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Using Solar Radiation Pressure and Luni-Solar Resonances for Debris Mitigation

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This research approaches the problem of debris mitigation at high altitudes by leveraging naturally occurring perturbations. These perturbations include effects due to solar radiation pressure and effects due to third body gravitation. Solar radiation pressure can be used for a variety of high altitude orbits beyond where atmospheric effects dominate. For third body effects, they impact the work discussed in medium Earth orbit where luni-solar resonances affect the stability of the region. These instabilities cause trajectories to increase in eccentricity on the order of decades to centuries.

This research is broken up into four main goals. The first goal studies the averaging tools used in this research. Doubly averaged solutions provide rapid computation power for studying orbits over long time-spans but can lead to a degradation of the solution. This goal characterizes the uncertainties of this model in the unstable regime they are used in. The second and third goals relate to the instability of medium Earth orbit. The second goal studies the graveyard orbit approach, placing satellites in a disposal orbit at their end-of-life, and the long-term behavior of debris in these orbits. The third goal deciphers whether it is feasible or not to target these regions of instability for an atmospheric reentry to depopulate the orbits. The final goal involves using solar sailing for end-of-life debris mitigation at high altitudes. Similar to how satellites in low Earth orbit use drag sails to depopulate the orbit, the solar sail could be deployed at end-of-life to change the orbit and achieve an atmospheric reentry for high altitude orbits.