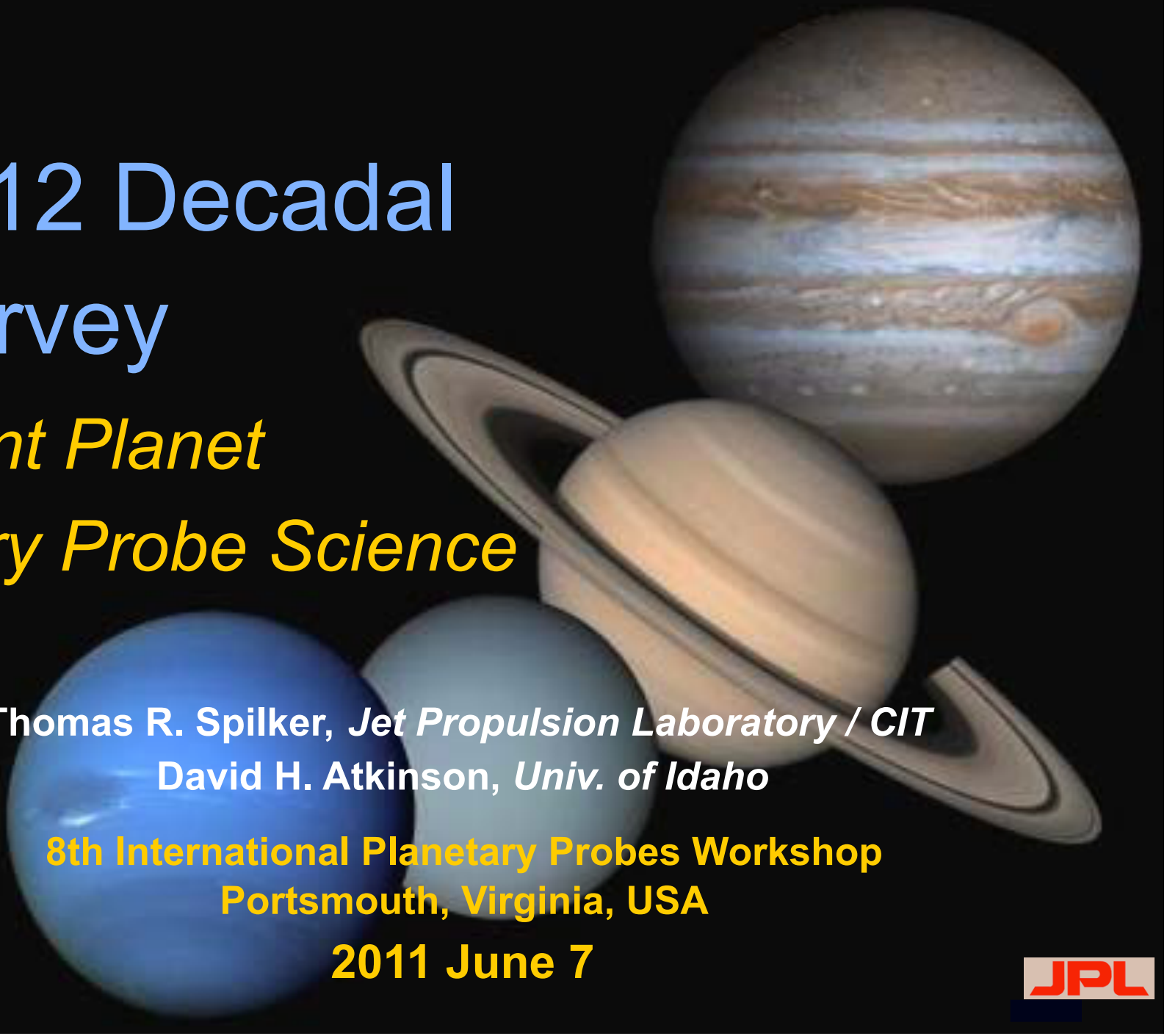
2012 Decadal Survey

Giant Planet Entry Probe Science



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8th International Planetary Probes Workshop
Portsmouth, Virginia, USA

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Organization

- What is the Planetary Science Decadal Survey (PSDS)?
- PSDS giant planet probes “white paper(s)”
- PSDS recommendations regarding giant planet probes
- PSDS Saturn probe science objectives
- PSDS Uranus probe science objectives
- PSDS Neptune probe science objectives
  - None specified!

