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Probing planetary interiors: Shock compression of water to 700 GPa and 3.8 g/cc, and recent high precision Hugoniot measurements of deuterium[1]

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The past several years have seen tremendous increase in the number of identified extra-solar planetary systems. Our understanding of the formation of these systems is tied to our understanding of the internal structure of these exoplanets, which in turn rely upon equations of state of light elements and compounds such as water and hydrogen. Here we present shock compression data for water with unprecedented accuracy that shows commonly used models for water in planetary modeling significantly overestimate the compressibility at conditions relevant to planetary interiors. Furthermore, we show that its behavior at these conditions, including reflectivity and isentropic response, is well described by a recent first-principles based equation of state. These findings advocate the use of this model as the standard for modeling Neptune, Uranus, and "hot Neptune" exoplanets, and should contribute to improved understanding of the interior structure of these planets, and perhaps improved understanding of formation mechanisms of planetary systems. We also present very recent experiments on deuterium that have taken advantage of continued improvements in both experimental configuration and the understanding of the quartz shock standard to obtain Hugoniot data with a significant increase in precision. These data will prove to provide a stringent test for the equation of state of hydrogen and its isotopes.

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