サブストーム拡大相オンセットの力学

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Mechanics of substorm expansion onset: An update

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Auroral breakup is a long-standing unsolved issue in the magnetospheric physics, despite many theories and models have been developed. Abrupt intensification of upward field-aligned current (FAC) is central to this issue because the upward FAC is responsible for accelerating electrons downward and emitting bright aurora. The purpose of this presentation is to update and refine the mechanisms that were suggested by Ebihara and Tanaka [2015, JGR, doi:10.1002/2015JA021516] by reanalyzing the result of the global magnetohydrodynamics (MHD) simulation. We obtained the following results: (1) When a near-Earth neutral line (NENL) forms, plasma originating in the lobe starts to be accelerated toward the equatorial plane. The plasma within 10 Re then traverses the separatrix, or a last-closed field line at off-equator, and enters the inner magnetosphere. (2) Near the separatrix, magnetic field is intensified by perpendicular motion of plasma (compression and advection), resulting in the intensification of the Lorentz force pointing toward the equatorial plane. (3) Successively, the trajectory of plasma turns to the east and west directions by pressure gradient force associated with filed-aligned pressure increase by compression. (4) The directional change of the flow at off-equator generates (matches with) the upward FAC that is responsible to auroral breakup. In short, the abrupt intensification of upward FAC is a result of the formation of the NENL and the subsequent magnetospheric reconfiguration that takes place three-dimensionally. In the course of the three-dimensional reconfiguration, the changes in the magnetic field and the plasma pressure result in turning of plasma motion that generates onset-associated upward FAC. The most important and relevant flow of plasma lies at off-equator.