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Europa or Mars: Which will be the New Checkpoint of Human Civilization?

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Abstract

The study of Europa, as well as other Galilean moons of Jupiter, was first done by Galileo Galilei himself. After Galileo discovered Europa on 8th January 1610 (possibly by Simon Marius too, independently), this heavenly body has been the hot topic of discussion. Galileo Orbiter orbited around Europa between 1995-2003 and it found many strong pieces of evidence of the presence of liquid water beneath the icy surface of Europa. Similarly, Hubble Space Telescope also found the water plumes coming out from Europa from the data collected on January 26, 2014. As per Neil deGrasse Tyson, "Wherever there is liquid water on earth, there is life, even on the Dead Sea. So, Europa might also sustain life on it despite it lies outside of the gold lock zone". The surface of Europa is young, with a resurfacing age of just 30-70 million years oldand it is rich in ridges. Europa is tidally locked to Jupiter but those ridges are present on the overall surface of Europa which provides strong support in evidence of the presence of water on Europa. With the presence of liquid water and its magnetic field, it also stands out as an extraordinary candidate (other than Mars) in which we should start conducting our interplanetary missions. Mars on other hands is close to us, and river beds, sedimentary deposits indicating the presence of lakes on its past and also with the presence of ice on its Utopia Planitia region, Mars is one of the best candidates for our interplanetary mission. In this paper, we will discuss both the heavenly bodies and finally present our hypothesis.

Keywords: Europa, Mars, Goldilock zone, Tidal locking.

Introduction

The smallest of four Galilean moons of Jupiter which is roughly the size of Moon [1], yes Europa can be a better option for habiting life than Mars. Situated, 780 million kilometers from Sun, the surface of Europa is covered by ice and as ice is a great insulator of heat and thanks to the tidal locking of Jupiter, there are high chances to have liquid water ocean beneath the icy surface. Europa can support life and help us be multi-planetary life forms. There are many experimental data and conclusions drawn from various sites that strongly suggest the presence of liquid water under Europa's icy surface. The average diameter of Europa is 3121.6 km [2] with the surface area of 3.09×10^7 km^2. Europa has a high potential to support life. The atmosphere of Europa isn't as dense as that of Earth, It mainly contains [3] Molecular Oxygen which might be helpful but it is present in a very scarce amount which will not be sufficient for Human Breathing. Cryovolcanism and fissures [4] and cracks with colored deposits coming from Europa from the inner side of the ocean are showing that the ocean might be a habitable world.

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On the other hand, Mars is the fourth planet from the Sun. It is 227.9 million kilometers away from the Sun and its closest distance from Earth is 54.6 million kilometers. It is the second smallest planet in the solar system and consists of two natural satellites Phobos and Deimos. Mars is almost half the size of Earth and its atmosphere is 10 times thinner [5] than that of Earth. Mars is often known as the red planet as its surface appears red due to the presence of ferrous oxide. Mars is often regarded by many people as Human's next destination to continue the life form and to be interplanetary. After NASA found the presence of underground ice in the Utopia Planitia region [6], many people thought that it will be a good choice to choose Mars as our next destination as the water can cover the entire planet up to 11 meters when that ice is melted. But choosing Mars is indeed not the best choice. The atmosphere of Mars consists largely of Carbon dioxide comprising up to 95.27% and it is believed that the inner core of Mars has cooled down so it does not consist of its own magnetosphere [7]. This makes Mars vulnerable to various cosmic rays and solar wind. This causes a high-temperature gradient in the Martian surface with an average temperature of 210.22K. Martian surface also consists of a large number of craters which comprises of 20.95% [8] of all named craters of the entire Solar system.

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Both of the heavenly bodies have both pros and cons of selecting to be the best choice to make our new home. Europa can ensure our safety, provide water and help to better understand outer planets but it is far and the icy bed is also very difficult to break. Similarly, Mars is close to us, lies in the Goldilock zone but the atmospheric pressure is so less that water cannot exist on its surface. Both of the heavenly bodies also do not have enough Oxygen to breathe on.

Europa and it's Magnetic Field

One of the most important findings of Galileo satellite is that it found the disruption of Jupiter's magnetic field around Europa [9]. It was unexpected as most of the satellites on our entire solar system don't have such magnetic fields. The sources of magnetic field on Galilean satellites of Jupiter are shown below:

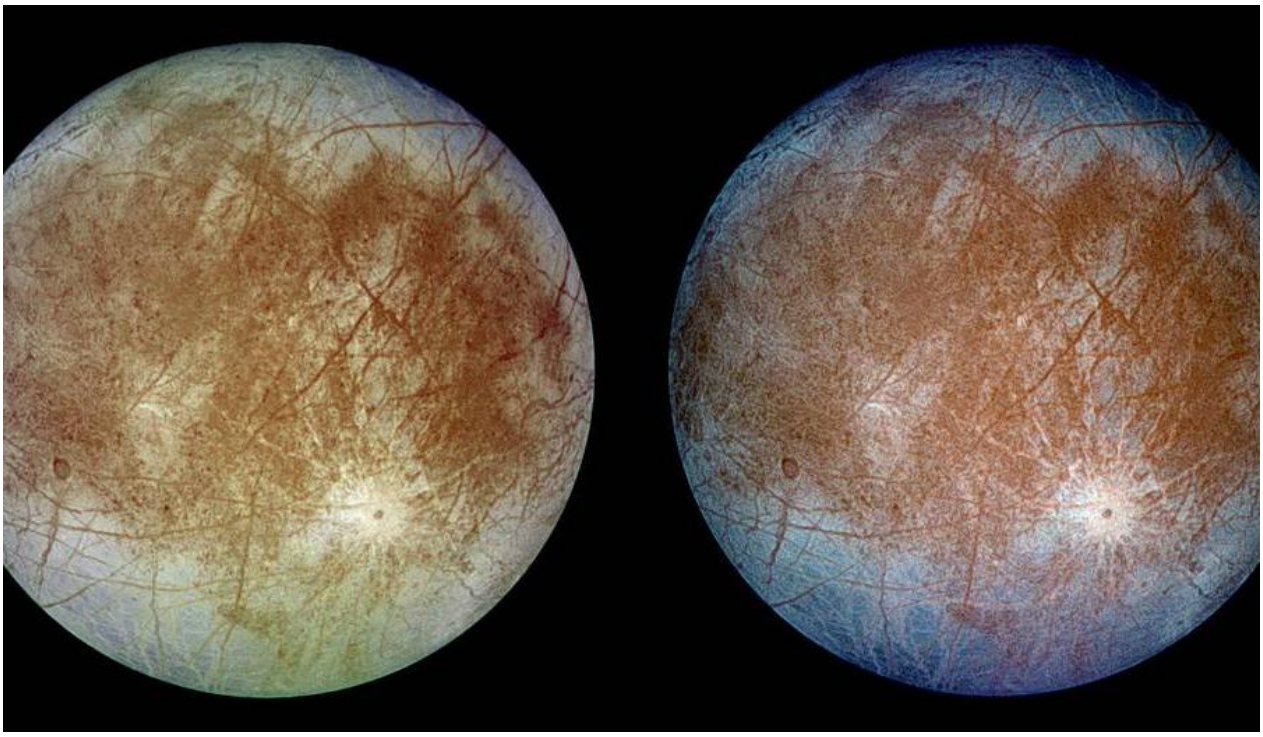

Figure I. Left image is the europa in its actual natural color. Right image is the false color composite of Europa.[source: **https://nssdc.gsfc.nasa.gov/image/planetary/jupiter/gal_eu2_48040.jpg**]

