Introductory Astronomy

Week 3: Solar System(s)

Clip 9: Giant Planets

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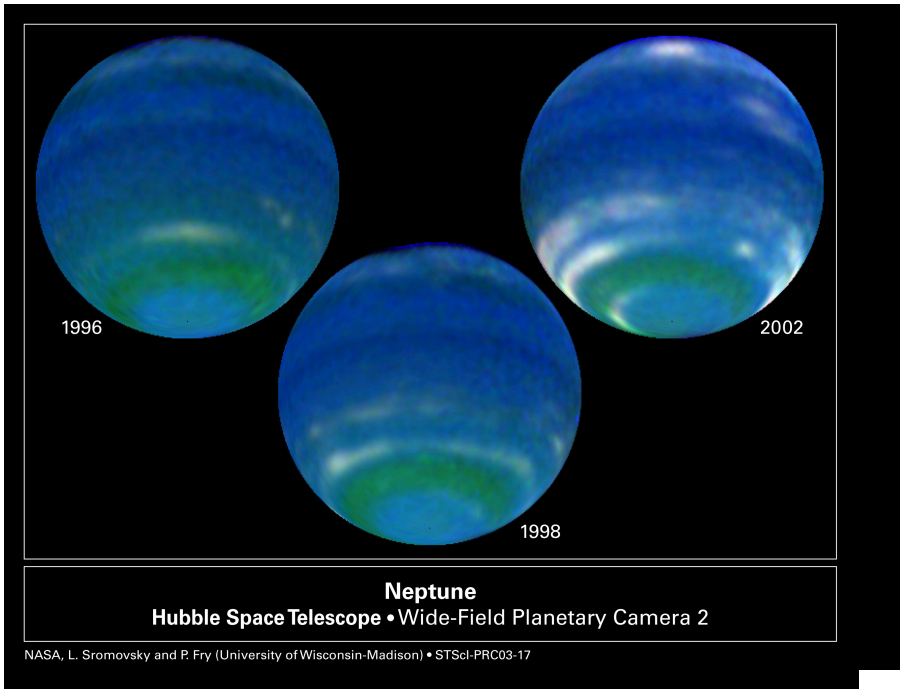
Spin and Orbit

- Jupiter: 11.9y orbit inclined 1.3°; 9.9h differential spin inclined 3.1°
- Saturn: 29.5y orbit inclined 2.5°; 10.6h differential spin inclined 26.7°
- Uranus: 84.3y orbit inclined 0.8°; 17.2h spin tilted 97.8°
- Neptune: 164.8y orbit inclined 1.8°; 16.1h spin tilted 28.3°

Surface - Atmosphere

- H_2 He atmosphere is all we see
- Uranus, Neptune blue due to trace methane
- Heating from interior drives convection
- Rapid rotation creates global winds with storms at boundaries



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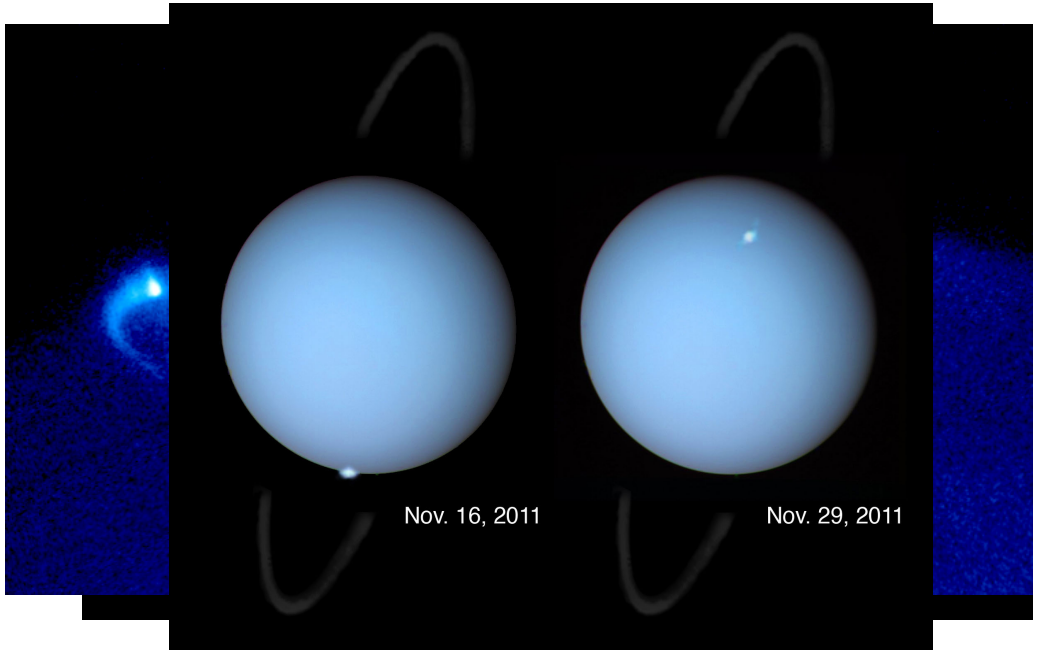
Inside

