Localized spins in solid

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ECTS credits: 3

Language of instruction: English

Examination: written exam (50 %) and oral (50 %)

Description:

The objective of this course is to cover the background required to understand one major system in future quantum-based technologies in the solid state, namely *localized spins of atoms embedded in a solid state matrix*.

It will also provide key notions on central theories in solid state physics (theory of group representations, defect formation, crystal field theory, spin-relaxation in crystals). These concepts will be illustrated by experimental tools and by a presentation of the currently employed material platforms.

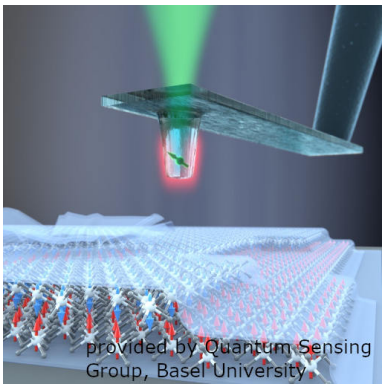

Figure 1 : quantum sensing with a single spin in diamond

Outline of the course:

I- Theory of group representations (CM : 6h, TD : 2h)

Group representation with application to quantum mechanics for point defects in crystals.

II- Stability of localized defects in crystals (CM : 4h, TD : 2h)

Formation energy. Deep/shallow defects in semi-conductors.
Thermodynamics (diffusion), charge states transfer.

III- Electronic structure / spin relaxation in solids (CM : 8h, TD : 6h)

- Wigner-Eckart theorem for rotation groups : spin Hamiltonian in crystals.
- Orbital momentum quenching of spin defects
- Spin-orbit interactions in crystals (*g-tensor)*, zero-field splitting …
- "Spin-temperature" : phonon relaxation.

IV- Solid state platforms for quantum technologies (CM : 2h)

Applications of the course to studies of novel defects : NV/SiV/GeV centers in diamonds, rare earth doped crystals…