Table 1. *Source(s) of magnetic field in Galilean Satellites. [Sources: [1]McGrath et al. (2004) and references therein [2]Kivelson et. al (2004) [3]Kivelson et. al (2000) [4]Kivelson et al. (1996) [5]Khurana et al. (1998)]*

S.N	Satellite	Radius(km)	Planetary radii	Orbital eccentricity	Density(kg/m^3)	Neutral source	Source(s) of magnetic field
1	Io	1821.6	5.91	0.0041	3530	SO_2[1]	Plasma(ind)[2]
2	Europa	1560.8	9.40	0.0094	3010	O_2[1]	Ind, Plasma[3]

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3	Ganymede	2631.2	14.97	0.0011	1940	O_2[1]	Intrinsic, Ind, Plasma[4]
4	Callisto	2410.3	26.33	0.0074	1830	(O_2,CO_2)[1]	Ind, Plasma[5]

The disruption of magnetic field of one heavenly body around the other supports in the argument that the second heavenly body must have its own magnetic field. Same was thought in the case of Europa too. Th[illegible] Galileo satellite helped scientists to broaden that statement. The Jupiter's magnetic field and its interaction with its Galilean satellites can be shown through the figure II:

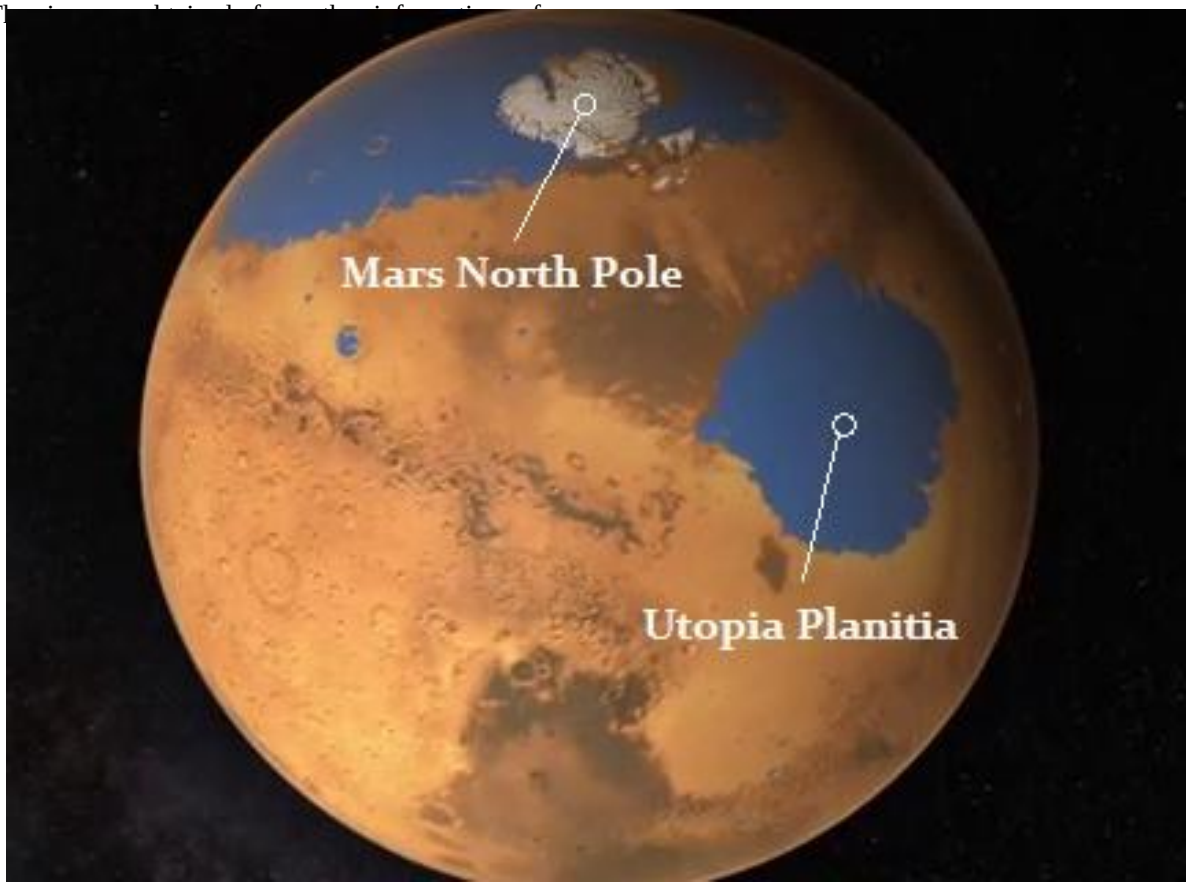

Figure II. Image of Mars showing underground water ice on North Pole and Utopia Planitia region.[Source: **https://en.es-static.us/upl/2016/11/Mars-North-Pole-and-Utopia-Planitia.png**]

This image clearly shows how there is interaction of Jupiter's magnetic field. The source of magnetic field on Europa is found to be internally induced through electromagnetic induction [10]. The main reason for the formation of magnetic lines of force on Europa is said to be the moving electrically active fluid (salty water) beneath its icy surface. We can support our claim with the simple image of formation of ridges and cracks on the Europa's icy surface. It is believed that those ridges are formed by the strong tidal forces of Jupiter [11]. As many other satellites in our solar system Europa is also tidally locked with Jupiter[12] that means the same face of Europa faces Jupiter every time. But those ridges and cracks are found all over the surface of Europa. So, it is strongly believed that the liquid water lies beneath the surface of Europa that is constantly moving and is changing the position of those cracks.

This image captured by Galilean satellite about the cracks of Europa shows its ridges. These cracks are all the reason of strong tidal forces exerted by Jupiter's gravity.

