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# A New Proxy for Identifying Non-Adiabatic Behavior of Charged Particle Dynamics in Jupiter's Radiation Belt

Ayushi Srivastava*, Bharati Kakad, Amar Kakad
Indian Institute of Geomagnetism, NaviMumbai, Maharashtra, India-410218
email: ayushisrivashtava@gmail.com, bharati.kakad@iigm.res.in, amar.kakad@iigm.res.in

Jupiter hosts the most intense and hazardous radiation belts in the solar system, populated by ultra-relativistic protons (~100 GeV), electrons (~100 MeV), and heavy ions such as $O^{+}$, $O^{2+}$, $S^{+}$, $S^{2+}$, and $S^{3+}$ (~100 MeV) [1]. Depending on their energy, and the local magnetic field strength, these charged particles may either escape or remain confined within Jupiter's magnetosphere. The trapped particles undergo gyro-motion, bounce motion, and drift motion due to the influence of the magnetic field. However, at higher energies, these particles can exhibit non-adiabatic behavior, deviating from classical adiabatic motion. Many theoretical and computational models employ the gyro-center approximation to study charged particle dynamics in planetary magnetospheres [2]. However, under non-adiabatic conditions, the validity of such approximations becomes uncertain. In this study, we perform three-dimensional relativistic test particle simulations to analyze the motion of charged particles in Jupiter's inner radiation belt. We introduce a new parameter, $\mathbf{r_L = \frac{mv_\perp}{qB}}$, as a criterion to distinguish adiabatic and non-adiabatic particle behavior. Our results indicate that when $r_L$ exceeds 1000 km, the charged particles exhibit non-adiabatic motion. This newly proposed proxy provides a useful diagnostic for identifying adiabatic and non-adiabatic regimes of trapped energetic particles, offering deeper insights into the complex dynamics of Jupiter's radiation belts.

References

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