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Quantum oscillations and decoherence in different types of materials

Bernard Barbara
Neel Institute, France

In a short introduction we recall how large spins systems, such as Single Molecular Magnets (SMMs) or diluted Rare-Earth ions (REs) interacting through weak dipolar interactions only, can be reversed by quantum tunneling along quantized hysteresis loops (incoherent at the measurement scale). Then we describe the first coherence measurements in a SMM (so-called V15) and a RE system (Er:$CaWO_4$). The study of Rabi oscillations enables the study of decoherence mechanisms in particular with the evidence of a mechanism of "driven" spin-bath decoherence where the stochastic noise of the excitation microwave pulse, amplified by magnetic dipolar interactions, constitutes a severe roadblock for quantum computation. At lower temperatures, when thermal or quantum fluctuations become smaller than weak dipolar interactions, quantum phase transitions take place, as this is shown for example in the Fe8 SMM. Magnetic order should suppress Rabi oscillation unless more sophisticated mechanisms take place (such as quantum oscillations of spin waves). Finally, the classical counterpart of the Landau-Zener model - the most famous and useful model to describe quantum dynamics is shown to be identical to the quantum model. This surprising but easy to understand result enables, in particular, an intuitive understanding of the above mentioned aspects of quantum spin dynamics. We shall end this talk by the demonstration of the existence of a new concept of spin-qubits in anti ferromagnetic spin-chains for which the first coherent measurements are given which should enable simpler implementation of a spin-based quantum computer.

Biography

Bernard Barbara, Director of Research at the CNRS has also been till 2012 a Scientific Adviser at the Atomic Energy Center (CEA-Grenoble), at the French Ministry of Science (ANR grants, Aeres) and the European Research Council (for advanced ERC grants). He is now Director of Research Emeritus and a board member of the European Academy of Sciences (EURASC.org). He defended his PhD in 1972 under the supervision of Remy Lemaire and Louis Néel, Nobel Prize of Physics. All along his career he has initiated and developed pioneering works on different subjects of magnetism and magnetic materials, some of them having been distinguished by international prizes.

bernard.barbara@grenoble.cnrs.fr

Synthesis, characterization and enhanced photocatalytic degradation efficiency of Se doped ZnO nanoparticles using trypan blue as a model dye

Bhavani Prasad Naik
Zhejiang University, China

Se doped ZnO nanoparticles (NPs) were successfully synthesized by thermo-mechanical method whose band gap increased with concentration of Se doping. Transmission electron microscopy of 5 wt% Se doped ZnO NPs revealed spherical nanoparticles of average size of 9.5 nm. X-ray photoelectron spectroscopy (XPS) revealed Se 3d binding energy at 59.5 eV, confirmed SeO_2 in the doped ZnO NPs. Fluorescence emission spectroscopy of Se doped ZnO NPs revealed oxygen vacancies which increased with the concentration of Se doping. The photodegradation efficiency of trypan blue (TB) using 30 W UV lamp was higher for Se

doped ZnO NPs than pristine ZnO NPs, depended on Se doping concentrations, UV illumination, concentrations of photocatalyst and pH of the dye solution. The batch of 0.6 mg of 5 wt% Se doped in ZnO NPs per mL of TB dye maintained at pH 5 exhibited maximum photodegradation efficiency (89.2±3.1%). Higher photocatalytic degradation efficiency for Se doped ZnO NPs was correlated with incorporation of oxygen vacancies due to Se doping, which were likely intermediate levels for transiting photoexcited charge carriers for generation of hydroxyl radicals and consequently facilitated photodegradation. Terephthalic acid assay confirmed formation of hydroxyl radicals in dye solution treated with photocatalyst.

nenavathbhavani@gmail.com