

The Great Exploratory Tragedy of Our Time: *Human* Space Exploration

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Abstract

In the twentieth century, our civilization set out into the darkness. In an effort to realize the dreams of our ancestors, we boldly launched machines and ourselves beyond our home planet and into the cosmic void. We shattered the boundary between science and science fiction and made so many great discoveries, but our accomplishments in space were and still are underlined by nationalistic pride and political agendas. In recent years, progress has become stagnant, the outlook has become bleak, and yet we find humanity's current situation being largely ignored and even romanticized by those in authority. In this talk, I will briefly review the history of space exploration and then share my thoughts on the path that our species is currently traversing. There is hope, but without a proper effort to solve the "Human Space Exploration Problem," our species does not stand a ghost of a chance at becoming a spacefaring civilization.

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1 Introduction

In the late nineteenth century, a deaf man was slaving away in Russia, isolated from other scientists. This man spoke of landing on other planets and their moons, picking up the rocks on these other worlds, and bringing those rocks back to Earth. All this before the Wright Brothers had even launched the first manned airplane in 1903. Considered to be a recluse by his contemporaries, he is now regarded as one of the founding fathers of astronautical engineering (navigating beyond the atmosphere). His name was **Konstantin Tsiolkovsky**.

Three hundred years before him, another man was forced to kneel before the Roman Inquisition and renounce the scientific findings he had made by simply observing the night sky through a telescope (and, in fact, he was the first human to do so). Legend has it that while this man rose, he said, under his breath, “And yet, it moves...” referring to the Earth revolving around the Sun as opposed to being stationary. His name was **Galileo Galilei**.

Around that same time, another man spoke of the possibility of there being an infinite number of stars each having its own companion planets, and each of those companion planets having its own companion moons. This man also spoke of the possibility of there being life on these other worlds. He was brought to Rome, tried for heresy, and burned at the stake. His name was **Giordano Bruno**.

So, the year is now 2012. Where are we with regards to exploring the Universe? Where are we with regards to the ideas of these **legends of humanity**?

This talk was originally entitled “The Epic Tragedy that *is* Human Space Exploration,” but that title would have been a lie. There *is* no such thing as *human* space exploration. It does not exist. There is American space exploration, European space exploration, Russian space exploration, Japanese space exploration... There is nationalistic space exploration. There is militaristic space exploration. But, there is no such thing as *human* space exploration. Not yet, but hopefully one day.

2 Defining Space Exploration

Let's define space exploration in two different ways:

Classic: We go to the Universe.

Galilean: The Universe "comes" to us.

In the classic sense, we or our machines personally go out there and explore, colonize worlds, establish outposts, and so on. In the Galilean sense, we use technology – telescopes – to visually explore space. The Galilean method of space exploration (regardless of whether it is through ground-based or space-based technology) is really the only way to currently explore the distant Universe.

For the purposes of this talk, for the most part, we will ignore human-based exploration in the classic definition, i.e. colonization (even of the Moon or Mars), planetary and orbital colonies, etc. I will argue that we are not yet ready for such grand things.

Sorry, we won't be indulging in Star Wars or Star Trek fantasies in this talk.

Now, let's review the history of space exploration. Throughout our review, you may notice that it feels like we're working against ourselves. Almost like we don't want to go into space.

3 A Brief History of Space Exploration

A lot of people thought spaceflight was impossible. For example, at one time, the great Lord Kelvin, who contributed *a lot* to science, was asked to join the Royal Aeronautical Society. He declined the invitation (which, of course, is fine) but he said this: "I have not the smallest molecule of faith in aerial navigation other than ballooning, or of the expectation of good results from any of the trials we heard of. So you will understand that I would not care to be a member of the Aeronautical Society." That was in 1896.

He and others were proved wrong because of Konstantin Tsiolkovsky in Rus-

sia, Hermann Oberth in Germany, and Robert Goddard in the U.S. All three of these had a very tough time getting their research proposals funded and accepted. Tsiolkovsky worked largely in isolation, Oberth taught mathematics and physics at a high school and felt betrayed by the system, and Goddard, a professor of physics, was ridiculed.

