

THE MARTIAN PAPERS: DEFINING MARS FOR THE PURPOSES OF A MARTIAN CONSTITUTION

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ABSTRACT

As part of the Martian Papers project, a series of accessible papers on the problems of Martian governance to be solved in preparation for the human settlement of Mars, in this paper we address the question of how a Martian state should be defined. Humans on Mars will depend on more than just the Martian surface to thrive and achieve the same benefits of modern life that are accessible to humans dwelling on Earth. By drawing parallels with the implicit global sovereignty of Earth over objects and regions in the Earth-Moon-Sun system, we argue for the inclusion of analogous regions in the political definition of Mars. We define a Martian Zone of Sovereignty such that the entire Mars-Sun system may be governed by, and for the benefit of, the people who will one day make Mars their home.

1. INTRODUCTION

“We, the Martians, declare Mars to be a free and independent state.”

The first line of the preamble of our proposed Martian constitution sets out clearly our intention for Mars to be an independent and self-governing entity, not subject to possession or rule from political entities on Earth. However, a question we should ask ourselves is, what exactly do we mean by Mars? And why would our constitution lay claim to an entire planet, not just a small part of it, as would be expected for a national constitution on Earth?

In this paper, we propose the definition of Mars for the purposes of a Martian constitution to refer to the greater Martian system—not only the entire planet itself, but its moons, its gravitational well, and the path that gravitational well traverses over the course of a Martian orbit—which we will call the **Martian Zone of Sovereignty**. We argue that only in this way can an independent Martian civilization receive the same benefits from the Martian system that the residents of Earth implicitly receive from the corresponding wider Earth system.

The planet Mars itself, as the principal massive body in the Martian system outside of the Sun, is perhaps the most obvious and straightforward component of this definition, so we shall return to this body at the end of this paper. At this point we will simply note that we define ‘the planet Mars’ to refer to the entire planetary body, including its surface, interior, and atmosphere.

2. THE MARTIAN MOONS

The significance of Earth's Moon to humanity throughout history is immeasurable. Since time immemorial it has been a comforting lantern in the darkness of night, a loved and revered subject of religious devotion and myth, and inspiration for song and story around the world in all ages. All people on Earth have benefited from its physical effects: the ebb and flow of the tides, the light it provides at night-time, and even the planetary stability that Earth enjoys due to the Moon's orbit potentially regulating the amount that Earth tilts on its axis.

More recently, scientific study of the Moon by orbiting satellites and by missions that have landed on its surface has provided humanity on Earth with a wealth of geological, seismological, and chemical data that offers unparalleled insight into the formation and evolution of their own planetary system, as well as a narrative of the human exploration of space that has served as inspiration for new generations of scientists, the impact of which can scarcely be calculated. In the future, these benefits of the Moon will only expand as missions become more sophisticated, with the Moon potentially serving as a departure point for missions from Earth travelling deeper into the Solar system.

Conversely, Mars does not have one large Moon, but two smaller ones—Phobos and Deimos. So small that their gravity is insufficient to pull them into spherical form, they appear irregular and lumpy in the Martian sky. Phobos orbits so swiftly that it rises in the west and sets in the east every eleven hours, whereas slow-moving Deimos takes over two and a half days to make its way across the sky from east to west. To humans living on Mars, Earth's moon will be distant and invisible, but Phobos and Deimos will likely develop similar roles in its place—cultural, logistical, and scientific.

Under the Outer Space Treaty of 1967 (OST67), no nation may claim sovereignty over the Moon, nor over any other celestial body. The reason for this is so that the exploration and use of space shall be carried out “for the benefit and in the interests of all countries... and shall be the province of all mankind” [1]. It is clear, then, that the benefits of the Moon are intended to be enjoyed by all humanity, and that the taking away of those benefits by the actions of a state through claiming sovereignty over the Moon or a region thereof will not be permitted under this treaty.

