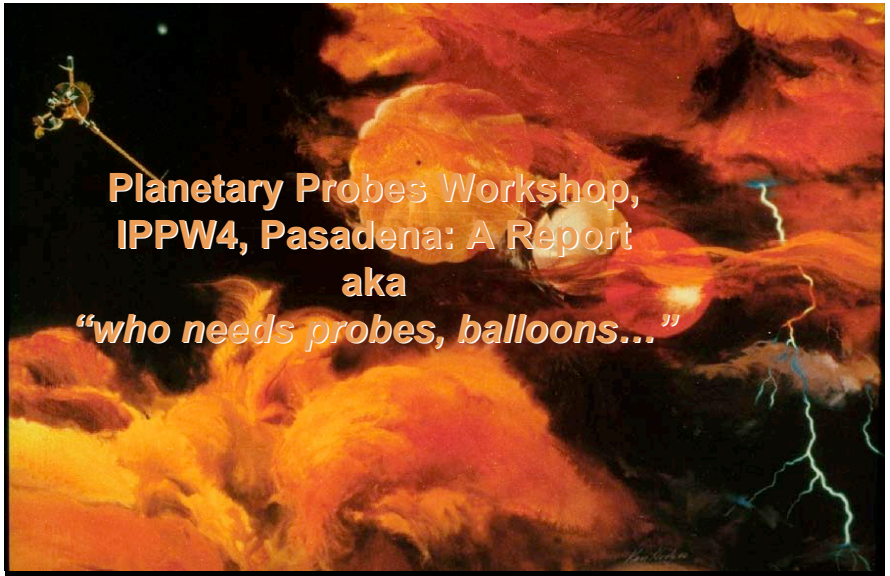
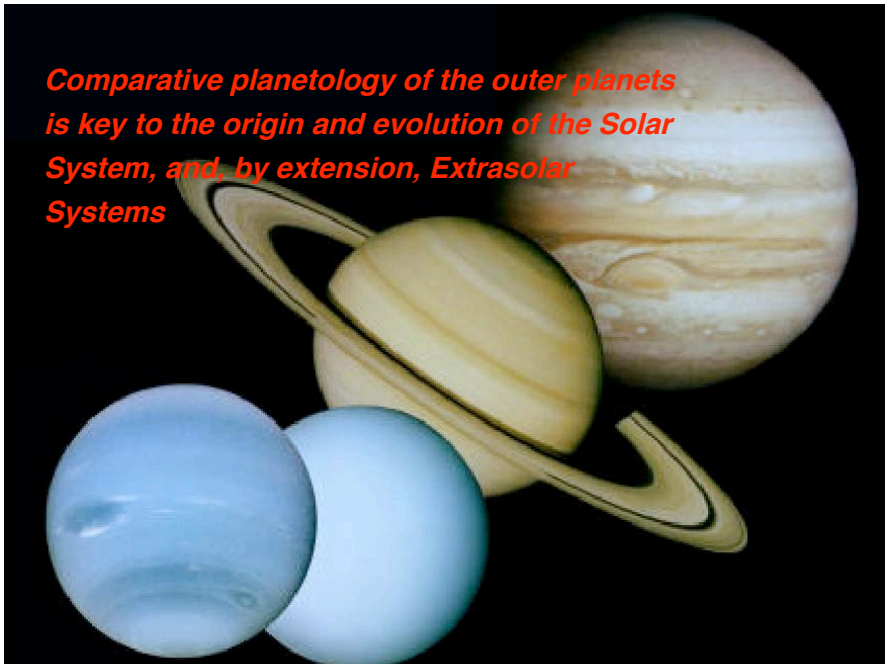


IPPW4, Pasadena, 27-30 June 2006
Organizers: Jim Cutts and Elizabeth Kolawa (co-chairs)
188 Participants (30 foreign). 42 students

Focus: Entry Descent and Flight in Planetary Atmospheres

Outer Planets: Science and Mission Concepts
Jonathan Lunine (Invited) *and the TiPEx Team*
Not Afraid to Ride the Wind: Titan by Balloon
Sushil Atreya (Invited) Saturn Probes: why, where, how?
Thomas Spilker (Invited) Mission Design Aspects of Planetary Entry Probe Missions
Tibor Balint *& Participants of the SSEP Study, JPL,*
On the Feasibility of a New Frontiers Class Saturn Probe Mission
David Atkinson Direct to Earth Communication

plus a dozen posters



Formation and Origin:
what must be known?

abundances of heavy elements* in *well-mixed* atmosphere, i.e.

