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Non-adiabatic ion acceleration in the Earth's inner magnetosphere on a substorm time scale
Non-adiabatic ion acceleration in the Earth's inner magnetosphere on a substorm time scale

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In order to investigate non-adiabatic ion acceleration in the Earth's inner magnetosphere on a short time scale (<30min) and its contribution to ring current development, we examine the temporal variations of energy spectra of energetic neutral atoms (ENAs) during substorms that occur in the storm main phase. ENAs are detected by the High Energy Neutral Atom (HENA) imager onboard the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) satellite. The ENA energy used in the present study ranges from 10 keV to 198 keV for hydrogen and from 29 keV to 222 keV for oxygen. We use ENA data obtained from two independent areas of a HENA image, for which HENA line-of-sights pass through the inner magnetosphere (~-6 RE<X<~-3 RE around the magnetic equator) and the outer magnetosphere (X<~-6 RE around the magnetic equator).

Case studies for three substorms on 21 October 2001 and two substorms on 19 March 2002 [Keika et al., 2010, JGR] showed that (1) the oxygen ENA flux displays 20 to 30-min bursts during all substorms, while the hydrogen ENA flux did not increase or less significantly increased than the oxygen flux; (2) the temporal evolution of energy spectra is mass dependent for all examined substorms; (3) for two of the substorms, the oxygen flux ratio between before and after a substorm increases with increasing energy, indicating the hardening of an O+ energy spectrum; and (4) the flux ratio for the inner image area is comparable to or higher than that in the outer area. The results confirm that nonadiabatic acceleration with regard to the first adiabatic invariant did occur in the near-Earth magnetotail (X>-8 RE) and that the acceleration is mass-dependent.

This paper presents statistical results of the energy spectral evolution during storm-time substorms that occur in 2001 - 2003. We study how frequently, in which storm phase, and under what solar wind and magnetospheric conditions the non-adiabatic acceleration occurs. We then discuss for what energies/species the violation of the first adiabatic invariant occurs and what field variations/fluctuations cause such non-adiabatic acceleration.

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