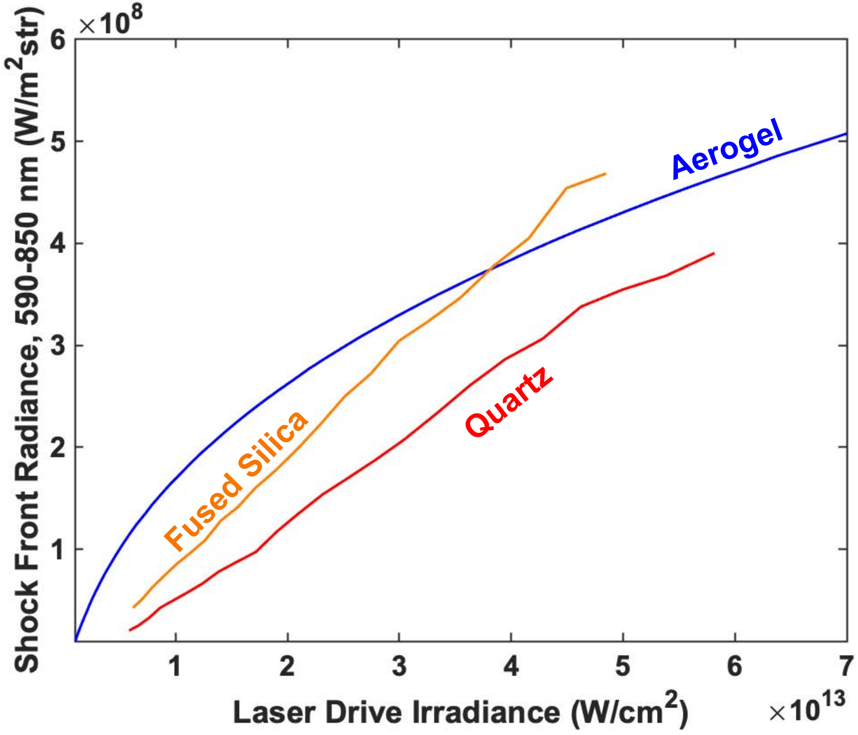
Thermal Emission and Reflectivity of Shocked SiO_2 Aerogel for Broadband Optical Probing



Brian Henderson
University of Rochester
Laboratory for Laser Energetics

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Division of Plasma Physics

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Summary

We have studied SiO_2 aerogel to develop a broadband optical source for high energy density physics (HEDP) experiments

- Traditional Thomas-Fermi models significantly overpredict brightness temperature (spectral radiance) in shock compressed aerogel, which can be attributed to a combination of microstructure effects and a radiative precursor

- SiO_2 aerogel's T-u_s behavior was expected to be quadratic similar to higher density polymorphs (fused silica, quartz, Stishovite), however we observe a linear trend

- A radiance model has been developed as a pragmatic approach to designing laser-driven shock experiments involving SiO_2

