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Quantum dynamics of relativistic charged particles interacting with a laser-induced plasmon wave

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We analyse the new exact solutions [1-3] of the relativistic wave equations of a charged particle propagating in a plasmon wave of arbitrary high amplitude. The nonlinearities associated to these solutions depend on a new intensity parameter, which is the work done by the laser field along the plasmon wavelength divided by the laser photon energy. These solutions describe a high-contrast periodic longitudinal density structure on the plasma length scale (a sort of ‘quantum-bubble’), whose existence relies on the discrete absorption of momentum quanta along the wave’s transverse electric field. We show that for vanishing plasma density, certain ‘coherent superpositions’ of our solutions reproduce the Volkov states [4], which, by now, have been the only closed form exact solutions in a plane wave in vacuum. This is relevant for solving the boundary-value problem at the plasma-vacuum interface.

[1] Varró S, *Las. Phys. Lett.* 10 (2013) 095301. [2] Varró S, *ibid.* 11 (2014) 016001.

[3] Varró S, *Nucl. Instr. Meth. Phys. Res. A* 740 (2014) 280-283.

[4] Volkov D M, *Zeitschrift für Physik* 94 (1935) 250-260.

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