However, implicit in this treaty, and the general position that the Moon should be of benefit to all humanity, is the assumption that all humanity is located on (or in orbit around) the Earth. All states under OST67 are located on Earth, and all humans who have ever lived have done so entirely within the Earth-Moon system, and thus have obtained benefits from the Moon. It could be said that by declaring that no nation can assume sovereignty over the Moon, the collected Earth-based nations that signed OST67 assumed an implicit, planet-wide sovereignty over the Moon.

For humans living on another planetary body such as Mars, the benefits of the Earth-Moon system will be unavailable or inapplicable. While some benefits may be shared between planets, such as scientific knowledge, the remaining benefits will instead be provided in an analogous sense by Phobos and Deimos. And while benefits such as simply being able to look

up and see them will be available to Martian residents for as long as humans are on Mars and the moons remain in orbit, resources extracted from those moons or the logistical use of them are not currently guaranteed to benefit residents of Mars. For example, a hypothetical Earth-based mission could land on Phobos, collect samples of minerals found there, and return them to Earth for analysis or sale, with no benefit provided to the residents of Mars if the results or profits of that mission are not shared with them. In this way, despite not claiming any national sovereignty over Phobos, organisations of Earth would still be able to exploit the benefits of the Martian moons at the expense of the people of Mars, unless the people of Mars have authority to set the terms of use of the Martian moons such that equivalent benefit can be provided—for example, in the form of taxation, trade agreements, or other such arrangements between Earth and Mars.

It would not be reasonable to expect Earth's Moon to provide benefits to Martian residents, so it makes sense for collective, planet-wide sovereignty of the Earth's Moon to remain with the nations of Earth. However, we believe that, since Earth's Moon can be considered primarily of benefit to the humans of Earth and not Mars, Phobos and Deimos should equivalently be considered of benefit to the humans of Mars and not Earth—that is, **sovereignty over the moons of Mars should solely belong to the people of Mars in their entirety.**

3. THE MARTIAN GRAVITATIONAL WELL

Phobos and Deimos are not the only objects in orbit around Mars, just as the Moon is not the only object in orbit around Earth—the orbits of both planets contain other small natural objects, as well as human-made satellites. On Earth, the location of orbit is used for a wealth of different purposes: for satellites, which are vital for modern-day life in the realms of communication, navigation, meteorology, Earth observation, and science; for residence and in situ research, within the International Space Station or the Chinese Tiangong space station today, and likely many others in the future; and for transportation, with Earth orbit serving as a natural part-way point for setting up trajectories for other destinations in space.

Given the nature of the vast majority of orbital trajectories, national sovereignty of airspace out to orbital altitudes is not a practicable concept, due to satellites having no option but to pass over multiple countries in the course of an orbit. Agreements and organisation with respect to the region of orbit are therefore global by necessity, if largely still unregulated (one exception being the International Telecommunications Union, which governs the use of geosynchronous orbit space [2]). And once again such agreements are implicitly Earth-based, since all affected parties are located on Earth and the benefits of objects in orbit are likewise enjoyed by people on Earth, be it specific Earth nations, commercial organisations, or projects designed to benefit all humanity (who currently all live on Earth).

People living on Mars will need to be able to use the gravitational well of their own planet for similar purposes and should have the right to do so without interference from Earth. Additionally, the monitoring of objects in Martian orbit and the assignment of Martian orbital real estate would be most relevant to, and most easily done by, those living on the Martian

surface. Therefore, it makes sense that sovereignty for the gravitational well of Mars in general should belong with the people living on the Martian surface, being the main beneficiaries of the Martian orbit and best placed to assume responsibility for it.

In which case, how should we define the gravitational well of Mars, from a political point of view? A good place to begin would be the Martian Hill sphere, which is centered on Mars and defined as the region of space in which the gravitational attraction of Mars dominates over that of the Sun, allowing it to sustain objects in orbit. The Martian Hill sphere is just under one million kilometers in radius. We would also want to include the Lagrange points of the Mars-Sun system—that is, the regions of space where the combination of the gravity of Mars and the Sun means that an object at that position will have the same orbital period around the Sun as Mars itself, and thus be stationary with respect to the Mars-Sun system.

