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## **The Dignity and Sustainability of Human Civilization**

### **--An Astronomer's Concern**

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"Space aliens" and "UFOs," which often appear on TV and other media, have been regarded as skeptical topics in the scientific world. In fact, it seems that there are many people who claim have seen UFOs and aliens, but no astronomers who say so publicly. UFO believers explain this situation by saying, "There must be astronomers who have seen UFOs, but they keep their mouths shut because they will lose their jobs if they say so publicly." Or "The aliens come to the Earth to avoid being seen by astronomers."

Well, be that as it may, most astronomers now feel that there are many other planets besides the Earth that could harbor life, and that the day when such planets are actually found is not far off. The first star with planets outside our solar system was discovered in 1995. Since then, more than 4000 stars with planets have already been discovered. According to recent researches, it is rather natural to assume that most stars

have planets. Since there are about 200 billion stars in our galaxy (the Milky Way), there should be an inexhaustible supply of planets. It is scientifically unreasonable to think that the Earth is the only one among them that is special enough to have nurtured life. Due to limitations in exploration technology, most of the planets discovered so far are orbiting close to their stars, where the temperature is too high to support life.

Water, which is considered essential for life, is lost through evaporation on planets that are too hot, or frozen on those that are too cold. Habitable planets are those that orbits at a reasonable distance from its mother star and has a temperature environment that allows water to exist in a liquid state. Recently, a number of habitable planets of the Earth's size have been discovered.

The Earth was born 4.6 billion years ago. It is thought that primitive life existed 4 billion years ago. Considering that what happened on the Earth could also happen on other planets, we should assume that there are many planets in the universe that could harbor life.

Life on the Earth has evolved over four billion years, and among them, we humans have experienced a rapid evolution of technological civilization since the Industrial Revolution in the 18th century. Radio broadcasting signal, which began in 1920, now extends to a radius of 100 light years (the distance

light travels in 100 years, or about 946 trillion kilometers). If there is a cosmic civilization observing the Earth's civilization within this range, it may have realized by now that the Earth's civilization has finally evolved to the level of radio broadcasting.

It was in 1923 that Edwin Hubble, the greatest astronomer of the 20th century, showed that there is a vast universe beyond our galaxy. It was in 1929 that he discovered that the universe is expanding. In other words, it has been less than 100 years since mankind began to recognize the universe scientifically (for more information on Hubble, please refer to my book, "Hubble: The Man Who Expanded the Universe," Iwanami Junior Shinsho).

In addition to the lack of progress in nuclear disarmament between the U.S. and the Soviet Union, the number of nations with nuclear powers is increasing. The risks associated with human activities are increasing, such as global warming caused by uncontrolled resource extraction and increasing carbon dioxide. The immature human civilization, infested with politicians who advocate "xxxx First" for local interests, has not been able to evolve socially to match its technological evolution.

How many more years will human civilization be able to prosper without destroying itself? Pessimists say it will not last 100 years. That is too sad. Let's

be optimistic and think that there will come a time when smart leaders (maybe AI governments) will emerge and we can avoid self-destruction and maintain our civilization. However, if we believe that the accumulation of failures is the foundation of progress, then the continuation of a stable society may itself be just the beginning of our fate to decline.

Let's assume that such a peaceful and stable civilization lasts for 10,000 years on Earth. Even if a million earth-level civilizations were to emerge in the galaxy over a period of about 10 billion years, if the average lifespan of each civilization is only 10,000 years, the average number of civilizations in the galaxy at any given moment would be only one. This would mean that they would disappear without any chance to be encountered each other.

To begin with, even if a neighboring civilization exists in a galaxy with a diameter of 100,000 light years, it is so far away that it would take more than 10,000 years for the message to reach them, even if it is just to say "hello." The universe is as big as it is, and we are in the middle of an eternal flow of time.

Astronomers are convinced that the earth is not unique and special. But many researchers of the origin of life say that life is so exquisite a combination of coincidences that it is hard to believe that such a miracle could have happened on any other planet. Astronomers are now

preparing the means and strategies to find out which is true.

This year marks the 20th anniversary of the Subaru Telescope, an 8.2-meter telescope built by the National Astronomical Observatory of Japan at the summit of Mauna Kea on the Big Island of Hawaii in 1999. The Subaru Telescope's visual acuity was improved tenfold in 2006 by wearing "magic glasses" called adaptive optics, which were developed by the author and others. By using these glasses to mitigate the glare of nearby stars by creating artificial stellar eclipses, we have begun to take some pictures of planets orbiting around the stars (Fig. 1).

