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Sustainable Governance of Future Outer Space Colonies

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In 2016, SpaceX announced its plans to send humans to Mars, with the end goal of colonizing the Red Planet. But what reasons are there to establish such a colony? Could we humans even survive and thrive away from Earth? If we can, what form of relations could exist between Earth and future colonies? Further, what form of governance should colonies adopt? In this article, Nayef Al-Rodhan tackles these questions and more.

In October 2016, SpaceX announced plans to **send humans to Mars**, with the end goal of establishing a sustainable colony on the planet. The announcement is further fueling debates surrounding extraterrestrial colonization and whether it is possible for humans to live in a self-sustained outer space society.

Astrobiology studies the conditions under which life arises and the possibility of life existing beyond Earth. Several space agencies and private companies are exploring these topics, as well as researching potential habitable worlds that humans may one day colonize. In late May 2016, the European Space Agency (ESA) announced that **the Rosetta spacecraft** had found "ingredients regarded as crucial for the origin of life on Earth", on the comet it had been probing for almost two years. The Rosetta mission, which ended in **September 2016**, **studied** comet 67P/Churyumov-Gerasimenko, from the Jupiter family. It discovered 'life ingredients' vital to all living organisms, including the amino acid glycine ($C_2H_5NO_2$), commonly found in proteins and phosphorous. Importantly, it also found DNA and RNA in cell membranes and adenosine triphosphate (ATP). This detection is enormously important for scientific debates on the origins of life and water on Earth.

Why Colonize at All?

While working on cosmic rays in the late 1940s, physicist Enrico Fermi developed the idea which would later become known as the **Fermi Paradox**. According to this hypothesis, it is highly probable that extraterrestrial civilizations similar to those on Earth exist, although we are yet to encounter evidence of their existence. In his theory, such civilizations would inevitably seek to spread beyond their planets of origin. Three reasons are cited for this: exploration, colonization and survival. Today, our march forward to colonize other planets could well be driven by the same set of factors.

There are numerous reasons why humans aspire to colonize space. Cosmologist **Stephen Hawking** argues that humanity is unlikely to survive another 1,000 years on Earth, and humans must

therefore move into space. Another reason to seek new habitats is that Earth limits our growth as a species, as there is a finite amount of inhabitable space. In addition, human industrial activity – inextricably linked to environmental degradation and the depletion of resources – is threatening the survival of the Earth's biosphere. According to a **study** by the WWF and the Zoological Society of London, published in October 2016, Earth is set to lose two-thirds of its wild animals by 2020. We are in fact witnessing a phase of **mass extinction** not seen since an asteroid wiped out dinosaurs 65 million years ago. This crisis is primarily caused by humans, and nobody knows quite how far reaching the environmental effects will be. Yet humanity appears to have reached a saturation point, in which it is overwhelming nature, meaning the Earth could feasibly become uninhabitable for our own species in the future.

Could Humans Survive and Thrive?

The predominant question concerning human colonization of space is whether we could survive and thrive outside our own planet. There are several prerequisites for and impediments to potential space colonization.

Firstly, space must be accessible at a relatively low cost. Today, a rocket launch is very expensive, with a price tag of the order of thousands of US$ per kilogram orbited in low Earth orbit (LEO). However, new approaches from both state programs and private companies interested in space tourism and colonizing Mars may offer less expensive approaches for sending people into space. For example, by reusing rocket boosters and creating ships large enough to transport over 100 passengers, SpaceX hopes to reduce the cost of a trip to Mars to US$200,000 – the median house price in the US. NASA is also contemplating using, in the very long-term (next century at the earliest), **antimatter as fuel**, as a few tens of milligrams of this substance could propel a human mission to Mars, which otherwise would require tons of chemical fuel. **The NASA Institute for Advanced Concepts (NIAC)** is now funding research on an antimatter-powered spaceship. Innovative approaches to space travel, stemming from increased competition in an industry previously exclusive to space agencies, may facilitate colonization efforts by increasing the accessibility of extraterrestrial travel.