Bulk Composition

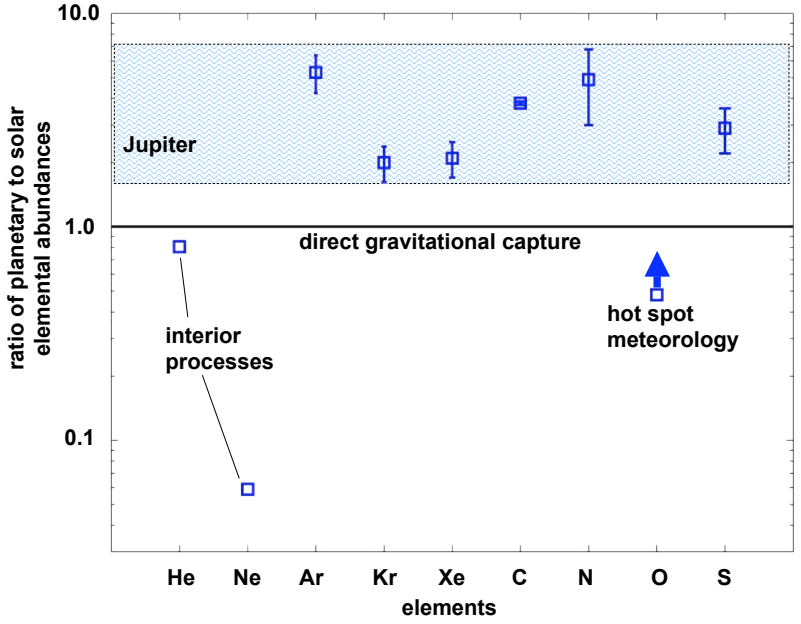
***m > ^{4}He**

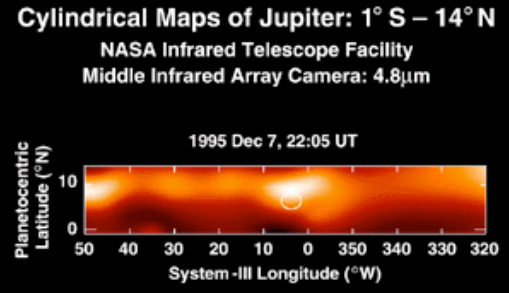
formation of Jupiter and origin of atmosphere

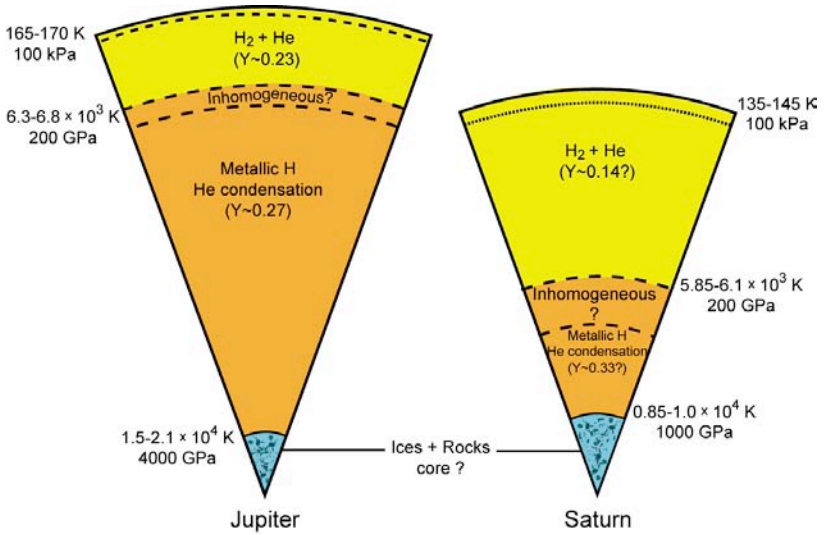
***gravitational instability: protoplanetary clumps**