The idea of building a rocket, putting people inside it, aiming at the Moon and actually landing on it, having those people come out and explore the Moon, and then return safely to Earth was crazy. Goddard was publicly humiliated in the New York Times when the editor said that he (Goddard), a professor of physics, did not know elementary physics. The New York Times did not retract that article until forty-nine years later.

Along came Wernher von Braun of Germany who was affiliated with the Nazi regime. Building on the work of these three pioneers, von Braun designed missiles for Germany during World War II. These very same missiles rained down on the UK, France, and other places killing thousands. You could see the power of spaceflight being corrupted. After the war, von Braun was brought to the U.S. by the U.S. Government where he became a NASA engineer and designed the Saturn V rocket which would later power Apollo 11 to the Moon.

The turning point in human space exploration comes in 1961 when the great Yuri Gagarin from the Soviet Union became the first human to go into space. This is where we branch off. It can be said that 1961 was the beginning of human spaceflight, and the end. Yuri Gagarin was, in fact, the first human to go into space, but other nations saw a Soviet leaving the Earth, not a human. The U.S., in particular, was upset. Soon, there was nationalistic and competitive spaceflight. The so-called “space race” had begun, and nations wanted to put the first human on the Moon, but that human had to be a citizen of their nation.

Of course, we know that it was the U.S. who did this in 1969 with Apollo 11. The U.S. put an American on the Moon. It would be ridiculous to deny how great this achievement of putting someone on the Moon was. Even though it was fueled by nationalism, our species did, for the first time, walk on another world.

From that point onwards, we see the development of national space agencies and national space transport systems like the U.S. Space Shuttle and the Russian Soyuz. The Soviets had a series of space stations put in orbit, leading to Mir, and then eventually to the International Space Station. The International Space Station is a vision of what could be possible in the future, but it, too, is ridden with many political issues such as who can become a member and who will maintain certain modules. There are also only fifteen nations who are members of the program.

If we ignore the problem of funding, then of everything, the greatest hope for space exploration by humanity comes from our scientific instruments: the telescopes, rovers, and space probes. When you look up at night and you see the planets, know that they have abnormal numbers of satellites now. They have their natural satellites (moons), but they also have artificial satellites. We put space probes in orbit around them. When you look beyond Pluto, you'll find Voyager I and II, and Pioneer 10 – humanmade spacecraft which are scheduled to actually exit the Solar System and drift in interstellar space – the very definition of that void between stars! We initially disregarded the problem of funding these scientific tools, but we cannot, in reality, ignore something as important as that.

Finally, we come to the present-day rise of commercial space exploration. There are private companies now that not only have ambitions to hold orbital tours, but who, in the case of SpaceX, also want to land people on Mars and single-handedly make “humanity” a multiplanetary species. There is something to note about this, in America’s case specifically. Since the government is failing to adequately support NASA (there are budget cuts), people are now glorifying the idea of America being at the mercy of its commercial space sector. But, financial motivations may only get you so far in space.

4 Space and Science Transcend Nations

We’ve come a long way in just a half-century, and there is no denying that – only admiring it. What’s the problem? Why can’t we just continue on with our nationalistic space programs? I think this is a good time to turn to science and art.

When you look at science, there is human science. Biology in America is the same as biology in Russia. For the most part, scientists are free to collaborate with one another despite their country of domicile. Think of academia. If you are a physicist in America, you can generally easily talk to a physicist in Russia or the UK and share information about a problem you are trying to solve. The same thing goes for art. There is human art. Music, paintings, literature, and other forms of art from some nation are generally available to other nations.

Most obvious, probably, is human mathematics. There is such a thing as human mathematics. Mathematics in America is the same as mathematics in China, Russia, and so on.

