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LONG-TERM EVOLUTION OF ORBITS IN CISLUNAR SPACE: CHARACTERISATION AND STABILITY ANALYSIS

Abstract

Space is one of the last frontiers of scientific exploration and, now more than ever, it is also a valuable economic and strategic resource. The exponential increase in academic and industry's focus on space, empowered by the usage of CubeSats, have inevitably increased the amount of in orbit objects. As space projects become more and more ambitious, the development of Space Situational Awareness (SSA) becomes more and more important. In this context, space agencies and companies have expressed a clear interest in the cislunar realm, defined as an area going from hyper-GEO all the way to the Moon. On the one hand, the Lunar Gateway and the Artemis projects will require continuous and safe access to the lunar surface. On the other hand, the whole cislunar environment is being considered for exploration and scientific missions. The increase in the number of spacecrafts in cislunar space can generate problems that, at least so far, have not been addressed. To understand why this statement is true, it is enough to observe how the debris issue affects the vicinity of Earth to date. It cannot be excluded that a similar problem may arise in the future for cislunar space too, with greater complications due to the more complex and chaotic dynamic. Consequently, the design of the end-of-life phase of these missions is of particular interest. In this paper, the complex dynamics in the Earth-Moon system will be analysed, employing the Circular Restricted Three-Body Problem (CR3BP) as a fundamental model. Leveraging differential corrections and continuation methods, it is possible to define equilibrium points and families of periodic orbits, including, for example, Halo or Near Rectilinear Halo Orbits (NRHOs). Insights related to the stability of these families of periodic orbits will be provided, computing different types of stability indicators, based on the linear dynamical behavior but not only. The aim of this research is to characterize orbital families in cislunar space from a stability standpoint. This will allow deriving stability maps that can be used to identify proper solutions of end-of-life disposal for the families of orbits considered.