Humankind in Outer Space

Gonzalo Munévar
Lawrence Technological University

Phillip McMurray
Lawrence Technological University

Abstract

The first part of this summary paper is based on my book *The Dimming of Starlight: The Philosophy of Space Exploration* (Munévar, 2023), mainly Ch. 7. The second part focuses on international relations.

Keywords: space exploration, wormholes, artificial gravity, Whitmire ramjet, Outer Space Treaty, space law

La humanidad en el espacio exterior

Resumen

La primera parte de este resumen se basa en mi libro «The Dimming of Starlight: The Philosophy of Space Exploration» (Munévar, 2023), principalmente en el capítulo 7. La segunda parte se centra en las relaciones internacionales.

Palabras clave: exploración espacial, agujeros de gusano, gravedad artificial, estatorreactor Whitmire, Tratado del Espacio Exterior, derecho espacial.

人类在外层空间

摘要

本篇总结的第一部分基于我的著作《星光暗淡：太空探索的哲学》(The Dimming of Starlight: The Philosophy of Space Exploration, Munévar, 2023)，主要基于第7章（的内容）。第二部分聚焦于国际关系。

关键词：太空探索，虫洞，人造重力，Whitmire冲压发动机，《外层空间条约》，空间法

doi: 10.18278/sesa.5.2.13

Philosophy is important to space exploration because it explores very important ideas about the nature of scientific knowledge. For example, the Aristotelians employed the Tower Argument to show that "facts" refuted the Copernican view. Suppose, with Copernicus, that the Earth moves. If you then drop a stone from the top of a tall tower, by the time the stone hits the ground the tower will have moved with the Earth, and thus the point of impact will be a considerable distance from the base of the tower. For the impact to be as close to the base of the tower as it actually is, the stone should follow a parabolic motion. But it obviously falls straight down. Thus, the supposition that the Earth moves cannot be correct.

However, Galileo explained, there are two components to the motion of the stone: one straight toward the center of the Earth and one circular, shared with the earth, the tower, and the observer. all share this circular inertia. We only "see" the one component we do not share: the vertical down motion. Therefore, concludes Galileo, the stone does not fall straight down—it only seems to. Galileo thus showed us "facts" make theoretical assumptions. The Copernican Revolution was, then, based on different theoretical assumptions.

Space Exploration in the Long Run

Einstein's Velocity-Addition Formula

When confronted with unusual circumstances, we are likely to change our theoretical approach and come up with new discoveries about the universe. Because of that serendipity, space exploration has led to great revolutionary advances in many areas of science and provided great benefits to the human species. Those benefits may extend for billions of years if we decide to move into the cosmos. To achieve this goal more easily, we may need starships that can travel faster than light or at least come close to the speed of light.

Many physicists, however, believe that Einstein's special theory of relativity makes it unfeasible to accelerate spaceships close to that of light, whereas accelerating spaceships beyond the speed of light is simply forbidden by that theory. What physicists have in mind is Einstein's equation:

$$m = m_0 / \sqrt{1 - v^2/c^2}$$

where m is the mass of the ship from the point of view of the observer, m_0 is the rest mass, v is the velocity of the ship with respect to the observer, and c is the speed of light. As v gets closer to c, the term v^2/c^2 approaches 1. This means that the denominator approaches 0, which makes m approach infinity. And presumably, continuing to accelerate that extraordinary mass would be out of the question.

This view is misguided. The mass that increases so extraordinarily is the mass relative to the observers, but the rest mass is the one that counts. And to the star travelers, that mass has not only not increased, but likely it has decreased if the ship is propelled by fuel being expelled. Moreover, m can never reach infinity for the simple reason that, if the velocity of the ship reached that of light, the denominator would become 0 and the function would be undefined. The problem is not that an infinite mass is physically inconceivable, but that the mathematical expression makes no sense.

In practice, of course, the faster a starship travels, the greater the resistance from the interstellar medium, but this is a different type of concern altogether. There is also a concern about the extraordinary amount of fuel needed for such long journeys. To get around these problems, we might employ starships that do not carry their fuel on board but take it from their environment. The best version of these, the Whitmire catalytic nuclear ramjet (Whitmire, 1975) works by scooping up the hydrogen ions in the path of the rocket and running them through a catalytic nuclear reaction cycle, which returns to the starting point of the reaction extremely fast so a new batch of protons can be used to propel the starship. Whitmire proposed the catalytic cycle of carbon-nitrogen-oxygen (CNO), which occurs in the thermonuclear reactions of very hot stars.

A compelling feature of the Whitmire ramjet is that it can generate as much as 10^{11} megawatts, about 10,000 times the energy produced in today's world (Mallowe & Matloff, 1989). The extraordinary amount of heat would be a problem, but we could solve that problem eventually. In a mission to the nearest stars, we could send thousands of scientists who will carry out of sorts of research, including terraforming some of their planets. A large human migration could then follow. The ship could be modelled after Gerard O'Neill's colonies and propelled by three or more Whitmire ramjets.

Faster-than-light Travel

I discuss the two main proposals for faster-than-light travel. One is Kip S. Thorne's idea to use a Wheeler quantum wormhole to travel in a very short time to places that in normal spacetime could be thousands or even millions of light years away (Thorne, 1994). Imagine that spacetime is folded (for example in a fifth dimension). That fold may bring close together, in that fifth dimension (or in "hyperspace"), regions of space that are extremely far from one another in the normal three space dimensions. Imagine we took a long cloth and folded the two ends together. If the cloth were laid flat, the two ends might be separated by one meter, but folding the cloth reduces the two ends' length to a millimeter apart. If we could only make a little tube that connected them across that millimeter, the trip from end to end would be far shorter. John Archibald Wheeler's proposed that, in extremely small regions (around a Planck length, 1×10^{-33} cm), strong gravitational quantum fluctuations create a sort of "quantum foam" (Wheeler, 1962), in which we might find such a little tube, a "wormhole." The trick is to find one wormhole in the foam, enlarge it so a ship can go through it, and then to keep it open so it will not crush the ship.

