Tides beyond the Earth-Moon system

- Tides in the solar system
  - Jupiter’s Moon Io
  - The case of comet Shoemaker Levy 9

- Tides in the Universe
  - Galaxy collisions

I : Io

- Io is a satellite of Jupiter
  - Closest of the 4 Galilean satellites
  - Orbits Jupiter with period of 1.77 days
  - Tidal forces have locked it into synchronous rotation with its orbit

- Here’s where life gets interesting...
  - Perturbations from Europa and Ganymede for Io’s orbit to be slightly elliptical...
  - So tidal forces slightly change over the course of the orbit
  - The varying flexing/squeezing of Io causes its interior to be heated... drives powerful volcanic action
II : Comet Shoemaker-Levy 9

- Discovered by Eugene/Carolyn Shoemaker and David Levy on 24th March 1993
- Unusual comet – a whole string of nuclei
Why a string of nuclei?

- Computations of the orbit show that...
  - SL9 came very close to Jupiter in 1992
  - Close enough for tidal forces to completely rip it to bits
  - SL9 would hit Jupiter in 1994
- First ever time that modern scientists could study comet-planet collision
III : Collisions of galaxies

- Galaxy collisions are curious...
  - Galaxies have A LOT of empty space
  - Very unlikely that even a single pair of stars will directly impact each other
  - But galaxies can still rip each other apart via the tidal forces...