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Theoretical insights into dynamically dressed states via nonlinear optical signals

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Nonlinear optical signals in optically driven quantum systems can reveal coherences and thereby open up the possibility for manipulation of quantum states, which is of key interest both for fundamental quantum optics and quantum technological applications. While the limiting cases of ultrafast and continuous-wave excitation have been extensively studied, the time-dynamics of finite pulses reveal intriguing phenomena.

In this talk, I will present the theory of dynamically dressed states and investigate the nonlinear optical probe signals of a two-level system excited with a laser pulse of finite duration. Beyond the well-known, prominent Mollow peaks, the probe spectra unveil several smaller peaks for certain time delays between probe and pump pulses. Similar features have been recently observed for resonance fluorescence emission signals of excitonic transitions in a semiconductor quantum dot driven by finite Gaussian pulses [1]. Our study explores these emergent features, attributing their presence to the interplay of Mollow triplet physics and perturbed free induction decay effects [2]. These insightful findings enhance the overall understanding of optical signals in quantum two-level systems.

[1] K. Boos et al., Phys. Rev. Lett. **132**, 053602 (2024)
[2] J. M. Kaspari, Phys. Rev. Res. **6**, 023155 (2024)