Motivation for exploring radiative shocks

- Inherently nonlinear
- Motivated by astrophysics
- Supernova and stellar shocks
- Some accretion phenomena
- Modelling radiative shocks is difficult
- Varying scales
- Radiation transport regime
- Ionizing media and 3D effects

Geometry of an optically thin (upstream) radiative shock

A postshock cooling layer forms when energy flux due to thermal radiative losses from shocked material approaches the energy flux entering shocked material. The parameter $R$ to be the ratio of the radiative fluxes to the material fluxes. When $R$ approaches 1, we enter the radiative regime.

$$ R = \frac{\text{radiative fluxes}}{\text{material fluxes}}, \quad \frac{T}{T_\text{init}} \sim u_s^2, \quad R \sim \frac{\sigma T^4}{\rho u_s^3}, \quad \frac{R}{\rho_o} = \frac{u_s^5}{\rho_o} \left(1 - \frac{n_e}{n_{t-c}}\right). $$

Radiation alters the structure and dynamics of the shock

- Inherently nonlinear
- Sometimes unstable
- Motivated by astrophysics
- Supernova and stellar shocks
- Some accretion phenomena
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Motivation for upcoming CRASH experiment on the Omega Laser

- Supernova and stellar shocks
- Motivated by astrophysics
- Radiative shocks are important for early time behavior
- Ionizing media and 3D effects
- Radiation alters the structure and dynamics of the shock
- Accuracy initialization for the CRASH code
- Conclusions and Future Directions

Additional VISAR experiments will attempt to reflect the probe beam off of the shock

This experiment would measure the shock breakout from the Be and possibly reflect the probe beam off of the shock. The absorption of the probe beam due to x-ray preheat and the radiative precursor would be a concern and experiments may be performed in a gas other than Xenon.

Will the VISAR beam be absorbed?

The radiative precursor has the potential to absorb the probe beam. For attenuation due to collisional absorption,

$$ K = \frac{v_e}{c} \frac{n_e}{n_c} \left(1 - \frac{n_e}{n_c}\right)^{1/2} \frac{\ln A(T_e)}{1.5} $$

The critical density, $n_c$, for the 532 nm probe beam is $3.9 \times 10^{17}$ cm$^{-3}$ for xenon $\kappa = 4397$ cm$^{-1}$ and the mean-free-path is 2 µm. For argon $\kappa = 427$ cm$^{-1}$ and the mean-free-path is 24 µm. For neon $\kappa = 85$ cm$^{-1}$ and the mean-free-path is 118 µm. We will also consider using hydrogen gas.

Other potential diagnostics include side-on SOP and streaked radiography

We may also use a Streaked Optical Pyrometer (SOP) in a side-on geometry to track the motion of the shock by its thermal emission.

Also, using a Sc backlighter and a streak camera we could possibly detect the motion of the shock in the first 0.5 ns to 2 ns.

Conclusions and Future Directions

Experiments to characterize the initial state of the Be plasma will be performed in December 2009.

The data and analysis will be used to calibrate Hyades and provide a more accurate initialization for the CRASH code.

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