Another prerequisite for attempting colonization is an attractive return on investment. **Rare earth elements** mined from asteroids or planets incentivize investments in exploration technologies that could be useful for colonization. As we start to run out of **these elements on Earth**, finding them elsewhere becomes more alluring, even at a far higher cost. To that end, in November 2015 the US legalized asteroid mining under the US **Commercial Space Launch Competitiveness Act**, which states that any materials found on asteroids by Americans can be exploited. Yet it is worth noting that asteroid companies are primarily focused on extracting resource for use in space, for example to provide water or materials for space stations or to support deep space exploration missions.

With SpaceX's Falcon Heavy, that may drastically change, as the prospect of asteroid mining seems now more achievable and with returns in profit that appear staggering. For example, the worth of the iron found in one asteroid, **16 Psyche**, which consists mostly of nickel-iron, is estimated at $10 quintillion. **According to calculations by NASA**, if we extracted the minerals from the belt of asteroids between the orbits of Mars of Jupiter, the overall profits would be so large that each person on Earth could receive about 100 billion dollars. Moreover, some of these asteroids contain

metals or materials that could also be used to build livelihoods **while in space**, giving further impetus to the possibility of colonizing space.

A key impediment to humans thriving in space, for now, is the array of **physical difficulties** presented by the outer space environment, which is extremely hostile for humans. Faced with a lack of oxygen and air pressure, extreme temperatures, solar wind, radiation, space dust and micrometeoroids, humans would not be able to **survive** without protective gear. Even with protection, being in space has short-term and long-term negative physiological **effects**. Bones become brittle, sleeping and eating are difficult and body fluids tend to float upwards, bloating the face. Vision is also deteriorated, as the eyeballs are not under the same pressure as on Earth. Preventing **muscles** from atrophying is also a challenge in a zero gravity environment; six months in space causes a 25% reduction in muscle strength. To combat this loss, **NASA's Advanced Resistance Exercise Device (ARED)** has developed vacuum resistance machines, but they cannot completely mitigate muscle strength reduction. After returning from space, astronauts have a difficult time regaining their strength. Some may never do so fully. Yet the biggest hurdle to space colonization remains cosmic radiation exposure, as it damages DNA and causes cancer. Earth's magnetic field shields us from **99.9%** of radiation coming from space and the atmosphere provides additional protection. Mars, for example, has **no magnetic field** (although magnetized rocks on its surface indicate there once existed a magnetosphere which later faded) and possesses very little atmosphere. Potential colonizers would invariably need to find ways to shield themselves from the dangerous levels of radiation on Mars.

Relations between Space Colonies: A Symbiotic Realism Paradigm

Under the Outer Space Treaty – **signed in 1967** - **Mars belongs to everyone**, as nobody can own a celestial body. SpaceX is thus free to set up a new society on Mars, as long as any activities follow the rules stipulated under the treaty. As a US-registered company, its Mars colony would fall under US jurisdiction. Interestingly, if state space agencies from different countries (with different laws) were to coexist on Mars, one state could theoretically use differing legal interpretations to avoid recognizing a crime. A possible legal hiccup could also stem from the treaty's provision prohibiting the "harmful contamination" of other planets – referring to contamination from human microbes. **Human bodies** are not easily decontaminated – especially as people rely on microbes for survival – and the extent to which they would need to be decontaminated under Space Law is unclear. Moreover, a large colony would have to introduce microbes from Earth to grow plants on Mars' unfertile soils, in order to be self-sustainable. Under current Space Law this could be illegal, as it could contaminate any potential Martian lifeforms and obscure years of research on the existence of life on the Red Planet. Such ethical and legal questions could be a hindrance to outer space colonization, and restrict the scope of a colony's activities in space.

Thus the possible scenarios for political life on a colonized planet depend on a variety of factors, including whether the current global system has changed drastically or not; whether there is just a small group of people on the colonies or if a large percentage of the population has moved into space; and whether space is colonized by a state, a non-state actor, or private entity.

