サブストーム拡大相オンセット時におけるエネルギーの流れと変換過程

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Pathway and conversion of energy at substorm expansion onset

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Substorm expansion onset is a long-standing unsolved issue in magnetospheric physics. One of the central issues is abrupt intensification of upward field-aligned current (FAC) that is responsible for accelerating electrons downward and emitting bright aurorae. Based on the results obtained by the global magnetohydrodynamics (MHD) simulation, we present energy flow and energy conversion associated with the upward FACs that manifest the onset of substorm expansion. The cusp/mantle region transmits electromagnetic energy to almost the entire region of the magnetosphere. A part of electromagnetic energy is stored in the lobe in the growth phase. When reconnection takes place in the near-Earth tail region, the stored energy is released in addition to the continuously supplied one from the cusp/mantle dynamo. Two types of pathways of energy seem to be involved in the generation of the onset-associated FACs. The first type is related to the earthward fast flow associated with reconnection on the nightside. The electromagnetic energy coming from the lobe splits into the thermal energy and the kinetic energy. The kinetic energy is then converted to the thermal energy and the electromagnetic energy, in association of flow braking. The second type is that the plasma coming from the lobe goes into the inner magnetosphere directly. The electromagnetic energy is converted to the thermal energy, followed by the electromagnetic energy at off-equator. The near-Earth dynamo region, where the electromagnetic energy is generated, seems to be embedded in the convection system. In this sense, the expansion onset may be regarded as a sudden, local intensification of the convection.