Quantum modulation of a coherent state with a single electron spin

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The scattering of light from quantum emitters has been extensively studied across a wide range of driving strengths. In the weak driving limit the characteristics of the field scattered from a two-level system is to exhibit second order coherence which is antibunched due to the single photon nature of the quantum emitter, while the first order coherence retains the properties of the driving laser. We show a drastic departure from this previously observed behaviour for charged quantum emitter systems. By scattering photons from a quantum dot that contains an intrinsic spin (charged QD) we can drastically alter the statistics observed in the scattered field. We find that the scattered field, rather than retaining the laser coherence, contains the coherence information of the spin. Essentially, the scattered photons become entangled with the spin, the result being that the single photon wave packet is imprinted with the state of the electron spin. By performing interferometric measurements of the scattered field we can reveal the precise underlying dynamics of a coherently evolving electron spin inside a charged quantum dot. In the first instance this allows us to measure sub natural linewidth Zeeman splittings in these systems. Moreover it implies a new way of generating spin photon entanglement which could be applicable to generating strings of entangled photons using an electron spin inside a QD [1].

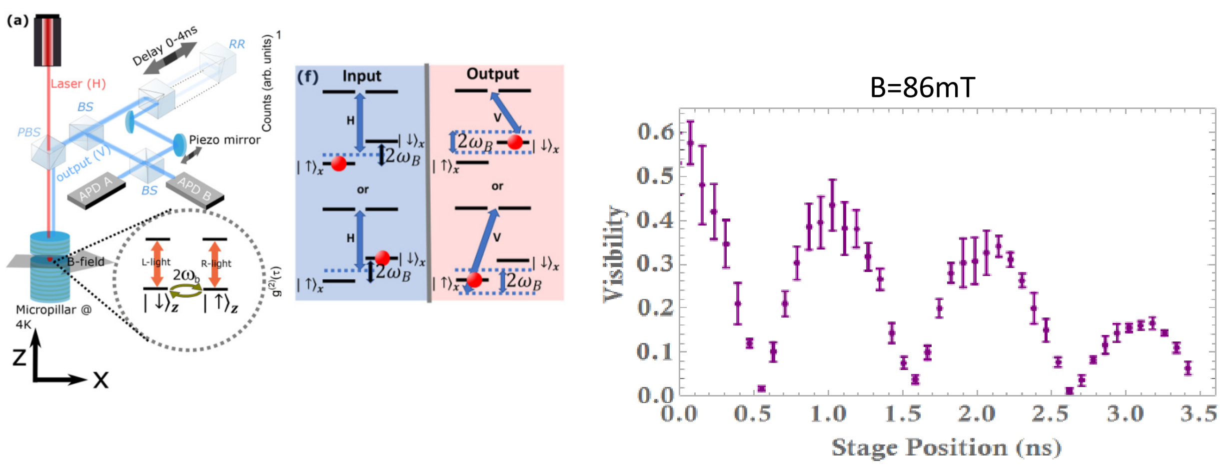

Figure 1. (a) Experimental setup (b) level scheme (c) visibility of interference of scattered coherent light

References

[1] Androvitsaneas et al., accepted in Physical Review Research (2024), arXiv https://arxiv.org/pdf/2207.05596

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