But, there was a time in the history of mathematics when Soviet mathematicians were discouraged from interacting with their American counterparts. So, after some time apart, there was essentially American (or World) Mathematics vs. Soviet Mathematics. And, I don't mean this like $1+1=2$ in the rest of the world but $1+1=3$ in the Soviet Union. I mean at the upper tiers of mathematical research, things were progressing at different rates. Progress was not the same in both groups, so when the Soviet Union fell, inefficiencies developed. This was studied by George Borjas of Harvard University, and he found that when the Soviet mathematicians began to interact with American mathematicians again, there were drops in productivity because some mathematicians were attempting to solve problems which were already solved by the other group.

Now, make the analogy with the absence of human space exploration. Imagine how quickly inefficiencies pile up because space agencies are prevented from freely working together on some particular problem. Space exploration is probably one of the grandest applications of science, so it should attain the same level of international cooperation and autonomy as science. In fact, it may even require more cooperation than you see in science.

Space and science should transcend national boundaries. These ideas have been around for a long time, perhaps in other forms and for different timescales. The famous astronomer Carl Sagan talked about such possibilities being realized in the distant future. Sir Martin Rees is also an astronomer who has

mentioned such grandiose things.

5 The *Human* Space Exploration Problem

The Space Exploration Problem is at this time – surprise, surprise – plagued by politics, and I daresay bad politics is the spectre of failures in quantum and cosmic curiosity.

Space exploration is currently primarily a political problem, but it needs to be transformed into a chiefly scientific problem. That is, just as how scientists call the shots in their experiments, the scientists and engineers working on the space exploration problem should not suffer the trivialities of human politics.

But, there are questions that must be answered before such a thing as Human Space Exploration can even come into existence. I think these questions must be answered to rationalize such an endeavor, and they include:

- **How does globalization affect space exploration?** (Globalization has been underway for a while now. The lifting of trade barriers, the establishment of, for example, the European Union, nations becoming multicultural, and so on. How does this increasingly globalized world affect space exploration, and conversely, how do the current nationalistic space exploration programs contribute to or impede the globalization of our world? [Presupposing globalization is a good thing.]
- **Is space exploration a personal concern?** (How can Opportunity, the rover running around on Mars right now, possibly affect you and me? How could something as distant as Pioneer 10 leaving the Solar System mean anything for you? This is a tough question, and the problem lies in the fact that it is very hard to gauge the timescale for investments in space exploration to have personal effects through, say, technological applications of research that have been conducted. The current consensus, and surely the public opinion, is that space exploration is not a personal concern – beyond just igniting a sense of wonder.)
- **What are the externalities of space exploration?** (Experts and organizations have researched this, but mostly in the late twentieth

century, and mostly about externalities from national space agencies *for* nations or businesses. NASA publishes information about their spinoffs annually. But, what about the global externalities, i.e. those not restricted to citizens of some particular nation? And, how does the undergoing privatization of space exploration affect the world?)

- **Is there an optimal (minimum) level of the militarization of space exploration?** (The militarization of space exploration is inevitable because safety is a big concern when you venture into the unknown. We don't know what we'll find out there. But, militarization comes with nasty politics, and the possibility of confrontation amongst ourselves. Of course, nations' defense agencies also get significantly more funding than their scientific and space exploration agencies. Is there some way to optimize military involvement in space exploration, and if so, what is that level?)
- **How is education affected by space exploration funding?** (Space is inspiring. There's so much out there. It can revitalize your sense of wonder for that which is terrestrial and extraterrestrial. It has the potential to greatly impact our education system, and influence the number of students who want to become scientists, or at least become proficient in understanding science. How can we account for this inflow of new scientists from space exploration?)
- **Some nations explore, and others do not. What are the consequences for not exploring?** (There are still many parts of the world that cannot *indulge* in space exploration. If we can show that nations suffer from other nations not exploring space, then a case could be made for a true human space exploration program as opposed to these relatively small nationalistic space exploration programs.)
- **What are the benefits to exploring as one federation as opposed to several smaller agencies?** (Pardon the Star Trek reference, but this is what we are asking here. What are the payoffs from exploring with a human space exploration program, not hindered by the political trivialities of nations, as opposed to smaller, nationalistic agencies?)

