

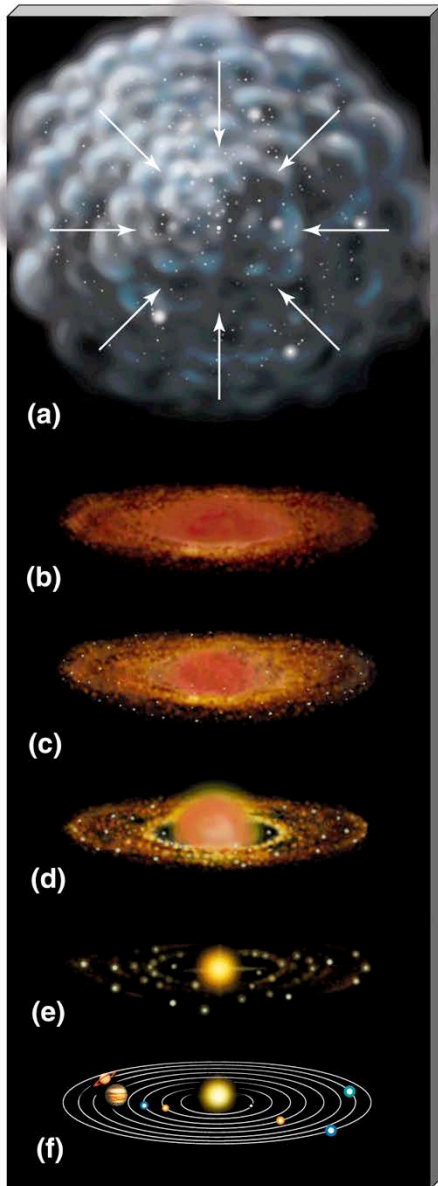
Solar System Formation in Brief



Solar System Formation: Constraints

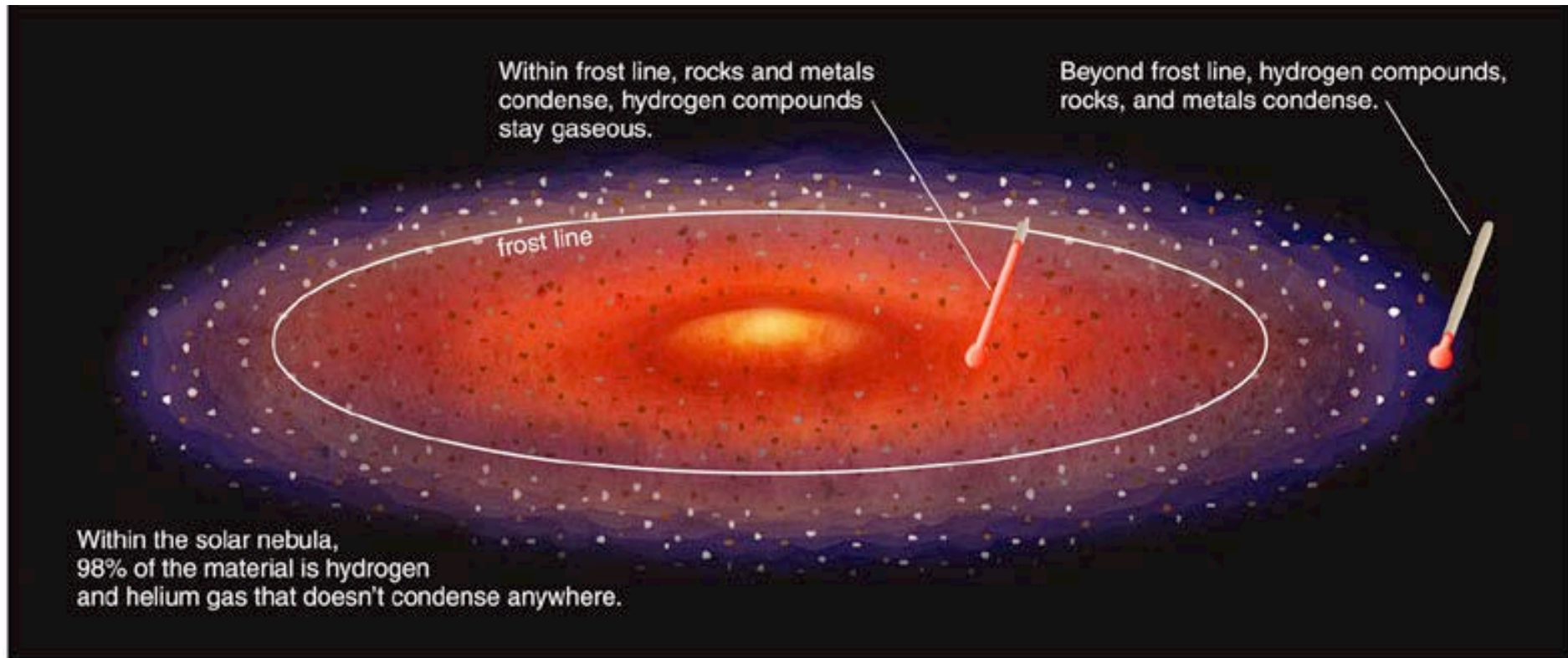
- Sun has 99.8% of mass, <2% of angular momentum
- Low inclination & eccentricity of planet orbits
- Most planets have low obliquity
- Large outer planets have ~solar composition
- Small inner planets enriched in heavy elements
- “Debris” in asteroid belt, Kuiper belt
- Meteorites have common age: ~4.6 Ga
- Oldest Moon rocks ~4.36 – 4.5 Ga