Lagrange points L1 and L2 are located at the edge of the Hill sphere, towards and away from the Sun respectively. These are useful locations for scientific satellites, with the equivalent regions of the Earth-Sun system being home to six different missions as of 2021, with plenty more planned for the future. However, these locations are gravitationally unstable, meaning that small perturbations in the position of an object there would rapidly lead to the object ‘falling’ out of the Lagrange point. This means that satellites located at L1 or L2 don’t sit precisely at these locations but rather orbit them in a large halo or Lissajous orbit, which can be as large as hundreds of thousands of kilometers in radius. Therefore, we propose a spherical region 1.5 million kilometers in radius and centred on Mars, that would comfortably encompass the full use of these points, all possible orbits of the planet Mars, and also plenty of room to facilitate maneuvers into and out of Martian orbit from other parts of the Solar system. (To put this into perspective, 1.5 million kilometers is a little under 3% of the distance between Earth and Mars at the point of absolute closest approach between the two planets.)

This sphere of immediate near-Martian space would become part of the political definition of the Martian Zone of Sovereignty, analogous to the national airspace and territorial waters of nations on Earth, and under the sovereignty of the people of Mars in their entirety.

4. BEYOND MARTIAN ORBIT

There are three further Lagrange points in the Mars-Sun system. The first is L3, located on the opposite side of the Sun from Mars and just within the Martian orbit, and is unstable in a similar way to L1 and L2. L3 in the Earth-Sun system is not currently used, though uses such as a sunspot warning system have been proposed, and the region may have important security implications in the future given the ability to hide something out of direct view of a planet by placing it permanently behind the Sun.

The other Lagrange points are L4 and L5, which are gravitationally stable regions located at 60 degrees ahead of and behind Mars in the path of its orbit respectively. Because of their stable nature, in contrast to the other Lagrange points, these regions naturally collect dust and other

objects such as asteroids, which are collectively called trojans. While the Earth-Sun system is not home to any trojans, as of 2021 there are nine Martian trojans recognized by the Minor Planet Center [3] between the two Mars-Sun Lagrange points. There are no missions currently located in L4 or L5 of the Earth-Sun system, though several missions have passed by these sites for scientific purposes and others have been proposed. The stability of these regions may make them an attractive location for future space missions, and trojans of the Mars-Sun system may be of particular interest for Martian science, communications, or resources.

As well as these regions of the Mars-Sun system, there are also potential uses for heliocentric orbits at or close to the orbit of Mars. For example, a planet-trailing orbit may be used as a very stable, thermally cool, and fuel-efficient option for a satellite to stay near to its launching planet without the planet being in the way of observations (two examples of space missions with Earth-trailing orbits are Kepler and Spitzer). At the planet-leading end, the method of ballistic capture, or low-energy transfer [4], is a fuel-efficient way of transporting materials to Mars by inserting the spacecraft ahead of Mars in its heliocentric orbit and allowing the planet to capture it as it catches up. This may become an important method of making non-time-critical deliveries to Mars from Earth in the future, particularly as the method does not require the use of narrow launch windows every two years that the Hohmann Transfer method necessitates. Additionally, further groups of natural objects occupy the space around the orbit of a planet around the Sun, such as objects in horseshoe or tadpole orbits and, like the trojans, may prove scientifically or logistically useful to residents of their associated planet in the future.

All this taken together with the fact that Mars and everything orbiting within its Hill sphere and associated Lagrange points moves through the whole of its orbit in a Martian year, it makes sense to expand the definition of the Martian Zone of Sovereignty to encompass the path that the planet Mars and its sphere of near-Martian space travel over the course of a full orbit around the Sun.

This full Martian Zone of Sovereignty would then be defined as an elliptical torus in space encompassing the full orbit of Mars around the Sun, with a minor radius of 1.5 million kilometers and a major radius (or more precisely, semimajor axis) of 1.52 astronomical units—that is, about 228 million kilometers i.e. the orbit of Mars.

