Exploring Space — Is It Justified?

Kaushik Vutukuru

I'm writing this paper to examine the costs and benefits of space exploration. After balancing the two, I've reached the conclusion that the amount of resources we put into space exploration is higher than what we should be putting in. Because of this, I think that space exploration is not entirely worth it. This is just my opinion and there are no rights or wrongs to what people think. So, without further ado, please enjoy this article.

Introduction- The Essential Question of Space Exploration

First, we need to think about the big picture, or the essential part of this article, which is the question: Why exactly do we need space exploration? There is no definitive “right or wrong” answer. So, let me start by scratching the surface of the topic here. As you may know, there are many famous space organizations. Prominent ones include NASA (National Aeronautics and Space Administration) from the United States, ISRO (Indian Space Research Organization) from India, Roscosmos from Russia, CNSA (China National Space Administration), ESA (European Space Agency), and JAXA (Japan Aerospace Exploration Agency). They have made a myriad of discoveries. For a very long time, humans have been profoundly fascinated by the many wonders of the universe, and of course, we have explored much of our solar system. We have made many discoveries since the time of Copernicus/Galileo, and we continue to do so. Our Solar System is not the only limit to our space exploration. Indeed, we don’t know much about our solar system because not many missions were focused on those distant planets. We have not sent any probes out of the solar system other than Voyager, which is not sending much information other than various measurements, readings, etc., definitely not photos/videos from its position out of the solar system. But most of the “exploration” we do is telescope and rover-based (and other robots). Viewing these massive planets using telescopes and sending robots and other rovers into space might spur some wonder in us human beings, but are all of these projects worth it in the first place?

Organizations such as NASA build and send probes, rockets, rovers, satellites, and other things into space. Probes are machines with no pilots or people in them, and they are sent to space. Examples of probes include the Voyager probes and the Mars rovers. According to a NASA article, “The agency was established over fifty years ago to address some of these issues. Since then, one of the most unifying and transnational human endeavors to date has been space exploration. The International Space Station is run by a multinational collaboration of five space agencies from fifteen nations, including scientists, engineers, and tinkerers” (NASA, 2023). Space exploration is fascinating, and I am very fascinated by it, too, just learning about the stars, planets, galaxies, and other celestial objects in space that are new to us. But we must think again. Is it worth using time, money, and resources to explore all of these things? Let's dive deeper.

Examples of Gains from Space Exploration

Before diving into any other subtopics of space exploration, we first need to consider what space exploration has done to us and whether or not it is worth achieving those feats that space organizations have planned so carefully and executed so well. Let us take NASA as an example, particularly a few examples from their article.NASA gives some great examples regarding 3D printing in microgravity: “ The first item was 3D printed on the space station in 2014. Since then, we have explored 3D printing using recycled materials and even printing human tissue” (NASA 2020). They add, "Testing tissue chips in space: Tissue chips are about the size of a thumb drive and contain human cells in a three-dimensional matrix that represent the functions of an organ." Chips have been sent to the station to understand better how microgravity affects human health and to apply that knowledge to enhance the health of Earth (NASA 2020). These are just a couple of many examples in their article. There are other notable examples in the article that they state will be useful to us in the future, such as the discovery of steadily burning cool flames, which will be useful for inventing less polluting vehicles.

Are Technological Improvements/Advancements Always Cost-Efficient?

Projects that space companies organize are very massive. They cost a lot of money and often millions or billions of dollars. Rockets that can hold many astronauts/resources that are heavily equipped with technology tend to be sent to space for more successful/broader missions. Thankfully, due to the improvement in technology, the costs of space exploration missions are being reduced. But, not all technology has the privilege of being cost-efficient. Newer technologies require more innovation and more materials to make (not always the case, but a lot of times, it is), costing them a lot of money. One such example of a cost-efficient technological advancement is the reusable rocket. The company that has progressed the furthest with reusable rockets is SpaceX. Not building a new fresh rocket every time is pretty cost-efficient. According to Space Economy Science Institute's Article: "The Role of Reusable Rockets in Reducing the Cost of Access to Space" they state, "While NASA and others have long researched reusable space transportation concepts, private companies like SpaceX and Blue Origin have more recently pioneered the path to operational reusable rockets" (Space Economy Institute 2023). Another quote states, "Reusability offers the promise of slashing launch costs by a factor of 10 or more. SpaceX has advertised about $60 million per flight for its partly reusable Falcon 9 rocket, compared to over $200 million for expendable launch vehicles. The company estimates the marginal cost for additional flights using a reused booster could be as low as $30 million. If rockets eventually approach high flight rates and rapid reusability like airplanes, the per-launch costs may decrease even further over time" (Space Economy Institute, 2023). Of course, the rockets need refurbishing and potential repairs, so they are not 100% cost-efficient, but they are pretty cost-efficient compared to other space technology. An example