However, the idea of colonizing space remains certainly appealing. Beyond the logistical and physical challenges of space colonization, there are also numerous transnational and transcultural implications of such an endeavor. While this issue has been imagined in the realm of Sci-Fi for the

longest time, we can now think about it more concretely and in a timeframe that no longer seems in a future that is millennia away. How would space colonies be governed and what kind of political relations would they have amongst each other or with other actors on Earth? Legally speaking, under current laws, these colonies would exist under state jurisdictions and could not be permanently claimed as independent territories, disconnected from states or companies on Earth. Therefore all relations among these colonies would be governed by laws that already define relations on Earth. In the very long term, that too may change, and new entities may emerge in space, which are more than extensions of states on Earth. Whichever format this takes, it is crucial to ensure peaceful relations.

I wish to briefly consider this from the perspective of **Symbiotic Realism**, a theoretical framework for international relations I previously suggested. Symbiotic Realism rests on four key tenets: the neurobiological substrates of human nature, global anarchy, instant connectivity, and interdependence. Like Classical Realism, Symbiotic Realism takes into account the centrality of human nature to politics. However, unlike Classical Realism, it does not depart from pessimistic views of human nature. While humans can be, and often are, immoral, competitive and selfish, this is not the sole defining thread of their character. Insights from neuroscience in recent decades portray human nature in more complex terms and reveal some surprising facts. I previously proposed a neuroscience-philosophical theory of human nature called *"Emotional Amoral Egoism"* to define **human nature**, which rests on three fundamental elements: *emotionality* (emotions play a critical role in our rational decision-making, much more than previously thought), *amorality* (most humans, most of the time, are neither intrinsically moral, nor immoral, but amoral – meaning their moral compass shifts according to circumstances and upbringing), and *egoism* (humans are egoistic insofar as they pursue their survival – a basic form of egoism). Symbiotic Realism also takes into account the particular features of international relations in the 21st century, where global interdependencies and instant connectivity continue to exist in a situation of anarchy, meaning there is still no "global government" to oversee the conduct of actors. However, these interdependencies run so deep that states cannot afford to turn against each other without losing a lot in the process. Symbiotic Realism thus emphasizes **absolute gains** because survival and prosperity in the 21st century are not limited to one domain (e.g. military) alone. States, of course, compete against each other – but even so, competition will mostly remain non-conflictual as any escalation incurs costs that will eventually offset the relative gains.

This framework also accommodates various actors that, alongside states, shape international relations and interests (such as economic and financial interdependence), which diminish the likelihood of confrontation even when ideological differences are glaring (**such as in the case of US-China relations**). Indeed, in some domains, especially financial and commercial, some countries are locked in what resembles symbiosis in nature, depending on each other in very profound ways.

In a globalized world, security can no longer be thought of as a one-track, zero-sum game involving states alone. Instead global security (and that includes space security) is better analyzed through the lens of the **multi-sum security principle**, whose five dimensions include human, environmental, national, transnational and transcultural security. Taking all these issues into account, as Symbiotic Realism compels us to do, we must ask the question of how life and politics might be on planets colonized by humans. The move away from a state-dominated paradigm is illustrated perfectly in space colonization, where the lead in creating settlements on other planets is taken by private actors

– the company **SpaceX** was founded in 2002 precisely "to revolutionize space technology, with the ultimate goal of enabling people to live on other planets". But it is only a matter of time before individual states will aspire to have a more ambitious role in such endeavors.

One of the most pressing issues, if we manage to colonize other planets, is the question of who will dominate. If Earth is still predominantly governed by a state system, inter-state relations will probably play a key role in determining who holds power in outer space and the likelihood of conflictual competition.

