高強度レーザー実験で生成される静電衝撃波の構造

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Structure of electrostatic shocks produced in high power laser experiments

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We have performed high power laser experiment on collisionless shocks by using Gekko XII laser at Osaka University. In the experiment an electrostatic shock is produced by irradiating a target Aluminium foil with the Gekko XII hyper laser in a chamber filled with 5 Torr Nitrogen gas. When the target foil is ablated, strong radiation is emitted and fully ionizes the surrounding Nitrogen gas. In such a situation a relatively hot and dense target plasma sweeps a relatively cool and tenuous gas plasma. As a result, an electrostatic shock wave is formed in the gas plasma.

While the shock formation scenario based on the above fluid-like viewpoint has been accepted, the detailed process with a kinetic point of view has not been understood. In this study the interaction between a target and a gas plasmas is reproduced by using a full particle-in-cell simulation. Initially, two different plasmas are contact, where the gas plasma is at rest and the target plasma has a finite bulk velocity in the direction pressing the gas plasma. Although the two plasmas are initially separated, strong electrostatic instability leads to mixing of the two plasmas. In the region initially filled with the gas plasma a sharp density jump is formed and propagates away from the target with a supersonic velocity, i.e., a shock wave is formed. The electron and ion foreshocks are produced in front of the shock. The foreshocks are turbulent due to the beam instabilities generated locally. Detailed electron and ion distribution functions are also discussed.