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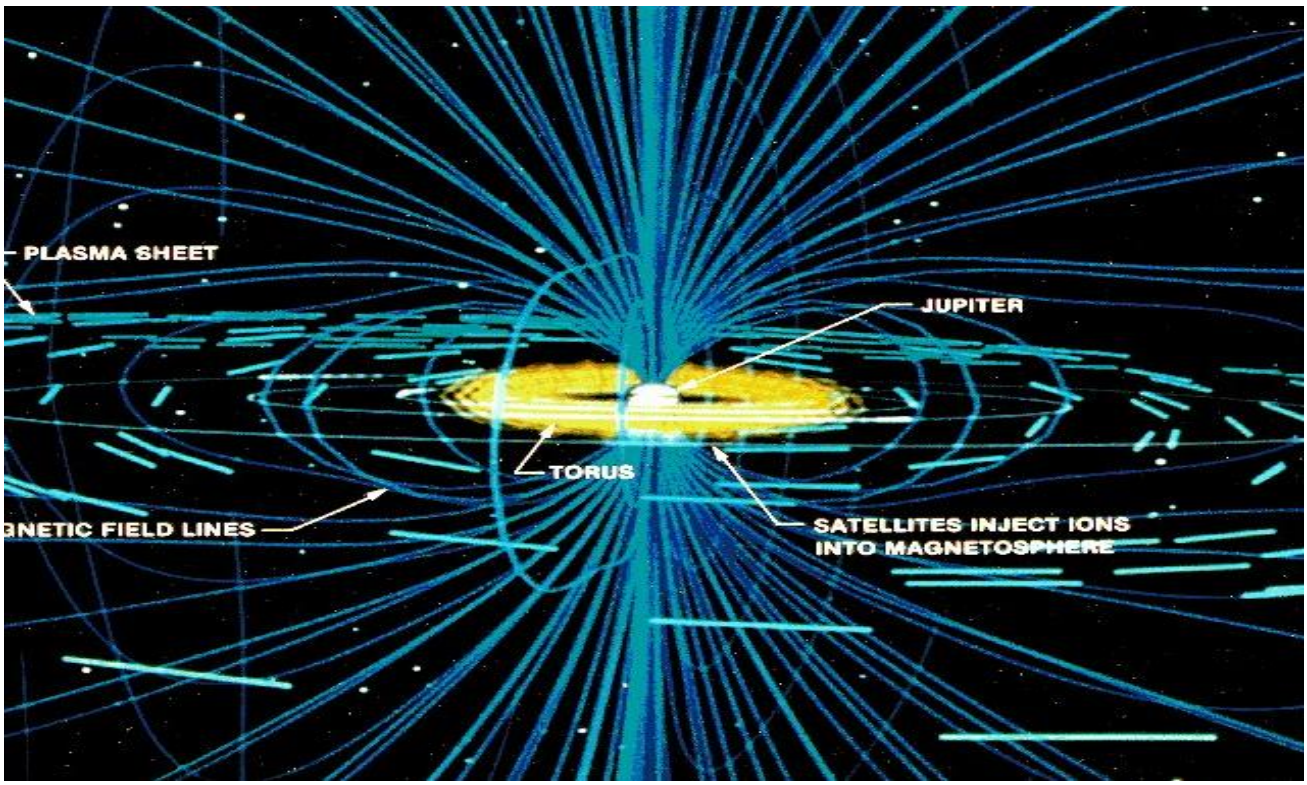

Figure III. Disruption of Magnetic Field of Jupiter
[Source:https://solarsystem.nasa.gov/missions/galileo/overview/]

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Past Missions Related To Europa

There have been many missions set by NASA and other space agencies to Europa. The most famous missions include the mission of Galileo orbiter and the flyby images of Cassini spacecraft and Voyager II. The future missions also hold in the queue to get up to that beautiful satellite of our gas giant.

Galileo Orbiter

Galileo orbiter was an unmanned American spacecraft named after Italian astronomer Galileo Galilee. Its primary function was to study the Jupiter and its moons. Galileo arrived on Jupiter on December 7, 1995 after gravitational assist of Venus and Earth. It also observed the famous collision of comet Shoemaker-Levi with Jupiter.

Galileo spacecraft provided most of the present known facts about Jupiter's own small system. It recorded the presence of clouds of Ammonia on the atmosphere of Jupiter. It studied the Io's volcanism and its plasma interactions with Jupiter. It also provided information about the presence of liquid water beneath

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the icy surface of Europa with its measurements. It also recorded the Jupiter's faint ring system formed by the dusts. On September 21, 2003 the mission was terminated by sending the spacecraft into Jupiter's atmosphere with speed [13] of over 48 km/hr eliminating all chances of contaminating its moons with Earthly bacterias.

Galileo orbiter mission was unmanned and it solved various mysteries of the Gas giant and its moons. It served a basis to provide us much information. In about 1990s there was not much informations about the gas giants. Galileo served as ice breaker in such moment. The image of Galileo Orbiter is present in the figure 4.

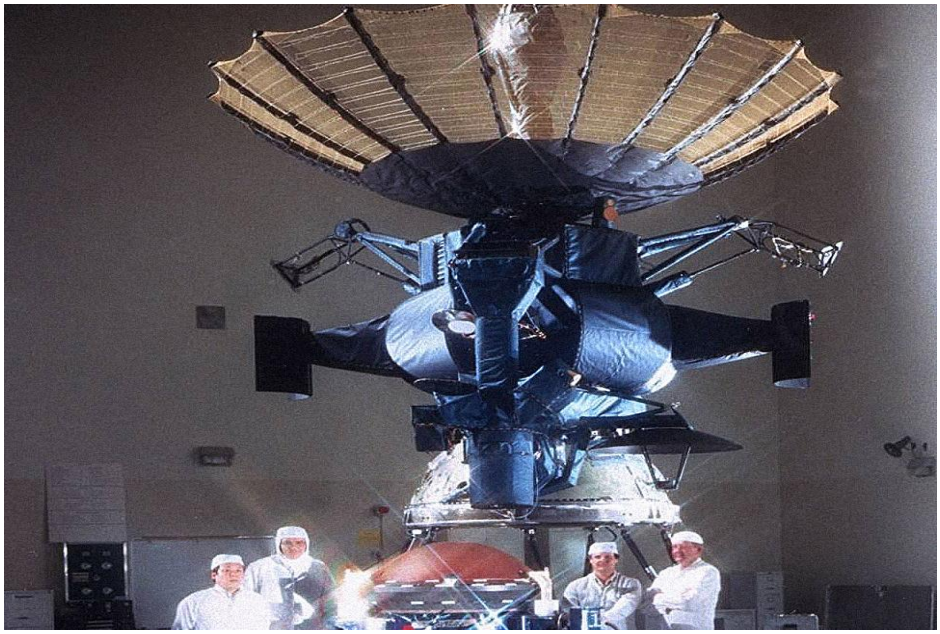

Figure. IV. Actual image of Galileo Orbiter. [Source: https://upload.wikimedia.org/wikipedia/commons/4/40/Galileo_in_1983.jpg]

Cassini-Huygens Space Mission

Though, this mission was not originally conducted to study about Jupiter and Europa but the images this spacecraft clicked during its flybys near Europa also induced the feeling of need to create a mission for Europa. It clicked some famous and spectacular images of Europa that we mostly see on the web today. Cassini spacecraft was launched on October 15, 1997 and its mission was officially ended on September 15, 2017 by making it dive to the Saturn. It was not made for study of Europa but it took some pictures of it. Also, the images of this spacecraft helped to induce the feeling of need of a rover for study of Europa. This image can show the comparison in size of super-massive Jupiter with its icy moon Europa. The same image is presented in the figure V.