An outcome of travel through the wormhole is that an astronaut would also travel back in time. You may return before you take off! You may not be born to take the trip. This gives rise to all sorts of time travel paradoxes which defeat Thorne's idea.

Miguel Alcubierre argued that if we were to build an engine that contracts spacetime in front of the starship and expands spacetime behind it, we could accelerate the starship to a velocity arbitrarily higher than that of light (Alcubierre, 1994). Since the local spacetime for the ship would be flat, the astronauts would not violate the relativistic speed limit at any point in their journey, although the Earth-bound observers perceive the ship traveling much faster than light. By thus warping spacetime, the ship may make a return trip to Vega (25 light yrs away) in about three or four Earth years, from the point of view of Earth-bound observers, instead of more than fifty, as would be the case under special-relativity considerations. Alcubierre's arrangement also has the ship move only into the future, as airplanes do, eliminating time travel paradoxes. What kind of technology could possibly contract spacetime? Unfortunately, Alcubierre only suggestion is exotic matter.

Space Exploration and International Relations

Achieving space exploration goals of any sort—whether it be future crewed lunar landings from *Artemis*, crewed Mars exploration, and further adventures outside our solar system to other stars—will require international cooperation. Though the spacefaring nations have the most capability and influence regarding space exploration, since space exploration provides benefits to all humanity, all countries and peoples with a vested interest in human affairs should participate. Our scope, however, will mainly focus on the spacefaring nations. This summary paper will focus on two broad challenges: (1) general disregard for international law, and (2) the prospect of space warfare through the militarization of space and ASAT testing. These flashpoints provide space enthusiasts areas of concern to focus on; continued human achievement in space exploration will not occur unless the challenges of our historical moment are met.

General Disregard for International Law

International law has been broken many times in the 21st century. Notable instances include Russia's invasion of Georgia in 2008, Russia's annexation of Crimea in 2014 leading to the full-scale war in Ukraine from 2022 onward, and China's continued provocations threatening freedom of navigation in the South China Sea. Great powers breaking international law is nothing new, but events in recent history have led to a strong deterioration in relations between the United States, Russia, and China. Deteriorating relations lead to spillover effects which disrupts diplomatic, economic, and cultural channels.

Space enthusiasts should worry that deteriorating relations between great powers could spill over into space science and space exploration. We cannot assume, for example, that the Outer Space Treaty—the cornerstone of space law—will be respected indefinitely. The U.S. and Russia have reduced their cooperation on a number of issues, notably the joint withdrawal of the Intermediate-Range Nuclear Forces (INF) Treaty. This lack of cooperation has extended into space, as Russia announced it would withdraw from the ISS in 2024 and launch a rival space station into orbit.

The Militarization of Space and ASAT Testing

The prospect of space warfare has intensified in recent years. More countries (Russia, India, China) have committed to and have conducted ASAT testing. Space is an emergent and important frontier in the global security infrastructure (Mosila & Burch, 2024). The United States banned ASAT testing in 2022 (Robison, 2022). So far, countries have only conducted ASAT testing on their own satellites. ASAT testing is a security concern because of space debris but also because it may encourage states in the future to break current norms and attack others' space infrastructure.

The overall militarization of space remains a looming issue. The U.S.' *Artemis* program and the Chinese *Chang'e* program both have ultimate goals of establishing lunar bases for continued use (Zheng, Ouyang, Li, Liu, & Zou, 2008). As countries establish lunar bases, the temptation to use them for dual-use purposes rises. This risk is further compounded by a fraught geopolitical climate and growing distrust between great powers.

Conclusion

Geopolitical rivalries dominated the early history of space exploration and will continue to influence decision making in the modern era of crewed and uncrewed exploration. Space enthusiasts should relieve themselves of idyllic notions and encourage collaboration between states to achieve goals which will benefit all humanity. The next generation of space explorers should focus on the immediate challenges of their historical moment and work to overcome them with curiosity, ingenuity, imagination, and spirited collaboration. Space law must be respected and maintained to ensure continued human achievement in space exploration.

References

Alcubierre, M. (1994). The warp drive: hyper-fast travel within general relativity. *Classical and Quantum Gravity*, *11*(5), L73–L77.

Mallove, E. F., & Matloff, G. L. (1989). *The starflight handbook*. John Wiley & Sons.

Mosila, A., & Burch, J. (2024). Antisatellite testing and a whole new era in spacefaring: The implication of China's 2007 ASAT test on global security and strategic intelligence. *Space Education & Strategic Applications*, *4*(4).

Munevar, G. (2023). *The dimming of starlight*. Oxford University Press.

Robison, S. G. (2022). Legality of non-kinetic ASAT weapons: A US perspective on how technology outpaces law. *Air and Space Law*, *47*(Issue 4/5), 491–514.

Thorne, K. S. (1994). *Black holes and time warps: Einstein's outrageous legacy*. W.W. Norton.

Wheeler, J. A. (1962). *Geometrodynamics*. Academic Press.

Whitmire, D. P. (1975). Relativistic spaceflight and the catalytic nuclear ramjet. *Acta Astronautica*, *2*(5-6), 497–509.

Zheng, Y., Ouyang, Z., Li, C., Liu, J., & Zou, Y. (2008). China's lunar exploration program: present and future. *Planetary and Space Science*, *56*(7), 881–886.