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Experimental Signatures of the Quantum Nature of Radiation Reaction in the Field of an Ultraintense Laser

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Quantum Electrodynamics (QED) represents one of the greatest theoretical achievements in modern physics, able to elegantly combine electromagnetism, quantum mechanics, and special relativity into a unified theory. Its predictions have been tested to a high degree of precision in relatively low fields but, thus far, little is experimentally known about the behaviour of quantum systems in fields comparable to the QED critical field ($E_S \sim 1.3 \times 10^{18}$ V/m). At these field intensities, exotic phenomena are predicted to occur, such as stochastic photon emission, electron-positron pair production in vacuum, and strong radiation reaction.
The fast-paced development of high-power laser technology is now opening up the possibility of studying high-field QED in the focus of a laser. For instance, a 1 GeV electron propagating through a laser field with a realistic intensity of 10^{21} W/cm^2, already experiences a field of the order of $0.2E_S$.
In this talk, we will discuss experimental campaigns carried out at the Central Laser Facility on quantum effects in radiation reaction and on pair production via linear Breit-Wheeler, together with future campaigns currently under preparation at the Eu-XFEL and FACET-II.The implications of these experiments for the next generation of ultra-high power laser facilities will also be discussed.

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