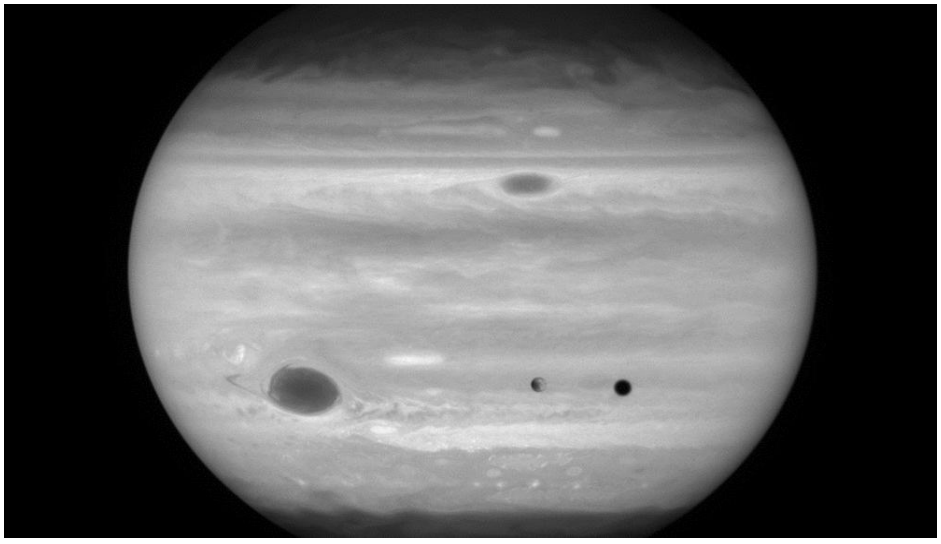

Figure V. Europa in front of Jupiter.
[Source:https://europa.nasa.gov/about-europa/ten-things/]

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Future Mission Related To Europa (Europa Clipper)

Europa Clipper is a mission set to particularly study about Europa. This mission is officially conducted by NASA. The clipper is set to launch by 2024.This mission has a lot of task to do. With space race beginning to get heat, most debates are based on the topics of Mars or Europa. Many space agencies like Space X are planning for their way to the Mars but it might not be the best choice. Europa also appears to be as better choice as Mars to make our new home. Now, all eyes are on Europa Clipper as it holds the responsibility to show the world why Europa is also better option as Mars.

Before Europa Clipper other missions were also set to Europa after the termination of Galileo satellite. Europa Orbiter was set to study the surface and internals of Europa but was cancelled in 2002 and Jupiter Icy Moons Orbiter was also set up for similar purpose but it was also cancelled in 2006. Both cancellations drew us back for exploration of Europa. Those projects were cancelled for various reasons but this new project of Europa Clipper should not be cancelled if we want to get interplanetary for real.

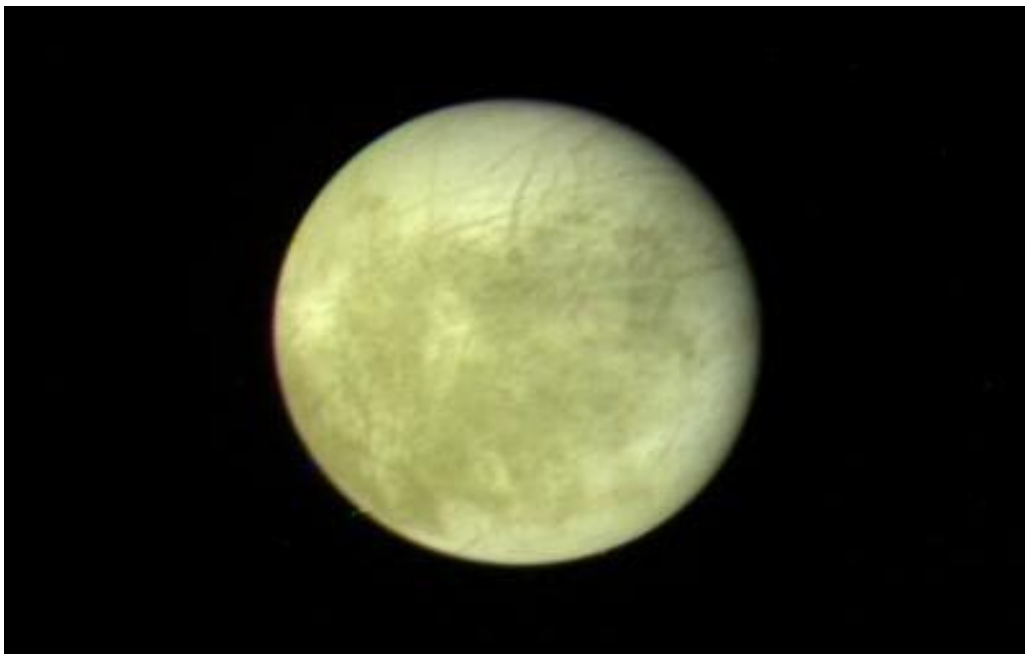

Figure VI. Image of Europa taken by Voyager 1 Probe.
[Source: https://www.jpl.nasa.gov/spaceimages/details.php?id=PIA00016]

Figure VII. Image of Europa taken by Voyager 2 Probe. [Source: https://photojournal.jpl.nasa.gov/spacecraft/Voyager+2]

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In August of 2015, a team of scientists and engineers for NASA's mission to Europa met for the first time in NASA's Jet Propulsion Laboratory. After two years of planning and hoping, the premiere gathering was the final page of the origin of a brand new chapter.The mission plans for a spacecraft to be launched on to the orbit near Jupiter so that it can study both, about Jupiter and also about its icy moons. The mission includes 45 flybys, during which the spacecraft would image the moon's icy surface at high resolution and investigate its composition and the structure of its interior and icy shell.

