Composition, Structure, Origin, and Entry Probes

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Abstract

Core accretion is the conventional model of the formation of the giant planets. Core-building planetesimals grew from non-gravitational collisions between small grains of dust, rock, metal and possibly refractory material, together with volatiles trapped in the solid material. The most volatile of the gases, hydrogen, helium and neon, were the last to be captured from the protoplanetary nebula, when the core mass became large, i.e. about 10-15 Earth Mass. During accretionary heating, it is generally assumed that volatiles were released from the core and mixed into the atmosphere. There are a number of variations to the above core accretion scenario, but all require knowledge of the abundance of "heavy elements" (mass $>$ 4He), as do alternate models such as gravitational instability. Isotopic ratios place further constraints on the nature and origin of the material. Certain heavy elements are sequestered in condensible volatiles, requiring access to atmospheric levels below the clouds. Galileo probe was thus designed to make measurements well below the deepest cloud layers expected in the atmosphere of Jupiter. Remote sensing does not permit such measurements. Well-mixed atmosphere below the clouds is expected to be even deeper in the colder icy giant planets. The heavy noble gases(Ne, Ar, Kr, Xe) and their isotope ratios, He/H, D/H, and the isotope ratios of certain other stable gases will provide the most robust constraints to their formation models, especially when combined with the interior models. They require relatively shallow probes. Gravity measurements and possibly abundance profiles of certain constituents with a Juno-like microwave radiometer on an orbiter would be highly complementary to the probe data. This talk will discuss all of the above aspects that will highlight the critical role entry probes play in our understanding of the formation of the giant planets, with a focus on Uranus and Neptune.

Keywords: Composition, Structure, Origin, Ice Giant Planets, Uranus, Neptune, Jupiter, Galileo, Probes

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