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Reaching limits of miniaturization related to atomic structure of matter opens important challenge of our times. A question arises whether further development of technologies such as nanometer scale electronics and material science will be limited by a finite size and discrete electronic states of single atoms? Or conversely, if we take advantage of properties of individual ions or defects, as it is proposed in solotronics - solitary dopant optoelectronics? Example of solotronic systems can be a single phosphorus dopant on a silicon surface, which can serve as a single atom transistor and a qubit, or NV center in diamond, which is a promising room-temperature qubit, or nanosensor of local magnetic fields. Magnetic ions such as transition metal ions are particularly interesting dopants in semiconductor crystals. They exhibit a partially filled electronic *d*-shell – a property distinguishing them from atoms forming typical semiconductors. Transition metal dopants *d*-shell hybridize with a host semiconductor states what brings a variety of magnetic, optical, and electrical properties. Most of these effects have been studied so far only as a result of averaging over ensemble of many magnetic ions, each interacting with its own environment. Studying and exploiting quantum properties of individual magnetic ions in their particular environment have been limited so far due to shortage of appropriate nanotechnologies and experimental methods.

A very efficient tool for a single magnetic ion studies and manipulation is provided by a semiconductor quantum dot (QD), which enhances interaction (*s,p-d* exchange interaction) of band carriers (forming excitons, that is Coulomb bound electron-hole pairs) with a single magnetic ion. In such a case, the excitonic states are split due to the interaction with individual magnetic ion, allowing unambiguous readout of the magnetic ion spin state from polarization and energy of a photon emitted in exciton recombination. So far this approach has been used only for manganese, which was introduced as a single dopant into a CdTe, InAs, and recently by my group, to CdSe QDs. For many years other transition metal ions such as Co^{2+}, Fe^{2+}, Cr^{2+} were considered as killers of excitonic photoluminescence, and consequently as being useless for optical studies and manipulation. Recently we have shown that this common belief seems to be not true for the case of single dopants in QDs. In work J. Kobak et al., Nature Communications 5, 3191 (2014), we have shown that the quenching effect is negligible for a quantum dot (CdTe/ZnTe) with a single Co^{2+} ion. This was proved by comparable exciton lifetime determined for a QD with and without the single cobalt ion.

Weak quenching in QDs with single cobalt ions suggests that also other transition metals can be considered now as single dopants in zero-dimensional optical structures. In addition to intensively explored Mn and relatively new Co, there are following interesting candidates: V, Cr, Fe, Ni, Cu - transition metals, which exhibit a significant *s,p-d* exchange interaction with semiconductor carriers. Potential applications in data storage and quantum computation, where it is important to obtain full control over single object provide an indication which transition metal acts as the most promising single dopants. We argue that the most promising systems for solotronics are based on QDs and individual transition metals which have stable isotopes without nuclear spin: Fe, Ni, Cr. In present project we will design and grow novel QD with single transition metals. We will present high degree of control of single dopants properties and we will demonstrate coherent manipulation of single spin in novel structures.