Applications of invariant manifolds in astrodynamics

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First AstroNet-II Training School, Rome, Italy
January 14–17, 2013

Personal background

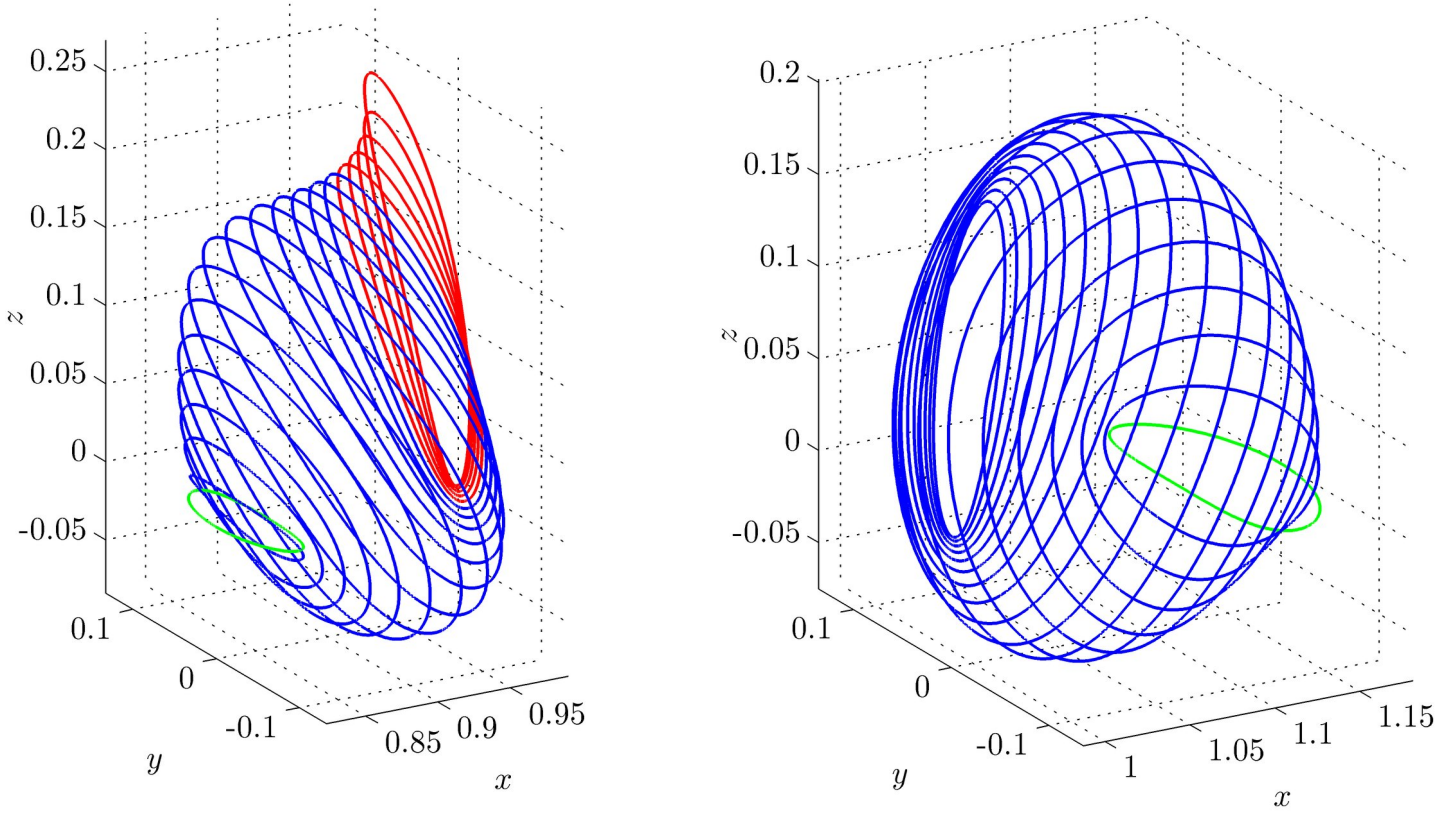
- B.S. in Aeronautical & Astronautical Engineering, 2007; Purdue University
- M.S. in Aeronautics & Astronautics, 2010; Purdue University (Advisor: Kathleen C. Howell)
- Ph.D. in Aerospace Engineering Sciences, *in progress*; University of Colorado Boulder (Advisor: Daniel J. Scheeres)
- AstroNet-II ESR; IEEC-UB (Scientists-in-charge: Gerard Gómez and Josep J. Masdemont)

Use natural dynamics to design efficient spacecraft trajectories satisfying mission objectives and constraints

