Ponderomotive and resonant effects in the acceleration of particles by electromagnetic modes in vacuum and plasmas

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In the present analysis we study the dynamics of charged particles submitted to the action of slowly modulated relativistic electromagnetic carrier waves, both in vacuum and in plasma media. Firstly, with the use of a high-frequency laser mode along with a modulated static magnetic wiggler, we show that the ensuing total field effectively acts as a slowly modulated high-frequency beat-wave field typical of inverse free-electron laser schemes. This effective resulting field is capable to accelerate particles much in the same way as space-charge wake fields do in plasmas accelerators [1], with the advantage of being more stable than plasma related settings. Acceleration occurs precisely as particles transition from ponderomotive to resonant regimes, so we develop the proper ponderomotive formalism to examine the problem. The formalism includes terms hitherto not discussed in the usual applications of the approximation, but that are nevertheless of crucial importance in the vicinity of resonant capture. The role of these terms is then also discussed in the broader context of laser-plasma interactions [2, 3].

References

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