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Frontiers in the Interiors of Massive Planets

DAVID J. STEVENSON, California Institute of Technology

The understanding of structures of massive planets such as Jupiter and somewhat lower mass planets such as Uranus can help us tackle some of the central questions in planetary science, such as whether and how planets form. On a decadal timescale, NASA is spending billions of dollars on missions devoted to answering such questions. A crucial part of this understanding is the properties of materials under extreme conditions. Typical conditions inside Jupiter are megabars and ten thousand kelvin, accessible in lab experiment and through simulation. Typical materials are cosmically abundant hydrogen, helium, oxygen, carbon and nitrogen (in appropriate mixtures) and also Earthlike ("rock" and iron). Equation of state, including slopes of isentropes, etc, phase diagrams and transport properties (especially electrical conductivity) are of particular interest. I will describe some of the outstanding unsolved problems for planets, including extrasolar planets more massive than Jupiter.