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MISSION ANALYSIS TO MEASURE RADIATION DOSE ABOUT THE EARTH-MOON LAGRANGIAN POINTS

Abstract

Future missions will bring humans to the Moon, Mars and beyond, which presents tighter constraints on the maximum radiation dose acceptable for an astronaut. This paper is focused on the study of radiations for deep space manned missions on the Gateway near the Earth-Moon Lagrangian (EML) points. The mission analysis study looks at the transfer of two CubeSats in the Circular Restricted Three Body problem (CR3BP) deployed from the Gateway onto a Near Rectilinear Halo orbit (NRHO) about the second Earth-Moon Lagrangian point (EML2) for calibration. These will be transferred to Halo orbits about EML1/2 points for data acquisition. The orbit choice was done using multiple parameters such as stability, station keeping costs etc., to determine the most cost efficient and goal oriented orbit. These transfers are computed using direct Lambert arcs or patched invariant manifolds. The latter transfer uses a genetic algorithm to optimise the cost and time of the transfer. A preliminary study of the radiation environment in the vicinity of the EML1/2 was performed. This study consists in the Total Ionising Dose (TID) calculation, the determination of the most abundant particles' fluence as well as the different particle fluxes' Linear Energy Transfer (LET) depending on their origin (solar, intergalactic or extra-galactic) and solar cycle phase. A sectoral analysis of radiation effects on the different subsystems of the CubeSats is being performed. A complete 3D model with all required components to be operative was analysed with the advanced radiation dose analysis and shielding optimization software, FASTRAD. Moreover, the most appropriate payload to perform a full field ion measuring for the mission is being studied. After the mission, the end-of-life phase of both CubeSats must be analysed to prevent future debris around the Earth-Moon Lagrangian points. The disposal strategy assessed is a Moon impact scenario, as it fulfills the demanding constraint of having little amount of fuel still available for this last phase. The transfers from the mission orbits towards the Moon surface are computed with the use of unstable manifolds in

CR3BP. A large number of these are analyzed in terms of departure position, impact time, site of impact and transfer cost, with additional constraints of avoiding historical lunar heritage sites.