If you will allow a brief interlude, I'd like to talk about the *language of humanity*. Unfortunately, the majority of humans care not for the intricacies

of science. The finished product, or the applications of scientific theory, are what the majority of people see; but all of the mistakes, failures, and apathy behind science (and art) are usually absent in the final product. We speak to each other not in terms of science, but in simple terms of resources, of which time and money are the most prominent. What does this mean?

There is a field, I believe, which has the potential, despite all its current flaws, to initiate the transformation of the space exploration problem from a primarily political problem into a chiefly scientific problem, and answer the questions I listed above. This field is not a science, nor is it an art. It is the social science known as economics.

Economics is the study of the allocation of scarce resources, but what's in space? An abundance of resources. Even though all of those resources in space are not readily available to us, I think there is something of interest for researchers here which is currently hidden or willfully ignored.

We all know space exploration is valuable, and that it's worth something, but we just don't know what that value, quantitatively, is yet. This is my research interest in economics (although I am primarily a mathematics major). *There is no economic argument in favor of space exploration yet!* Using current economic models, it does not seem possible to justify the costs of space exploration for the extremely latent and delayed benefits.

There is, surprisingly, not a lot of research on the economics of space exploration, perhaps for this reason. There are a few articles scattered around here and there from the late twentieth century analyzing NASA, its externalities, and so on. But, there are very few papers analyzing space exploration from a global perspective, or from a non-agency perspective – even if *only* theoretically.

And, of course, there are many papers which analyze how to finance space exploration. But, I argue that this isn't enough. *Discussions on the financial aspects of space exploration do not constitute the underpinnings of an economic theory of space exploration.* Financial analyses do not tell you why you should be out there, or who should do the exploring, or what will constitute the exploration.

It is unfortunate that we are reduced to justifying something as awe-inspiring as space exploration with a petty economic argument, but the “scarcity problem” in science has yet to be solved. It is made painfully obvious to us that we do not have an unlimited amount of resources, and that there are many other more pressing problems in the world. This is why we need to justify how we do allocate our scarce resources, and make an economic case for space exploration.

Until there is an “economic theory of space exploration” which can prove that (human) space exploration is important, nationalistic and competitive space exploration will reign supreme. Until economists get involved, the odds are not in favor of human space exploration and so it will not come to fruition. But, you have to try.

There is good news, however. Several weeks ago, I learned of a new research project being undertaken by the Organization for Economic Co-operation and Development (OECD). They have launched a space exploration research component with a truly global focus. And, perhaps someone here with the economic, mathematical, and astrophysical inclinations will also be interested in this non-existent research field. I must warn you, however, that it seems to me that space exploration is to economics now what exoplanets were to astronomy decades ago: still science fiction.

Let me end this section by noting an article by the well-respected magazine, *The Economist*. The U.S. Space Shuttle was retired in 2011, and *The Economist* ran a story (featured on the cover, I believe) on June 30, 2011 entitled: “The End of the Space Age.” To put it lightly, that is not true. The retirement of the U.S. Space Shuttle program does not imply the end of space exploration. Perhaps, it was sensationalism, or perhaps they were one of the many pessimists you can find in every age.

6 A Naive World View

Are the delusions of space nationalists (an oxymoron?) really not delusions?

Many have spoken of the need for a true international human space exploration program, not affected by the politics of nations. The astronomer Carl

Sagan, among others, spoke of this idea being realized centuries and millennia from now.

But, there are those who will say that this idea of complete international cooperation, at least for space exploration, is naive. It's like asking for world peace. That's crazy, right?

But, this time, it's not about the world. It's about the Solar System, our stellar neighborhood, the Milky Way, the local cluster of galaxies, the Observable Universe...

Those who think that all of this can and will be explored as a politically-divided civilization are the ones who are naive. But, who knows? Maybe one day there will be *human* space exploration.