On stochastic electron dynamics in colliding plane waves

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Stochastic dynamics of the electron interacting with multiple electromagnetic waves is a subject of active research [1-6]. Recently, dynamics of the relativistic electron interacting with two counter-propagating plane waves was described with a 3/2-Hamiltonian, [5] allowing to utilize the techniques used in previous studies of stochastic dynamics in such systems. This novel Hamiltonian approach provided a clear physical picture of the mechanism behind the onset of stochasticity in electron motion. However, the previous analysis [5] did not consider the impact of the electron's canonical momentum $\bar{P}_{\perp}$ perpendicular to the laser propagation axis. Assessing the effects of $\bar{P}_{\perp}$ enables [5] a better understanding of the recent numerical results of stochastic heating in colliding laser pulses, such as the dependence on the initial laser phases [6].

This talk presents a recently published [5] study of stochastic heating of an electron with an arbitrary canonical momentum P in the presence of two counter-propagating linear plane waves with vector potentials $\mathbf{a}_1$ and $\mathbf{a_2}$, with an arbitrary angle between the polarizations. The onset of stochasticity for both parallel and perpendicular polarization setups is demonstrated.

For $a_2 \ll a_1$ case, i.e. when laser amplitude a_1 of one of the lasers dominates the other, the stochasticity threshold is derived, showing how the stochastic region of H decreases with an increase of perpendicular canonical momenta $\mathbf{P}_{\perp}$. The physics behind the impact of $\mathbf{P}_{\perp}$ on the stochasticity boundary is revealed. Finally, the Hamiltonian analysis is expanded to include the impact of radiation friction in the classical radiation reaction limits. It is shown that Hamiltonian analysis remains valid within applicability of classical RF approximation. Presented results are useful for understanding the electron dynamics in counter-propagating laser pulses such as, for example, the incident-reflected laser pulses in laser-target interactions.

References

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