

POTENTIAL RISKS AND HAZARDS OF SCIENTIFIC EXPLORATION MISSIONS TO MERCURY



Malaya Kumar Biswal M, Noor Basanta Das and Ramesh Naidu Annavarapu

Department of Physics, Pondicherry University, Puducherry – 605014, India.
Email: malaykumar1997@gmail.com; noorbasantadas@gmail.com; rameshnaidu.phy@pondiuni.edu.in



INTRODUCTION

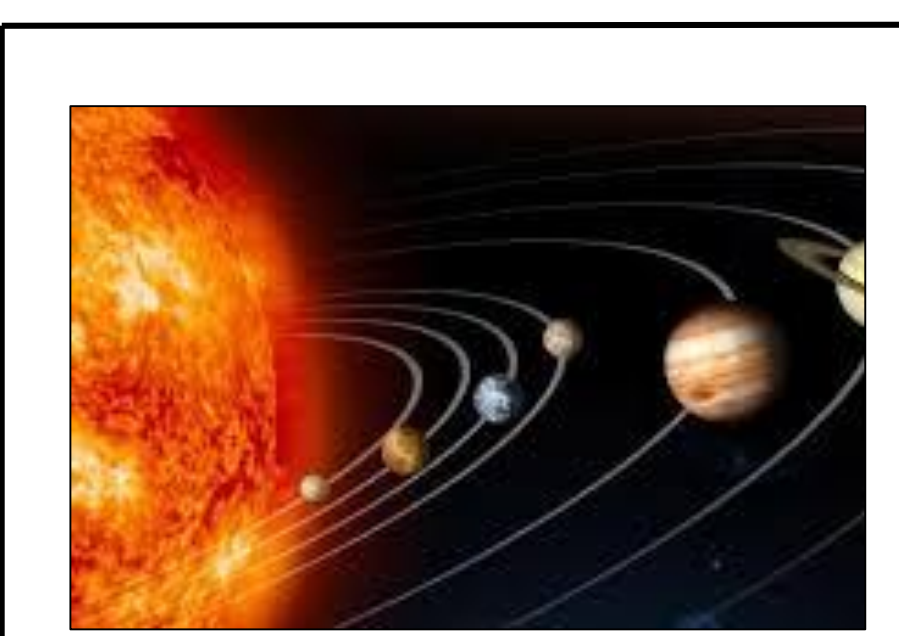
- Space exploration is filled with hazards that need to be prepared for in advance and overcome for a safe and successful mission (manned or unmanned).
- These challenges arise due to galactic natural phenomena, cracks in artificial technologies and human error.
- They prevail at every step of a space exploration mission starting from launch off of Earth's surface to re-entry into alien planet and landing.
- The primary intent of this study is to present every prospective challenge and its recommendations impending a scientific exploration mission to Mercury.
- These hazards include the long distance from Earth to Mercury, high temperatures due to proximity to the Sun, scrambling of communication due to heavy electromagnetic interference, risk of solar flares and coronal mass ejection, execution of successful entry, descent, and landing, failure of solar panels, energy production, finding a scientific landing site, navigation and relay of information.

DISTANCE FROM THE EARTH

- The distance from Mercury to the Earth varies greatly as both planets orbit the Sun.
- At its closest approach, Mercury is about 77 million kilometers (48 million miles) from Earth; at its furthest, about 222 million kilometers (138 million miles).
- With current technology the Messenger space probe took 6.5 years to reach Mercury. This number might be reduced with future technology to a few years.

HIGH TEMPERATURE

- Due to close proximity to the sun Inner planets like Venus and mercury are very hot.
- Mercury's surface temperatures are both extremely hot and cold. Because the planet is so close to the Sun, day temperatures can reach highs of 800°F (430°C).
- Without an atmosphere to retain that heat at night, temperatures can dip as low as -290°F (-180°C).



Distance from the Earth



High Temperature



Solar Flares



Coronal Mass Ejection



Entry, Descent and Landing



Solar Energy Production



Scrambling Communication & Navigation



Mariner 10 Spacecraft



Mercury Messenger

SOLAR FLARES AND CORONAL MASS EJECTION

- Being close to the sun Mercury is very prone to solar flares and coronal mass ejections.
- Mercury's magnetic field at the surface interacts with the magnetic field of the solar wind to sometimes create intense magnetic tornadoes that funnel the fast, hot solar wind plasma down to the surface of the planet.

ENTRY, DESCENT AND LANDING

- The speed required to reach Mercury is relatively high, and its proximity to the Sun makes it difficult to maneuver a spacecraft into a stable orbit around it making entry and descent very difficult.

ENERGY PRODUCTION

- Due to the extreme temperatures solar panels will malfunction and will be unable to produce energy. This can be overcome by using nuclear fuel cells and nuclear energy.

SCRAMBLING OF COMMUNICATIONS & NAVIGATION

- Spacecraft around Mercury orbit may experience communication and navigation related issues due to the effect of solar flares and solar radiations.
- Because the hazardous elements from sun has the potential deflect the radio communication waves results in the scrambling of communication.

LANDING SITE

- The hostile environment of planet Mercury may pose a challenge for descending probes affecting the spacecraft components.
- The task of selecting a robust landing site to meet all the objective of scientific exploration. Because landing probe require a favourable environment for proper functioning of its scientific instruments.

CONCLUSION

- From the perspective of successful mission, we have outlined all possible challenges on the way to robotic exploration of Mercury.

REFERENCES

- 1) Biswal M, M. K., & Annavarapu, R. N. (2021). Human Mars Exploration and Expedition Challenges. In AIAA Scitech 2021 Forum (p. 0628).
- 2) Iess, L., Asmar, S., & Tortora, P. (2009). MORE: An advanced tracking experiment for the exploration of Mercury with the mission BepiColombo. Acta Astronautica, 65(5-6), 666-675.
- 3) Biswal M, M. K., Basanta Das, N., & Annavarapu, R. N. (2021). Orbital and Planetary Challenges for Human Mars Exploration. arXiv e-prints, arXiv-2101.

Image Courtesy: National Aeronautics and Space Administration; European Space Agency, Japanese Aerospace Exploration Agency

Mercury Exploration Assessment Group (MEXAG)

LUNAR AND PLANETARY INSTITUTE



Malaya Kumar Biswal M
Graduate Researcher



Noor Basanta Das
Graduate Researcher



A. Ramesh Naidu
Associate Professor