Optical control of solid-state quantum emitters

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Solid-state quantum emitters play a vital role in quantum technologies as photon sources. To make them viable for actual applications, the emitted photons need to have close to perfect properties. This includes a high brightness, high purity, high indistinguishability and, in case of entangled photons, a high concurrence. Semiconductor quantum dots are at the moment the most promising candidates to fulfil these requirements as astonishing good values for such quantities have been reported in the last few years. However, there is still room for improvement.

One aspect is the preparation of the excited state, which then leads to the emission of the photons. The straight forward method of resonant excitation, making use of the Rabi scheme, suffers from the influence of phonons [1]. Furthermore, because the exciting frequency is the same as the frequency of the emitted photons, sophisticated polarization filtering results in a loss of half the photons. Off-resonant schemes like the phonon-assisted state preparation [1] are incoherent, which can be disadvantageous depending on the target state. Accordingly, new protocols are proposed to optimize the excitation of quantum emitters.

In this talk, I will review different optical preparation schemes to excite the quantum emitter. In addition to well established schemes like Rabi or phonon-assisted processes, I will introduce the Swing-UP of EmitteR Population (SUPER) scheme that uses two red-detuned pulses to excite a quantum emitter [2]. Besides displaying interesting physics, the SUPER scheme is coherent and truly off-resonant and, thus, spectral filtering can be applied [3]. This could boost the photon rate up to a factor of two, making the SUPER scheme highly interesting for applications in quantum technology.

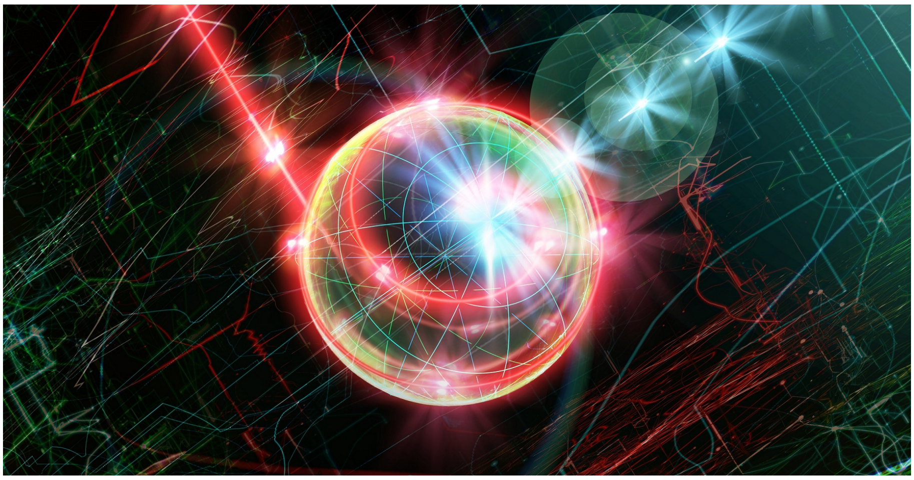

Figure 1: Artistic view of the Bloch sphere under the SUPER scheme

[1] D. E. Reiter, Acta Phys. Pol. A 122,1065 (2012).
[2] T. K. Bracht, D. E. Reiter et al., PRX Quantum 2, 040354 (2021).
[3] Y. Karli et al., Nano Lett. 16, 6567 (2022).