

## Formation of Giant Planets

Alan Boss

(Email: [boss@dtm.ciw.edu](mailto:boss@dtm.ciw.edu))

Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D.C.

Two very different mechanisms have been proposed for the formation of the gas and ice giant planets. The conventional explanation for the formation of gas giant planets, core accretion, presumes that a gaseous envelope collapses upon a roughly 10 Earth-mass, solid rock/ice core that was formed by the collisional accumulation of planetary embryos orbiting in the solar nebula. The more radical explanation, disk instability, hypothesizes that the gaseous portion of the nebula underwent a gravitational instability, leading to the formation of self-gravitating clumps, within which dust grains coagulated and settled to form cores. Core accretion appears to require several million years or more to form a gas giant planet, implying that only long-lived disks would form gas giants. Disk instability, on the other hand, is so rapid (forming clumps in thousands of years), that gas giants could form in even the shortest-lived disks. Core accretion has difficulty in explaining the formation of the ice giant planets, unless two extra protoplanets are formed in the gas giant planet region and thereafter migrate outward. Recently, an alternative mechanism for ice giant planet formation has been proposed, based on observations of protoplanetary disks in the Orion nebula cluster: disk instability leading to the formation of four gas giant protoplanets with cores, followed by photoevaporation of the disk and gaseous envelopes of the protoplanets outside about 10 AU by a nearby OB star, producing ice giants. In this scenario, Jupiter survives unscathed, while Saturn is a transitional planet. Terrestrial planets seem to be likely to form under either scenario for giant planet formation, though the likelihood does depend strongly on the orbital properties of the giant planets in the system. The advantages and disadvantages of each mechanism for giant planet formation will be summarized.