Invariant manifold tools

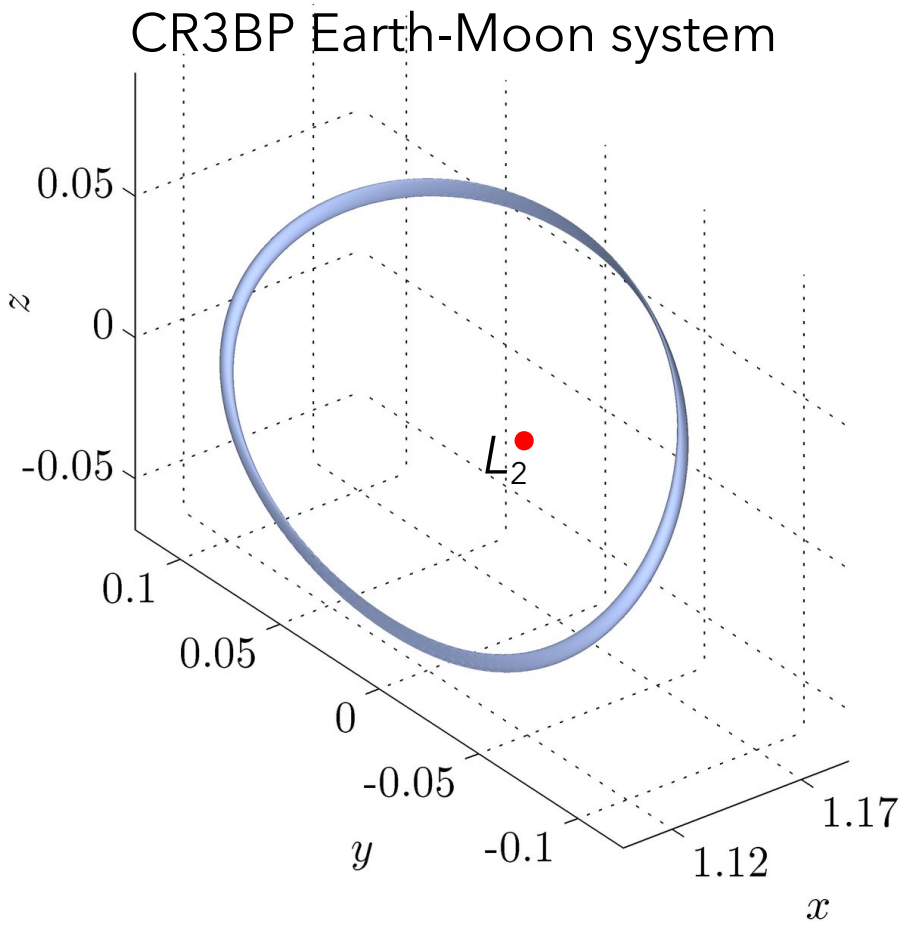
- Computation of periodic orbits and associated manifolds

CR3BP Earth-Moon system



Invariant manifold tools

- Computation of quasi-periodic orbits and associated manifolds



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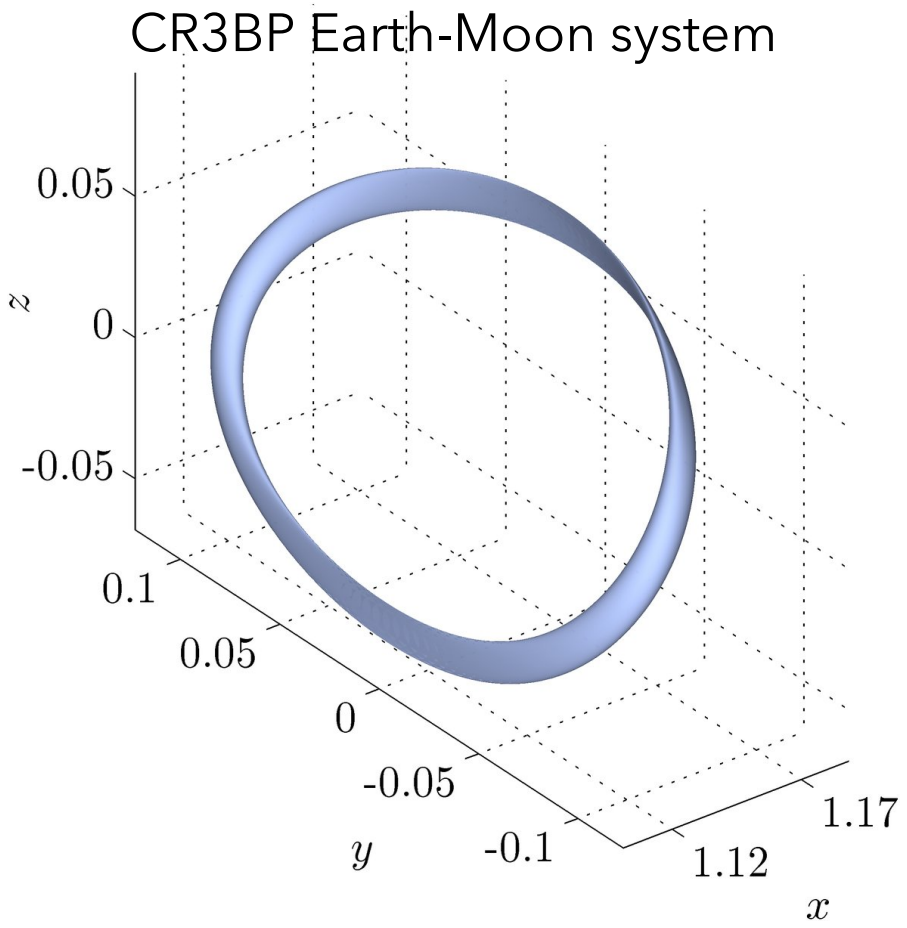

