

# Dynamical Systems, Three-Body Problem and Space Mission Design

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New space missions are increasingly more complex; demands on exotic orbits to solve engineering problems have grown beyond the conic-centered astrodynamics infrastructure. The delicate heteroclinic dynamics used by the Genesis Mission dramatically illustrates the need for a new paradigm: dynamical system study of three-body problem.

Furthermore, it appears this dynamics has much to say about the morphology and transport of materials within the Solar System. The synergistic interplay between the natural dynamics of the Solar System and applications to engineering has produced a number of new techniques for constructing spacecraft trajectories with desired characteristics.

Specifically, these techniques are used to construct a “Petit Grand Tour” of the moons of Jupiter. We have designed an orbit which follows a prescribed itinerary in its visit to the many moons (e.g., one orbit around Ganymede, four around Europa, etc.).

We also apply similar techniques to produce a lunar capture mission which uses less fuel than a Hohmann transfer. We decouple the Sun-Earth-Moon-Spacecraft 4-body problem into two 3-body problems. Using the invariant manifold theory of the Lagrange points of the 3-body systems, we construct low energy transfer trajectories from the Earth to the Moon with a ballistic capture at the Moon.

This is joint work with Martin W. Lo, Jerrold E. Marsden and Shane D. Ross.