Gekko XII experiment on magnetized collisionless shock

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Collisionless shocks often play important roles in various high energy phenomena in space. Shock reformation is a periodic collapse and formation process of the shock front occurring even when the upstream plasma is completely uniform and steady, and contributes to the generation of large amplitude waves and to particle acceleration. It is a phenomenon unique to a collisionless system. The structure called a foot, ramp, and overshoot repeats formation and collapse with gyro motion of the ions reflected at a shock. It was theoretically predicted in the 1980s by using computer simulation, but has not been proven yet. In this research we aim at the demonstration of shock reformation, which is not realized by the in-situ observation in space, by using the Gekko XII high power laser experiment at Institute of Laser Engineering (ILE), Osaka University. An aluminum plate target surrounded by nitrogen gas, to which an external magnetic field is applied, is irradiated by the Gekko XII laser (700 J * 4 beam, a wavelength of 1053 nm, a Gaussian long pulse (1.3 ns)). The target plasma sweeps the magnetized gas plasma which is produced by the strong radiation due to laser-target interaction. As a result, a shock wave is generated in the magnetized gas plasma. In the experiment in 2019 we could successfully apply 3.8T ambient magnetic field in the experimental system for the first time. The observed shock clearly contains inner structures not seen in our previous experiments without ambient magnetic field. We identified the so-called overshoot and foot in the shock transition region. In addition, a precursor of a shock modified by the ambient magnetic field is also identified in the early stage after the main laser shot.

Keywords: high power laser experiment, collisionless shock, magnetic field

