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Relativistic beam loading and recoil effects using a covariant, retarded-potential iterator

Wednesday, 10 May 2023 16:30 (2 hours)

A algorithm is demonstrated which performs first-principles tracking of relativsitic charged-particles for determining the power they deposit into their surroundings (in particular, blackbody cavities and pillbox accelerating cavities). A computationally costly, but highly accurate covariant approach is used, which employs retarded vector potentials for trajectory integration instead of performing field calculations.

The peak vector potential and related Lorentz force in the direction of travel is shown to increase asymptotically for high β particles approaching a conductive surface or another charged particle. This effect produces a very strong field distribution at small angles from the source particle's direction of travel, which, for high-intensity beams, can deposit significant power onto the surface surrounding a cavity's exit aperture.

Changes in momentum of a charged particle occurring after a cut-off of external fields are shown to be non-conservative, such that any resulting power deposition causes a recoil effect on the cavity.

We present benchmark cases for this framework and results for two-particle simulations as well as small-bunch simulations using a macroparticle formalism.

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Footnotes

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Yes

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