Experimental results on seed magnetic fields generation in laser produced shock waves

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Abstract

Even if astronomical observations indicate that large scale magnetic fields are ubiquitous in the universe, their origin and amplification mechanisms remain one of the most intriguing mystery of modern astrophysics. We have experimentally studied the generation and amplification of self-generated magnetic fields at shock fronts using a high power laser. This approach is based on the scaling of astrophysical environments to laboratory dimensions, yet preserving the essential physics. In this experiment, performed at the Laboratoire pour l'Utilisation des Lasers Intenses (LULI2000) laser facility, a nanosecond laser pulse was focused on a carbon rod inside a low pressure gas filled chamber, generating an asymmetric blast wave. Three-axis induction coils placed several centimetres from the target were used to measure the generated magnetic fields, while several optical diagnostics, including interferometry, Thomson scattering, Schlieren and space resolved emission spectroscopy, were set up to measure the shock wave properties. Here we will present the results and discuss the B-field generation by the Biermann battery mechanism [G. Gregori, Nature, v. 481, p. 480, 2012]. The scaling to the protogalactic shocks will also be considered.