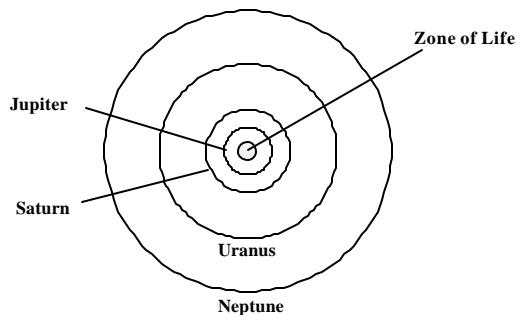


Topics

- ◆ today formation of Jovian planets
- ◆ next time, moons of Jovian planets
- ◆ 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

Orbits of the Jovian Planets



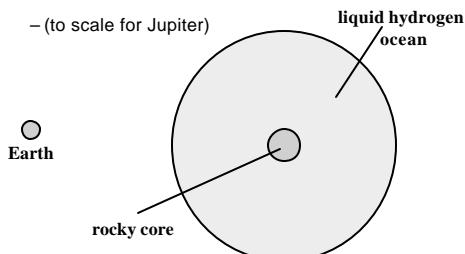
The most abundant elements & molecules

- ◆ The most abundant elements in the cosmos
 - Hydrogen - 90%
 - Helium 9.9%
 - Oxygen, Carbon, Nitrogen, less than 0.1%
- ◆ The most abundant molecules made from these elements
 - H_2 hydrogen
 - H_2O water
 - CH_4 methane
 - NH_3 ammonia

Atmospheres of Jovian Planets

- ◆ atmosphere
 - mostly hydrogen and helium (like sun)
 - some methane, ammonia, water
 - atmosphere roughly 500 miles thick
 - clouds less colorful for more distant planets
 - » too cold to form colorful molecules
- ◆ “surface”
 - completely covered by clouds
 - ocean mostly liquid hydrogen

Interiors of Jovian Planets



Jupiter's Interior

- ◆ most of Jupiter is 40,000 mile deep ocean of liquid hydrogen
 - liquid due to high pressure
 - hot too - surface of ocean at 4000F
- ◆ “core” is solid ice, rock, iron, nickel
 - 30x Earth's mass, twice Earth's radius
 - pressure 1 billion pounds per square inch
 - temperature 50,000F

Formation of Jovian Planets

- ◆ **Step 1**

- accretion of planetesimals to form large Earth-like planets
- solid, mostly rocks, iron, nickel

- ◆ **Mass of Rocky Cores**

- | | |
|-----------|-----------|
| – Jupiter | 28xEarth |
| – Saturn | 17xEarth |
| – Uranus | 4.3xEarth |
| – Neptune | 3.5xEarth |

Step 2

- ◆ accretion of massive primitive atmosphere from solar nebula
- ◆ mostly hydrogen and helium, some water, methane, ammonia
- ◆ accretion process sped up as mass and gravity built up
- ◆ today 75% to 95% of mass came from primitive atmosphere

Step 3

- ◆ proto-planet accretes large quantities of solar nebula
- ◆ small-scale “solar nebula” disk forms surrounding proto-planet
- ◆ moons form here

All Jovian planets have . . .

- ◆ Lots of moons
- ◆ Rings
- ◆ Large body of liquid hydrogen
- ◆ Small rocky terrestrial planet at center