室内および数値実験による無衝突衝撃波の研究

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Experimental and numerical studies on collisionless shocks

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Collisionless shocks are ubiquitous in various space and astrophysical environments like planetary bow shocks, the termination shock, supernova remnant shocks etc. In space there is an observational dilemma in heliospheric physics and astrophysics. In-situ observations in heliosphere can resolve detailed local and kinetic structures of a shock (electromagnetic fields, particle distribution functions, ...), while the global structure of the system at the same time is usually unknown. In contrast remote sensing in astrophysics can capture global or fluid scale structures of a shock, although its local or kinetic scale structures can never be resolved. Recent numerical simulations, on the other hand, show that multi-scale phenomena often play crucial roles in collisionless shock physics.

Recently, a collisionless shock can have been generated in a laboratory. The laboratory astrophysics is expected to enable us to access both the local and the global structures of the system simultaneously. However, there are a number of difficulties in measuring the structures of the shock as well as the interpretation of the results. For instance, although a high Mach number unmagnetized shock with M > 10 appears to be produced in a counter streaming plasma flows in the laboratory, its generation mechanism has been totally unknown (There is no plausible candidate of plasma instability in the observed condition.). Moreover, the measurement of local plasma quantities in nonequilibrium, nonstationary, and nonlinear plasma as in the transition region of a shock is inherently difficult and has not been established. We will review the current status of the collisionless shock experiment and discuss our recent approaches using numerical simulations to the above mentioned issues.