First, what’s really different about Jupiter and the Sun?

Second, well talk about gravity

Next (fun part) we’ll explore Jupiter!
Mean Distances Of The Terrestrial Planets From The Sun

(Orbits drawn approximately to scale)

Jupiter
(Shown for Scale)

Motion Viewed from North

Sun

Mercury

Venus

Earth

Mars

Light Minutes  |  Astronomical Units

43  13  8.3  3.2  0  0.39  1.01  1.5  5.2
Mean Distances Of The Jovian Planets From The sun
(Orbits drawn approximately to scale. Pluto omitted to accommodate scale)
Galileo Mission
Galileo Spacecraft spins 3 rpm
Jupiter is a giant ball of hydrogen gas. Only outermost layers were probed.
Probe Entered Downdraft Region Between Clouds
**Probe Results**

- Probe measured temperature, pressure, wind speed and chemical composition as it descended ~ 100km.
- Probe detected
  - Only tenuous clouds
  - Very dry air
  - Strong winds >600 km/hr
- Chemical composition consistent with solar abundance + cometary material
• White = ammonia clouds
• Orange = sulfur-colored ammonia
• Small scale turbulence generated by wind shears coalesce to form large scale vortices.
• Storms such as the Great Red Spot and white ovals last for decades to centuries.
Wind Shear and Eddies
Eddies Merging

Two white ovals formed in 1930s

Two Merged to one oval 60+ years later

Feb. 1997

Sep. 1998
Jupiter’s Ring

- Faint, tenuous rings of small particles chipped off small inner moons.
- Orbits shaped by satellites, evolve rapidly.
The Galilean Satellites
The Largest Moons and Smallest Planets

Ganymede: 5262 km
Titan: 5150 km
Mercury: 4880 km
Callisto: 4806 km

Io: 3642 km
Moon: 3476 km
Europa: 3138 km
Triton: 2706 km
Pluto: 2300 km
Titania: 1580 km
Galilean Satellite Geology
Zooming in on Callisto’s Craters
Chain of craters on Callisto

Caused by broken up comets - such as Comet Shoemaker-Levy 9
Ganymede’s Varied Geology

Bright Terrain
Fewer craters
Younger
Grooved & folded

Dark Terrain
Many craters
Older
Grooves caused by expansion of Ganymede’s crust
Callisto and Ganymede

- Heating of Ganymede led to separation of dense iron core, surrounded by rock with thick layer of ice on top.
- Dark dust has accumulated on older surfaces of Callisto and Ganymede, burying small craters.
- Callisto suffered little heating and remains a mixture of ice and rock.
Europa
Dark Material Seeping
Through Cracks
Ridges, Spots & Smooth Icy Plains
California

San Andreas Fault

Europa

Astypalaea Linea
Zooming in on Cracks and Flows

Ice - sometimes it suddenly cracks, sometimes it slowly flows
Europa’s young surface shows few craters.

Did this impactor crash right through the ice?
High resolution images show ice "rafts" - indication of thin ice crust, liquid ocean below?
The interior is mostly rock covered by a ~150 km layer of water. A brittle crust (1-10 km thick) has been disrupted in the past 10 million years by underlying fluid motions. Does Europa have a liquid ocean? Could such ocean contain life? Or, is the water layer frozen, moving slowly, like a glacier?
Io
3.57 g/cc

Ganymede
1.94 g/cc

Europa
2.97 g/cc

Callisto
1.86 g/cc
Tidal Heating

Laplace orbital Resonance

Tidal forces increase strongly closer to Jupiter

- Heat the interior
- Remove water
- Drive volcanic activity
Io

Amirani

300 km
After quantities of lava are removed from below, the crust cracks and tilts, making tall, blocky mountains.

Hiiaka Patera

11 km high
Nightside of Io - Visible

Glowing Lava

Plume Gas & Dust + Airglow
Io Plasma Torus (Schneider & Trauger)
Cassini UltraViolet Imaging Spectrometer
Larry Esposito, University of Colorado

- UV images of the toroidal cloud of ions at Io’s orbit,
- The \( S^+ \) and \( O^+ \) ions are trapped by Jupiter’s magnetic field.
- Jupiter is dark at UV wavelengths.

QuickTime™ and a GIF decompressor are needed to see this picture.
**Jovian Aurora**

- Radio to X-rays
- Power into polar atmosphere > solar flux

1. Main oval linked to middle magnetosphere
2. Polar storms
3. Satellite footprints
Clarke et al.

- Main Oval
- Polar storms
- Dusk Distortion?
- Io wake
- Io footprint
- NP
- 220°_III
- 140°_III
- 180°_III
Galileo: The End Game

• Must never hit Earth or Europa

• 3 passes close to Io—to determine if Io has a magnetic field

• Hits Jupiter October 2003
Cassini Spacecraft

4m High-Gain Antenna

11m Magnetometer Boom

Radio/Plasma Wave Subsystem Antenna (1 of 3)

Remote Sensing Pallet

Radar Bay

Fields and Particles Pallet

Huygens Titan Probe

Radioisotope Thermoelectric Generator (1 of 3)

445 N Engine (1 of 2)
Cassini Flyby of Jupiter

QuickTime™ and a GIF decompressor are needed to see this picture.
2004
Cassini
Reaches
Saturn