2012 Planetary Science Decadal Survey

- Occurs *approximately* every decade
  - Previous Decadal Survey draft report released in mid-2002
  - Current draft report released March 7, 2011
- Mandated by US Congress
  - Conducted by the National Research Council's Space Studies Board
    - Survey team consists of a Steering Committee and five Topical Panels
  - NASA funds supporting mission concept studies
- Combination of backward- and forward-looking assessment
  - State of planetary science at the time of the survey
    - Progress toward the goals stated in the previous PSDS
  - Science and NASA mission priorities for the next decade
    - Also technologies and supporting research
  - "Mid-course correction" is generally encouraged, not just allowed

Giant Planet Entry Probes White Paper

http://sites.nationalacademies.org/SSB/SSB_059331

Entry Probe Missions to the Giant Planets

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White Paper Recommendations Concerning Giant Planet Entry Probes

- Saturn probe in NASA's New Frontiers Program
  - Highest priorities: *composition* and *thermal structure*
  - Shallow probe: penetration to the 5-10 bar level
  - Also discussed in J.J. Fortney white paper
- Ice giant (Uranus or Neptune) probe
- Probe to the *other* ice giant
- Single- or multi-probe return to Jupiter
  - After results obtained from Juno
- NASA adopt a "small flagship" mission class

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PSDS Draft Report
Saturn Entry Probe Science Objectives

- Tier 1 Objectives (measured to the 5-10 bar level)
  - Composition
    - Abundances of noble gases He, Ne, Ar, Kr, and Xe *(and their isotopes!)*
    - Isotopic ratios of H, C, N, and O
  - Atmospheric structure (T, P, and mass density vs. depth)

- Tier 2 Objectives
  - Vertical profile of zonal winds at the probe entry location
  - Location, density, and composition of clouds as a function of depth
  - Variability of atmospheric structure and clouds in two locations
    - Would require two probes
  - Vertical profile of water abundance at the probe entry location
  - Precision isotope measurements for light elements in simple molecules
    - Elements such as N, O, & S

Omits measurements of diagnostic species such as CO, PH_3, AsH_3, SiH_4, GeH_4

Saturn Entry Probe Science Objectives: What's the Big Picture?

- Composition Measurements
  - Clues to the composition of the presolar nebula
  - Giant planet and solar system formation processes and timeline
  - Critical component of understanding Saturn's thermal evolution (He), heat flow, and radiation balance
  - Search for chemical evidence of planetary migration
- Atmospheric Structure Measurements
  - Context for the composition measurements
  - Atmospheric heat flow and radiation balance
  - Energy source(s) for deep zonal winds
    - Depth of solar energy deposition
  - Static stability, propensity for convective mixing

