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Wave-particle interactions and radiation belt dynamics

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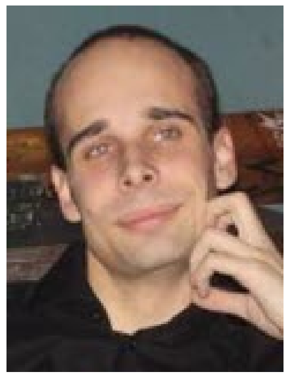

Wave-particle interactions represent a unique mechanism of an energy transfer in the nearly collisionless plasma environment of the near-Earth space, so-called Earth's magnetosphere. These interactions ultimately affect distribution functions of energetic particles trapped in the Van Allen radiation belts. Depending on the actual situation, they may be responsible both for the particle energization and loss. We present an overview of the radiation belt dynamics, discussing the particle trapping, and relevant source and loss mechanisms. We start with a general picture of the Earth's magnetosphere, focusing on the inner part and introducing the plasmasphere and Van Allen radiation belts. Then, energetic particle movement in the nearly dipolar Earth's magnetic field and related adiabatic invariants are discussed. We focus in particular on consequences and means of a possible violation of these invariants. The concept of a random walk and diffusion, both radial and in pitch angle is introduced. We demonstrate the importance of a resonant interaction between a wave and a particle, both theoretically and using actual experimental data. We further focus on the most important wave phenomena observed in the Earth's magnetosphere. We introduce their basic classification and properties, along with the propagation scheme through the inner magnetosphere. We review the suggested generation mechanisms and impacts of individual emission types on energetic particles in the radiation belts. Recent spacecraft data and scientific results are used to demonstrate the progress in our understanding of these amazing near-Earth space phenomena. Finally, we briefly introduce examples of a few open questions related to the radiation belt dynamics and generation and propagation of electromagnetic emissions in the Earth's inner magnetosphere.