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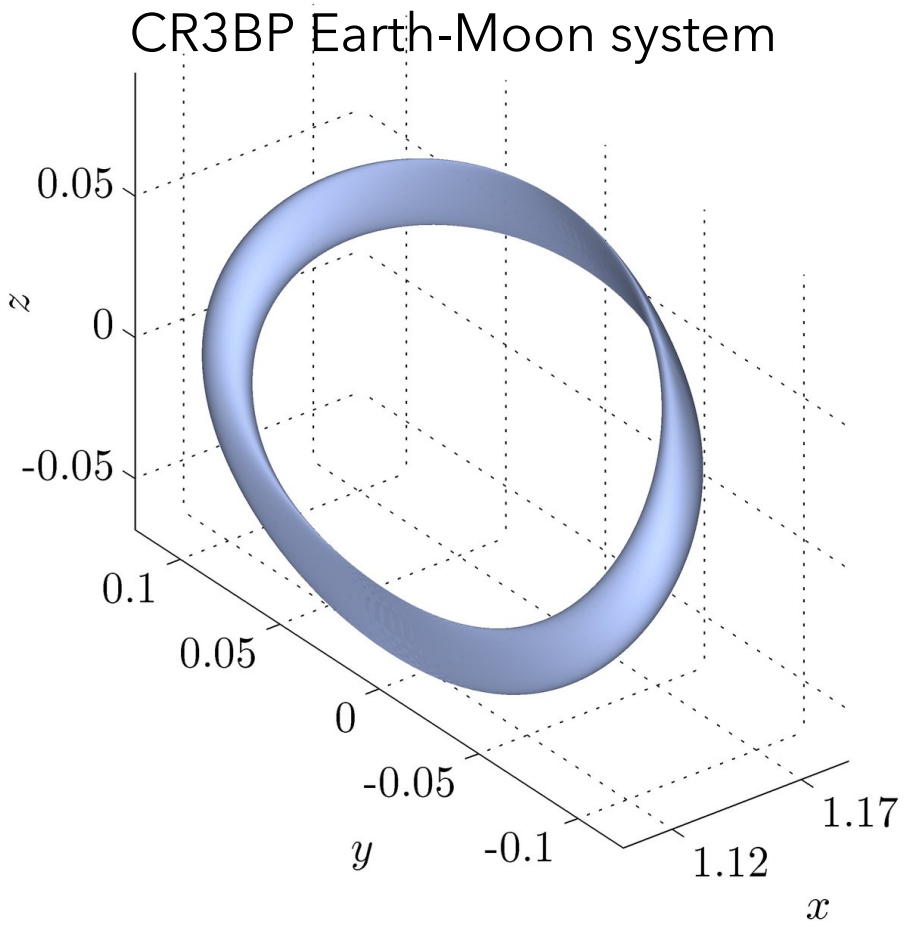

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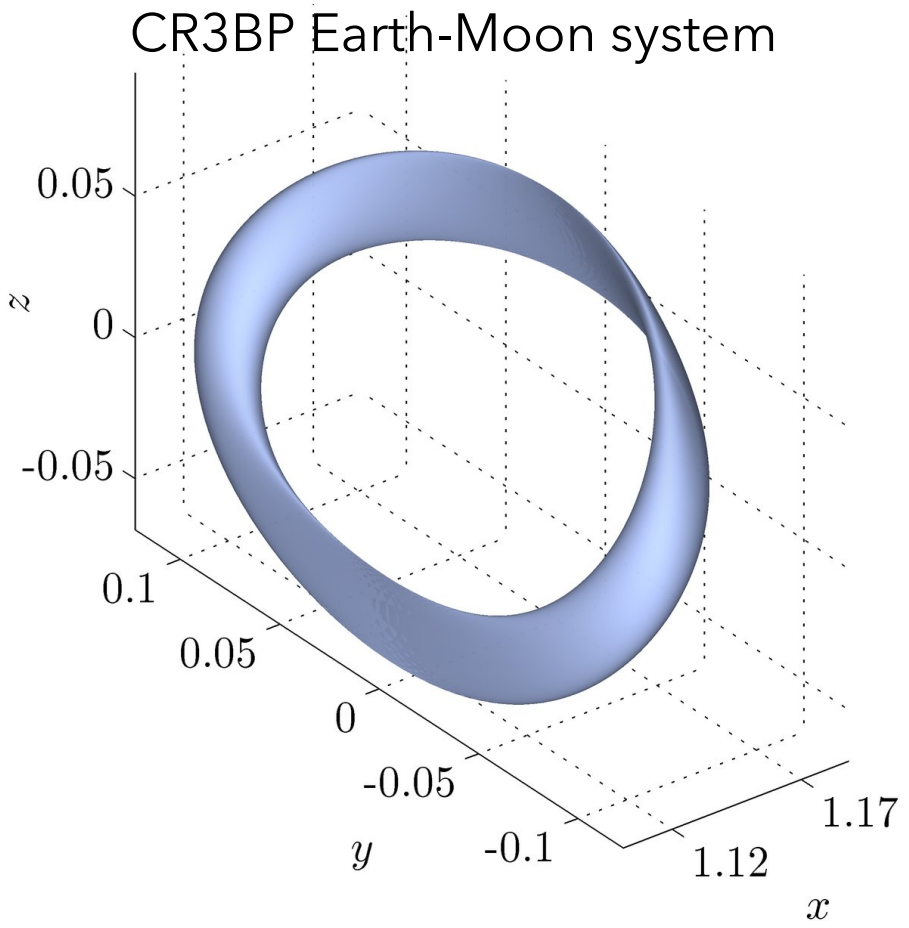