Solar System Formation in Brief



- Gravity leads to collapse of gas/dust cloud
- Initial net rotation \rightarrow rotating disk
- Dust grains in disk collide, forming planetesimals
- Planetesimals collide and merge, forming planetary embryos
- Late collisions of embryos may have disproportionate influence
- Eventually, solar wind disperses unaccreted gas

Solar System Formation in Brief



- Inner planets built from only rock and metals
- Outer solar system forms cores of ices+rocks+metals
- Sufficiently large cores accrete gaseous H and He
→ Need to form these cores before the gas is blown away!

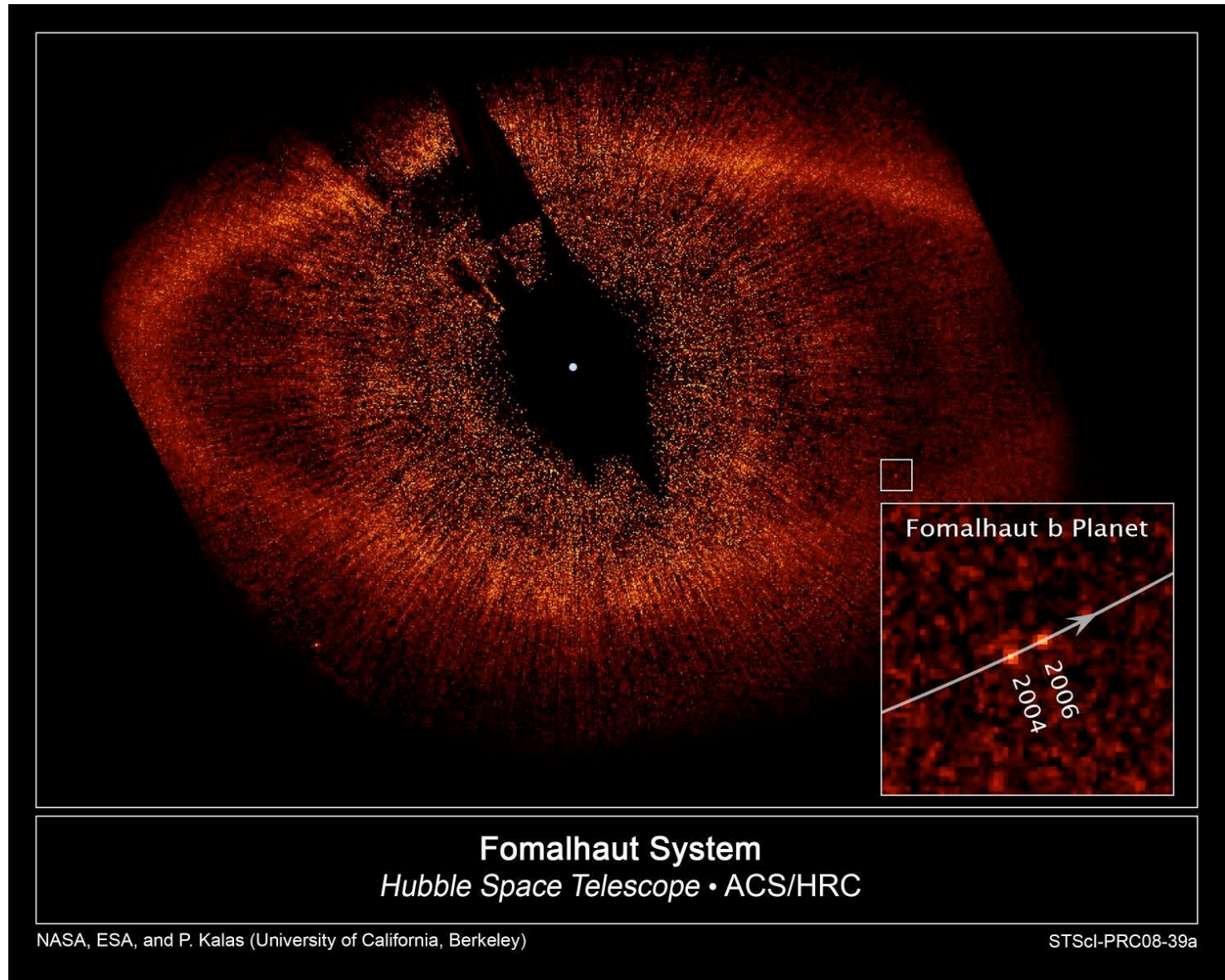
Solar System Formation in Brief



“These are some of the things that hydrogen atoms do given fifteen billion years of cosmic evolution.”

