Single magnetic dopants and how to find them

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The application of quantum technologies such as spintronics, solotronics or quantum computing is highly promising when it comes to miniaturization in modern technology. In order to achieve effective devices, there is a need to investigate the spin properties of single dopant interacting with the semiconductor lattice and confined carriers. Zero-dimensional semiconductor structures such as epitaxial quantum dot (QD) is a model system to probe fundamental interactions in condensed matter. For example, QDs can be used to examine the spin of a single magnetic ion [1,2,3].

Vanadium is a transitional metal with a nuclear spin $\frac{7}{2}$ and 3 electrons on the d shell. It exhibits spin $\frac{3}{2}$ in V^{2+} configuration [4] leading to two possible fundamental states with spin projection $\pm\frac{3}{2}$ or $\pm\frac{1}{2}$. Particular spin configuration is expected to depend on the strain of the crystal lattice in a QD.

In this work we examine self-assembled CdTe QDs doped with V, in ZnTe barrier, fabricated using molecular beam epitaxy. We observed a single QD including a single vanadium dopant and measured magneto-optical properties of such a system. According to numerical modelling based on experimental data, we conclude that V in this case exhibit spin $\frac{1}{2}$, which makes our system a realization of a qubit.

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