In the team, some came fresh from leading roles in the recent successful flyby of Pluto by NASA's Horizons missions. Several have worked together for decades, exploring Europa and other icy moons with NASA's Cassini, Galileo and Voyager missions. The instruments that are going to be used in Europa Clipper are listed in the table below along with their uses:

Table 2. *Instruments that are going to be used in Europa Clipper.*

[Source: Jet Propulsion Laboratory, NASA. Principal investigators are: [1]Dr. Joseph Westlake [2]Dr. Carol Raymond [3]Dr. Diana Blaney [4]Dr. Elizabeth Turtle [5]Dr. Donald Blankenship [6]Dr. Philip Christensen [7]Dr. Jack Waite [8]Dr. Kurt Retherford [9]Dr. Sascha Kempf]

S.N.	Instrument name	Abbreviation	Description and Objectives
1	Plasma Instrument for Magnetic Sounding[1]	PIMS	It will help to determine Europa's ice shell thickness, depth of Europa's water ocean and its salinity.
2	Interior Characterization of Europa using Magnetometry[2]	ICEMAG	It will help to measure magnetic lines near Europa and will also help PIMS to get accurate information.
3	Mapping Imaging Spectrometer for Europa[3]	MISE	It will help to find the composition of Europa and distribution of organics, salts and other materials to determine habitability of Europa.
4	Europa Imaging System[4]	EIS	It will help to provide images of Europa's surface at 50 meter with 100 times higher resolution.
5	Radar for Europa Assessment and Sounding: Ocean to Near-surface[5]	REASON	It will help to find the hidden structures of Europa.

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6	Europa Thermal Emission Imaging System[6]	E-THEMIS	It will help to provide thermal imaging of Europa to detect Europa's active sites.
7	Mass Spectrometer for Planetary Exploration/Europa[7]	MASPEX	It will help to determine the composition of surface and subsurface ocean of Europa by the help of any surface material ejected into space.
8	Ultraviolet Spectrograph/Europa[8]	UVS	It will help to detect the small plumes and will provide data about Europa's atmosphere.
9	Surface Dust Mass Analyzer[9]	SUDA	It will help to find the composition of small solid particles ejected from Europa.

These instruments make up to the weight of about 82 kg. These instruments will help us to get the detailed information of Europa that might be indeed a better option than Mars to make it our new home.

Tidal Forces

Tidal force is the force that causes the change in centre of gravity of one heavenly body from another heavenly body's perspective. The tidal forces of Sun and Moon are responsible for the formation of tides upon seas and oceans. It causes the stretching of celestial bodies, spaghettification and also the breaking of objects. It is caused due to the variation in effect of gravity on various parts of a heavenly body.

We know that,

From Newton's law of Gravitation,

$$\vec{F_g} = -\hat{r}G\frac{Mm}{R^2}$$

And acceleration due to gravity is equivalent to,

$$\vec{a_g} = -\hat{r}G\frac{M}{R^2}$$

Where $\hat{r}$ is unit vector pointing from the body *M* to the body *m* (here, acceleration from *m* towards *M* has negative sign due to attraction).

Consider now the acceleration due to the sphere of mass *M* experienced by a particle in the vicinity of the body of mass *m*. With *R* as the distance from the centre of *M* to the centre of *m*, let Δr be the (relatively small) distance of the particle from the centre of the body of mass *m*. For simplicity, distances are first considered only in the direction pointing towards or away from the sphere of mass *M*. If the body of mass *m* is itself a sphere of radius

Δr, then the new particle considered may be located on its surface, at a distance ($R \pm \Delta r$) from the centre of the sphere of mass *M*, and Δr may be taken as positive where the particle's distance from *M* is greater than *R*. Leaving aside whatever gravitational acceleration may be experienced by the particle towards *m* on account of *m*'s own mass, we have the acceleration on the particle due to gravitational force towards *M* as:

$$\vec{a_g} = -\hat{r}G\frac{M}{(R \pm \Delta r)^2}$$

Pulling out the R^2 term from the denominator gives:

$$\vec{a_g} = -\hat{r}G\frac{M}{R^2}\frac{1}{\left(1 \pm \frac{\Delta r}{R}\right)^2}$$

The Maclaurin series of $1/(1 \pm x)2$ is $1 \mp 2x + 3x2 \mp \cdots 1 \mp 2x + 3x^2 \mp \cdots$ which gives the expansion as:

$$\vec{a_g} = -\hat{r}G\frac{M}{R^2} \pm \hat{r}G\frac{2M}{R^2}\frac{\Delta r}{R} + \cdots$$

The first term is Newton's Gravitational force of

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attraction while the second term is the required expression for tidal force. This tidal force is responsible for keeping the same face pf Europa towards Jupiter at all time. But the ridges and cracks are found all over the surface of Europa ,even on the side of Europa which never faces toward the Jupiter, so there must be some fluid beneath the icy surface that is causing the change in position of those ridges and cracks.

