Formation of the Giant Planets, and the Origin and Evolution of their Atmospheres: Multiple Probes to Multiple Planets

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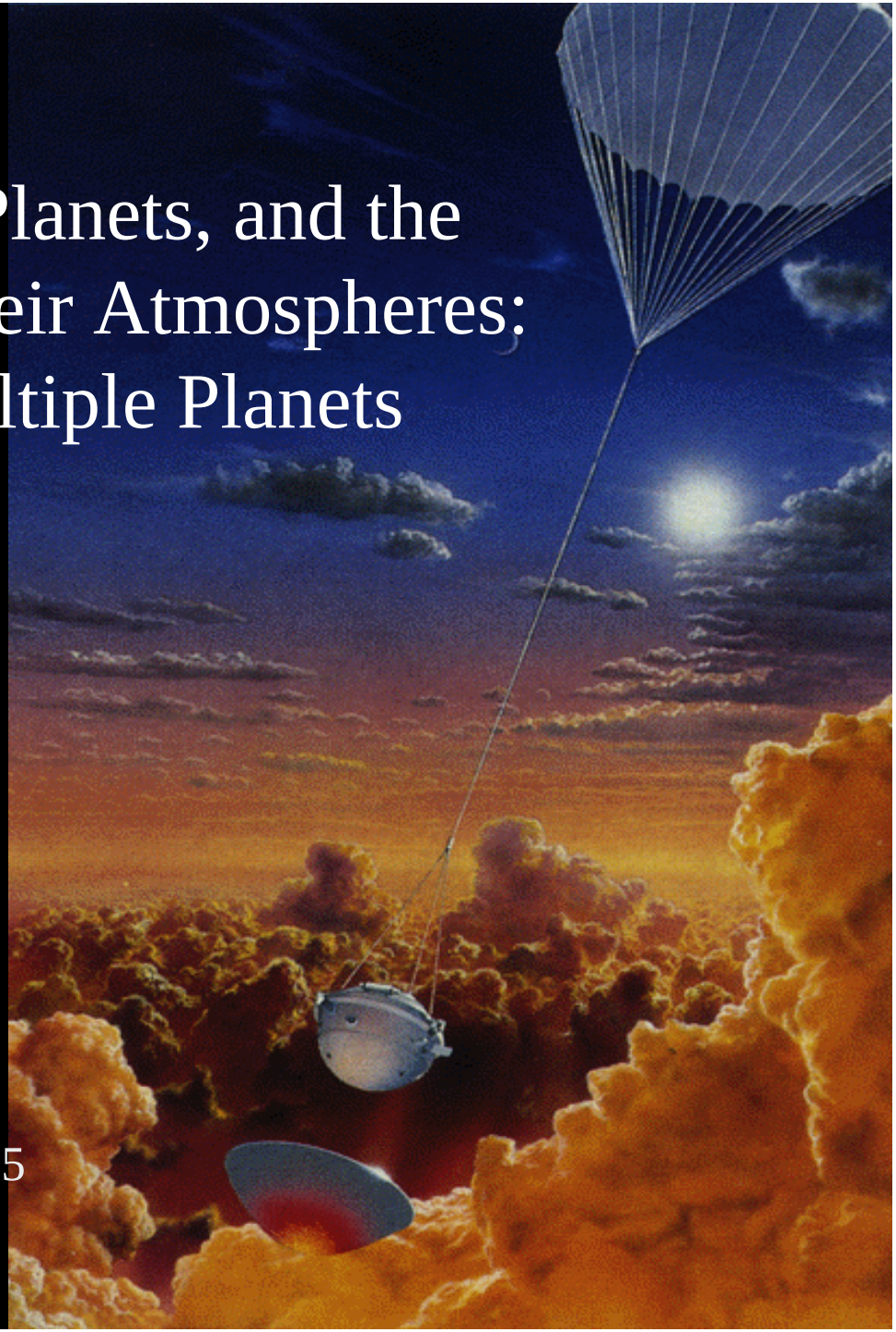


OPAG, Bethesda, MD, 11 February 2005


Comparative Planetology of deep well-mixed atmospheres
of the Outer Planets is Key to the Origin and Evolution of the
Solar System, and by extension, Extrasolar Systems

