21. Giant Planets
Two Types of Giant Planets

“Gas Giants”

- **Jupiter**
  - Distance from Sun: 5.20 AU
  - Mass: 318 $M_{\text{Earth}}$
  - Density: 1.33 g/cm$^3$
  - Composition: mostly H, He

- **Saturn**
  - Distance from Sun: 9.54 AU
  - Mass: 95 $M_{\text{Earth}}$
  - Density: 0.71 g/cm$^3$
  - Composition: mostly H, He

“Ice Worlds”

- **Uranus**
  - Distance from Sun: 19.2 AU
  - Mass: 14 $M_{\text{Earth}}$
  - Density: 1.24 g/cm$^3$
  - Composition: H compounds, rock, H and He

- **Neptune**
  - Distance from Sun: 30.1 AU
  - Mass: 17 $M_{\text{Earth}}$
  - Density: 1.67 g/cm$^3$
  - Composition: H compounds, rock, H and He
Internal Structure: Heat Sources

J. & S. put out *lots* of heat — *not* due to radioactivity since H and He isotopes are *stable*.

— Jupiter: left-over heat.
— Saturn: + He settling.

U. puts out *very little* heat —
— bottled up in interior?

N. puts out more heat —
— deeper convection.
Internal Structure: Magnetic Fields

J. & S. have strong fields which are well-aligned with rotation.
— convection in metallic H!

U. & N. have weaker fields which are highly mis-aligned.
— local dynamo in “ocean”?
Internal Structure: Magnetic Fields
Atmosphere & Clouds

View of JUPITER from EARTH
2010 FEB 15 00:00:00 UTC
1.2° field of view

Solar System Simulator v4.0

JUPITER
891,840 mil km
33.1° arc
2.0° phase

12 hours on Jupiter
Cloud Colors

cold enough for ammonia to condense to form clouds

cold enough for ammonium hydrosulfide to condense to form clouds

cold enough for water to condense to form clouds

NH₃

NH₄SH

H₂O
Belts & Zones

Convection and rapid rotation organize atmospheric motion.

Shallow convection model:

Belts: *sinking* gas exposes red NH$_4$SH clouds; circulate *faster*.

Zones: *rising* gas forms white NH$_3$ clouds; circulate *slower*. 
Equatorial zone’s motion contradicts shallow model.
Great Red Spot: an Anti-cyclone
Bands like Jupiter’s, but less dramatic since atmosphere is deeper due to weaker gravity.
Uranus & Neptune

Atmospheres are deep, methane-rich, and very cold.

- Cloud layers often too deep to be easily seen.
- Methane (CH₄) absorbs red light, transmits blue.

— blue planets with subtle cloud features.
Surface Appearance: Uranus & Neptune

Great Dark Spot