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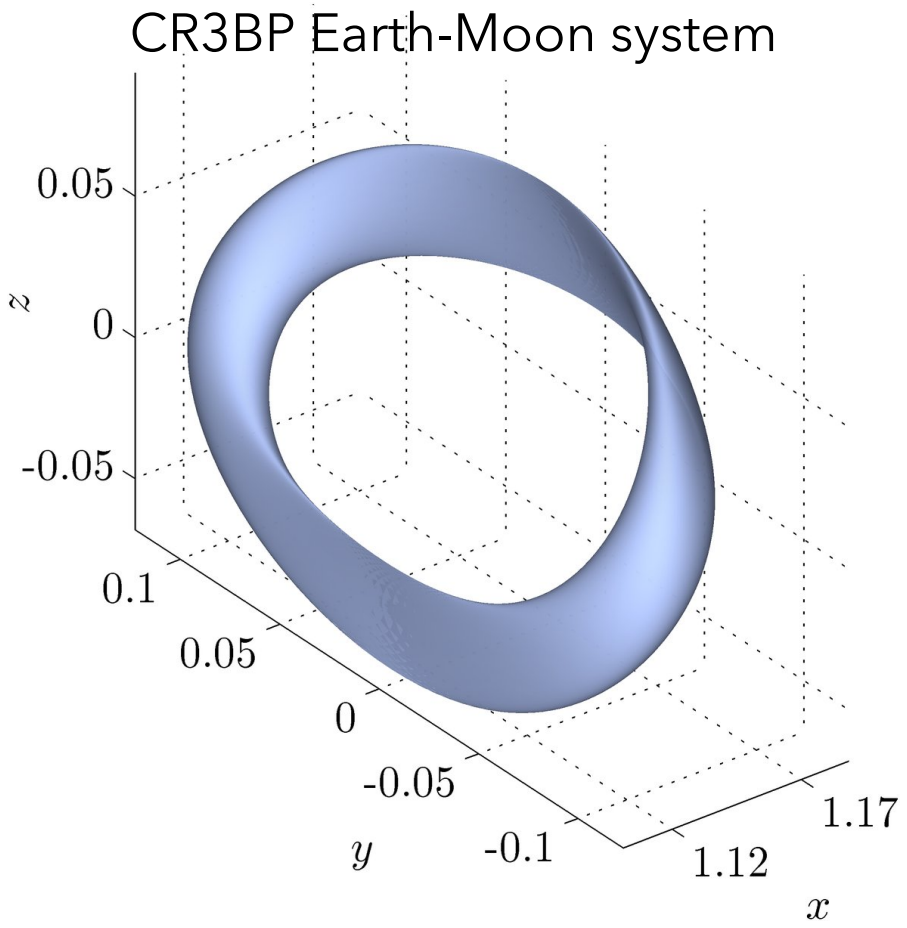

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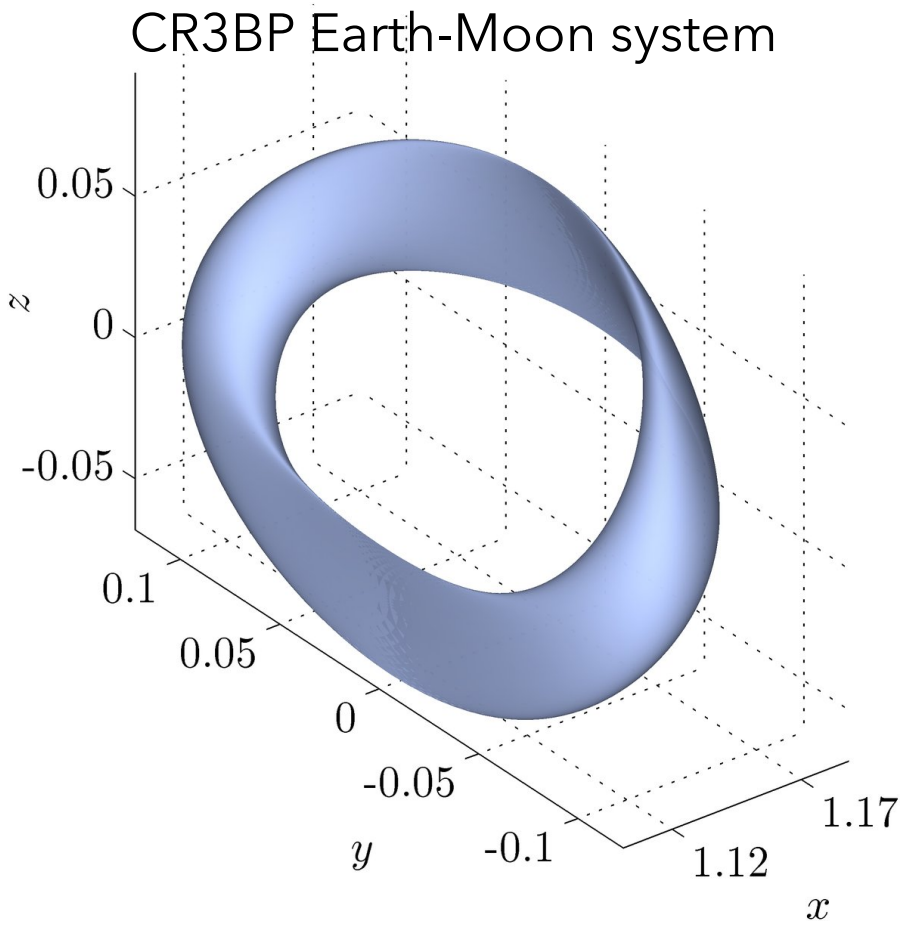

