Deuterium equation-of-state experiments on the OMEGA laser system

VISAR for shot 27934

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Many people contributed to the design, implementation, and execution of cryogenic-target experiments

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Summary

Preliminary results show increased D$_2$ compressibility at ~1 Mb, with “stiffer” behavior at higher pressures

- Gas gun$^1$ and laser$^2$ Hugoniot experiments show higher deuterium compressibility than predicted by SESAME.
- Magnetically driven$^3$ Hugoniot experiments show compressibility closer to SESAME.
- “Re-shock” experiments$^4$ can enhance the differences between equation-of-state models.
- Deuterium re-shock experiments on OMEGA exhibit compressibility that agrees with the Saumon-Chabrier$^5$ model.

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Consensus on the compressibility of deuterium has been elusive

![Graph showing Shock temperature vs. Volume (cc/mole) and Pressure vs. Density (g/cm$^{-3}$)]
Consensus on the compressibility of deuterium has been elusive
Multi-shock experiments are useful for resolving different models for $D_2$ EOS

Simulations are used for target design to ensure only the primary shock is measured.
“Diving board” targets provide both impedance match and reshock data on cryogenic deuterium.
The measured EOS for quartz matches established measurements and models.

![Graph showing quartz shock velocity vs. Al shock velocity with data points and trends for OMEGA and Trunin data, along with labels for fused silica and polycrystalline SiO2.]
Preliminary experiments agree with the Saumon-Chabrier model for compressibility.
Preliminary experiments agree with the Saumon-Chabrier model for compressibility.
Shock reverberations in the Al-D$_2$-Quartz system are observed in the data.

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Reverberation times are consistent with a stiff EOS.
Conclusions

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- Gas gun and laser Hugoniot experiments show higher deuterium compressibility than predicted by SESAME.

- Magnetically driven Hugoniot experiments show compressibility closer to SESAME.

- “Re-shock” experiments can enhance the differences between equation-of-state models.

- Deuterium re-shock experiments on OMEGA exhibit compressibility that agrees with the Saumon-Chabrier model.

- Future work: establish quartz as standard, study reverberation data, radiography, and temperature measurements.