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Implicit Particle-in-Cell simulations of wave-particle interactions between electrons and whistler waves in the radiation belt

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Whistler wave chorus are believed to play a crucial role in the radiation belt dynamics, possibly being responsible for the loss and acceleration of energetic electrons.
For this reason, the mechanisms related to the formation and propagation of whistlers in the radiation belt have been intensively investigated during the last decade.
It is now generally acknowledged, via observational and simulation studies, that the whistler waves generated close to the magnetic equator through linear temperature anisotropy instabilities undergo an amplitude amplification that is essentially regulated by nonlinear mechanisms.
In this work we focus on the wave-particle interaction between electrons and whistler chorus by employing two-dimensional fully-kinetic Particle-in-Cell simulations. The magnetic field is assumed to form a magnetic bottle that captures the particle bouncing motions and mimics the Earth's magnetic dipole.
The code employs a semi-implicit time stepping algorithm that, in this context, is shown to be important in order to achieve accurate results with realistic parameters.
We analyze and discuss the pitch-angle/energy scattering of energetic particles and comment on the applicability of the quasi-linear diffusion paradigm.