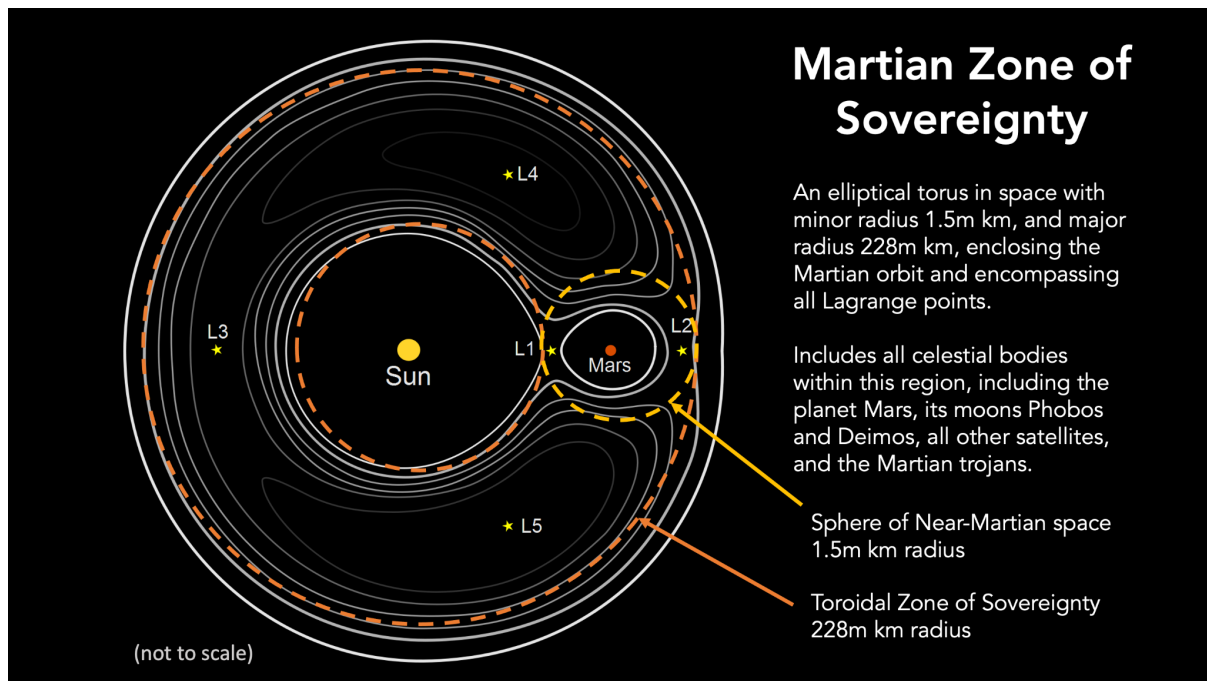


Figure 1: A diagram (not to scale) of the Sun-Mars system, showing the relative locations of the Sun and Mars, with Lagrange points marked with yellow stars and labelled, the sphere of Near-Martian space (Section 3) marked in yellow, and the full Martian Zone of Sovereignty (Section 4) marked in orange.

Much like maritime boundaries or airspace over a terrestrial country, there is nothing to say that this region of space cannot be entered or used by Earth-owned spacecraft, simply that this region would be under Martian sovereignty, and the conditions of its use would ultimately be decided by the people of Mars. In particular, Earth-based science missions would likely still be encouraged to access and study these regions of interest, since scientific research of the future, shared between planets, will be of benefit to humanity as a whole, and Earth will likely have better capabilities than Mars for creating such missions for a long time into the timeline of Martian settlement. Rather, it is to protect the long-term interests of a small and relatively less powerful Martian population that we propose that this entire Zone of Sovereignty be set aside for Martian civilization to grow into the full use thereof, just as Earth is making forays into its own equivalent zone.

5. THE PLANET MARS

We shall return then to the case of the planet Mars itself, the principal body within our defined Martian space. At this point it may be reasonable for the reader to ask why an independent Martian state would want to lay claim to the entire planet, not to mention the vast associated regions of space. Wouldn't an initial settlement, and even a well-developed Martian nation of multiple cities, only require a relatively small amount of the Martian surface for its operation?

