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Plasma flow bursts in the plasma sheet and field-aligned acceleration

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The substorm ignition on the field-aligned acceleration region is derived from the dynamical behavior of auroral kilometric radiation (AKR). Based on this circumstance, the association of AKR with plasma flow-bursts was statistically examined to investigate the response of the M-I coupling region to magnetospheric dynamics at substorm onset. Important evidence disclosed from the statistical study is that about 40 % of flow bursts do not affect the intensification or activation of field-aligned acceleration, i.e., they have no effect on substorms. The flows in this group show contrastive plasma-beta characteristics to the flow bursts associated with substorm, indicating that flow bursts composed of higher-beta plasma are less effective in activating the M-I coupling region. Although the physical meaning of this evidence is now an open question, one possible explanation is that the magnetic-field pile-up of high-beta flow bursts is less effective at the braking zone in the near-earth plasma sheet.
The other important evidence obtained from the statistical study is that the magnitude of flow velocity, which is considered to be a rough measure of flow braking near the earth, is not always an essential factor in triggering full-substorms, being consistent with the case study by Ohtani et al. [2002a] who showed that the magnitude of earthward magnetic-flux transport does not distinguish full-substorms from pseudo-substorms.
It is suggested from these relationships between the plasma flow burst in the plasma sheet and its response to the M-I coupling region that a field-aligned current (FAC) system originated by the plasma flow burst first enhances low-altitude acceleration (initial brightening), and the increasing field-aligned current induces sudden acceleration (auroral breakup) above the preexisting low-altitude acceleration as a consequence of current/current-driven instabilities. In this sense, substorm is finally ignited in the auroral M-I coupling region.

Keywords: substorm onset, field-aligned acceleration, flow burst