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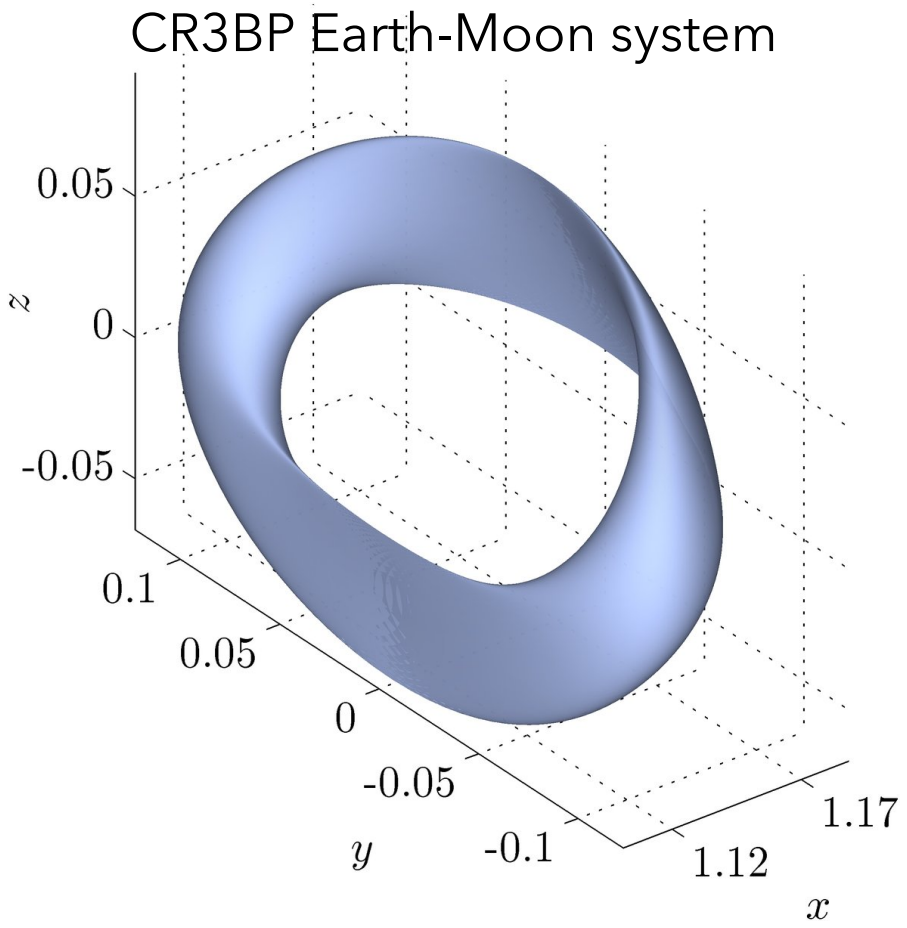

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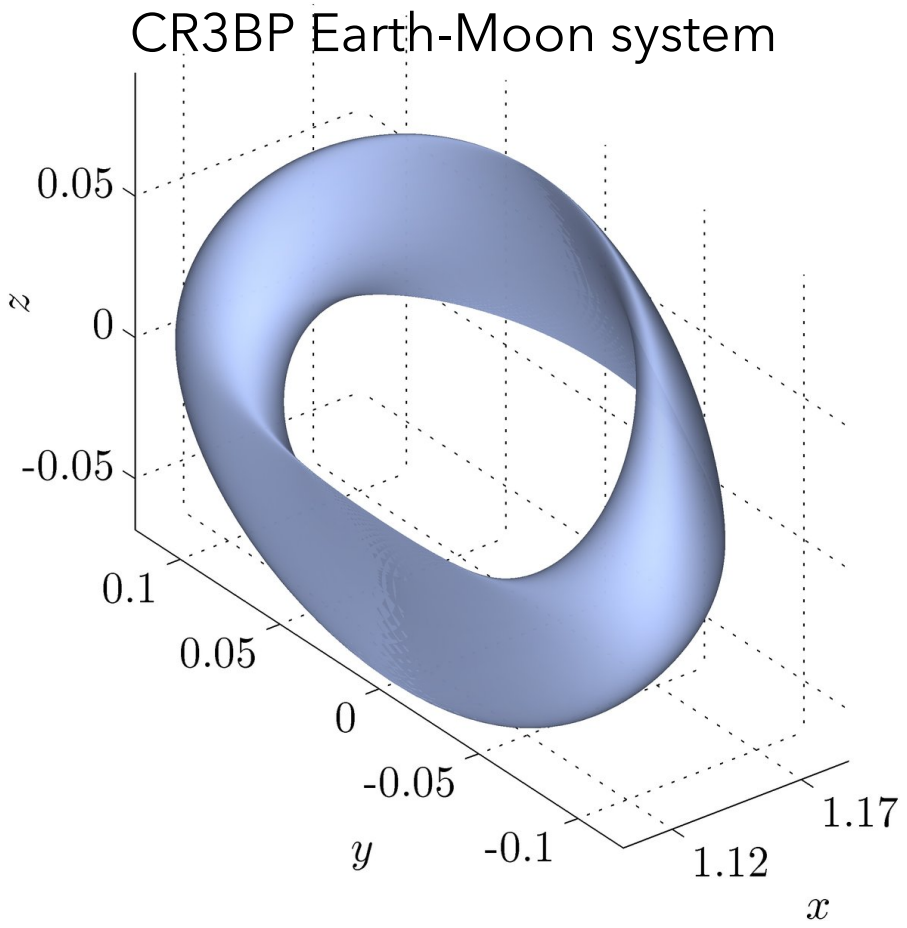