States, and non-state actors, like people, are **emotional amoral egoists**. They are neither good nor bad, and are often influenced by perceived emotional self-interests. Their moral compass varies according to circumstances and survival needs. When speculating about the future, one can look at the current level of inter-state cooperation concerning space activities. Though states have been focusing on space as a means of achieving national security and military power, there are many examples of inter-state cooperation. On the **International Space Station (ISS)**, fifteen countries are represented and are peacefully collaborating. From a **Symbiotic Realist** standpoint, one could argue that they are doing this out of necessity, not out of altruism. That is, the potential gains for states cooperating in space are much larger than those achieved individually, partially due to the high cost of space activities. While this model has led to outstanding cooperation – often between actors that share animosities on Earth – it may not be automatically replicated in space colonization. In a new territory such as Mars, states may want to establish their own domains of control and sovereignty – and boost their prestige. Indeed, in space matters, prestige has always played a key role for space powers. (It is, for instance, one of the driving factors for **China's ambitious and well-funded pursuits** at the moment.) Such motivators risk hampering the incentive for cooperation. However, just like on Earth, space colonies will exist in a setting where there will be no overarching authority, as no one nation has the legal right to claim a distant planet or portion of it. The framework of Symbiotic Realism will need to guide space colonies too. States will not be able to afford to start conflicts over colonies in space because those tensions will reflect on their relations on Earth. In an era of interdependencies, states cannot afford such escalations of tensions. Similarly, if space colonies were to be entirely independent from states on Earth, they would need to cooperate, or at least agree on frameworks for peaceful co-existence. This is because a situation of permanent conflict would defeat the purpose of moving to another planet, where life would only be hostile and even less predictable than on Earth.

Of course, entities such as corporations or global civil society will also play a role. As a result, they will consequently influence the internal and external relations of these colonies, whether amongst themselves or in relation to states and non-state actors on Earth. SpaceX's plans to create a **Mars colony for humans** in the 2030s clearly demonstrates the plausibility of this scenario. For instance, the possible involvement of a private company in colonizing outer space raises the question of whether that company would decide the political system of a particular colony. Space X has already stated that they would favor a system of **direct democracy**.

Governance of Space Colonies: A Sustainable History Paradigm

With regards to the state system that exists on our planet, I previously advocated a governance paradigm that takes into account the fundamental tenets of human nature. Only by taking human nature into account (without determinism or reductionism), can governance be inclusive and ensure

social and political stability. This paradigm is called "**Sustainable History**". It rests on the guarantee of **human dignity**for all, at all times and under all circumstances. This "sustainable history" is propelled by good governance paradigms that balance tensions between the three attributes of human nature (*emotionality, amorality and egoisms*) on the one hand and the nine human dignity needs (*reason, security, human rights, accountability, transparency, justice, opportunity, innovation and inclusiveness*) on the other.

Many aspects of life will be different in space, but any form of governance in space will still need to reflect the basic tenets of accountable and sustainable governance on Earth. The reason for this is that, despite the extraordinarily different aspects of life on a space colony, a fundamental element would be the same: they would still be populated by humans (for the foreseeable future, at least), and humans share a set of genetic and neurobiological commonalities. This may change in the future with the inevitable developments of **trans-humans and post-humans**, and that may require a slight modification of this paradigm, although I suspect that it will still be a valuable guide. These commonalities also reflect needs that all humans aspire to have in any governance system. A model similar to Sustainable History can guide the governance of space colonies too: according to this, the best predictor of a successful outcome in any space colony would be the guarantee of individual and collective dignity for all the inhabitants, all the time, and under all circumstances.

A look into a possible future

Aside from its traditional military and civilian uses, space is increasingly seen as the environment in which the human species may ultimately survive. Although developing colonies on other planets is far from becoming a reality any time soon, the prospects of space colonization are set against a background of issues that affect the whole of humanity.

From a global security standpoint, the colonization of space also confronts us with intriguing scenarios about possible new confrontations. Will the exploration of space resemble the scramble for colonial territories that defined global politics in the 19th century? Who would compete in this race? Unlike the colonial pattern of conquest, setting up colonies in space would involve private actors and entrepreneurs - not only states alone. To avoid increased competition, potential conflict and especially weaponization, we need to think of innovative ways to allow for the conquering of space in a way that is just and does not add more frictions to terrestrial politics.

In the very long term, the so-called colonization of space must not be limited to planets of our solar system. The solar system extends far beyond the most distant planet, Neptune, with thousands of objects in the Kuiper belt, and probably millions of comets in the Oort Cloud, which goes all the way to about a quarter of the distance to the closest star, Proxima Centaury. The Solar System is huge, and, beyond the Sun environment, colonizing planets and other bodies around other stars could become a possibility in the coming centuries and millennia, now that we know that "habitable exoplanets" exist around a large share of the stars in our Galaxy.

About the Author

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