A team of Five countries for an international scientific collaboration (Japan, the U.S., Canada, China, and India) is currently constructing the next-generation Thirty Meter Telescope (TMT), which will have a mirror 30 meters in diameter near the Subaru Telescope (Fig. 2). When this telescope is completed in ten years, it will be able to analyze the chemical composition of the atmospheres of planets discovered by the Subaru Telescope and other telescopes.

It is believed that the oxygen in the Earth's atmosphere is produced by cyanobacteria breaking down water. If we can confirm the presence of oxygen and methane, which are indicators of life on other planets, it will be circumstantial

evidence that life exists there. Astronomers and biologists are engaged in a cross-disciplinary debate over what, if anything, would be conclusive evidence of life on another planet. But even on the Earth, life is diverse. Near hydrothermal vents on the ocean floor, where sunlight does not reach, there are biological societies that are quite different from the surface ecosystems. On other planets, life forms may be born and evolve in ways we cannot even imagine.

"Evidence of life on Planet XX finally found!" It won't be long before the world hears such news. If the next generation of astronomers finds not only signs of life, but an evidence of civilization emitting artificial signals that cannot be caused by natural phenomena, what should he or she do? Publish a paper or report it to the government as a top secret information? Who will represent the Earth when the first contact is made with such a space civilization? Neither the academic community nor the United Nations has yet begun to discuss how to deal with this kind of situation. We should seriously consider it before it is too late.

Based on the aforementioned considerations, if there is a space civilization coming into contact with the earth, it should be a civilization that has evolved to a stable level, having long ago overcome low-grade risks of self-destruction such as nuclear war and

environmental destruction. Trying to get rid of them with weapons is not going to help. The only option would be to reverse them with open arms and ask them to improve ourselves through education and guidance. If you think that you don't want to be colonized, there is one passive way to deal with it. That is to ban all television and radio from tomorrow, and not send out any signals to space. But it would be impossible to ask human civilization, which has learned to enjoy many things, to be silent, isn't it?

As a matter of fact, the TMT construction project is going through a tough phase as it is caught in the middle of a restoration movement of rights to Native Hawaiians. Japanese researchers have been assigned to Hawaii to work on the Subaru Telescope and for the past 20 years, they have had a good relationship with the local society. In recent years, however, the movement to restore the rights of the Hawaiian Kingdom and its indigenous people, who have been under injustice, is growing. They have raised the issue that the Hawaiian state government did not adequately reflect the wishes of the indigenous people in its decision to allow construction of telescopes on the sacred mountain. The governor, county mayors, and the business community have expressed the importance of the TMT, but have taken a cautious approach due to the sensitive nature of the issue.

When the universe began with the Big Bang 13.8 billion years ago, there were only hydrogen and helium atoms. The various atoms that are essential for building our bodies, such as carbon, oxygen, nitrogen, and iron, were all created by nuclear fusion reactions in the stars that were born afterwards.

If you were to interview a carbon atom that make up a protein in your hair, he/she might say, "Well, actually, I happen to be a member of the proteins in your hair right now, but I was actually born in a nuclear fusion reaction from hydrogen atoms in nearly eighty million years ago in a star YY." In this sense, we are "cosmological beings" who exist thanks to the stardust. I believe that ambition and selfishness are important drivers of development, but I hope that by being aware of our position in the universe, we can overcome historical and political problems that tend to develop into emotional hostility.

(Masanori Iye, Astronomer)

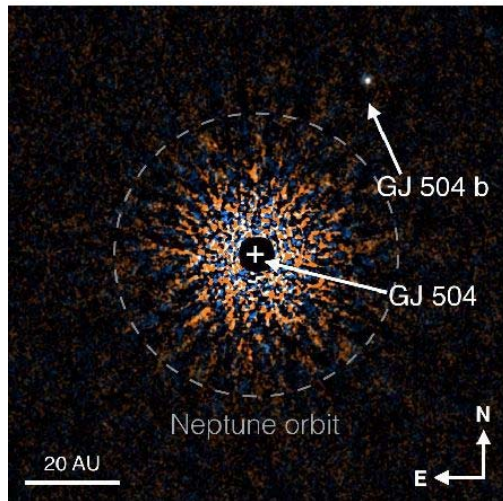


Figure 1: Subaru Telescope image of the planet GJ504b orbiting the star GJ504 (erased by artificial stellar eclipse technology) (National Astronomical Observatory of Japan) AU = astronomical unit = average distance between the Earth and the Sun. Neptune orbit = orbital radius of Neptune.



Figure 2: Next-generation Very Large Telescope (TMT) (completed image, NAOJ)