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Title: *"Notes on logarithmic spiral trajectories generated by solar sails"*
Abstract. A solar sail represents a very promising option in the set of low-thrust propulsion systems. It exploits the solar radiation pressure that acts on a large reflective surface to generate a propulsive acceleration. The recent successful missions of IKAROS, Nanosail-D2 and LightSail-1 have confirmed the potentialities of such a propulsive concept and laid the foundation for future space missions. The trajectory design for a solar sail-based spacecraft within a heliocentric mission is usually addressed by numerically integrating the spacecraft equations of motion, since in general no closed-form analytical solution exists. In this respect an exception is offered by the special case of logarithmic spiral. The latter is characterized by a constant flight path angle and a thrust vector direction that remains fixed in an orbital reference frame. Therefore, the Sun-spacecraft distance exponentially grows (or reduces) with respect to an angular coordinate measured from a given heliocentric direction. Even though the logarithmic spiral has some intrinsic limitations (such as the inability of generating a circle-to-circle orbit transfer), it may represent an useful tool for the preliminary analysis of some mission scenarios. The aim of this paper is to provide a systematic study about the possibility of inserting a solar sail spacecraft into a heliocentric logarithmic spiral trajectory. The required conditions in terms of solar sail (fixed) attitude, performance, and initial position are discussed. It is shown that the spiral trajectory is required to start from a specific point that depends on the solar sail performance and the parking orbit characteristics. Moreover, the evolution of the osculating orbital parameters are presented, and some potential mission scenarios involving logarithmic spirals are analyzed, including the rotation of the apse line and the phasing trajectories of a spacecraft placed along an elliptic orbit.

Joint work with Lorenzo Niccolai, Alessandro A. Quarta, Giovanni Mengali.