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MODEL AND TRAJECTORY OPTIMIZATION FOR AN IDEAL LASER-ENHANCED SOLAR SAIL

Abstract

A laser-enhanced solar sail is a solar sail that is not solely propelled by solar radiation but additionally by a laser beam that illuminates the sail. This way, the propulsive acceleration of the sail results from the combined action of the solar and the laser radiation pressure onto the sail. The potential source of the laser beam is a laser satellite that coverts solar power (in the inner solar system) or nuclear power (in the outer solar system) into laser power. Such a laser satellite (or many of them) can orbit anywhere in the solar system and its optimal orbit (or their optimal orbits) for a given mission is a subject for future research. This contribution provides the model for an ideal laser-enhanced solar sail and investigates how a laser can enhance the thrusting capability of such a sail. The term "ideal" means that the solar sail is assumed to be perfectly reflecting and that the laser beam is assumed to have a constant areal power density over the whole sail area. Since a laser beam has a limited divergence, it can provide radiation pressure at much larger solar distances and increase the radiation pressure force into the desired direction. Therefore, laser-enhanced solar sails may make missions feasible, that would otherwise have prohibitively long flight times, e.g. rendezvous missions in the outer solar system. This contribution will also analyze exemplary mission scenarios and present optimial trajectories without laying too much emphasis on the design and operations of the laser satellites. If the mission studies conclude that laser-enhanced solar sails would have advantages with respect to "traditional" solar sails, a detailed study of the laser satellites and the whole system architecture would be the second next step.