PHYSICS OF CONDENSED MATER

Relaxation phenomena in low-dimensional and molecular magnets
supervisor: doc. RNDr. Erik Čižmár, PhD.
study form: full time
Annotation: Thesis is devoted to the experimental study of selected low-dimensional and molecular magnets with aim to study slow magnetic relaxation related to the spin-lattice relaxation processes. Spin-lattice relaxation rate represents the upper limit for spin-spin relaxation, which is a characteristic parameter (quantum coherence time) related to the application of a molecular magnet as a quantum bit. Low-dimensional magnets also represent a natural playground for the study of quantum entanglement. Analysis of EPR spectra, magnetic and thermodynamic properties at low-temperatures will be performed for determination of characteristic parameters of magnetic system and their relation to possible quantum computing applications. Studied low-dimensional magnets will be based on 3d ions.

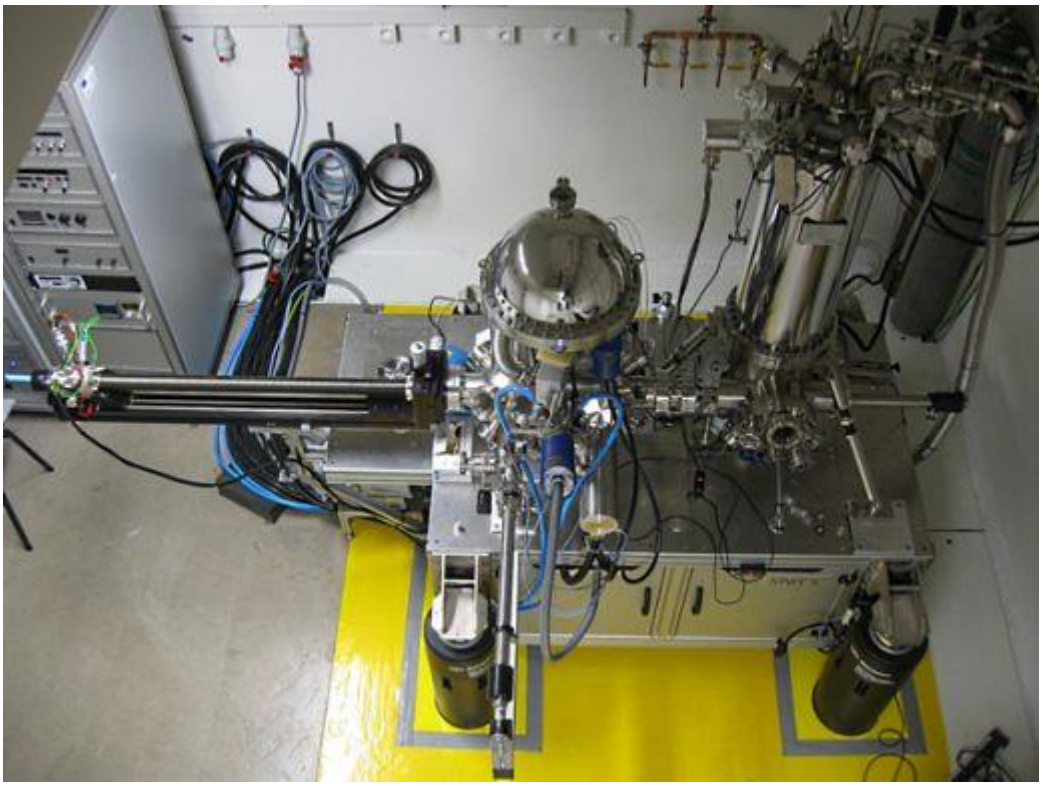
Magnetization processes in quantum and nanoscopic systems
supervisor: prof. Ing. Martin Orendáč, CSc.
consultant: RNDr. Róbert Tarasenko, PhD.
study form: full time
Annotation: The thesis will be focused on experimental study of static and dynamic magnetic properties of selected quantum and nanoscopic systems. Systematic study of the influence of the size of Au, Pt, Pd nanoparticles as well as thiol – based surfactants on magnetic properties of the nanoparticles will be performed, the nanoparticles will be deposited on various substrates. Specifically arranged Fe_2O_3 nanoparticles will be adopted for the investigation of forming reentrant superspin glass state. Static properties and relaxation phenomena in systems with random anisotropy will be studied, the systems will be obtained by doping of 3d and 4f ions into phosphate glass $Zn_2(PO_3)_5$.

