

Why do humans explore space?

Humans pursue space exploration for five basic reasons. The first emphasizes the gains made through science, the second reason favors national defense. The third deals with what commentators call signaling or national prestige. The fourth is commerce.

The fifth is survival of the species.

Someday the sun will run out of fuel. Its mass will decline. With less gravity to hold it together, the size of our central star in the daytime sky will swell. As the sun's luminosity increases, our planet's oceans will disappear. Plant life will die away; animal life will follow. Any intelligent beings that have not long since moved to other destinations will cease to exist. Our ability to survive the alteration of the sun will depend upon our ability to move to other homes.

Fortunately, this will not occur soon. Some estimates place the appearance of change at about one billion years from now. Humans have plenty of time to get ready. Unfortunately, our demise is so far away that we may never feel motivated to adopt measures to avoid it.

When dealing with outer space, survival of the species concurrently offers some of the most pressing reasons to get off the planet and some of the weakest incentives for doing so. Plenty of more pressing problems present themselves for our attention. The technological challenges fostered by overpopulation, urban crowding, depletion of natural resources, and alterations to the Earth's atmosphere demand immediate consideration. Yet resolving these challenges do not depend upon Earth-based solutions alone. Space travel is involved too.

Consider energy. A technological civilization that relies entirely on its home planet for new sources of energy will soon run into its limits, to say nothing of the possibility of altering the planet's chemistry at the same time.

Early in the space age, just seven years after the launch of the first earth-orbiting satellite, the Russian astrophysicist Nikolai Kardashev suggested a simple classification scheme that expressed this concern. Kardashev was particularly interested in the energy required to communicate with other civilizations in the galaxy. A class I civilization, Kardashev said, limited its energy sources to those available on the home planet, an amount "close to the level presently attained on the earth." The civilization might not last long enough to realize the benefits of communicating with more advanced beings.

It is important to point out that what is involved here fundamentally is the survival of a planet's technological condition – cars and planes and refrigeration, restaurants, central heating, and such. Humans in lesser numbers might continue to exist, but in a manner more akin to an agricultural or nomadic form.

Kardashev defined a stage II civilization as one that could harness energy available in its entire solar system, including sources that might otherwise bypass the celestial home. This included much of the energy "radiated by its own star." A class III civilization would have access to energy "on the scale of its own galaxy."¹

¹ N.S. Kardashev, "Transmission of Information by Extraterrestrial Civilizations," *Soviet Astronomy* 8 (Sept.-Oct., 1964) 219.

Kardashev's classification scheme challenged readers to imagine different methods of gathering more motive power. His followers advanced a diverse collection of sources that ranged from orbiting solar deflectors to the energy released from black holes.

The overall implications were clear. A home planet whose inhabitants were unable to accommodate the energy demands of industrialization and a burgeoning population using local resources would not maintain their progress long. They would be unlikely to establish communication with planetary beings more advanced than their own – not unless they learned how to take advantage of the materials and resources available in space. This point has been frequently made.

Writers of science fiction and popular science eagerly portrayed the issues involved. Not surprisingly, some stories involved contact with extraterrestrial beings – the purpose of Kardashev's original point.

Reports of strange flying objects increased sharply in the aftermath of nuclear weapon discovery, testing, and use. Some observers suggested that the unidentified flying objects (UFOs) housed visitors from other worlds. Some writers even suggested that the visitors might be willing to share their measures for avoiding nuclear war, an event clearly capable of driving humans back into a pre-industrial phase.

Any technological civilization that learns how to utilize outer space is likely to involve itself in atomic energy as well. The inhabitants of that civilization need look no further than their central star for a demonstration of how nuclear fission and fusion work. Adding rockets and guided missiles, the inhabitants are likely to acquire the means of destroying their civilization in the process of creating it.

Visitors to Earth In the classic science fiction film *The Day the Earth Stood Still* (1951) offer an extraterrestrial solution to the earthly challenges of nuclear proliferation. A spaceship captain and an on-board robot named Gort land their saucer-shaped ship in Washington, DC, from where they deliver a message from an external federation of planets. Extend your weapons into space, they warn, and robots will destroy the Earth. In 1967, nations of the real world approved the Outer Space Treaty, which among other provisions banned the placement of nuclear weapons in outer space. Satellite technology gave Earthly superpowers the means to monitor each other's actions in that regard.

Space travel advocates offered a wide selection of extraterrestrial solutions to Earthly issues such as these. Some are realistic, many are fanciful. A civilization that utilizes outer space to maintain its technological edge is likely to employ a global network of orbiting satellites that make possible the efficiencies of a global economy. Access to space may provide a platform from which satellite designers can verify weapons agreements and detect the movement of ballistic missiles.

Beyond that, imagination prevails. Humans are at the beginning stages of space travel and the process of sorting out realistic predictions from unrealistic ones is still ongoing.

