliminary studies of space trips to this star. Occupying the third place of the destination star line-up is τ -Cetus, 11.8 light-years away. The diameter of τ -Cetus is about ½ solar diameter and its mass, temperature and luminosity are all similar to the sun. There is a good chance that τ -Cetus has a planet system similar to the solar system. Figure 1 shows the approximate location of stars within 12 light years. Numbers in front of the star names indicate their order in the line-up.

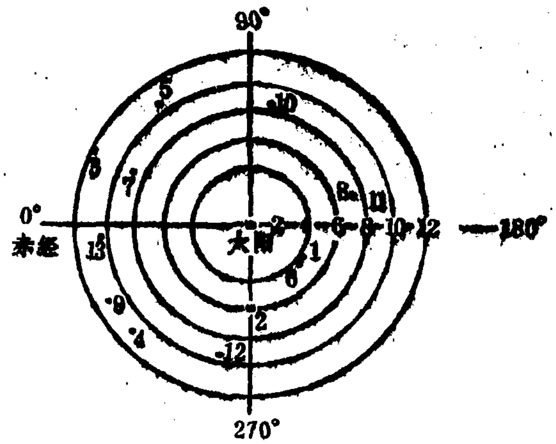

Fig. 1. Schematic diagram of the location and distance of the destination stars within 12 light-years.

1.6. α -Centaur, 2. Barnard, 3. τ -Cetus, 4. Cygnus A/B, 5. Nanho 3, 7. Luytens 726-8 A/B, 8. Wolf 359, 9. E-Indian, 10. Sirus, 11. Leland 21185, 12. Ross 154, 13. Ross 248.

<u>How long ~~are the cosmic travels?~~</u> would space voyages take?

Assume our destination is the α -Centaur and assume a purely idealized situation that the spaceship reaches the speed of light almost instantly and reports to earth as soon as it reaches the destination star. Since it takes the electric signal 4.3 years to reach Earth, it will be the 9th year after the spaceship's departure when people on Earth hear the good news from α -Centaur. In actuality, however, there must be an acceleration stage before it reaches its maximum speed, close to the speed of light at best, and a deceleration stage before reaching the destination. The total time from departure to receiving the message will certainly be much longer than 9 years.

There are two ways to reduce the travel time: first one can increase the acceleration and thus reduce ~~the~~ acceleration and deceleration time, secondly, the maximum speed can be increased to reduce the inertial flight time. Assume the acceleration of the spaceship is equal to the gravitational acceleration on the surface of Earth, of 1 g, then, after 0.9 years of acceleration, the speed will be 9/10 of the speed of light and 0.4 light-years of distance is covered. This is followed by 3.9 years of inertial flight at 9/10 the speed of light and 0.9 years of deceleration to reach the destination. Total time used is 5.7 years, very close to the minimum flight time of 4.3 years. Therefore, even though acceleration greater than 1 g will decrease the acceleration time, the effect is not very pronounced. But, if the acceleration is too small, the acceleration stage will take too long. For example, if the acceleration is 0.01 g, it takes twenty years to acceleration to reach a mere ½ the speed of light, while in the meantime, the spaceship is half way to ~~the~~ α-Centaur. The rest of the trip is deceleration, another twenty years. With the time required for return message, total time will exceed 40 years.

A higher maximum speed reduces the time for the inertial flight, but the acceleration time is lengthened for the same acceleration. If the acceleration is 0.1 g and the maximum speed desired is the speed of light, it takes 10 years to accelerate and this 10 years flight will bring the spaceship to α-Centaur. If only ½ the speed of light is desired, then the acceleration time will be 5 years and there will be 6 years of inertial flight, a total of 11 years, only one year longer than the maximum speed (the speed of light) case, but the saving of energy amounts to 3/4.

The table below shows the relation between the maximum speed and the time it takes to complete the mission. The destination is α - Centaur and the flight is ~~sweep-by~~ fly-by, i.e., no deceleration stage. "c" in the table represents the speed of light.

a	最大速度	1.0C	0.5C	0.3C	0.1C	0.05 C
b	加速段时间(年)(加速度 0.1g)	10	5	3	1	0.5
c	惯性飞行时间(年)	0	6	13	43	85
d	回电时间(年)	4.3	4.3	4.3	4.3	4.3
e	完成任务时间(年)	14	15	20	48	90

a. Maximum speed, b. acceleration stage (years), acceleration = 0.1 g, c. inertial flight time (years), d. Message return (years), e. mission completion time (years).

The simple analysis and the above table indicate that, for stars within 10 light years, the maximum speed need not be greater than ½ the speed of light. The efficiency actually goes down for speeds greater than ½ the speed of light. The acceleration should be less than 1 g, with very little gain at higher acceleration. From a practical point of view, the maximum speed of space travel in the next 10 years or more may reach the level of 0.1 c or 0.5 c at the most. A flight to the nearest star will consume an entire half century.

GOOD NEWS FOR YOUNG AVIATION FANS -- AVIATION SUMMER CAMP IMINENT

Aviation Knowledge News -- The great leader Chairman Hua, in the National Science Conference, called upon the nation to "greatly elevate the Chinese science and culture standard" and he emphatically pointed out that education of youths is "an extremely important aspect, needs special attention." A national youth aviation summer camp will be held in Peking this summer. Three hundred students from 29 provinces, cities and autonomous regions will attend, including certain numbers of Taiwanese students and minority students.

Interesting and many-faceted activities are scheduled to take place in the summer camp: seminars on aviation science knowledge, various ~~tours on various aviation technologies~~ aviation science & technology tours, participation of athletic activities, meetings with battle heroes and experts in the field of aviation science and technology, etc. The young people will gain a preliminary understanding of aeronautic and space technology, become more enthusiastic about China's aviation and space enterprise and work hard for the early realization of the four modernization movement.

In order to educate the youths so that they will continue to hold high the great flag of ~~the great~~ Chairman Mao and struggle for the cause of communism ~~cause~~ the rest of their lives, among ~~two of~~ the activities of the summer camp will be ~~an~~ a organized ~~worship~~ visit to the tomb of the great & respected leader Chairman Mao, and visit the exhibitions of the life and achievements of the respected and beloved Premier Chow.

This summer camp is organized jointly by the National Science Association, the Education Department, National Committee on Athletics, and Communist Youth Corp Tenth Organization Committee. Activities are coordinated by the Air Force, the Navy, the Civil Aeronautics Bureau, and various offices in the aeronautics and space industry. The camp site will be at the Peking Aviation College and the actual programs will be run by the Chinese Aviation Society and the Peking Aviation College. The selection of participants is entrusted to the regional bureau of education of various provinces, cities and autonomous regions. Students coming to the camp must be outstanding students in their respective high schools and priorities are given to students enthusiastic about aviation. Through the acitivities of this summer camp, the love of science and technology among the youths will be stimulated and the good trend of love of science, learn science and apply science will be established in a meaningful summer.

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