Relativistic and quantum theory of ultra-high intensity laser-matter interaction

Proposed in collaboration with ELI ERIC

Abstract: The new multi-PW laser installations worldwide intend to explore new regimes of light-matter interaction at extreme intensities. On the one side one would like to investigate fundamental physics aspects, on the other side new possibilities for applications present themselves. Due to the high intensities atoms are immediately ionized, and the interaction takes place with a plasma. Plasmas are dominated by collective effects. It is possible to exploit the interaction of laser pulses with collective effects in a controlled, designed way and generate the possibility for coherent radiation in a very extreme environment. The thesis will explore in more detail the conditions and effects of coherence by employing analytics and dedicated simulation tools.
The project is dedicated to the theoretical and numerical investigation of the interaction of relativistic particles with ultra-high intensity laser pulses. In particular, we will study the strong field processes – radiation emission, electron-positron pair creation, back-reaction of radiation on particles motion (radiation friction) beyond the already explored case, when a single particle emits a single photon/pair. We will investigate the correlations in radiation emission by single/many particles, which are important for accurate theoretical description of strong laser – plasma interactions.

Type of thesis: dissertation thesis

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