# Large-amplitude oblique whistler waves and relativistic electron acceleration

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Spacecraft observation shows that large-amplitude whistler waves propagating in oblique directions with respect to the ambient magnetic field may be responsible for energizing the radiation belt electrons to relativistic energies within a time scale as short as a fraction of a second. Test-particle simulations available in the literature invariably adopt simple model waveforms for the oblique whistlers. Solutions of fully nonlinear warm electron fluid equation show that oblique whistlers not only undergo steepening but also large-amplitude whistlers are unstable to nonlinear parametric instability. The physics of whistler wave steepening and nonlinear processes as well as their impact on particle interaction will be discussed. Relativistic test particle simulation shows that a population of initially low energy electrons can be accelerated in a few seconds to O(10) MeV energies. However, it is shown that such an efficient electron acceleration is possible only if the wave propagation angle is sufficiently large so that quasi-parallel propagation of whistler waves cannot accelerate the electrons.