Vacuum Channeling Radiation by Relativistic Electrons in a Transverse Field of a Laser-Based Bessel Beam

L. Schächter[1,*] and W. D. Kimura[2]

[1]*Technion—Israel Institute of Technology, Haifa 32000, Israel*

[2]*STI Optronics Incorporated, Redmond, Washington 98052, USA*

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Relativistic electrons counterpropagating through the center of a radially polarized J_1 optical Bessel beam in vacuum will emit radiation in a manner analogous to the channeling radiation that occurs when charged particles traverse through a crystal lattice. However, since this interaction occurs in vacuum, problems with scattering of the electrons by the lattice atoms are eliminated. Contrary to inverse Compton scattering, the emitted frequency is also determined by the amplitude of the laser field, rather than only by its frequency. Adjusting the value of the laser field permits the tuning of the emitted frequency over orders of magnitude, from terahertz to soft X rays. High flux intensities are predicted ($\sim$100 MW/cm^2). Extended interaction lengths are feasible due to the diffraction-free properties of the Bessel beam and its radial field, which confines the electron trajectory within the center of the Bessel beam.

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