Topics

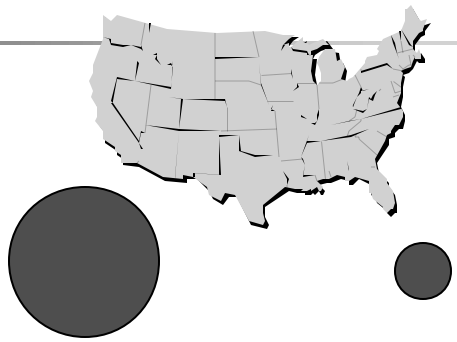
- **today Pluto, comets**
- **Course grades posted on web site**
- **Final exams:**
  - Sec 1 (Dec 11), Sec 2 (Dec 14); both 8AM
  - Review Monday Dec 10, 5-6PM, this room
  - 100 questions, worth 200 points
  - 50% review, 50% last quarter of course

Collisions and Jovian Planets

- **Uranus**
  - rotation axis tilted 98 degrees to orbit
  - due to collision with large body??
  - (5x Earth's mass needed)
- **Neptune**
  - 1 moon in backwards orbit, another with decaying orbit

Pluto and Charon

- **tiny size**
  - 1/5 of Earth's moon's mass
  - Diameter 1400 mi (fit in US)
- **Separation: a bit larger than the Earth**
- **Density: roughly 2x water**
  - so, mostly water ice and rocks



Pluto and Charon

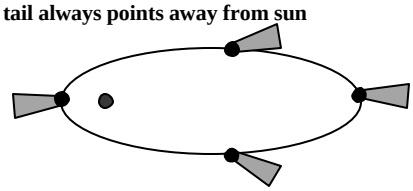
- **8 moons of Jovian planets are larger**
- **orbit is tilted and eccentric**
  - crosses orbit of Neptune
  - only planet out of the ecliptic's plane
- **two possibilities for origin:**
  - escaped moon of Neptune or Uranus
  - or largest comet in solar system
- **but not one of the major planets of the solar system**

Comets - when close to sun

- **Nucleus**
  - "dirty iceberg" roughly 5 miles wide
  - composed of ices mixed with rocks
- **Coma**
  - 100,000 mi wide cloud of dust and vaporized ices melted by heat of sun

Tail

- **gas and dust from coma pushed away from sun by solar wind**
- **produces tail 10 to 100 million miles long**
- **tail always points away from sun**



Oort cloud - Comets far from the sun

- **tens of millions of comets, roughly 50,000 AU from sun**
  - 1/8 distance to nearest star
- **total mass 1000 Earth's**
  - 3x more than Jupiter
- **comets spend most of their time here, as inert, frozen icebergs**
  - most comets have periods of roughly one million years
  - short period comets (like Halley) had orbits changed by near-misses with Jovian planets

Formation of Oort Cloud

- **planetesimals formed near orbits of Jovian planets were mostly water ice**
- **many planetesimals swept up into planets**
  - some of our water came from here
- **more than half ejected from inner solar system by near misses with Jovian planets**
  - now far from sun