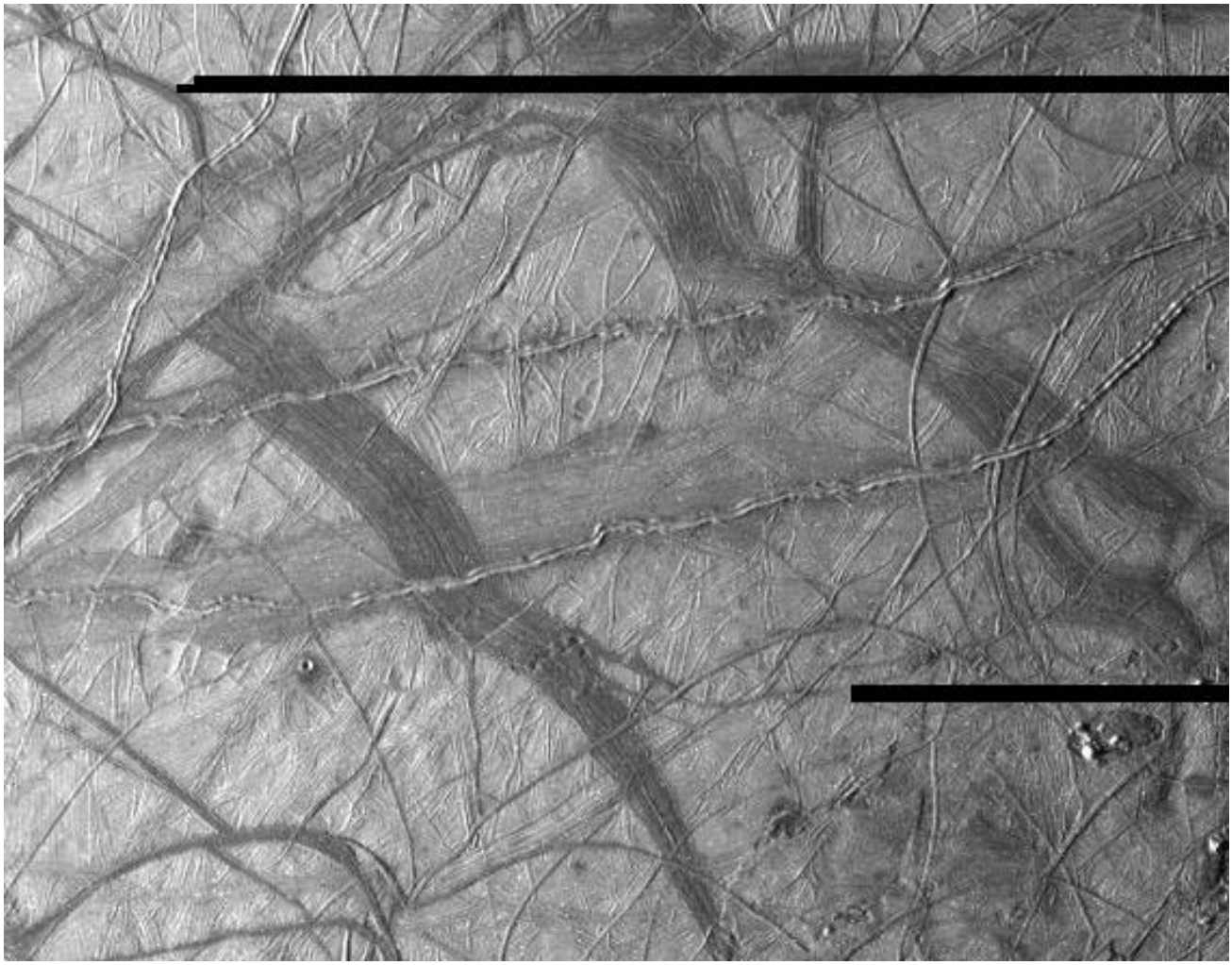

Figure VIII. Cracks and Ridges of Europa.
[Source: http://news.bbc.co.uk/2/hi/science/nature/449135.stm]

Mars's Magnetosphere's Condition

Unlike Earth, Mars has very weak magnetic field [14] but that does not mean that it don't have any. Our Earth has molten iron in the outer core which produces magnetic field by constantly moving and thus by electric induction. But Mars do not have such infrastructure. It is believed that the core of Mars has already cooled down [15] due to which it is not geologically active. So, there is no such electric induction on Mars to create strong magnetic field. However, the magnetosphere is present on Mars, though very weak than compared to that of the Earth. The magnetic field plays huge role in the survival of living beings on any heavenly body. Specially, from the solar wind. The particles present in the Solar wind are generally charged and when they interact with the magnetic field of a heavenly body, they get pushed outwards. In such a way, magnetic field protects us from harsh Solar winds and cosmic radiations.

Despite the fact that Mars no longer has an internal dynamo capable of generating a large global magnetic field as on Earth, there is evidence to suggest that Mars may once have had such a dynamo. This is mainly supported by observations from the American satellite mission MGS (Mars Global Surveyor), which from 1997 to 2006 measured the magnetic field of Mars using a small magnetometer from an altitude of 100-400 km above the planet's surface. These measurements showed the existence of powerful magnetic crustal fields

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on the planet's surface, far more powerful than those found on Earth.

But, how did the magnetic field of Mars vanished? The magnetic field that used to be stronger than that of Earth, now have become one of the weakest magnetic field among the planets of our Solar System. The clear reason for this is still not known yet. One of the explanation for it is that, due to the small size of Mars the core of the Mars was cooled much faster than that of Earth. It is believed that Mars lost its global magnetic fields almost about a billion years ago. Now, tailed magnetic field is supposed to be on Mars which is much weaker and fainter than that of Earth.

Past Missions Related to Mars

Being second closest planet to Earth, Mars has many missions set on it. Altogether 55 rockets have been sent to Mars from agencies of different nations out of which only about 36% have succeeded.

Table 3. *All past missions related to Mars.*

S.N.	Spacecraft	Launch Date	Mission	Outcome
1	1M No.1	10 Oct.,1960	Flyby	Launch failure
2	1M No.2	14 Oct.,1960	Flyby	Launch failure
3	2MV-4 No.1	24 Oct.,1963	Flyby	Launch failure
4	Mars 1	1 Nov.,1962	Flyby	Spacecraft failure
5	2MV-3 No.1	4 Nov.,1962	Lander	Launch failure
6	Mariner 3	5 Nov.,1964	Flyby	Launch failure
7	Mariner 4	28 Nov.,1964	Flyby	Successful
8	Zond 2	30 Nov.,1964	Flyby	Spacecraft failure
9	Mariner 6	25 Feb.,1969	Flyby	Successful
10	2M No.521	27 Mar.,1969	Orbiter	Launch failure
11	Mariner 7	27 Mar.,1969	Flyby	Successful
12	2M No.522	2 Apr.,1969	Orbiter	Launch failure
13	Mariner 8	9 May.,1971	Orbiter	Launch failure
14	Kosmos 419	10 May.,1971	Orbiter	Launch failure
15	Mars 2	19 May.,1971	Orbiter	Successful
16	Mars 2 lander	19 May.,1971	Lander	Spacecraft failure
17	Mars 3	28 May.,1971	Orbiter	Successful

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18	Mars 3 lander	28 May.,1971	Lander	Partial failure
19	Prop-M Rover	28 May.,1971	Rover	Spacecraft failure
20	Mariner 9	30 May.,1971	Orbiter	Successful
21	Mars 4	21 Jul.,1973	Orbiter	Spacecraft failure
22	Mars 5	25 Jul.,1973	Orbiter	Partial failure
23	Mars 6	5 Aug.,1973	Lander flyby	Spacecraft failure
24	Mars 7	9 Aug.,1973	Lander flyby	Spacecraft failure
25	Viking 1 lander	20 Aug.,1975	Orbiter	Successful
26	Viking 2 orbiter	9 Sep.,1975	Orbiter	Successful
27	Viking 2 lander	9 Sep.,1975	Lander	Successful
28	Phobos 1	7 Jul.,1988	Orbiter Phobos lander	Spacecraft failure
29	Phobos 2	12 Jul.,1988	Orbiter Phobos lander	Partial failure
30	Mars Observer	25 Sep.,1992	Orbiter	Spacecraft failure
31	Mars Global Surveyor	7 Nov.,1996	Orbiter	Successful
32	Mars 96	16 Nov.,1996	Orbiter Penetrators	Launch failure
33	Mars Pathfinder	4 Dec.,1996	Lander	Successful
34	Sojourner	4 Dec.,1996	Rover	Successful
35	Nozomi	3 Jul.,1998	Orbiter	Spacecraft failure
36	Mars Climate Orbiter	11 Dec.,1998	Orbiter	Spacecraft failure
37	Mars Polar Orbiter	3 Jan.,1999	Lander	Spacecraft failure

