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Prediction, Testing, Measurement and Effects of space environment on space missions (3)

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COMPARATIVE STUDY OF RADIATION ON EUROPA ORBITER AND FLY-BY MISSIONS

Abstract

Deep space missions particularly have significant exposure to solar and cosmic radiations over the course of their lifetime. The radiations affect the life span and functionality of the on-board electronics and spacecraft systems. A mission to Europa would be no exception to the harsh environment of the solar system and the strong magnetic field around Jupiter. As JUICE and Europa Clipper exploration mission to the Jovian moons in this decade might make way for future robotic and human missions, there would be a concern for high radiation. Europa orbits Jupiter at an average radius of 9.4 times the radius of Jupiter which exposes spacecrafts to the highest planetary radiation in the entire solar system, due to the strong magnetosphere of Jupiter having an equatorial field strength of 417.0 T and extending to about 3 million kilometers. Close proximity fly-by around Jupiter or orbiter would face consequences of the same. High radiation environment would require thicker shielding around the spacecraft subsystems in turn reducing the payload mass. Thus, estimation of radiation on missions is critical due to the many factors affecting spacecraft design. Having designed preliminary trajectories to Europa, a mathematical model for analytical determination of radiation on the orbiter and fly-by trajectories around Europa has been developed. The model is developed considering the radiation field strength around Earth, Jupiter, and the coasting trajectory along with the time of flight in a particular environment. This paper aims to provide a comparative study of nominal and worst-case scenario of ionizing doze on orbiter and fly-by missions to Europa. It is expected that Europa multiple fly-by trajectory would have lower radiation doze compared to an orbiter around Europa. This is due to the orbiter mission being entirely in the influence of Jupiter's magnetosphere. This would determine the amount of radiation future missions would have to sustain for successful exploration of the Jovian moon.