*core accretion model

- core from grains of ice, rock, metal
- core grows to critical mass (~10 M_E)
- gravitational collapse: most volatile gases (H_2, He) captured
- atmosphere from H_2, He; and gases released from core
- planetesimals added throughout the formation (and afterward) to explain heavy element enrichment
  - cold icy planetesimals
  - clathrate hydrates, "cold", nevertheless







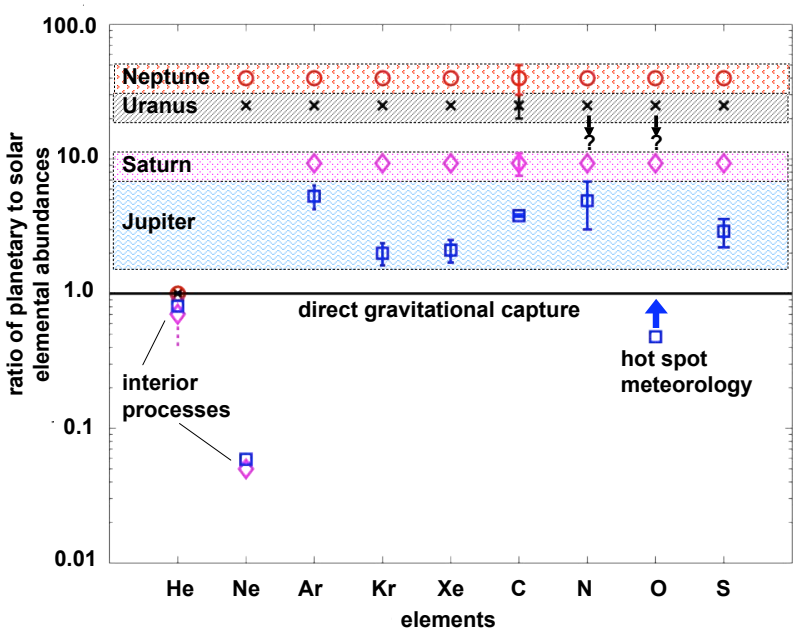
Cassini at Saturn

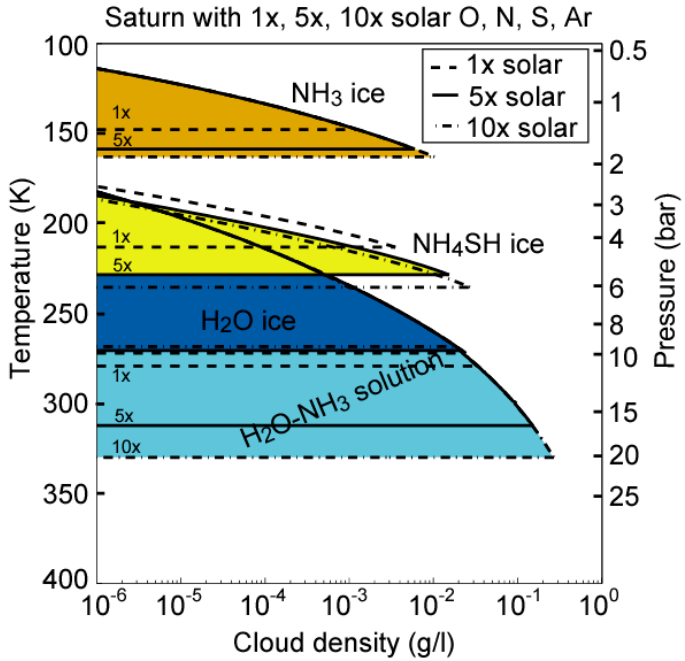
- atmos <1 bar; magnetosph. → exceptional!
- C/H = 9 x solar (from CH_4) measured by CIRS
- P/H = 5 - 10 x solar → *disequilibrium,* ISO/CIRS
- O, N, S, noble gases and their isotopes? *no*
- isotopes (D/H, $^3He/^4He$, $^{14}N/^{15}N$)? *no*
- deep winds, dynamics? *no*