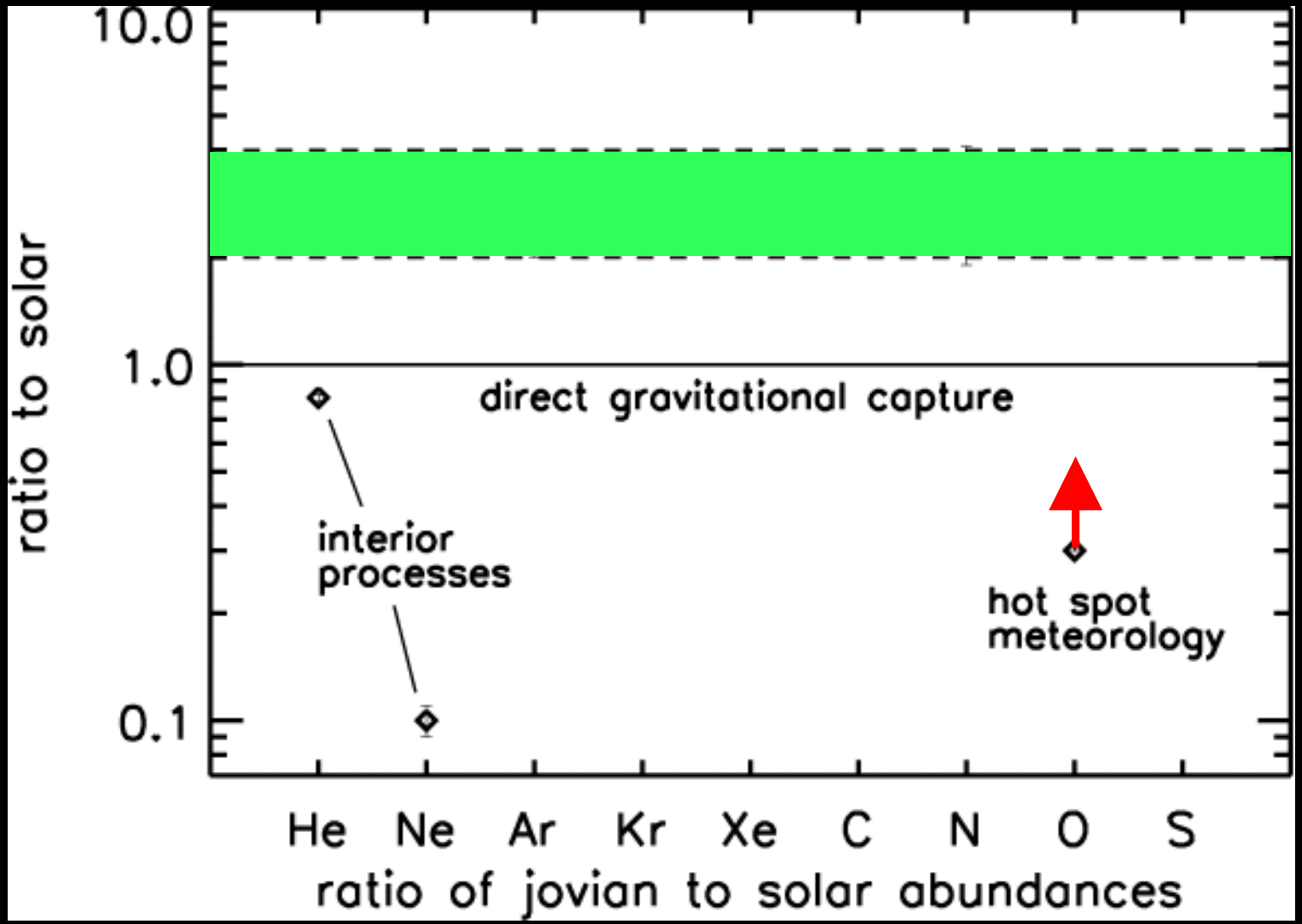
Formation and Origin: what must be known?

abundances of heavy elements in deep well-mixed atmosphere

Elemental abundances

Elements	Sun	Jupiter/Sun	Saturn/Sun	Uranus, Neptune /Sun
He/H	0.0975	0.807	0.56 – 0.85	0.92 – 1.0
Ne/H	1.23×10^{-4}	0.10	(?)	20 – 50 (?)
Ar/H	3.62×10^{-6}	2.5		20 – 50 (model)
Kr/H	1.61×10^{-9}	2.7		20 – 50 (model)
Xe/H	1.68×10^{-10}	2.6		20 – 50 (model)
C/H	3.62×10^{-4}	2.9	4 – 6	20 – 50
N/H	1.12×10^{-4}	3.0 (9-12 bar-hs)	2 – 4	20 – 50 (model)
O/H	8.51×10^{-4}	0.35↑ (19 bar-hs)		20 – 50 (model)
S/H	1.62×10^{-5}	2.75 (16 bar-hs)		20 – 50 (model)
P/H	3.73×10^{-7}	0.82	5 – 10	20 – 50 (model)

Elemental abundances at Jupiter
(Galileo Probe Mass Spectrometer, GPMS)



What is missing?

Water

abundance in deep well-mixed atmosphere

H_2O is presumably the original carrier of heavy elements to Jupiter

Multiple Probes to Multiple Planets, with Multinational Partners

- Primary measurements
  - Elemental composition of Jupiter, Saturn, Neptune, Uranus
    - Gas giants: C, N, S, O; He, Ne, Ar, Kr, Xe, isotopes; $^{15}N/^{14}N$
    - Icy giants: C, S; He, Ne, Ar, Kr, Xe, isotopes; $^{15}N/^{14}N$
    - Probe to 100 bars (J & S); 50 bars (U & N)

      Supporting/complementary measurements
      - Imaging, dynamics, magnetometry/plasma…..
- Orbital Tour Description (Delivery Truck,or **Assembly Line**)
  - Flyby dropping 2 probes each at Jupiter, Saturn, Neptune/Uranus
  - Orbit about final target, Neptune/Uranus
  - Identical Spacecrafts and Payload to Each Planet

Juno: microwave radiometry--guide to more ambitious (and expensive) probe missions.