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Towards the determination of the equation of state of hydrogen and helium at extreme densities: Laser induced shocks on pre-compressed samples.

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The determination of the equation of state of helium and hydrogen at very high density is an important problem at the frontier between condensed matter physics and plasma physics. It is also an important issue in planetary physics for understanding the formation of giant and extrasolar planets. However, the extreme densities relevant to most of the interior of Jupiter are unreachable by either static or single-shock compression techniques alone. Recently, a laser-driven shock-wave in a hydrogen sample, pre-compressed in a diamond anvil cell, has been demonstrated [1]. Consequently, the compression factors of the dynamic and static techniques can now be multiplied. We will present our current effort with the Omega laser at LLE to measure accurately the Hugoniot curves of hydrogen and helium pre-compressed up to 1.5 GPa. The metrology and error bars of the measurements will be discussed. The Hugoniot data points will be compared to published calculations, and an interesting difference in the insulator-metal transition of hydrogen and helium will be discussed.

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[1] P. Loubeyre et al., High Pressure Research **24**, 25- 31 (2004).