Development and stability of shockwaves generated in tenuous laboratory plasmas

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In Space, the generation of shockwaves and their unstable development are frequently occurring natural phenomena. A noteworthy example is giving by the supernova (SN) explosion, which produces a blast wave that interacting with the interstellar medium (ISM) brings to the formation of sharp plasma boundaries which are unstable to a wide range of physical processes. One of the most usual instability generated by the interaction of these plasma discontinuities with the much less dense ISM is the Rayleigh–Taylor instability[1]. Destabilization of the expanding blastshell in those events can also occur via so-called thin-shell instabilities[2]. It is thought that the disruption of the blastshell front by these instabilities gives rise to the intricate density and flow patterns displayed by some SN remnants. The actual state of technology allows to recreate these phenomena on the laboratory scale by employing high power lasers, giving the opportunity to study them in detail and under controlled conditions, using advanced diagnostics, such as proton radiography.

Thanks to this scientific approach, it is now possible to study several plasma processes and instabilities of relevance to the formation and evolution of collisionless shock waves in laser-produced tenuous plasmas, both magnetized and unmagnetized. A recent, important example is the first experimental observation of the nonlinear thin-shell instability in a colliding flow [3], also extensively supported by PIC simulation[4]. This talk will give a brief overview of the experimental results obtained so far with this approach, and the techniques used to diagnose those features.

References