Fourth International Conference on
SUPERSTRONG FIELDS IN PLASMAS
October 2010, Sunday 3 to Saturday 9
Villa Monastero, Varenna, Italy

Studying radiative shocks using laser driven blast waves in clustered gases

Daniel Symes

Central Laser Facility, Rutherford Appleton Laboratory,

Harwell Campus, Didcot OX11 0QX, UK

dan.symes@stfc.ac.uk, http://www.clf.rl.ac.uk/

Gases formed of atomic clusters exhibit extremely efficient absorption of intense laser light, creating hot plasmas in a low average density target. The potential of such a medium to perform shock wave studies of astrophysical importance has been demonstrated [1]. We discuss blast waves in high *Z* gases which enter a radiative phase identified by a large ionisation precursor in the gas ahead of the shock and significant deviations in the shock front trajectory from the energy conserving prediction. Radiative energy losses from the blast wave approach 100%, causing a reduction in the polytropic index of the shocked material and an observable thinning of the shock shell as the gas becomes more compressible [2].

The low density of the target medium places the radiative shocks in clusters in an interesting regime, distinct from experiments performed in solid or foam targets. The regions ahead of and behind the shock are expected to be optically thin to the radiation, meaning that the system is suitable for investigations of the conditions created in supernova remnants. However, the situation is complicated by the partial ionisation of the gas which affects the compression and strength of the blast waves. The experimental data provide a good test for radiation-hydrodynamics and atomic physics codes and we will discuss some calculations performed using such codes.

In astrophysical blast waves the radiative compression makes the shock shell more susceptible to instabilities such as the pressure driven thin shell overstability – an oscillation of ripples on the shock front – and the thermal cooling instability – an oscillation in the shock velocity. We have investigated whether these instabilities are present in our blast waves and find that spatial non-uniformities tend to smooth out, possibly because of insufficient shock velocity. We demonstrate a method for imprinting a periodic modulation on the shock front with the aim of seeding these instabilities [3]. Using a streaked measurement of the shock position to obtain the entire trajectory in a single shot [4], we have identified oscillations in the shock velocity. These arise as energy is exchanged between the shocked gas and the radiative precursor alternately weakening and rebuilding the shock. The timescale for these oscillations matches a calculation of the radiative cooling time.

[1] K Shigemori *et al.*, AstroPhys. J. **533**, L159 (2000)

[2] J Osterhoff *et al*., New Journal of Physics **11**, 023022 (2009)

[3] DR Symes *et al.*, High Energy Density Physics **3**, 353 (2007)

[4] AS Moore *et al*., Phys. Rev. Lett. **100**, 055001 (2008).