—C. Sagan

Solar System Formation in Brief



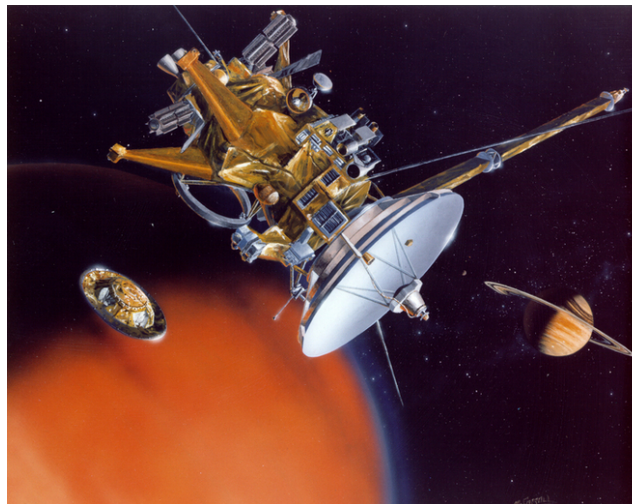
Observables vs. Inferables

Observations

Remote Sensing

In Situ

Inferred Properties



Hubble
Cassini
Keck



Planetary Properties

Orbit

Mass

Size

Rotation

Shape

Temperature

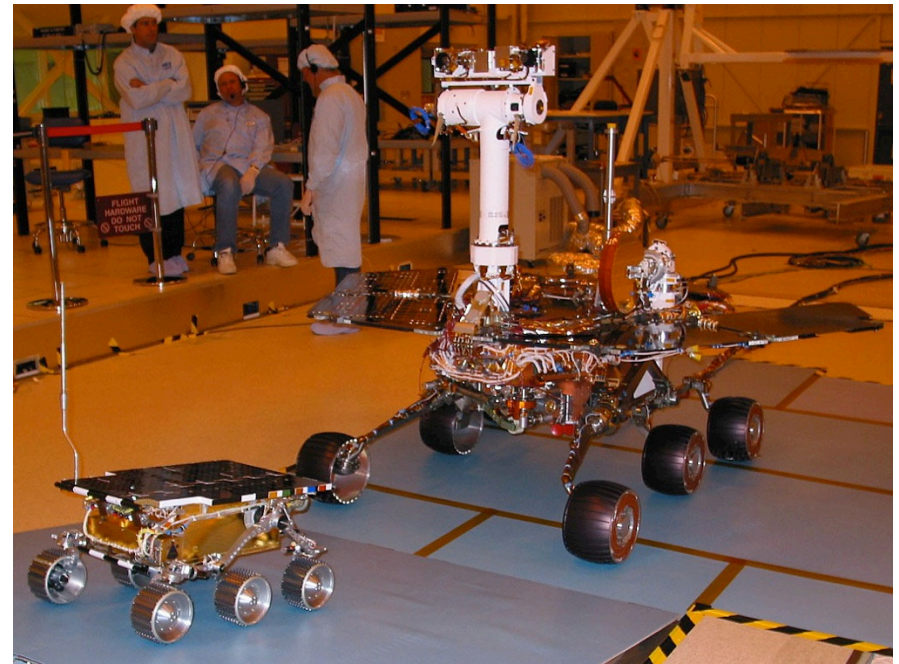
Magnetic Field

Surface Composition

Surface Structure

Bulk Composition

Interior Structure



Mars rovers: Sojourner and MER

Observations

Remote Sensing:

Can be Earth-based or satellite-based

Generally refers to studying distal phenomenon by observing the electromagnetic spectrum emitted/perturbed that propagates to the observer (i.e. to a telescope, camera, antenna, etc).

