# Importance of the equation of state for a mixture of hydrogen and helium under high pressure to the theory of planet formation

# Masahiro Ikoma[1]

[1] Earth Planet. Sci.
Tokyo Inst. Tech.

Jupiter and Saturn have a central rocky/icy core surrounded by a massive gas envelope whose mass is of the order of 100 Earth mass; those planets are thus called gas giant planets. The gas envelope consists mainly of hydrogen and helium. Because of its large mass, the pressure in the deep envelope is as high as 1-10 Mbar, so that hydrogen exists in the form of metallic hydrogen. The interiors of the giant planets are known only by constructing theoretical models that account for observational data such as the gravitational moments, the effective temperature, the atmospheric composition, and so on. The equation of state (EOS) of a mixture of hydrogen and helium is essential in the modeling. Because of its uncertainty, the interiors of the gas giant planets, especially the masses of the cores, are not definitely constrained. For Jupiter the problem is more serious from the view point of planet formation theory. Planet formation takes place in a gas disk composed of hydrogen and helium. In the disk a massive solid core first forms, followed by gravitational capture of the disk gas by the core. The current theory of planet formation prefers a large core of more than about 10 Earth mass for the onset of the gravitational capture of the disk gas, while the interior model of Jupiter shows that the mass of Jupiter's central core is likely less than 10 Earth mass. This contradiction is one of the most serious problems in the study of planet formation. Thus, improvement of the EOS of hydrogen and helium under high pressure is essential to give a better constraint on the mass of the core of Jupiter (and Saturn).