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Experimental Discovery of Superionic Water with Dynamic Compression.

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The pressure-temperature phase diagram of water exhibits a striking degree of polymorphism with more than 15 polymorphs of molecular ice and the pressure-induced transition to the ionic ice X near 70 GPa. Upon further compression and at elevated temperature, several molecular dynamics studies have predicted that water becomes superionic, an extraordinary state with liquid-like hydrogen ions diffusing within a solid lattice of oxygen. We will report experimental evidence for superionic electrical conductivity above 100 GPa and 2000 K using velocimetry, pyrometry and optical property measurements of shock compressed H_2O ice VII. We will also present in-situ x-ray diffraction of ice up to 4 Mbar using reverberation compression showing that the superionic conduction indeed exists in the presence of a solid oxygen lattice as predicted three decades ago. The new XRD data also suggest the discovery of a new solid ice phase having a face-centered-cubic oxygen lattice. Prepared by LLNL under Contract DE-AC52-07NA27344. LLNL-ABS-724285.