VORTEX AND TURBULENCE GENERATED BY SHOCKS IN TWO COUNTERSTREAMING LASER PLASMAS

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The collisionless shocks are important phenomena frequently observed along the edges of supernova remnants. These astrophysical shocks are considered to be capable of amplifying magnetic fields through generation of vortex and turbulence [1], and also act as the acceleration source of ultra high energy cosmic rays [2]. Due to the extreme long time span of astrophysical shocks, it is difficult to study their evolution characteristics and influences on the surrounding materials with seed magnetic fields. With giant lasers now available for producing plasmas, it is possible for people to have various shocks for studies of the astrophysical shock's entire evolution and verifications of the hypothesis of their influences in astrophysical environments.

Here we reported the characteristics of shocks generated between two counter streaming plasmas. The experiments were conducted on SG II laser facility, which delivers eight beams of 300J/each laser pulses of 1ns. With the south and the north bunches of laser beams focused respectively on two 5 mm^2 foil targets standing face-to-face with a separation distance of 4.8mm, two counter streaming plasmas were produced, and shocks formed when the two plasmas encountered each other. With time- and space- resolved diagnosis, the shock characteristics were studied.

At 5ns delay after the laser pulse, plasmas located at the middle between the two foil targets presented density enhancement with filamentary structures. According to various instability growth rate calculation and comparison, the shock is attributed to the electrostatic shocks. The filamentary structure disappears at late evolution stage. However at 11ns delay, shock structure appears again, with the magnetic field measured to be around tens of Teslas. The mechanism of magnetic generation/magnification is attributed to be the Weibel instability.

When plasmas were allowed to evolve into much later time, and the two plasmas were not homogeneous, the shock front deformed. At later time, one density cavity was produced at the apex of the shock front. When the cavity rolled off along the shock front from the apex to the wing, a vortex was left after the shock propagating through. This process duplicated itself until the shock front dissipated completely into plasma turbulence. Such experimental results is helpful to understanding of the turbulence formation and magnetic field amplification in astronomy observations [3].

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