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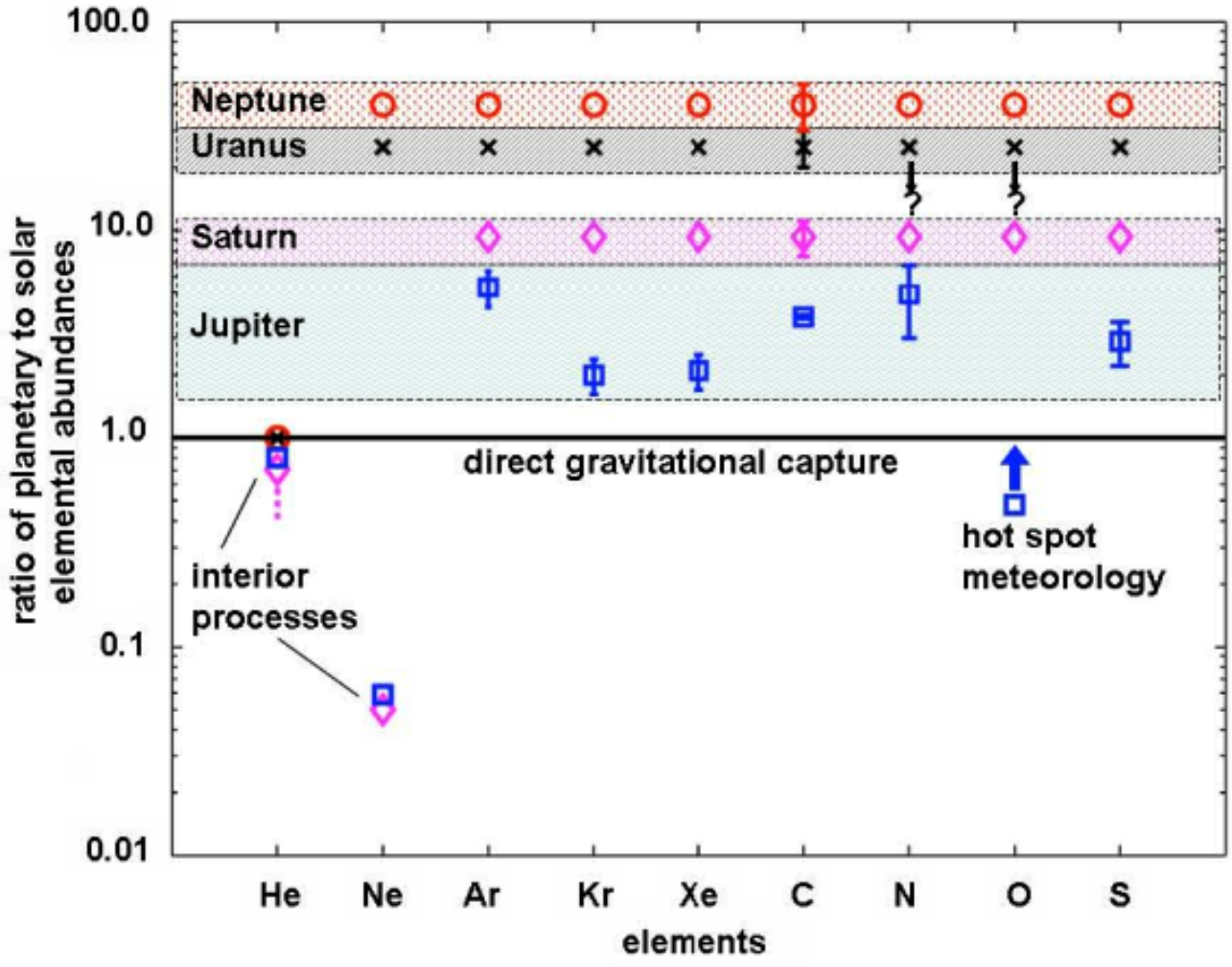

Atreya, 1999

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Saturn Entry Probe Science Objectives: What's the Big Picture?

(for Tier 2)

- Vertical profile of zonal winds at the probe entry location
  - Atmospheric dynamics and circulation
  - Redistribution of energy in the atmosphere
- Location, density, and composition of clouds as a function of depth
  - Vertical circulation and mixing
  - Radiant energy balance
- Variability of atmospheric structure and clouds in two locations
  - Spatial variation
  - Vertical and lateral circulation and mixing
- Vertical profile of water abundance at the probe entry location
  - Giant planet and solar system formation processes
- Precision isotope measurements for light elements in simple molecules
  - Mechanism of delivering ices to gas giant planets

PSDS Draft Report
Uranus Entry Probe Science Objectives

- "Highest Priority Science Objectives"
  - Determine the atmospheric zonal winds, composition, and structure at high spatial resolution...
- "Medium Priority Science Objectives"
  - Determine the noble gas abundances and isotopic ratios of H, C, N, and O *(and their isotopes!)*
  - Measure atmospheric structure at the probe descent location
- "Lower Priority Science Objectives"
  - Determine the vertical profile of zonal winds
  - Determine the presence of clouds as a function of depth in the atmosphere

Omits measurements of diagnostic species such as CO, PH_3, AsH_3, SiH_4, GeH_4

PSDS Draft Report
Uranus Entry Probe Science Objectives

- "Highest Priority Science Objectives"
  - Determine the atmospheric zonal winds, composition, and structure at high spatial resolution...
- "Medium Priority Science Objectives"
  - Determine the noble gas abundances and isotopic ratios of H, C, N, and O
  - Measure atmospheric structure at the probe descent location
- "Lower Priority Science Objectives"
  - Determine the vertical profile of zonal winds
  - Determine the presence of clouds as a function of depth in the atmosphere

??

(and their isotopes!)

Omits measurements of diagnostic species such as CO, PH_3, AsH_3, SiH_4, GeH_4

PSDS Draft Report
Neptune Entry Probe Science Objectives

- Not specified
- Most likely similar to Uranus objectives

Questions?