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Seminar Talk

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"Light emission from strongly driven many-body systems"

Abstract

Strongly driven systems of emitters offer an attractive source of light over broad spectral ranges up to the X-ray region. A key limitation of these systems is that the light they emit is for the most part classical. We challenge this paradigm by building a quantum-optical theory of strongly driven many-body systems, showing that the presence of correlations among the emitters creates emission of nonclassical many-photon states of light. We consider the example of high-harmonic generation (HHG), by which a strongly driven system emits photons at integer multiples of the drive frequency. In the conventional case of uncorrelated emitters, the harmonics are in an almost perfectly multi-mode coherent state lacking any correlation between harmonics. By contrast, a correlation of the emitters prior to the strong drive is converted onto nonclassical features of the output light, including doubly-peaked photon statistics, ring-shaped Wigner functions, and quantum correlations between harmonics. We propose schemes for implementing these concepts – creating the correlations between emitters via an interaction between them or their joint interaction with the background electromagnetic field (as in superradiance). By tuning the time at which these processes are interrupted by the strong drive, one can control the amount of correlations between the emitters, and correspondingly the deviation of the emitted light from a classical state. Our work paves the way towards the engineering of novel many-photon states of light over a broadband spectrum of frequencies, and suggests HHG as a diagnostic tool for characterizing correlations in many-body systems with attosecond temporal resolution.

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