- Compressed-Earth-like core conjectured from oblateness
- Metallic H mantle – strong magnetic dipole
- Ice mantle – magnetic field tilted offset
- Internal heat from Kelvin-Helmholtz significant



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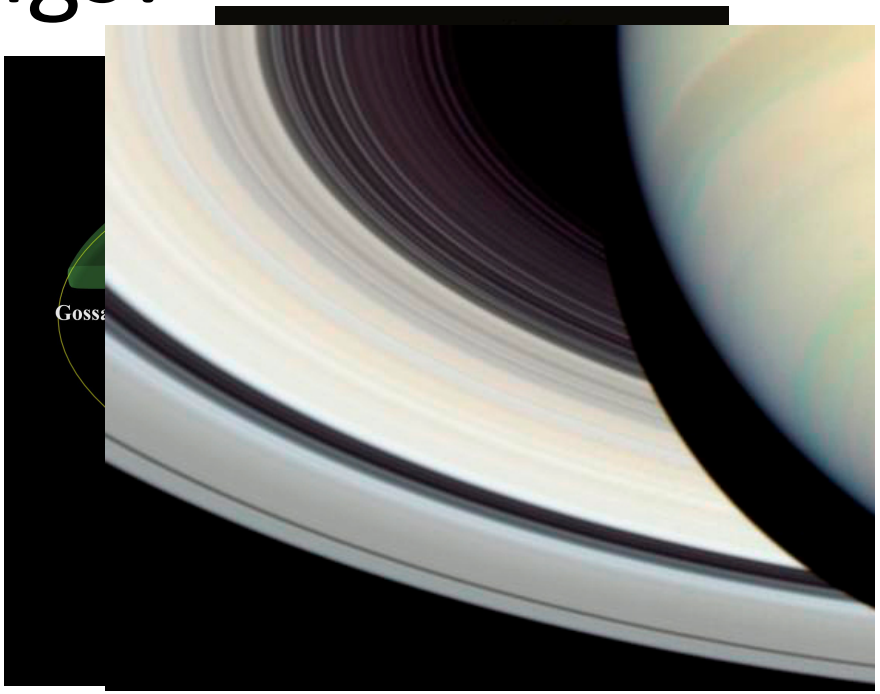
Rings!