Collaborators

M. C. Marshall, J. R. Rygg, D. N. Polsin, L. Crandall, M. K. Ginnane, and G. W. Collins

University of Rochester
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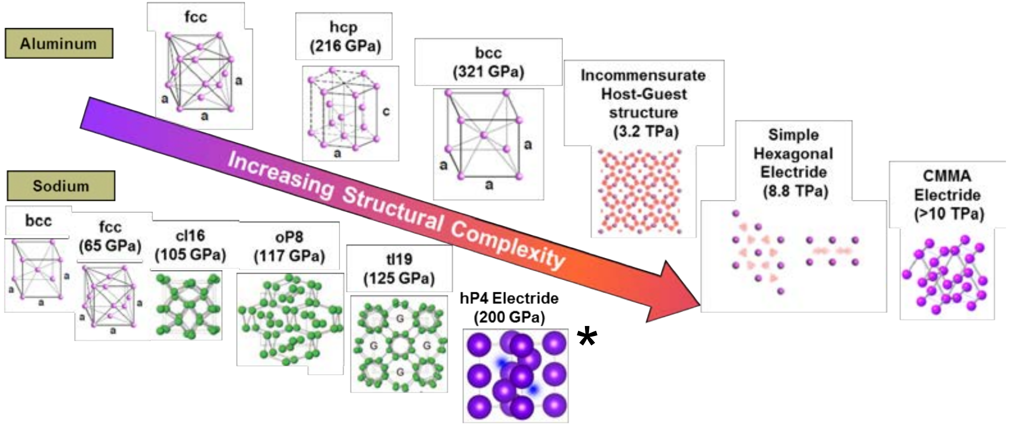
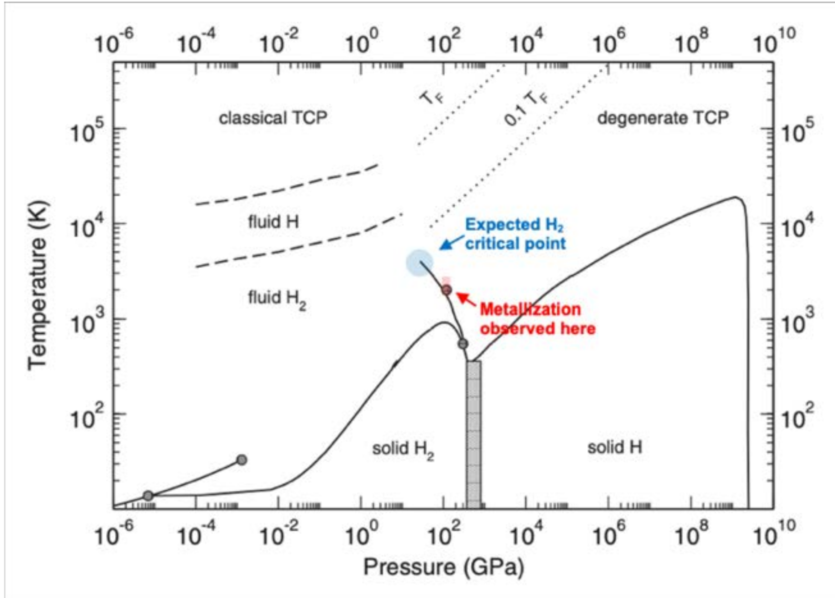
Optical probes are necessary for measurements of optical and electronic properties at extreme conditions

- Optical spectroscopy can be used to observe band gap closure during compression
- Other topics of interest: d-band slitting in compressed aluminum, electride phases in alkali metals