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38	Deep Space 2	3 Jan.,1999	Penetrator	Spacecraft failure
39	Mars Odyssey	7 April,2001	Orbiter **r**	Operational
40	Mars Express	2 Jun.,2003	Orbiter	Operational
41	Beagle 2	2 Jun.,2003	Lander	Lander failure
42	Spirit	10 Jun.,2003	Rover	Successful
43	Opportunity	8 Jul.,2003	Rover	Successful
44	Rosetta	2 Mar.,2004	Gravity assist	Successful
45	Mars Reconnaissance Orbiter	12 Aug.,2005	Orbiter	Operational
46	Phoenix	4 Aug.,2007	Lander	Successful
47	Dawn	27 Sep.,2007	Gravity assist	Successful
48	Fobos-Grunt	8 Nov,,2011	Orbiter Phobos sample	Spacecraft failure
49	Yinghuo-1	8 Nov,,2011	Orbiter	Failure Lost with Fobos-Grunt
50	Curiosity	26 Nov.,2011	Rover	Operational
51	Mars Orbiter Mission	5 Nov.,2013	Orbiter	Operational
52	MAVEN	18 Nov.,2013	Orbiter	Operational
53	ExoMars Trace Gas Orbiter	14 Mar.,2016	Orbiter	Operational
54	Schiaparelli EDM lander	14 Mar.,2016	Lander	Spacecraft failure
55	InSight & MarCO	5 May, 2018	Lander and two CubeSats Flyby	Operational

From this table, we can clearly say that although, Mars is very close to us than Europa but there is no guarantee about the success of our mission. Out of past 55 missions, only 16 are completely successful.

Future Missions Related to Mars

Future missions related to Mars can be represented by this table:

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Table 4. *All future missions related to Mars.*

	Mission	Expected Launch Date	Purpose
1	Hope Mars Mission	July,2020	Orbiter
2	Mars 2020	July,2020	Rover, Helicopter
3	ExoMars 2020	July,2020	Lander, Rover
4	Mars Global Remote Sensing Orbiter and Small Rover	July/August,2020	Orbiter, Rover
5	Mars Terahertz Microsatellite	2022	Orbiter, Lander
6	Mars Orbiter Mission 2	2024	Orbiter
7	Martian Moons Exoloration	2024	Orbiter, Phobos lander

We can clearly see that the interest of many organizations is more on Mars than on Europa as there are many past as well as future missions related to Mars than to Europa.

Long Lasting Chances On Mars

After seeing, all those missions, many of us would have thought Mars have something to give, thats why those agencies are in race with various missions, but in reality Mars is much more harsh. The atmosphere of Mars is about 10 times thinner [16] than that of Earth. Also, that atmosphere do not carry Oxygen. Most of its atmosphere is made up of CO_2 on which we cannot survive by breathing. The escape velocity of Mars is much less, that is about 5.03 km/s [17]. So, the lighter greenhouse gases like NH_3 cannot remain there when temperature is increased. Also, the atmospheric pressure is also very less on Mars, even less than the Armstrong value. This leaves us with no choice but to build domes with automatically set atmospheric pressure if we want to make Mars as our new home and want to stay there for more time. The atmospheric composition of Mars can be shown through this table:

Table 5. *Atmospheric composition of Mars.*

S.N.	Atmospheric Content	Percentage Composition
1	Carbon Dioxide	94.9%
2	Nitrogen	2.6%
3	Argon	1.9%
4	Oxygen	0.174%
5	Carbon Monoxide	0.0747%
6	Water Vapour	0.03%(varying)

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From Biological Point of View

There have been many supporting statements regarding the presence of life on Mars. One of the major sources of life on Mars is believed to be because of Earth [18]. Some microbe-laden dust could be ejected out from the Earth's atmosphere and they may reach unto the Mars. Similarly, microbes could be present in the rocks thrown out by meteor strikes which may eventually lead their way up to the Mars. The Martian rovers sent from Earth could also be the source of contamination. Though, the rovers are continuously sterilized, some organisms like fungi, *Bacillus* and *Staphylococcus* spp. may survive the sterilization [19]. The spacecrafts that crashed in the Martian surface may also contaminate the Mars.

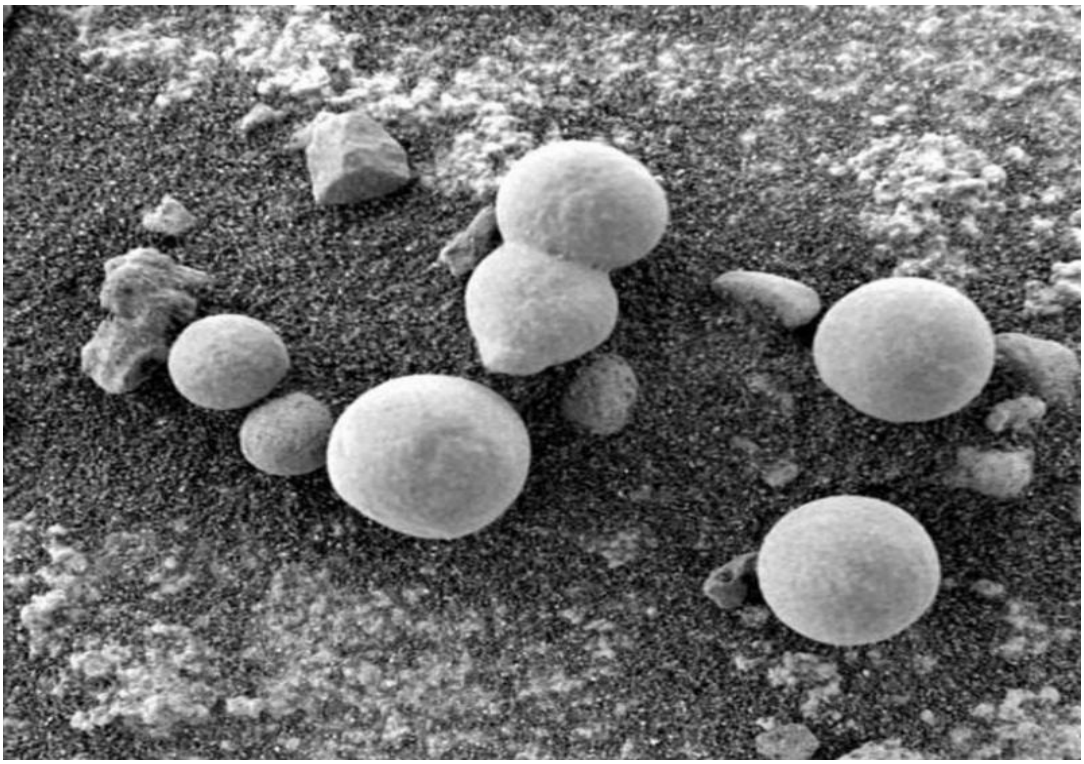

Figure IX. The Image clicked by Curiosity Rover which is supposed to be Fungi. [Source: https://www.dailymail.co.uk/sciencetech/article-6848453/Life-Mars-NASAs-Curiosity-rover-snaps-photos-mushrooms.html]

The simulated Martian environment also suggest that the microorganisms could survive the Martian surrounding [20]. Seasonal waxing and waning of Martian surface and replenishment of methane in its atmosphere strongly suggest the presence of life on Mars. Bacillus can survive both heat sterilization done to prevent the contamination of Martian surface by Earthly bacterias and also the long term exposure in radiation. One of the major supporting statement for the evidence of life on Mars comes from the images captured by Mars Curiosity rover on Mars [21]. Four investigators detected the fungi, mushrooms and lichens on the Martian surface after examining hundreds of images from the Curiosity rover. One of the image clicked by Curiosity Rover is given below in the figure 9.