Observations

In Situ:

Observations made by the observer or via spacecraft/rockets/balloons/rovers of their local environment

Can serve to observe properties such as composition, magnetic field, neutral/plasma populations and energy, dust; can also calibrate remote sensing observations

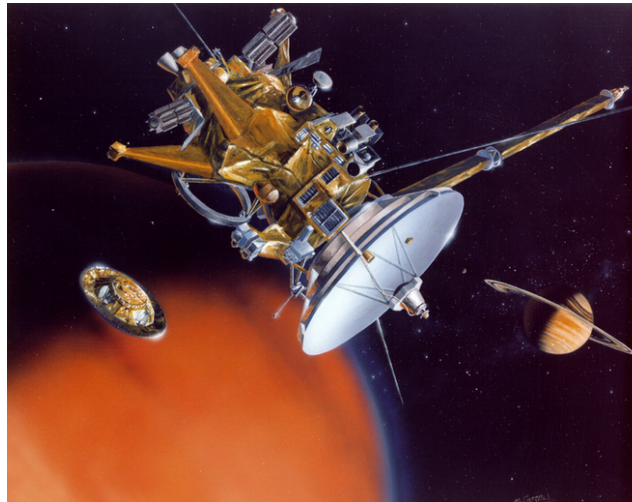
Observables vs. Inferables

Observations

Remote Sensing

In Situ

Inferring Properties



Hubble

Cassini/Huygens

Keck

Planetary Properties

Orbit

Mass

Size

Rotation

Shape

Temperature

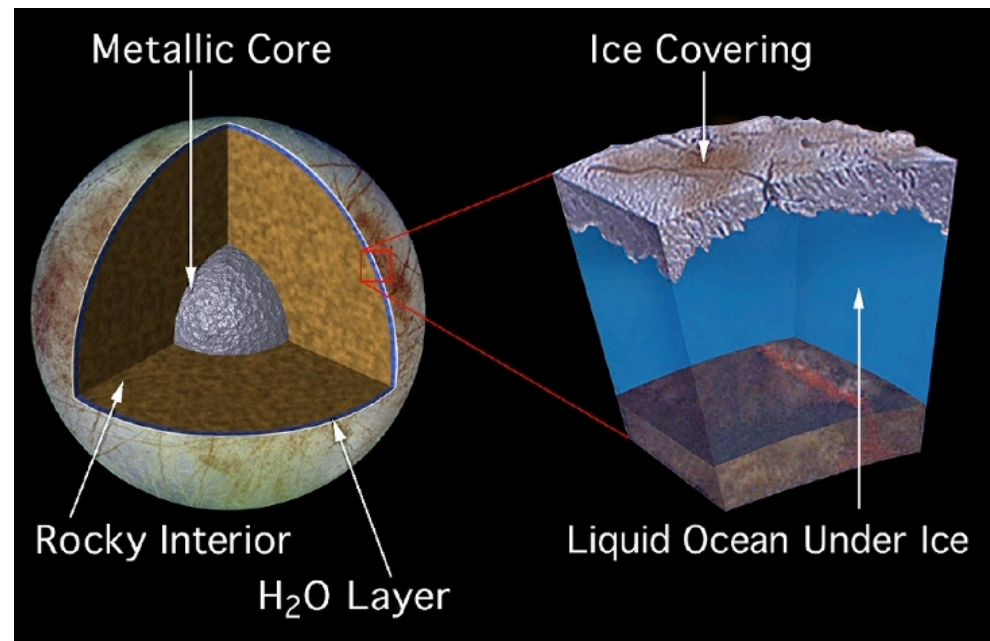
Magnetic Field

Surface Composition

Surface Structure

Bulk Composition

Interior Structure



Inferred Quantities

Several characteristics can be determined from a combination of observations and theory constrained by those observations

Examples include internal structure and existence of a subsurface ocean to name a few...