STUDIES OF LASER-PRODUCED ELECTROSTATIC COLLISIONLESS SHOCK USING COLLECTIVE THOMSON SCATTERING ION-TERM MEASUREMENT

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In the Universe, high Mach-number collisionless shocks are observed in many astronomical phenomena such as Supernova Remnants, which are known as the sources of galactic cosmic rays, and to reveal physics behind them is essential. Recently, experimental results of laser-produced high Mach-number electrostatic collisionless shocks have been reported, for example, a large density-jump[1], time-evolution of the emission profiles[2], and the local plasma temperature and velocity using collective Thomson scattering (CTS)[3].

The experiment was carried out at Institute of Laser Engineering, Osaka University. Gekko II HIPER laser system was used for the drive laser (Nd: Glass laser: 351 nm, 500 ps, ~360 J / 3beams), and double-plane target was used to produce counter-streaming plasmas. The drive laser beams irradiate the first plane (plane1), and an ablation plasma was produced. The second plane (plane2) was ablated by radiation and the plasma from the plane1, and resulting in counter-streaming plasmas. Materials of planes are Al, Cu, CH, and C. CTS technique can be used when the scattering parameter $\alpha = 1/|\mathbf{k}|\lambda_D > 1$, where λ_D is the Debye length, $\mathbf{k} = \mathbf{k}_s - \mathbf{k}_0$ is the scattering vector, and $\mathbf{k}_s$ and $\mathbf{k}_0$ are the wave vectors of the scattered light and the incident laser, respectively. In this experiment, α was nearly 2 for electron temperature T_e ~ 20 eV. An incident angle of the TS probe laser (Nd: YAG laser: 532 nm, ~10 ns, ~350 mJ) was 45 degrees with respect to the drive laser, and it passed the center of the two planes. Scattered light from the plasma was focused by a first lens in the target chamber placed at 90 degrees from the probe laser, and imaged on a spectrometer. We also used optical diagnostics to measure the structure of the plasmas from the vertical direction using the second Nd: YAG laser (532 nm, ~10 ns, ~300 mJ) for shadowgraphy and self-emission imaging.

As a result, the time-evolution of the shock was investigated in Al plane, and plasma parameters of counter-streaming plasmas in the upstream and downstream regions were determined by CTS ion-term measurement.

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