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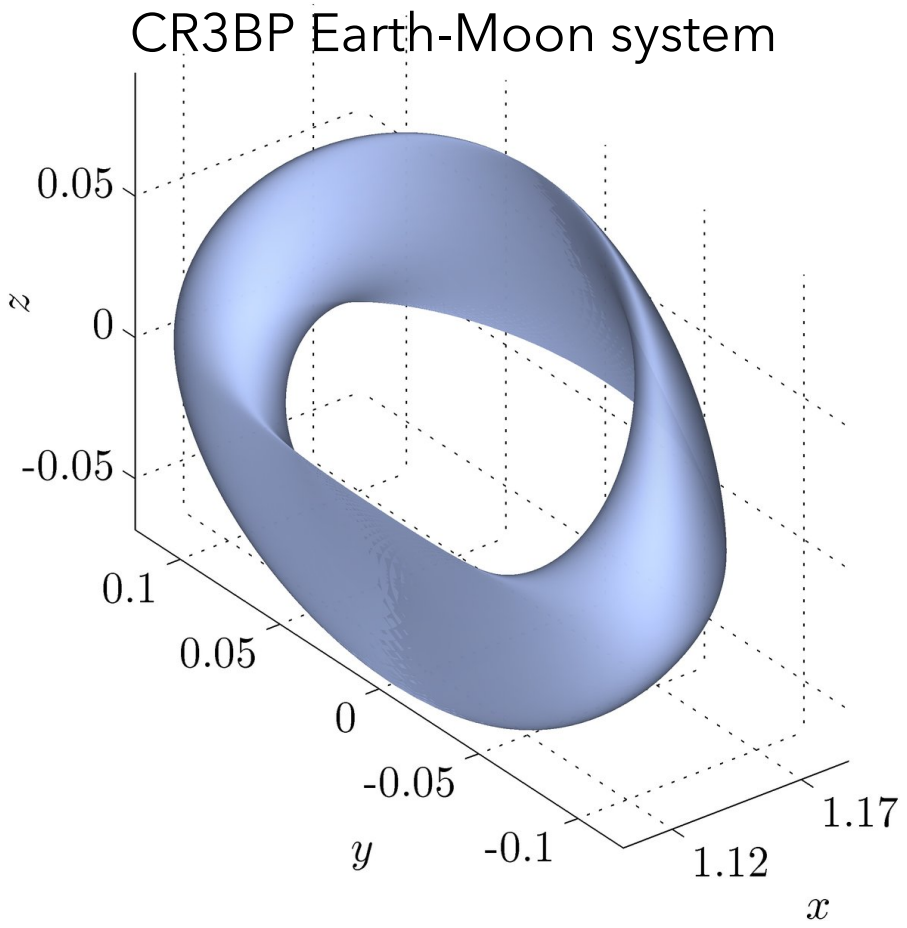