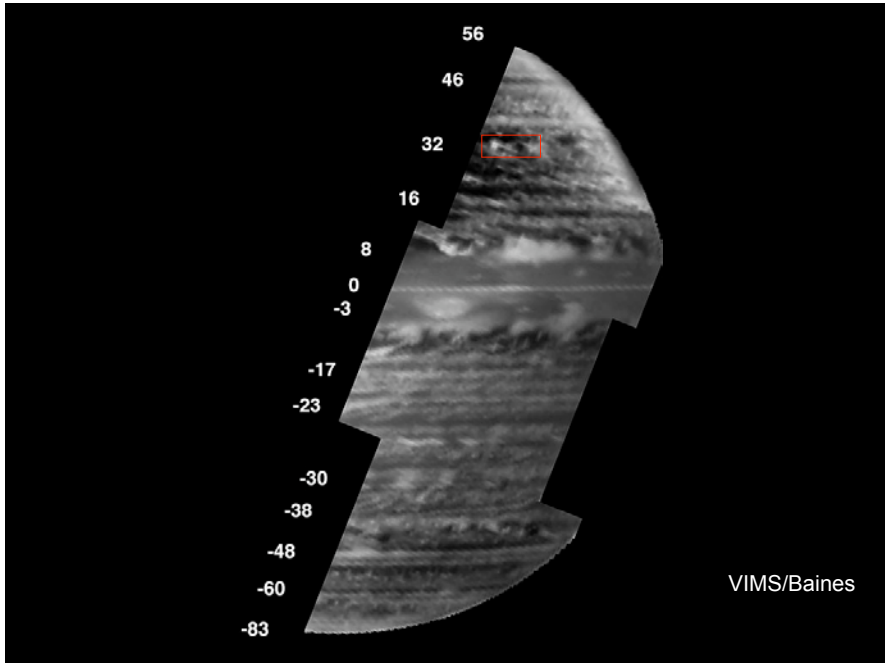
formation, and atmospheric origin:
what <u>must</u> be known?

heavy element* abundances in *well-mixed* atmosphere, i.e.
<u>bulk composition</u>

*** m/z > ^4He**







Saturn Probes

how deep → shallow or deep?

- probes only: deep (50 - 100 bar), or
- probes + microwave radiometry: shallow (~10 bar)

how many?

- 2 - 3, for diversity and risk mitigation

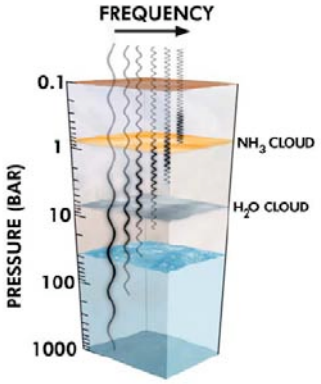
where?

- equatorial, mid- and/or high latitudes

Juno Microwave Radiometry

Radiometry sounds the deep atmosphere

Determines and *maps* the water and ammonia global abundances



Saturn Probes

critical measurements:

- composition of well-mixed atmosphere
  - C, O, N, S, noble gases and their isotopes
  - D/H, $^{3}He/^{4}He$, $^{14}N/^{15}N$ isotopes
  - GeH_4, SiH_4, AsH_3, PH_3, CO: internal process
- deep winds, dynamics
- core determination?

Saturn Probes

technology challenges

- tps (heat shield):
  left over from Galileo probe; enough for two probes?
- communication:
  direct-to-earth, or relay?
- power:
  solar arrays (battery assisted?), or rps/rtg?
- probe technology (light probes?)
- microwave radiometry (on flyby s/c or probes, e.g.)?

atmospheric modelling: MWR retrievals; communication…

→Study underway at JPL

Saturn Probes

flyby spacecraft, with

two shallow probes plus microwave radiometry

→ → →

NASA's New Frontiers program