On the other hand, there have been no signs for the existence of life on Europa so far. For Europa, the environment looks extreme depending on temperature. The temperature range of Earth is from 273K-373K [22]. However, in Europa temperature is very low compared to this temperature on Earth which is supposed be key factor for the possibility of life on Earth. Similarly in the salinity factor, Europa seems to be adaptable for only most extreme fungi that can tolerate extreme salinity levels [23].

Hypothesis

Many Government as well as private space companies are aiming to colonize Mars which may not be probably the best choice. The minimum distance of Mars from Earth is 54.6 million kilometers. It will take 240 days for Apollo crews to get up to there. The main problem is that Mars is almost complete barren desert. It doesn't have its own magnetosphere which means unlike Earth there is no way that Mars can protect us from harmful cosmic rays and solar wind of the Sun. Americans, Europeans, Japanese, Chinese and Indians have sent total of 56 rockets to the Mars out of which

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only about 1/3rd have succeed. It means although it is closer to us than Europa but still it's not easier to get there and even if we get up there we are only left with dead desert showing no chance to help us. We have to spend tons of resources where we have just about 36% chance of success and it is even more difficult to terraform Mars. Also, Government companies are no longer leading the space but private companies are so with limited resources they shouldn't spend those precious resources just to get on Mars rather they should wisely utilize those resources to get on the land which could support us to live there.

On the other hand, it's not easier to set up a base in Europa though. It takes 3 years to get up there even with the gravity assists and the icy surface is expected to be 10-15 miles thick [24]. We will need to have some special equipment to dig up the surface. Europa Clipper is expected to have RADAR which will penetrate the icy surface up to certain extent. Many projects set for Europa has been cancelled for various reasons but it will be better for humanity if it doesn't. Unlike many satellites of the solar system, Europa has its own magnetosphere. With magnetic field, it is believed that it might also have an Iron core, which will be investigated by the future missions. Presence of its own magnetosphere means that it can protect us from harmful cosmic rays and from the solar wind of the Sun unlike Mars.

Some people even think that it is out of reach to have manned mission in the land which is 628.3 million kilometers from Earth, but it is perishable. For a manned mission to Europa, first we have to study about Europa in more detail with the findings of Europa Clipper. We will also need large spacecraft which can support necessary fuel for lift-off, enough space for solar panels and also large food reservoirs. Some people blame asteroid belt that it can be huge obstruction in the path but it wouldn't as asteroid belt is not dense as we think. There is huge space between asteroids and it shouldn't be much problem to bypass it pretty easily while traveling at 58,000 kilometers per second. With about 82 kg of mass, there should not be much problem for energy source for Europa. But the radiation of Sun will be much thinner at location near Europa than that of Earth. So, solar panels will be required of much larger sizes that will be able to collect maximum light that falls onto it.

At first, we have to understand why we want to be interplanetary. We have got our beautiful planet Earth which can easily support life and we can easily spend our lives in here so why to be interplanetary? Well, there's a reason for it. Our beautiful planet is surrounded by 19,470 [25] (Near Earth Objects)which includes over hundreds of comets and maximum of asteroids and meteors. Out of those 19,470 NEAs, 10.04% of them are PHOs (Potential Hazardous Objects) which are of size more than 140 meters which mean they can penetrate through the Earth's atmosphere and reach to the ground and also cause hazards. So, being interplanetary helps us to conserve this human civilization because even if such mishap happens to one planet or land there will be another to continue this race.

The problem with Mars is that it is even more vulnerable to asteroids, comets and meteors. More smaller space rocks can also penetrate it's 10 times thin atmosphere than Earth. A new study conducted by HiRISE (The Mars Reconnaissance High Resolution Imaging Science Experiment) reveals that more than 200 asteroids impacts occur on the red planet every year. Thousands of craters are found on Mars which are caused by asteroids. Out of 5,211 named craters of the Solar system, 20.95% that is 1,092 are Martian craters. The surface of Mars is pocked by more than 635,000 impact craters.

On the other hand, Europa ensures full protection against such hazards. Its atmosphere is comparatively thicker and the enormous sized Jupiter (which on average lies 670,000 km away) ensures to defend Europa from any possible threats of space rocks as gravity of Jupiter pulls such potential hazards towards its surface. Europa, in front of Jupiter is like an Ant in front of us. So, whenever any asteroid or comet approaches near Europa, Jupiter's gravity attracts that heavenly body and thus, Europa has very less chance that it will be struck by heavenly bodies. Similarly, if we are in Mars then we have to continuously think of searching water that will be enough to drink and to carryout various activities. It is not possible to transport the water from Earth to Mars and the water obtained by melting the ice from poles of Mars will easily evaporate out. Though Europa is about quarter the volume of Earth but it contains almost double the volume of water on Earth. So, this is also a great factor to choose Europa as our option than to Mars for habiting life.

The atmosphere of Europa is way thinner than that of Earth but it is rich in Oxygen. Also, it shouldn't be much problem to obtain required amount of Oxygen from the water present in Europa. Moreover, being on Europa will help us to colonize the outer planets as well. It can help us to make detail study of the gas giants like never before. We can learn much more about our own Solar system and it will take us one step closer to the other Galilean moons which also bear potential to support life.

Conclusion

Being interplanetary is our next mission to prosper the Human civilization. The option to colonize Europa should be kept one step higher than the option to terraform Mars. Mars has numerous challenges and we can't also ensure whether or not it can protect us from space rocks. While on the other hand, Europa appeals to be best option as it has comparatively less challenges and can ensure our protection. The gas giant, Jupiter can protect from space rocks and there will be less problem of cosmic rays as Europa has its own magnetosphere. To live on Mars, we will need to nuke it to create appropriate environment while we don't have to think about any of such stuffs on Europa.

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To conclude, Europa is a better destination than Mars for permanent living and to start a colony for better Human Civilization. After all the study of various components of these two heavenly bodies, by comparison Europa seems to be the one that can help us to gain our main motive to be interplanetary and also can provide us the keys to our gas giants. So, Europa is of course a better choice.

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