HEDLA 2022
13th International Conference on High Energy Density Laboratory Astrophysics
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Investigating planetary interior structure with laboratory laser-compression and X-ray diffraction experiments

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The use of lasers to induce extreme compression states has enabled the study of material properties and equations of state at unprecedented pressures and temperature conditions. Combined with ultra-fast x-ray diagnostics these techniques allow us to probe in-situ the transformation happening in matter subjected to extreme conditions, providing key insights into material behavior at pressures and temperatures existing deep inside planets. In this talk, I will present the results of recent x-ray diffraction experiments on laser-compressed water ice and oxides, the main components of the mantle of ice giant and terrestrial planets. The experiments highlight the emergence of new phases that deeply affect the interior structure of the planets. We find that water transforms into a superionic ice (ice XVIII) that may explain the magnetic field topology of the Ice Giant planets. Iron oxide assumes a closely packed structure at pressures exceeding those existing within the Earth mantle, with important consequences for the stratification of large terrestrial exoplanets (more than 5 Earth masses).
This work was performed under the auspices of the US Department of Energy by Lawrence Livermore National Laboratory under Contract No. DE-AC52-07NA27344