Constructing a Low Energy Transfer Between Jovian Moons

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There has recently been considerable interest in sending a spacecraft to orbit Europa, the smallest of the four Galilean moons of Jupiter. The trajectory design involved in effecting a capture by Europa presents formidable challenges to traditional conic analysis since the regimes of motion involved depend heavily on three-body dynamics. New three-body perspectives are required to design successful and effcient missions which take full advantage of the natural dynamics. Not only does a three-body approach provide low-fuel trajectories, but it also increases the flexibility and versatility of missions.We apply this approach to design a new mission concept wherein a spacecraft "leap-frogs" between moons, orbiting each for a desired duration in a temporary capture orbit. We call this concept the "Petit Grand Tour."

For this application, we apply dynamical systems techniques developed in a previous paper to design a Europa capture orbit. We show how it is possible, using a gravitional boost from Ganymede, to go from a jovicentric orbit beyond the orbit of Ganymede to a ballistic capture orbit around Europa. The main new technical result is the employment of dynamical channels in the phase space tubes in the energy surface which naturally link the vicinity of Ganymede to the vicinity of Europa. The transfer $\triangle V$ necessary to jump from one moon to another is less than half that required by a standard Hohmann transfer.