- Jovian planets form by gravitational instability in nebula and collapse to accretion disk
- Near planet, tidal forces prevent gravitational accretion of light matter leaving ring structures
- Saturn's rings brilliant made of ice



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Roche (1848) Limit

- Roche Limit

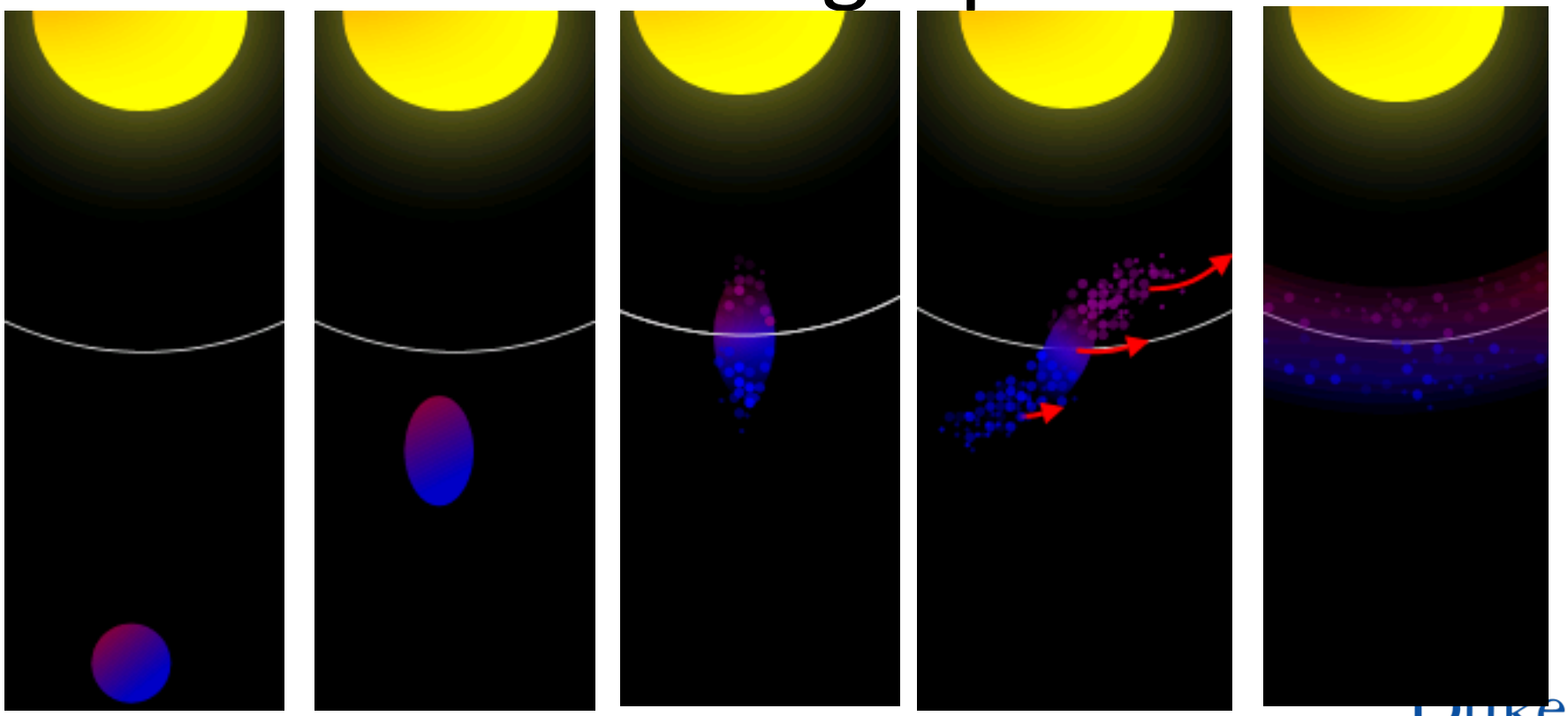
$$\frac{GM_m}{R_m^2} = \frac{2GM_pR_m}{D^3}$$

