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Relativistic surfatron process for Landau resonant electrons in radiation belts

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Recent theoretical studies of the nonlinear wave-particle interactions for relativistic electrons have shown that energy-momentum exchange of Landau resonant orbits is strongly dependent on the propagation angles θ_{kB} between the wave vector $\mathbf{k}$ and the background magnetic field $\mathbf{B_0}$. Large-amplitude waves ($\frac{\delta B}{B_0} \sim 1\%$) propagating near a critical propagation angle θ_c associated with a Hopf-Hopf bifurcation condition can efficiently accelerate electrons along the background field, a process equivalent to surfatron mechanisms studied in laser-plasma interactions. We extend previous studies to reach greater modeling capacities for the study of electrons in radiation belts by including electrostatic wave effects and inhomogeneous magnetic fields. We find that even though the inclusion of electrostatic components and field inhomogeneities can limit the surfatron acceleration of electrons in radiation belts, gain in energy of the order of 100 keV, taking place on one tenth of a millisecond, are sufficiently strong for the mechanism to result in lower pitch angle transport and precipitations. The probability of generating relativistic microbursts, through a few coherent interactions, is also computed as a function of equatorial pitch-angle and energy.