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Wake-field generated by a line charge moving in the vicinity of a dielectric cylinder

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Abstract

The wake-field generated by a moving line charge in the vicinity of a dielectric cylinder is analyzed. It is shown that the emitted energy increases logarithmically with the kinetic energy $(\gamma - 1)$ of the line charge and decays exponentially as a function of the ratio h/R, where R is the cylinder radius and h is the distance of the line charge from the cylinder's axis. Upon investigation of the angular distribution of the radiated energy we found it to be almost uniform in the non-relativistic case, whereas for the relativistic case most of the emitted energy is radiated parallel to the direction of motion of the line charge. For a relativistic regime, the emitted energy is almost independent of the cylinder dielectric coefficient (ε_r) provided the latter is frequency-independent. Frequency dependence of ε_r reduces significantly the deceleration of the line charge. For the ultra-relativistic case the transverse kick is inversely proportional to the kinetic energy and, as expected, increases as the line charge gets closer to the cylinder. Finally, a finite size bunch has been considered. As the transverse width of the bunch is increased, the total emitted energy also increases and the spectrum is broadened.

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