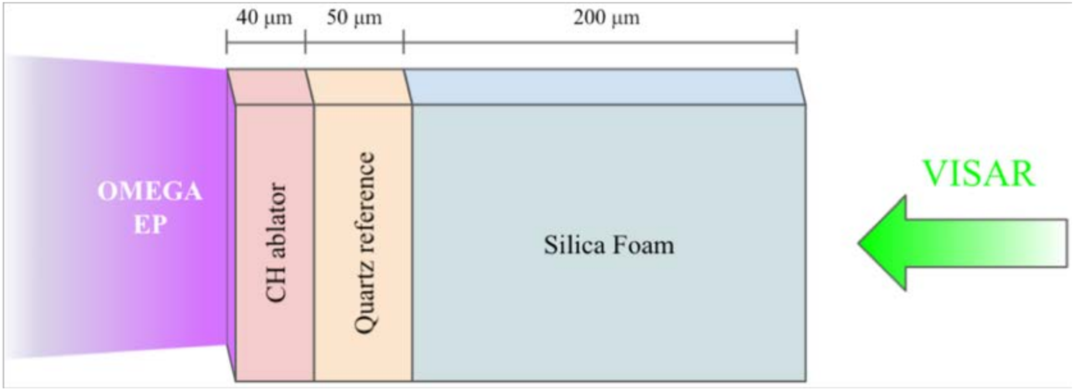


Hydrogen Phase Diagram

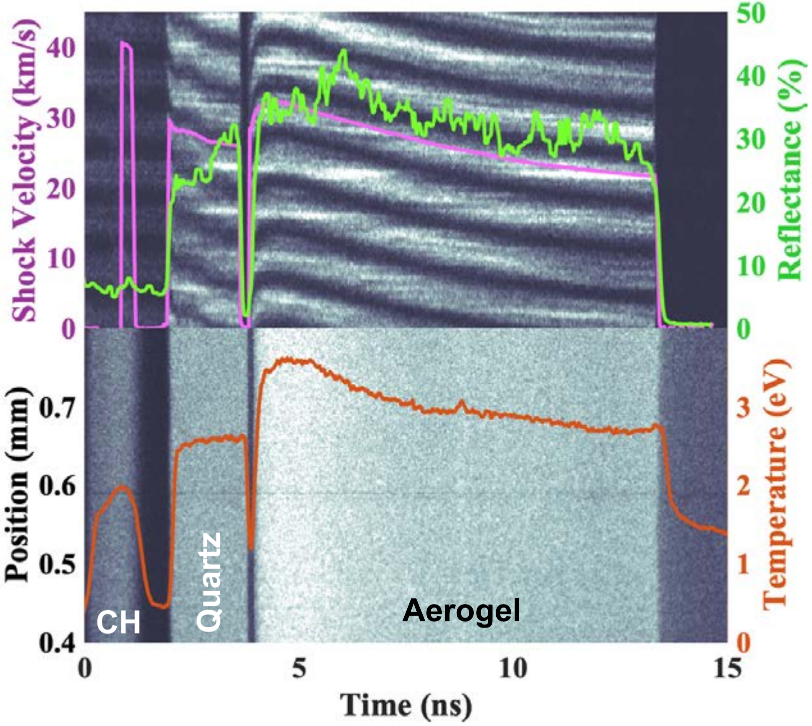


* From D. N. Polsin PhD Thesis [See PI01:2]

Decaying shocks were driven through aerogel samples with initial densities of 0.1, 0.2, and 0.3 g/cc



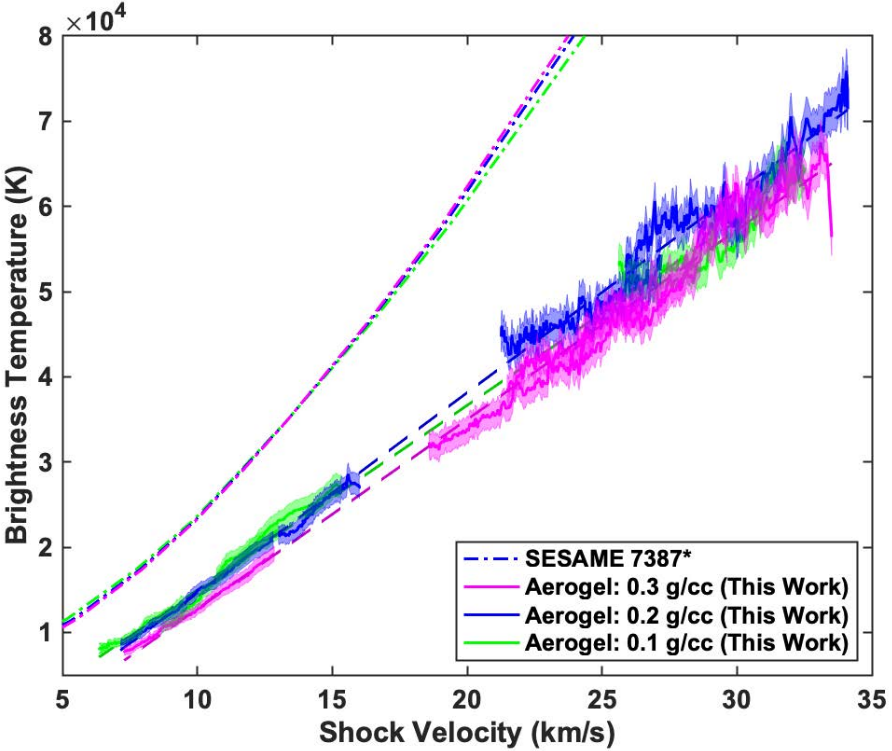
Quartz acts as a pressure and reflectance reference



Results

Predictions of brightness temperature in shocked aerogel are significantly higher than the observed values

- **Disagreement between predictions and data might be due to:**
  1. **Overestimation of the emissivity**
  2. **Microstructure**
  3. **Radiative Precursor**



Reflectance measurements are similar to those of solid quartz, suggesting that the temperature discrepancy cannot be corrected further through the emissivity

