

## Pulsed Power High-Energy-Density Physics

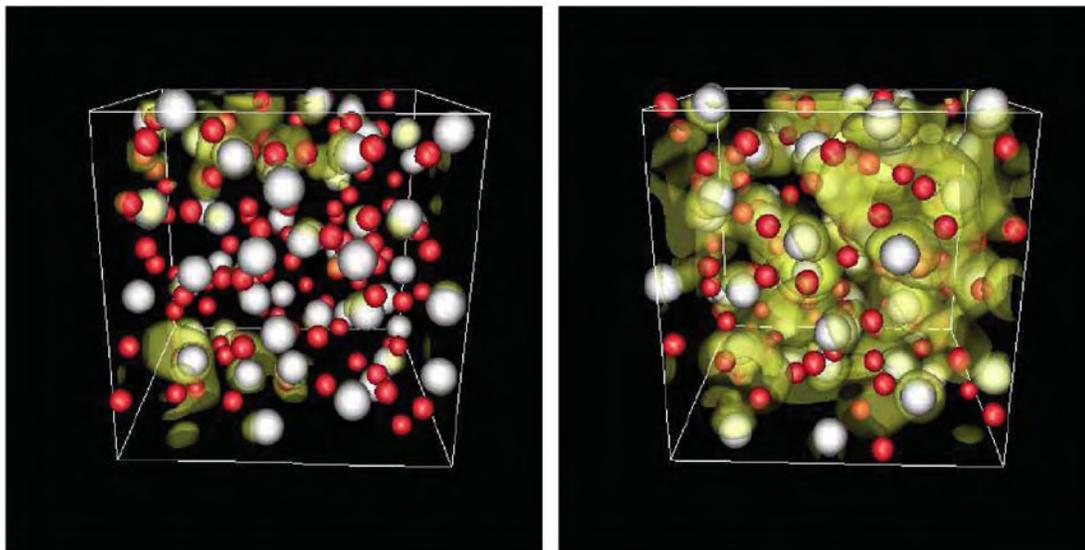


Figure 1. Snapshots from first-principles simulations, showing the disordered structure of conducting water. Red spheres are hydrogen atoms while white spheres are oxygen atoms. The electron density from a partially occupied electron state, responsible for the conductivity, is shown as gold. High-energy-density water has a density of more than  $2 \text{ g/cm}^3$ , which is more than twice as dense as regular water ( $1 \text{ g/cm}^3$ ).

## Sandia study suggests that water turns metallic at temperatures and pressure that occur in giant planets

*Data from Sandia's high-energy-density water studies add to the body of knowledge about the electronic properties of water, a prerequisite for correctly describing the physics of various objects such as giant planets and shock waves in water.*

Sandia researchers began work in the high-energy-density water arena to better understand the short-lived, high-temperature, high-pressure fluid environment inside Sandia's Z Machine, the highest peak-current pulsed-power device in the world. As the most potent source of soft X-rays, Z is used for studying the physics of nuclear weapons and for learning about fusion reactions that may someday produce commercial power.

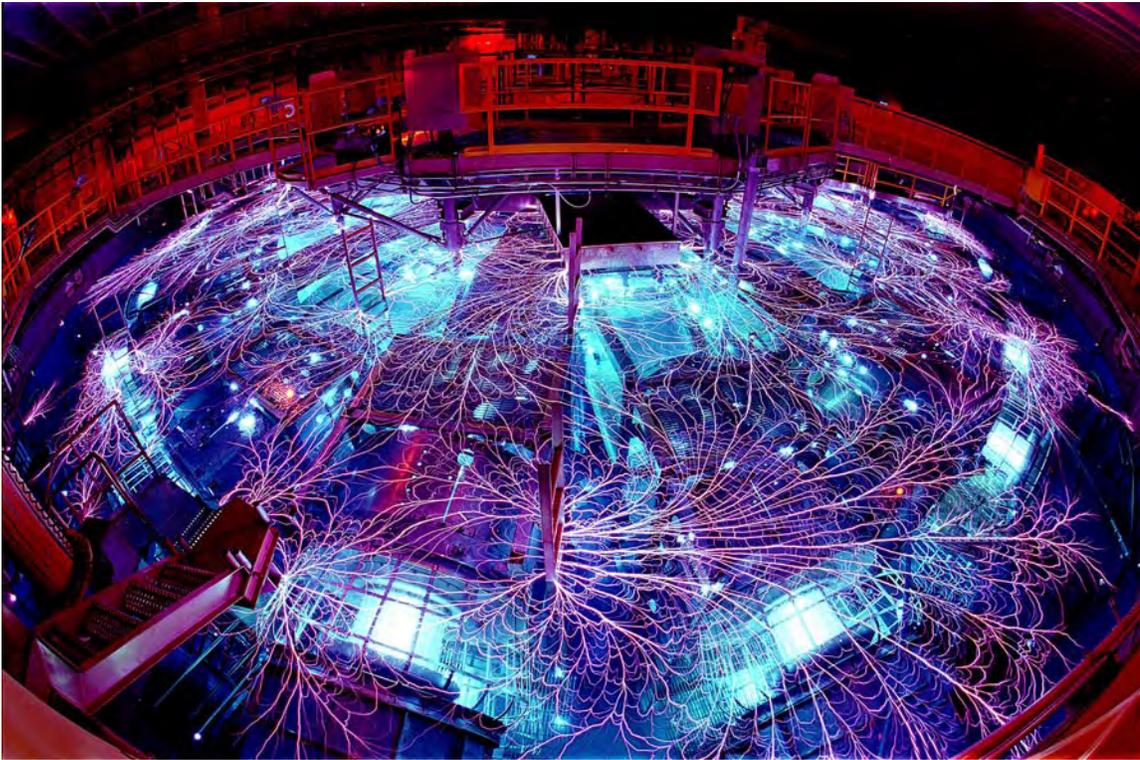
While earlier work predicted a transition to metallic fluid at 7000 K and 250 GPa, the new findings place the conducting phase of water occurring at a temperature of 4000 K and a pressure of 100 GPa. While researching the conditions of shocked water found in the heart of Sandia's Z machines' pulsed power system, we discovered a new phase of water which is relevant to the physics of giant planets.

Furthermore, the new work shows, unexpectedly, that on a pressure-vs-temperature phase diagram, the conducting phase of water directly borders the super-ionic phase of water (a phase where the water molecule's two hydrogen atoms are free to move about while the oxygen atoms remain frozen in place).

*For more information:*

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Z machine is the world's brightest, most energetic x-radiation source (1.8 MJ, 230 TW).

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