The reason for making a bold move such as this is because, since all human nations in the past have existed solely on Earth, there has been no external need for codification of sovereignty at

a planetary level. However, this doesn't mean that such sovereignty does not already exist. Similar to the arguments in previous sections, it is implicit in the national and international governance of Earth that any part of the planet can be lived upon, worked, preserved, set aside for no one to own, or otherwise laid claim to by people from Earth. While the practical need to protect Earth territory and resources from intrusion by external entities has not yet arisen, once viable independent human settlements exist beyond Earth, this will become necessary.

A first step for an initial independent Martian settlement must then be to lay claim to Mars for Martians. With the entire initial Martian population originating from Earth, the goal of this claim would not be to rule out other groups from arriving with the intention of becoming Martian citizens, or the arrival of parties representing nations of Earth. However, it will establish sovereignty over Mars and the Martian Zone of Sovereignty as belonging to those who live there, not to remote rule from Earth (see upcoming Martian Paper on Sovereignty). New settlements of people arriving at Mars with the intention to live there could then be incorporated into this planetary level of sovereignty as they arrive, earning an equal stake in the entire Martian Zone of Sovereignty as part of their commitment to living fully on the Red Planet. The government of Mars would then be a federated system, with different self-governing settlements as federal states within a unified planet-scale government.

Making a planet-scale claim to sovereignty from the start will allow for a more collaborative model of Martian land use to exist from the very beginning of human settlement of the planet. Rather than individual organizations laying claim to whatever they can as they arrive and operating completely independently of each other, decisions can be taken collectively by the groups that arrive on Mars in light of the long-term good of the planet. Immediate joint responsibility for the entire Martian Zone of Sovereignty would not only be good for inter-settlement relations in the early stage of Martian habitation but would also be able to embed values such as environmental caretaking—a planet-scale responsibility that Earth is currently badly equipped to handle—into Martian governance from the very beginning.

Declaring a Martian Zone of Sovereignty, that includes the entire planet Mars, to be under the joint sovereign rule of all political entities solely based on Mars is the best way to ensure the long-term thriving of Martian civilization.

6. IMPLICATIONS

Throughout this work we argue for the establishment of a Martian Zone of Sovereignty by comparison to an existing implicit Earth Zone of Sovereignty. However, the formal establishment of an Earth Zone of Sovereignty may be of clear benefit to the current residents of Earth as well.

Using the same reasoning with which we reached the definition of a Martian Zone of Sovereignty, the equivalent Earth Zone of Sovereignty would be defined as an elliptical torus of space surrounding the orbit of Earth, with minor radius of around 2 million kilometers and major radius of around 150 million kilometers. The larger minor radius results from Earth's

higher mass and resulting larger region in which orbits are viable. The smaller major radius is due to Earth's closer orbit to the Sun than Mars. The resulting volumes of space are remarkably comparable, being approximately $1.2 \times 10^{22} \text{ km}^3$ for Earth, and $9.9 \times 10^{21} \text{ km}^3$ for Mars.

There are currently many groups calling for the strengthening of Earth system governance as a way to address the modern challenges of climate change and other international-scale issues: for example, the Stockholm Memorandum, signed by members of the 3rd Nobel Laureate Symposium [5] calls for the development and strengthening of institutions that can tackle planet-scale problems. Increased commercial use of orbit also necessitates a more concrete system of governance for regions within the Earth Hill Sphere. We hope that, by discussing the political needs of future Martian civilization, we can add a voice in encouragement for the development of full Earth-Sun system governance on Earth. This kind of work may also lay the groundwork for the human governance of other planets in the Solar System in the far future.

There are some larger-scale considerations one could make about the theoretical use of Solar System space—for example, the construction of a Dyson Ring or other star-system-scale structures designed to make full use of the Sun's power—which are beyond the scope of this project due to being so far beyond current human capacity as to remain in the realm of thought experiment at this time. Nevertheless, matters such as planetary rights to insolation would be most easily solved by political entities on the Planet-Sun scale defined with respect to the natural geometry of the Solar System, as our proposed Zone of Sovereignty is. Therefore, we foresee such entities being useful far into the future.

The human settlement of Mars will be a transformative event in the social and political landscape of humanity. There exists a great opportunity to begin life on a new planet in a positive and future-facing manner, if we are bold enough to take it.

References

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