Following through on the energy problem, physicist Freeman Dyson suggested a methodology for capturing most of the energy emitted from a central star. Using an extensive network of solar reflectors, a planetary civilization could enclose the inner planets of its solar

system. The mechanism is known as a Dyson Sphere. To an external observer, the system retains the signatures of gravity but gives off little external light.

Having apparently altered the atmosphere of their home planet, scientists suggested that humans might want to repeat the process on other worlds. The procedure is known as terraforming. Applied to other planets, it could theoretically transform places like Mars into wetter and more temperate worlds, making them suitable for human habitation. A complete transformation of a planet like Mars might take only a few hundred years.

Such speculation returned space travel advocates to their original suggestion. Preserve humanity by moving humans to other worlds. In case something terrible happens, prepare to do so now – not tens of million years in the future.

In 1974 the Princeton physicist Gerard O’Neill proposed one of the most imaginative solutions to the possibility of planetary destruction and the effects of overpopulation. He proposed the creation of space colonies scattered in various gravitationally stable points around the solar system. O’Neill prophesized that the massive colonies could each accommodate ten million humans, reducing Earth’s population to a few billion people and beginning the process of repairing the planet. Work on the first colony might begin in just thirty years, assuming suitable advances in space transportation.

The fact that none of these visions would be undertaken during the first century of space travel testified to their high cost and the difficulty of their implementation.

Undeterred, advocates of space exploration took another step back into the future, emphasizing an additional survival strategy that could be undertaken now. Large comets and asteroids intersect the Earth’s pathway with statistical frequency. Every ten to thirty million years or so a species-killer arrives. A civilization on the Earth at that time without an effective space program would not survive. As evidence, physicist Luis and geologist Walter Alvarez pointed to rock formations suggesting that a large object struck the Earth’s Yucatan peninsula sixty-five million years ago, potentially hastening an end to the reign of the dinosaurs.²

The likelihood of such a collision is high, the frequency low, factors discouraging immediate attention. Nonetheless, the United States undertook an early test in 2022 that measured the force needed to alter the course of a small object orbiting the larger asteroid Didymos. The test was called Double Asteroid Redirection Test or DART.

Ultimately, space travel advocates returned to long term migration as the principal means of species survival. Despite its lack of urgency, the justification is deeply ingrained in the belief systems of organizations like the US National Aeronautics and Space Administration. Discussion of this rationale appears in often obscure studies and parsimonious funding for workshops on the subject. George Mueller, NASA’s Associate Administrator for human space flight during the Apollo era, announced that the space program’s ultimate purpose was “developing the technology to visit the stars and begin populating the universe.” A speechwriter

² Luis W. Alvarez, Walter Alvarez, Frank Asaro, and Helen V. Michel, “Extraterrestrial Cause for the Cretaceous-Tertiary Extinction,” *Science* 208 (1980): 1095-1108.

for President George H.W. Bush inserted a few lines into a speech that the president dutifully read, making him the first chief executive to commit the United States to reach for other stars.³

We will travel to neighboring stars, to new worlds, to discover the unknown. And it will not happen in my lifetime, and probably not during the lives of my children, but a dream to be realized by future generations must begin with this generation.

The vast distances involved and the commensurate difficulties of reaching other stars led many advocates of space travel to contemplate unconventional pathways through the galaxy. The methods appear frequently in works of imagination. Matthew McConaughey uses a wormhole to search for a future human home in the science fiction film *Interstellar* (2014); Jody Foster uses a machine that bends space and time (*Contact*, 1997). Robert Goddard, the reclusive rocket engineer, suggested that the seeds of humanity be dispatched in some form of protoplasm, along with a durable set of instructions for reassembly at the other end.⁴

Ultimately, the greatest obstacle to long-lasting space flight may be time itself. Any species that embarks on a journey between solar systems will inevitably evolve as the centuries drift by, a process prospectively accelerated by advances in bioengineering and artificial intelligence. The species that begins the voyage may be totally unlike the species that ends it. Perhaps they will not even like space travel.

Such obstacles have not stopped the most devoted advocates from using survival of the species as their ultimate justification for space travel.

Dr. Howard McCurdy, September 9, 2023

³ George Mueller, "Space: The Future of Mankind." *Spaceflight* 27 (March 1985) 105; George H. W. Bush, Remarks on the 20th Anniversary of the Apollo 11 Moon Landing, July 20, 1989.

⁴ Robert H. Goddard, "The Ultimate Migration," in *The Papers of Robert H. Goddard, Including the Reports to the Smithsonian Institution and the Daniel and Florence Guggenheim Foundation*. Esther C. Goddard, Editor. G. Edward Pendray, Associate Editor. New York: McGraw-Hill, 1970. Print: 1611-12.

