3-Body Problem
Lagrangian points

- An analytic solution to the 3-body problem is possible for a specific case: with two co-orbiting bodies with nearly circular orbits and a third body with nearly the same revolution period $P$ as the other two.
- There are five points at which the third body can be placed and it will remain fixed relative to the other two bodies. Only L4 and L5 are stable.
L1 and Hill sphere

- The distance from the planet (or secondary) to the L1 defines the maximum size of a secondary's (i.e., a satellite's) orbit.
- It can be approximately determined \((M2 << M1, rh << a)\) by the Hill radius.
Trojan asteroids

- Two groups of asteroids, occupying the L₄ and L₅ points of Jupiter.
- Trojans may drift well away from the Lagrangian points, but tend to librate about the L₄ and L₅
- How did they get there?
Horseshoe orbits

- Two small moons of Saturn, Janus and Epimetheus, only separated by about 50 km.
- As inner (faster moving) moon catches up with slower moon, it is given a gravitational kick into a higher orbit.
- It then moves more slowly and lags behind the other moon. (see movie link from wiki page)
Coorbital (aka Trojan) Companions

Objects with coorbitals at L4 & L5

- Jupiter
- Neptune
- Mars
- Earth
- Saturnian Satellites
  - Tethys
  - Dione
  - Janus-Epimetheus
- Extrasolar Planets?
- The early Moon? Pluto's Moons?

- The formation and evolution of these secondaries must have also involved the creation and/or survival of coorbitals.
- Coorbitals are 'fragile'; they can be easily dislodged.
- Coorbitals constrain evolution!
- Coorbitals help us understand the late evolution of planets and satellites.