$$\frac{M_m}{R_m^3} = 2\frac{M_p}{R_p^3}\left(\frac{R_p}{D}\right)^3$$

$$D = R_p\left(\frac{2\rho_p}{\rho_m}\right)^{1/3}$$

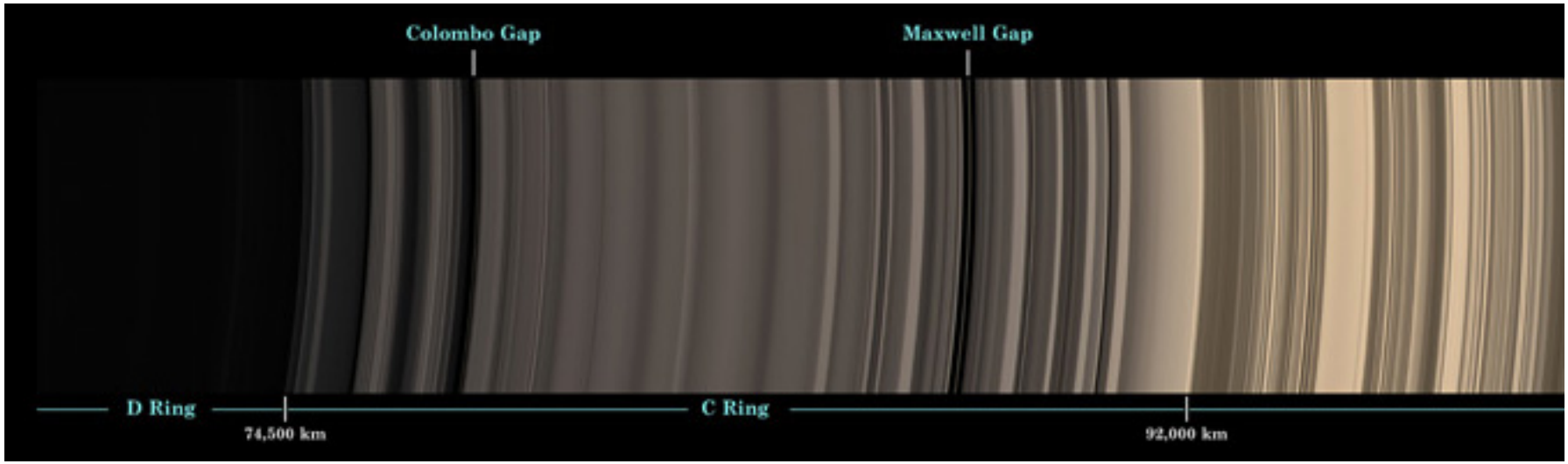
- Rings exist inside Roche Limit
- Small objects held together by chemical forces
- Gravitationally bound objects dispersed over time

Breaking Up



Ring Stability

- Shepherd Moons maintain gaps at resonant orbits
- Moons inside Roche Limit provide ring material



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Credits

- Jupiter Globe: NASA/JPL/University of Arizona http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=9523
- Saturn HST: NASA/JPL/STSI http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=7903
- Uranus HST: NASA/Space Telescope Science Institute http://solarsystem.nasa.gov/multimedia/display.cfm?IM_ID=10191
- Neptune HST: NASA Planetary Photojournal http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=2117
- Jovian Interiors: Lunar and Planetary Institute http://solarsystem.nasa.gov/multimedia/display.cfm?IM_ID=166
- Jupiter Aurora: John T. Clarke (U. Michigan), ESA, NASA http://apod.nasa.gov/apod/ap001219.html
- Saturn Aurora: NASA/Hubble/Z. Levay and J. Clarke http://solarsystem.nasa.gov/multimedia/display.cfm?Category=Planets&IM_ID=3723
- Uranus Aurora: NASA, ESA, and L. Lamy (Observatory of Paris, CNRS, CNES) http://www.nasa.gov/mission_pages/hubble/science/uranus-aurora.html
- Jupiter Rings: NASA/JPL/Cornell University http://photojournal.jpl.nasa.gov/catalog/PIA01627
- Uranus Rings: NASA, Erich Karkoschka, University of Arizona http://hubblesite.org/gallery/album/solar_system/pr2004005a/
- Saturn Rings: NASA, ESA, E. Karkoschka (University of Arizona) http://hubblesite.org/gallery/album/solar_system/pr2004018b/
- Saturn Ring Mosaic: NASA/JPL/Space Science Institute http://photojournal.jpl.nasa.gov/catalog/PIA08389

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