The Interior of Saturn and Matter at Extreme Conditions Studied with First-Principles Computer Simulations

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During the final phase of its mission, the Cassini spacecraft travelled inside Saturn's rings in order to perform a series of unique measurements of the planet's gravitational field before the spacecraft disintegrated in the planet's atmosphere. Such measurements provide us with information about the planet's interior structure and the depth of winds that we see on the its visible surface. The gravity results were so unusual that they could not be reproduced with any model that assumed Saturn to rotate uniformly, like a solid body. Here describes a suite of novel interior models with differential rotation that match the measured gravity coefficients J_2, J_4, J_6, and J_8. Implication for Saturn's interior will be discussed.

In the second part of this presentation, we focus on first-principles computer simulations of silicates at extreme conditions. We compute electronic transport properties, such as conductivity and reflectivity, in a various silicates and phases. We find that liquid and solid silicates behave differently at extreme conditions, which has implications for the interiors of rocky exoplanets. Finally, we compare our computational results with recent laboratory shock wave experiments.