Collisionless Driven Reconnection Under The Influence Of Strong Guide Magnetic Field In An Open System

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It is widely believed that magnetic reconnection observed in various natural systems is controlled by common or similar physical processes, regardless of big differences in magnetic configurations and temporal-spatial scales. A series of particle-in-cell (PIC) simulation studies have disclosed that that there are two microscopic mechanisms, which break frozen-in condition and excite magnetic reconnection in a collisionless plasma without any guide field, i.e., one is due to anomalous resistivity associated with plasma instabilities [1] and the other is due to the effect of a nongyrotropic particle motion, called "meandering motion", in the vicinity of a reconnection point [2, 3]. It is easily expected that these microscopic mechanisms controlling collisionless reconnection may be altered under a strong guide field such as fusion devices.

Influence of a guide magnetic field on collisionless driven reconnection is investigated by means of two-dimensional and three-dimensional electromagnetic particle simulations in an open system which is subject to an externally driving source [4]. In a quasi-steady state when reconnection electric field evolves fully, a current layer evolves locally in a narrow kinetic region and its scale decreases in proportion to an electron meandering scale as the guide field is intensified. Off-diagonal components of electron and ion pressure tensor terms, which are originating from nongyrotropic motions of charged particles, becomes dominant at the reconnection point and sustain the reconnection electric field even for a strong guide field case. It is also found that thermalization of both ions and electrons is suppressed by the guide field. An electron non-thermal component is significantly created through a fast outburst from the kinetic region for the weak guide field, while an ion non-thermal component is generated through the acceleration by an in-plane electric field near a magnetic separatrix for the strong guide field. We will also discuss how anomalous resistivity associated with plasma instabilities is modified in a strong guide field.

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