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Toward Gigabar Pressures and Kilovolt Chemistry

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Developments in laboratory techniques, combining Megajoule-lasers with dynamic compression methods and diamond-anvil cells, extend the range of high-pressure experiments from the Megabar to the Gigabar regime. Materials could be compressed 100-fold, with prospects of new correlation phenomena being uncovered. First-principles theory will be tested to far more extreme conditions than previously possible. The feasibility of such experiments has been demonstrated, with current work documenting the metallization of liquid diamond at TPa pressures and of He at 12-fold compression over liquid density ($\sim$104 STP density). Shock pressures to the 10 TPa (100 Mbar) regime have been achieved in the laboratory for the first time. Such capabilities allow new questions to be addressed, such as: What is a solid at TPa (tens of Mbar) pressures? What are the properties of hydrogen atoms compressed to the de Broglie wavelength? What is the nature of the chemical bond at Gbar pressures? How do material properties determine the evolution of exoplanets and brown dwarfs, and what does this reveal about the origins of planets?