**Autler-Townes spectroscopy in a Mn-doped InGaAs/GaAs quantum dot**

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For more than a decade, doping of semiconductor quantum dots (QDs) with a single magnetic atom has provided the unique possibility to investigate exchange interaction in the quantum regime [1,2] and to manipulate the corresponding spin states with light [3, 4]. In particular, the optical Stark effect induced by a strong optical excitation was demonstrated in II–VI QDs [4]. Here, we investigate similar effects in a self-assembled InGaAs/GaAs QD doped with a single Mn atom. This point defect in a III-V matrix forms a neutral acceptor A0 with a spin=1 [2]. In our present experiment, it is further coupled to a resident single hole giving rise to ferromagnetic (FM) and antiferromagnetic (AFM) levels split by about 1 meV. Under inter-band optical excitation, the QD exhibits thus a specific scheme of transitions consisting in a double lambda-system (Fig.1a). A continuous-wave (cw) tunable laser can be used to drive successively two transitions from the FM ground state, whereas the excited populations are directly monitored via the micro-photoluminescence (μPL) towards the AFM level (Fig.1b). In this sample, the observed resonance linewidths are dominated by spectral diffusion (~20 µeV) and does not reveal the QD natural linewidth (~1.5 µeV). Still, optical Stark shift was clearly observed, and far above the saturation regime, an Autler-Townes splitting was spectrally resolved with the expected $∝\sqrt{P}$ power dependence. More interestingly, by driving the system with a weak probe laser at resonance with the upper transition, while a stronger pump laser is scanned through the lower transition (Fig.1c), it is possible to spectrally resolve the Autler-Townes effect experienced by the FM ground state, much below the spectral diffusion broadening limit. In this regime, the probe signal shows a Lorentzian dip with typical 10 µeV spectral width, near the pump laser resonance (Fig.1d). This is a signature of the Autler-Townes effect in the ground state, which moreover reveals that the spin coherence of the two excited states is essentially unaffected by the spectral diffusion.



**Figure 1.** **a**) Energy levels of single positively charged Mn-doped QD driven by probe and pump cw lasers. Under strong resonant driving, dressed states are indicated (orange) for the ground state with Rabi frequency ΩR. **b**) μPL spectra against detuning of a single scanning laser (P=16 μW). **c**) μPL spectra for a fix resonant probe laser (P=1.3 μW) and a scanning pump laser (P=11 μW). **d**) Intensities of the two transitions extracted from **c** (circles) fit with Lorentzian curves (solid lines).

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