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Plenary Talk 3

Quantum Technology with Spin Centres in Semiconductors

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Abstract:

Spin centres in crystals, particularly in diamond and silicon carbide (SiC), have emerged as a key platform for the development of quantum technology. Following a brief overview of the field, two defect systems will be discussed which are being researched at IQOQI-Vienna.

The nitrogen-vacancy (NV) centre in diamond has spearheaded the development of spin centres for quantum technology, chiefly towards devices for quantum sensing. Their sensitivity is in part limited by the spin contrast and by the collection of photoluminescence. I will present a method to improve the spin contrast by tailoring the optical initialization to the NV's ionization cycle[1]. I will also describe progress on electrical readout, which allows to circumvent optical collection, with a view to highly integrated sensing devices with enhanced state readout[2]. Lastly, I will present a method to control and read out scalable arrays of sensors based on NV centres.

For quantum photonics, other systems are being explored in search of better optical properties. In many cases, their performance is significantly reduced by wavelength conversion from the telecom range to the optical transition frequency of the atoms or defects[3]. Vanadium in SiC has emerged as a strong candidate for these applications[4–9]: It has a strong optical transition at 1.3 µm, compatible with optical fiber networks, a long-lived electron spin, and is hosted in a material that is available with high quality at an industrial scale. Our investigations have resulted in significant advances in our understanding of this remarkable system, the control of its electron spin, and the development of photonic interfaces for quantum networks[10].

We have shown that vanadium can be used as an extremely sensitive probe for the crystalline structure and electronic properties of the silicon carbide host: Its charge state stability depends strongly on the electronic environment in the SiC crystal, and its zero-phonon line resonance frequency is dependent on the isotope composition of the neighbouring lattice sites[8].

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