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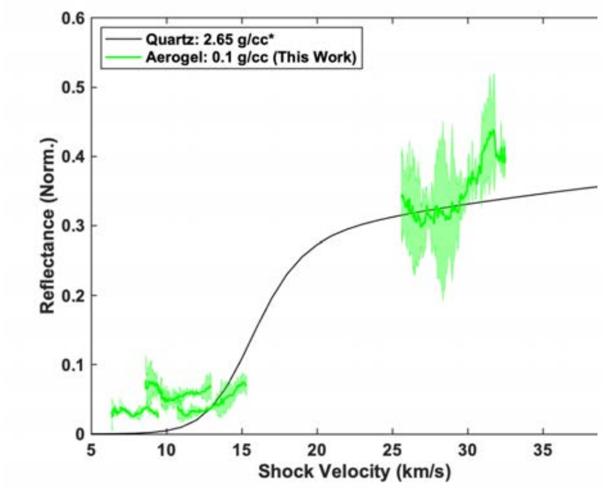
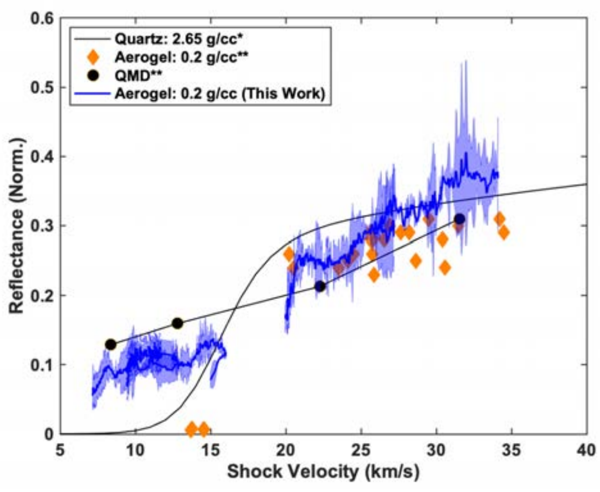
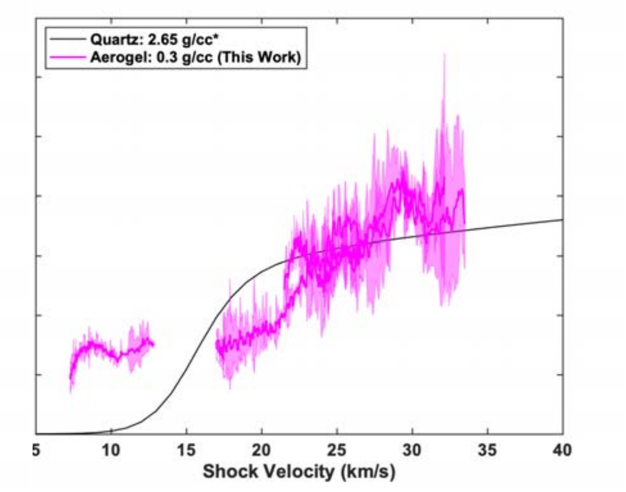
0.1 g/cc



