2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Resonant interactions between charged particles and ULF waves: theory and observations

Xuzhi Zhou[1], Li Li[1], Zihan Wang[1,2], Qiugang Zong[1], and Robert Rankin[3]
[1] School of Earth and Space Sciences, Peking University, Beijing
[2] Climate and Space Sciences and Engineering, University of Michigan, Ann Arbor, MI
[3] Department of Physics, University of Alberta, Edmonton, AB
e-mail (speaker): xzzhou@pku.edu.cn

In Earth's inner magnetosphere, electromagnetic waves in the ultralow frequency (ULF) range have long been considered to play an important role in accelerating and diffusing charged particles via a resonant process named drift resonance. When drift resonance occurs, particles drifting at the same speed as the waves observe a stable phase of the wave electric field and therefore experience a net energy excursion. In the prevailing theory of ULF wave-particle interactions[1,2], a few assumptions are made to reveal the most essential, drift resonant process. Here we relax some of the assumptions so as to understand the particle behavior in a more realistic, ULF wave field. For example, we introduce in the wave model a time[3] and a longitude[4] dependence of the ULF wave amplitude. Also, we extend the prevailing, linear theory of drift resonance into the nonlinear regime to accommodate those waves with a large amplitude and/or duration[5]. Based on these extensions, we predict from the extended scenario the observable signatures of nonlinear drift resonance in a more realistic magnetosphere. The predicted signatures agree with spacecraft observations, which validates the extended theory and therefore also provides an improved understanding of particle dynamics and interactions with ULF waves in the inner magnetosphere.

References

1. Southwood, D. J., and M. G. Kivelson (1981), Charged particle behavior in low-frequency geomagnetic pulsations: I. Transverse waves, J. Geophys. Res., 86, 5643.
2. Southwood, D. J., and M. G. Kivelson (1982), Charged particle behavior in low-frequency geomagnetic pulsations. II - Graphical approach, J. Geophys. Res., 87, 1707.
3. Zhou, X.-Z., Z.-H. Wang, et al. (2016), Charged particle behavior in the growth and damping stages of ultralow frequency waves: Theory and Van Allen Probes observations, J. Geophys. Res. Space Physics, 121, 3254, doi:10.1002/2016JA022447
4. Li, L., X.-Z. Zhou, et al. (2017), Charged particle behavior in localized ultralow frequency waves: Theory and observations, Geophys. Res. Lett., 44, doi:10.1002/2017GL073392
5. Li, L., X.-Z. Zhou, et al. (2018), Nonlinear drift resonance between charged particles and ultralow frequency waves, manuscript in preparation