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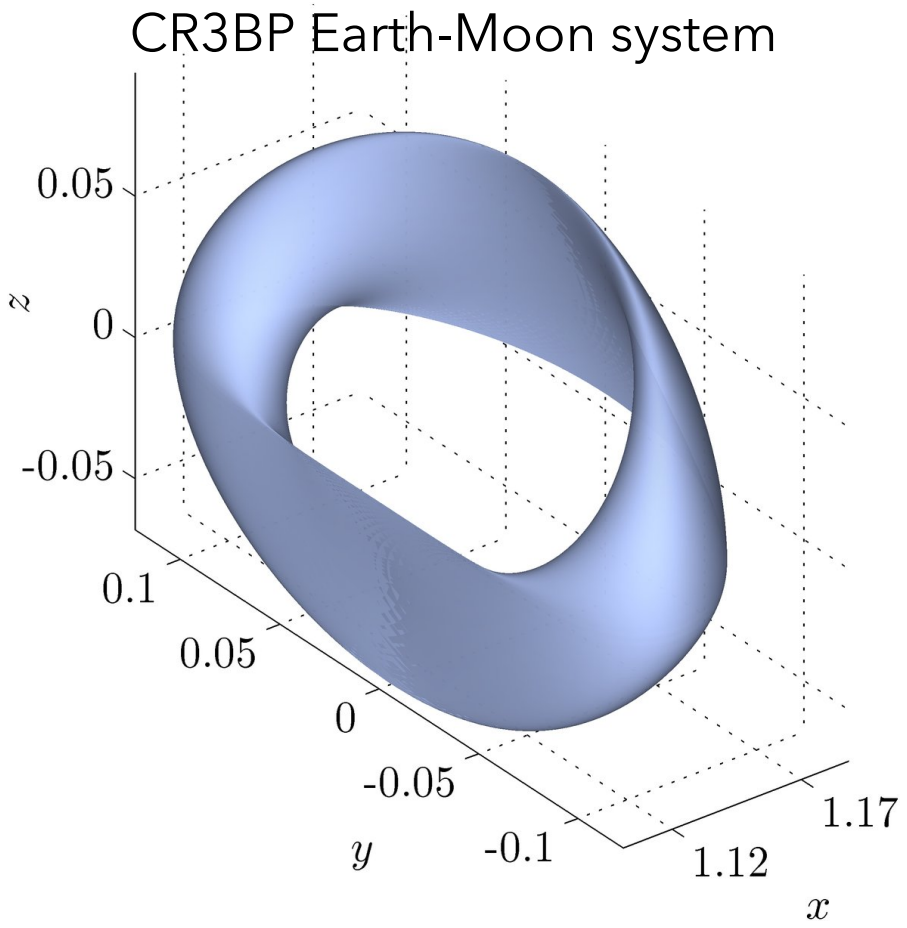

Invariant manifold tools

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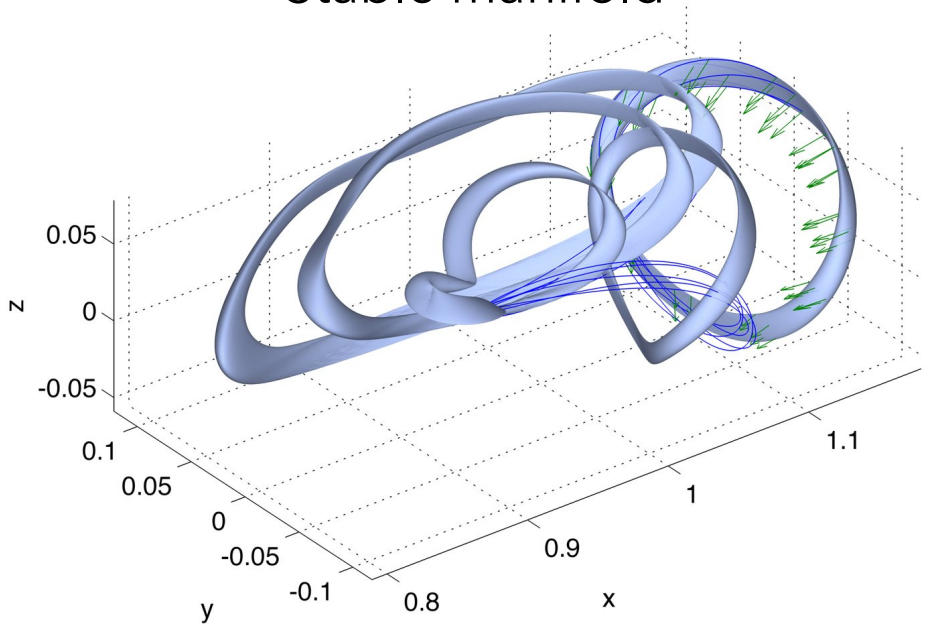
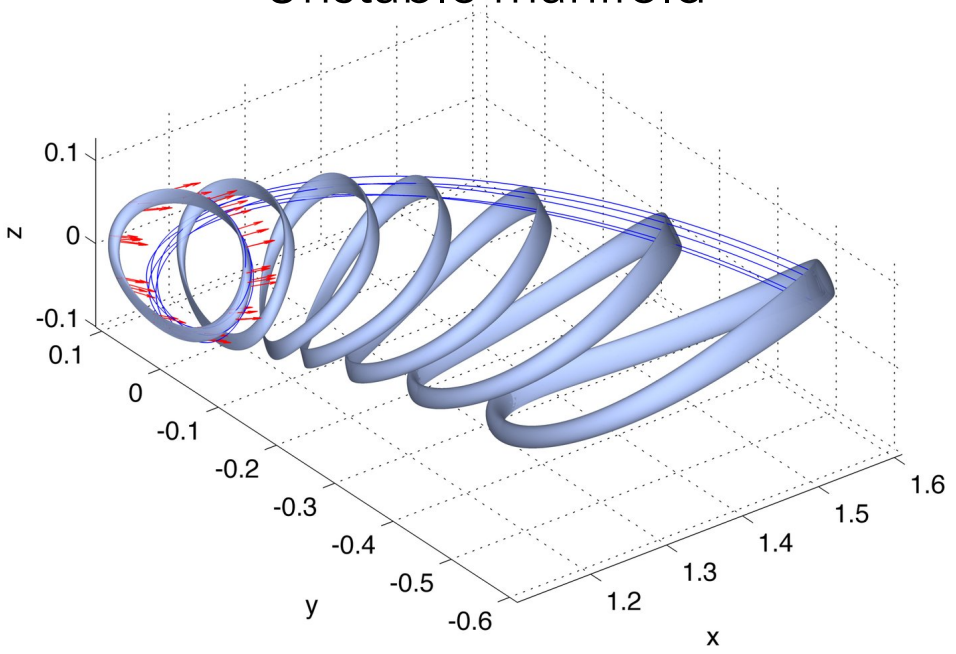
CR3BP Earth-Moon system

