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Microsecond evolution of laser driven blast waves, the influence of shock asymmetries and the resulting development of magnetic fields

ELEANOR TUBMAN, R. CROWSTON, G. LAM, G. DIMOLINE, R. ALRADDADI, University of York, UK, H. DOYLE, J. MEINECKE, J. CROSS, R. BOLIS, University of Oxford, UK, D. LAMB, P. TZEFERACOS, University of Chicago, USA, D. DORIA, B. REVILLE, H. AHMED, M. BORGHESI, Queen's University, Belfast, UK, G. GREGORI, University of Oxford, UK, N. WOOLSEY, University of York, UK —

The ability to recreate scaled conditions of a supernova remnant within a laboratory environment is of great interest for informing the understanding of the evolution of galactic magnetic fields. The experiments rely on a near point explosion driven by one sided laser illumination producing a plasma, surrounded by a background gas. The subsequent shock and blast waves emerge following an initial ballistic phase into a self-similar expansion. Studies have been undertaken into the evolution of shock asymmetries which lead to magnetic field generation via the Biermann battery mechanism. [1] Here we use the Vulcan laser facility, with targets such as carbon rods and plastic spheres placed in ambient gases of argon, helium or hydrogen, to produce the blast waves. These conditions allow us to study the asymmetries of the shocks using multi-frame imaging cameras, interferometry, and spectroscopy, while measuring the resulting magnetic fields with B-dot probes. The velocity of the shock and the temporal resolution of the asymmetries can be acquired on a single shot by the multi-framing cameras, and comparison with the measured B-dot fields allow for detailed inferences to be made.

[1] J. Meinecke et al., Nature Phys. 10, 520 (2014)

Eleanor Tubman
University of York

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