0.2 g/cc



0.3 g/cc



Results for 0.2 g/cc match well with QMD simulations

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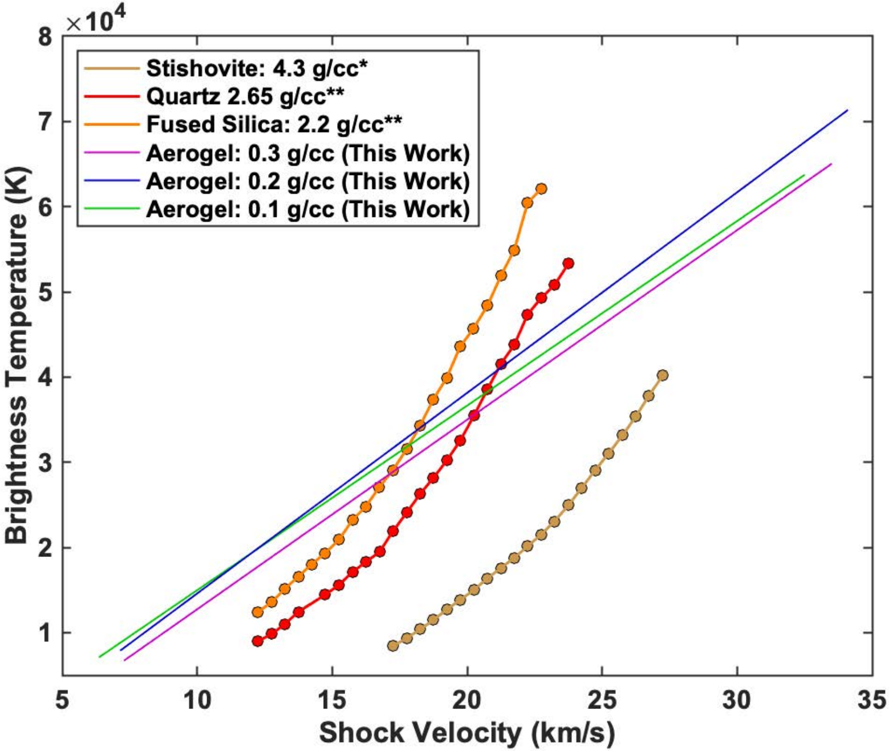
*S. Brygoo *et al*, J. App. Phys.118, 195901(2015)
** K. Falk *et al*, Phys. Rev. E90, 033107 (2014)

Results

Linear T-u_s behavior was observed for silica aerogel, contrary to the predicted quadratic behavior exhibited by higher density polymorphs

- SiO_2 aerogel was expected to have a higher brightness temperature than fused silica, quartz, and Stishovite
- An emissivity correction is included in the shown data



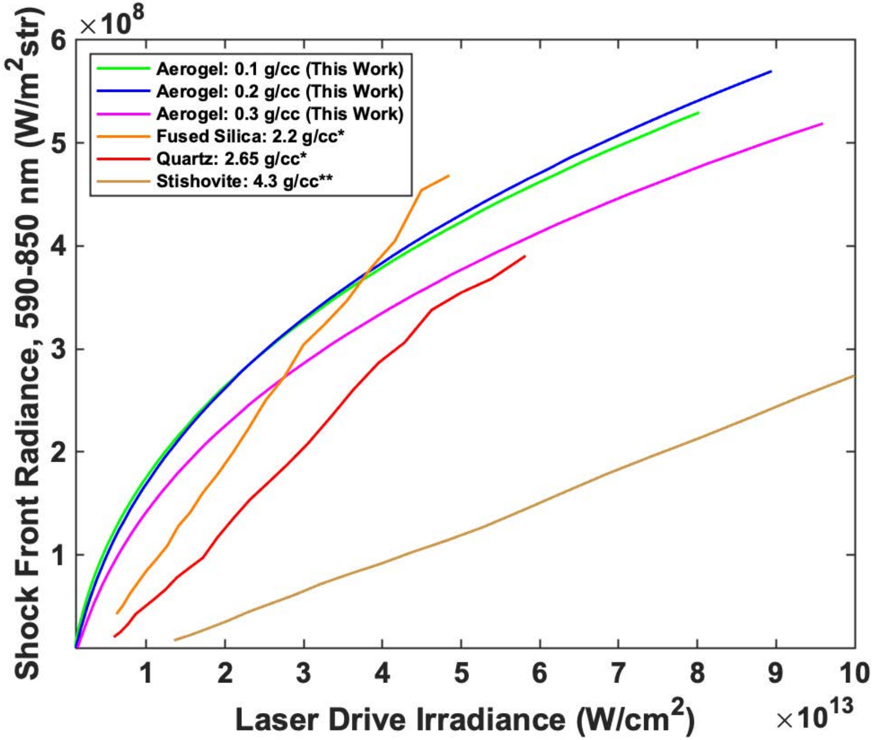
*M. Millot *et al,* Science.347, 418–420(2015)
** D. G. Hick *et al*, Phys. Rev. Lett.97,025502 (2006)

Results

A radiance model was developed for convenient use when designing experiments involving SiO_2

- On the right is a modeled three-component target with the same CH/Quartz/Sample configuration shown previously

- 0.1 and 0.2 g/cc aerogel produce the brightest shocks when driven with less than 4E13 W/cm². If you can drive a target with greater than 4E13 W/cm², then fused silica will produce the brightest shocks.



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