Stable manifold

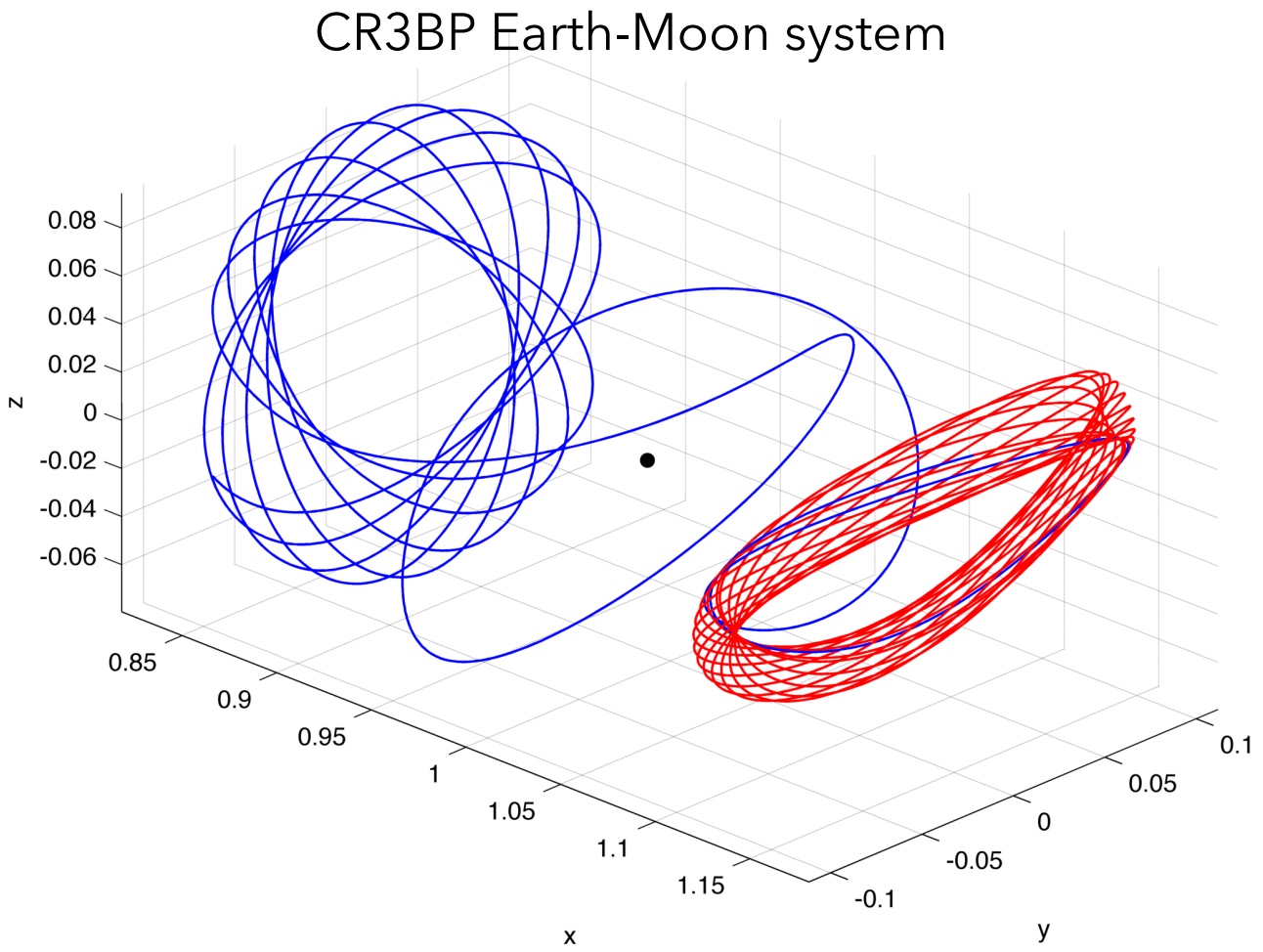


Unstable manifold



Invariant manifold tools

- Locating connecting orbits between quasi-periodic solutions



Application: Motion near binary asteroid

- ESA interest in binary asteroid mission:
  e.g., MarcoPolo-R sample return proposal
- Study dynamics in vicinity of binary asteroids by finding invariant solutions

(Antiope asteroid illustration, source: ESO)

Application: End-of-life mission design

- Invariant manifolds show set of natural outcomes for spacecraft in libration point orbit
- Use as framework for designing end-of-life trajectories; potentially incorporate control such as solar sail