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P1.4003 Excitation of a plasma wakefield by incoherent radiation via Compton scattering

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See the full abstract here:
http://ocs.ciemat.es/EPS2019ABS/pdf/P1.4003.pdf

We show from first principles that an incoherent photon pulse traversing a plasma can excite a plasma wake via Compton scattering. We distinguish two regimes: i) the non-relativistic regime, where the incoherent photons have energy below the electron rest mass, and ii) the relativistic regime, where the incoherent photons have energy larger that the electron rest mass. In the first regime, the displacement of the plasma electrons due to the photon-electron scattering events is smaller than the electron inertial length and the wake is established likewise the ponderomotive force of a laser would do. In the second regime, the displacement of the plasma electrons due to the photon-electron scattering events is larger than the electron inertial length, this loads over time a relativistic electron beam that almost co-propagates with the incoherent photon pulse. Here the wake is driven by the loaded electron beam which grows in charge as the photon driver propagates. This fundamental mechanism may have implications both in wakefield accelerator technology, where an incoherent pulse of photons could replace a laser (coherent driver), and in astrophysics as an an acceleration engine of particles alongside already known processes (e.g. magnetic reconnection, shock acceleration, etc …). We illustrate these processes via the recently implemented Compton scattering module into the PIC code OSIRIS 4.0 [1], following the pioneer numerical work of Frederiksen [2]. This enables us to couple self-consistently and from first principles the interaction of the incoherent photons with the plasma. We have also derived from linear perturbation theory the average momentum transfer from the photon pulse to the plasma electrons, the amplitude of the perturbed electron density and the accelerating field strength. Our simulations show excellent agreement with the analytical estimates.

References
[1] R. Fonseca et al., Lecture Notes in Comput. Sci. 2331, 342 (2002)
[2] J. T. Frederiksen, The Astrophysical Journal 680 , L5 (2008)

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