From Theory to Experiment: Challenges and Opportunities in Strong-Field QED

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(Dated: August 11, 2021)

This talk aims at providing an intuitive understanding for some of the most intriguing strong-field quantum phenomena that could soon be investigated experimentally, e.g., using laser-electron or beam-beam collisions, including: *Photon emission*: from classical to quantum, from linear Compton scattering to multi-photon effects; formation region and local constant field approximation (LCFA), breakdown at low photon energies; radiative corrections and radiative lifetime; change in the spectrum in the extreme quantum regime. *Radiation reaction*: from classical to quantum; changes in the photon spectrum induced by multiple emissions; deviations from the Poissonian limit. *Pair production*: multi-photon vs. tunneling regime; single- vs. two-step approximation; quantum vs. classical absorption of laser energy; exponential wavefunction decay. *Recollision physics*: relativistic electron-positron recollisions in a strong laser field. *Vacuum polarization*: vacuum birefringence and vacuum dichroism, Euler-Heisenberg effective action vs. quantum corrections. *QED cascades*: seeded laser-laser vs. beam-laser collisions. *Pair plasma*: observing collective effects, frequency upshift of the driving laser field. *Fully nonperturbative QED*: asymptotic scaling of radiative corrections, change of the relevant mass scale; Ritus-Narozhny conjecture; experimental challenges in probing the fully nonperturbative regime.

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