Coherent Enhancement of QED Cross-Sections in Electromagnetic Backgrounds

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In this talk, I will describe form factors that can be used to relate the amplitude of a QED process in vacuum to its corresponding process in a background field. The latter is characterised by a reduced S-matrix element in which one or more photon field operators are replaced by classical background fields. In the associated Feynman diagrams, external photon lines are supplanted with lines representing the c-number field. This modifies the cross section by factors proportional to powers of the Fourier amplitude of the classical field. This modification is demonstrated explicitly by comparing different reaction channels of low-energy photon-photon scattering in a classical background. It is found that the background-field cross sections typically undergo coherent enhancement and, for some reaction channels, exhibit more favourable scaling with centre-of-mass energy compared to the vacuum process. Similar coherent enhancement may also occur in leading-order pair annihilation to a single photon, though this competes with kinematic suppression. It is shown that this suppression can be minimised by using an X-ray free electron laser as the classical background.