EPSC Abstracts,
Vol. 4, EPSC2009-684, 2009
European Planetary Science Congress,

Does Fermi Acceleration of second-order account for the variations of the fluxes of radiation belt particles observed during geomagnetic storms?

J. F. Lemaire (1)

(1) BISA & CSR, Louvain-La-Neuve, Belgium (jfl@astr.ucl.ac.be)

Abstract

Betatron acceleration and deceleration are known to play a fundamental role in the dynamics of Ring Current and Earth's Radiation Belt particles ([1]-[3]). Indeed, the betatron mechanism accounts quite well for observed adiabatic variations of the inner belt protons as well of outer zone electrons mirroring close to the equatorial plane of the magnetosphere. Especially, during small (< 100 nT) geomagnetic field intensity, simple models based on this physical process are able to predict satisfactorily the changes of the trapped energetic particles observed by the early EXPLORER 15 and 26 measurements (see: [4]).

But occasionally, fluxes of energetic trapped protons and electrons exhibit rapid non-adiabatic decreases and increases which are not yet explained (see: [4]).

It will be shown, that the second-order Fermi acceleration (and deceleration) is an additional physical process modulating the fluxes of all trapped RB particles, and most importantly for those mirroring at lower altitudes: i.e. particles whose mirror points are at higher latitudes far away from the equatorial region.

Direct numerical simulations of Fermi deceleration will be presented. These simulations illustrate how, during the main phase of geomagnetic storms, Fermi deceleration is always accompanied by an uplifting of the altitudes mirror points for particles of all energies; it is also accompanied by a lengthening the segment of magnetic field line between the conjugate mirror points. As a consequence of the combined effects of the Fermi acceleration, the flux of particles measured at low altitudes is expected to decrease. This is indeed consistently observed during main phases of geomagnetic storms. Conversely, during recovery phases, when the B_z-component of the Ring Current magnetic field intensity gradually recovers the pre-storm value, all trapped particles are adiabatically accelerated by the Fermi mechanism, and their mirror points drop back into the denser part of the atmosphere. The combination of Fermi acceleration and downward movement of mirror altitudes accounts for adiabatic variations of the RB fluxes measured on LEO orbits during recovery phases of some geomagnetic storms events.

However, in order to explain that for a number of other events the post-storm RB fluxes are either larger or smaller than the pre-storm values, a non-adiabatic physical process is required as pointed out by McIlwain [3], and more recently by Kim and Chan [5], McAdams and Reeves [6] and others.

Such a potential physical mechanism will be proposed and discussed in this presentation.

References

[1] Dessler, A.J. and R. Karplus (1961), *JGR*, 66, 2289.

[2] McIlwain, C.E. (1964), *Space Research V*, 374.

[3] McIlwain, C.E. (1966), J*GR* 71, 3623.

[4] McIlwain, C.E. (1996), In "*Radiation Belts: Models and Standards*", AGU Geophysical Monograph 97, Eds J. F. Lemaire, D. Heynderickx and D.N. Baker, 15-26.

[5] Kim, H.-J. and A. Chan [1997], *JGR* 102, 22107.

[6] McAdams K.L. and G.D. Reeves (2001), *GRL,* 28, 1897.