of advanced space technology that comes at a decently high cost is in-situ resource utilization (ISRU), an active testing mission currently being carried out in Mauna Kea, Hawaii. It is a collaboration between NASA, PISCES (Pacific International Space Center for Exploration Systems), and the CSA (Canadian Space Agency). They are testing out how they can extract resources in volcanic environments. It is the technology that hopes to extract natural resources from outside the Earth, such as from the Moon or Mars. But for resources to be extracted, a machine needs to do it, right? Definitely not an astronaut going to another planet. That machine also needs to be launched into space through a capsule, and the space agency(ies) planning to launch it may have to build a fresh new capsule tailored for this machine, and they need to make it ready to launch into space. According to a NASA article from 2020 regarding in-situ propellant production, it may cost between 1 to 2 billion dollars to deploy such equipment (NASA 2020). For the propellant production itself, it takes about 1.2 billion dollars. Since the ISRU is an ongoing mission to deploy new technologies to improve the success rate, it still costs more due to the need for more intricate structures inside the product. Their basic idea is to produce things on other planets instead of producing everything on Earth. Even though the idea is very interesting, it is a good concept, which is already being tested. For space exploration to be successful, complex ideas like this need to be thought about, which takes time and effort.

Costs of Missions and Improvements

Reiterating the idea of cost consciousness, we need to consider not only the costs of building parts but also the human costs. The space exploration missions I am discussing here are not just recent ones. Let us take one for example, which was known as the Columbia STS-107 mission, in which the shuttle disintegrated as it entered back into the Earth's atmosphere over Texas and Louisiana and killed all of the astronauts inside of the capsule. "Upon reentering the atmosphere on February 1, 2003, the Columbia orbiter suffered a catastrophic failure due to a breach that occurred during launch when falling foam from the External Tank struck the Reinforced Carbon Carbon panels on the underside of the left-wing" (NASA 2024). The cause of the disintegration of the shuttle was damage to the left wing's edge by debris from the external tank during the launch. The victims were Rick Husband, pilot Willie McCool, mission specialists Kalpana Chawla, Laurel Clark, Michael Anderson, David Brown, and payload specialist Ilan Ramon from Israel. Even though it was in 2003, 22 years ago, and it may not seem so recent, it was one of the most significant failures of space history, the second Space Shuttle mission, which ended in unfortunate ways after the loss of the Challenger in 1986. Even before and after that, some missions failed, which had human cost, sadly. Even though it was only five missions and eight training/testing incidents, it is still an unfortunate number. But the good news is that the missions that failed after the Columbia mission did not have any human cost in them, which was a great improvement because, in these current circumstances, it is really tough and risky to send humans into space because the outcome of the missions is very tough to determine, since there are many out-of-capability missions that we are planning on doing. Those missions make it very risky and difficult to have people in them. Let us consider the Starliner mission, which was launched into space to reach the ISS on June

5, 2024, and it reached the ISS on June 6. Sunita Williams and Barry Wilmore were the two astronauts launched on that mission. Unfortunately, they could not bring them down due to delays, even though they had a Dragon capsule ready. It wasn't worth the risk to bring them down early as the Starliner, which was originally planned for return, had potential risks. Fortunately, on March 18, 2025, Sunita Williams and Barry Wilmore returned in the same Dragon capsule after spending nearly 9 months in space. The 8-day mission of the Boeing Starliner turned into a nearly nine-month stay in space. The main point here is that even with advanced technology and equipment, there are many risks that we need to realize and see beforehand so that our missions can continue.

Conclusion

In this article, we have reviewed the advantages and disadvantages of space exploration. It is up to you to decide whether space exploration is worth it. This topic is important because it focuses on the debatable costs of space exploration. I think space exploration has some benefits, but it's not entirely worth it. I think you should stand with me on this because it is something that many people who are trying to understand space exploration's purposes wonder about. In my opinion, the time and resources we spend on space exploration should be reduced to some extent, but not to the full extent.

Works Cited:

- https://www.nasa.gov/humans-in-space/why-go-to-space/
- https://www.planetary.org/video/is-space-exploration-worth-the-money
- https://www.cnn.com/science/live-news/nasa-boeing-starliner-capsule-09-06-24/index.html
- https://space.stackexchange.com/questions/65010/cost-and-quantity-of-space-mission-in-2020s-vs-1980s
- https://indianexpress.com/article/explained/explained-sci-tech/nasa-sunita-williams-barry-wilmore-stuck-space-2025-9508520/
- https://www.apu.apus.edu/area-of-study/math-and-science/resources/why-should-we-explore-space/#:~:text=Space%20Exploration%20Advances%20Scientific%20Understanding&text=They%20can%20gather%20data%20about,advancements%20in%20astrophysics%20and%20cosmology.
- https://www.nasa.gov/missions/station/20-breakthroughs-from-20-years-of-science-aboard-the-international-space-station/
- https://ntrs.nasa.gov/api/citations/20205007564/downloads/ISRU-Paper3-Final.pdf
- https://www.nasa.gov/remembering-columbia-sts-107/