

Rethinking Resonance Fluorescence: Fundamental Insights and Emerging Quantum Technologies

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Resonance fluorescence - the light emitted by a coherently driven two-level quantum emitter - has long served as a paradigm in quantum optics. In this talk, I will present two recent experimental investigations that reveal both the fundamental richness and the technological potential of this seemingly simple system. In the first part, I revisit the textbook notion that a single atom cannot scatter two photons simultaneously. Our results provide direct experimental evidence for an alternative quantum interference-based explanation, in which antibunching emerges from the coherent superposition of distinct two-photon scattering amplitudes. By selectively suppressing the coherently scattered component of the fluorescence spectrum, we isolate photon pairs that are simultaneously scattered by the atom, thereby validating a decades-old theoretical prediction. In the second part, I will show how resonance fluorescence can be harnessed as a highly efficient source of time-bin entangled photon pairs. Using a beam splitter followed by a coincidence detection, we transform the emission from a single atom into a stream of maximally entangled photon pairs, achieving a strong violation of a Bell inequality. Together, these experiments illustrate how resonance fluorescence - traditionally viewed as a fundamental textbook example - can be reimagined as a powerful resource for quantum information science.