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Manipulating the Particle Phase Space with Nonadiabatic Ponderomotive Barriers[1]

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A ponderomotive potential is an effective potential seen by a particle in ac field on average over the fast oscillations. It is not a true potential though, and hence can be used for particle manipulations more advanced compared to those via static potentials. If the field scale is small enough, the particle motion in a ponderomotive barrier is essentially phase-dependent and resembles the dynamics of a quantum object in a conservative field. Probabilistic transmission is possible in this case [1, 2] and can produce attosecond electron bunches when a uniform relativistic electron beam is scattered off an intense laser wave in vacuum. For particles exhibiting natural oscillations (e.g., Larmor rotation or internal vibrations), nonadiabatic yet phase-independent ponderomotive manipulations by resonant ac fields are also available [3-5]. An approximate integral of particle motion is found for resonant nonlinear interactions, and a new ponderomotive potential is introduced accordingly [6]. Unlike static potentials, resonant barriers can produce a ratchet effect by asymmetrically transmitting thermal particles in a preferential direction [3, 4, 7]; techniques of selective separation and cooling of plasma species are also proposed [6].

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[1]The work is done in collaboration with N. J. Fisch.