Interplay of the spin and lattice dimensionality in the quantum processes in the selected quantum magnets with extremely high measure of spatial anisotropy of exchange coupling.
supervisor: doc. RNDr. Alžbeta Orendáčová, DrSc.
consultant: RNDr. Vladimír Tkáč, PhD.
study form: full time
Annotation: The work has experimental character focused on the understanding of microscopic origin of mechanisms responsible for the change of lattice dimensionality (phase transitions) and spin dimensionality (type of anisotropy -dipolar, exchange, crystal field,etc). Using selected compounds, various experiments will be performed including measuring of thermodynamic quantities, electron paramagnetic resonance and infrared spectroscopy. If need arises, also other quantities as heat transport, neutron diffraction and ac susceptibility will be measured. Analysis of exp. data will enable to define the character of magnetic system. When we find a proper system with high measure of spatial anisotropy of exchange coupling, the compound will serve as a toy-model system for the study of quantum processes in the dimension 0, 1 or 2. Besides standard managing of exp. methods available in our laboratories, the student is expected to learn at least one of standard program packages which enable simple DFT calculations or others like EasySpin, Fullproff , ALPS atc. With respect to actual conditions in our society, acquirement of softwer literacy is crucial for future potential job of PHD student.

Spatial distribution of superconducting order parameter in unconventional superconductors

supervisor: Mgr. Tomáš Samuely, PhD.
consultant: prof. RNDr. Peter Samuely, DrSc.
study form: full time

Annotation: Scanning tunneling microscopy (STM) is the perfect tool for the investigation of superconducting materials, since it is extremely sensitive to the slightest differences in the local density of states. In tandem with the scanning Hall-probe microscopy, the two main aspects of superconductivity, namely magnetic and electronic properties, can be examined with superior spatial resolution. In our laboratories both scanning probe microscopies are at hand. Naturally, both techniques are operational at ultra-low temperatures and in high magnetic fields, which is an essential requirement for studying superconductivity. What is more, in addition to sample materials provided by our collaborators, which will be examined during the thesis, in-situ preparation of superconductors will be a pivotal subject. This will be carried out in our state of the art ultra-high vacuum system featuring a complete set of experimental techniques for in-situ sample preparation, surface characterization and STM studies.



Influence of anisotropy on the domain wall shape and domain wall dynamics.

supervisor: prof. RNDr. Rastislav Varga, DrSc.
consultant: RNDr. Kornel Richter, PhD.
study form: full time

Annotation: The aim of the work is to study the influence of anisotropy on the shape of domain wall in static and dynamic regime. To find the parameters influencing the shape and to suggest experiment to control the domain wall shape and dynamics by properly selected anisotropy.

The study of dynamic magnetic properties and relaxation process in magnetic nanoparticles.

supervisor: doc. RNDr. Adriana Zeleňáková, PhD.
study form: full time
Annotation: Mono-domain magnetic nanoparticles based on Fe, Co, and Gd have recently been the subject of great interest due to their intrinsic physical properties, associated with quantum size effect, as well as applications in electronics and biomedicine. The spin structure of nanoparticles can be affected by inter-particle interactions. One of the powerful ways how to get a better insight into the nature of inter-particle interactions and estimate their strong is the analysis of ac magnetic susceptibility.
The PhD. study is oriented on investigation of dynamic magnetic properties and analyses of relaxation processes. The aim is to study the possibility of change in relaxation processes by controlling the inter-particle interactions, energy barrier distribution, particles size, in the term of magnetic hyperthermia applications.

Self-organization in nanocomposites based on liquid crystals
supervisor: RNDr. Natália Tomašovičová, CSc. - Institute of Experimental Physics Slovak Academy of Sciences Košice
study form: full time/external
Annotation: Currently, one of the hot topics of the worldwide research is to design nanomaterials that are capable to assemble into functional superstructures in multiple direction. Liquid crystals themselves are prominent example of materials in which the self-organization (self-assembly) appears spontaneously on different scales. Besides the local ordering on the molecular level, they may form micro/macroscopic superstructures via the appearance of topological defects. The research targets the exploration of physical properties of anisotropic composite systems and understanding of phenomena related to the self-assembly.

Magnetic nanoparticles with usable properties
supervisor: RNDr. Mária Zentková, CSc. - Institute of Experimental Physics Slovak Academy of Sciences Košice
consultant: RNDr. Martin Vavra, PhD. - PF UPJŠ Košice
study form: full time
Annotation: The hole-doped $La_{1-x}A_xMnO_3$(A = Ag, K,Sr) magnetic nanoparticles display set of properties suitable for various applications including magnetic hyperthermy. Substitution of La positions in perovskite lattice by appropriate atoms allows fine tuning of the value of Curie temperature within the therapeutic values for mild hyperthermy (41- 46°C). The main task of the study is preparation of magnetic colloids for application in biomedicine. The following partial tasks will be addressed: study of optimal conditions for preparation of stable magnetic nanoparticles with narrow particle size distribution and optimal specific absorption rate SAR, the effect of heat treatment on Curie temperature. From the point of view of methodology the study will include preparation of magnetic nanoparticles, scanning electron microscopy, X-ray diffraction, magnetic measurements, data analysis and presentation.

Phase diagrams of $RMn_{1-x}Ti_xO_3$ (R = rareearth metal) substitutional systems
supervisor: RNDr. Marián Mihalik, CSc. - Institute of Experimental Physics Slovak Academy of Sciences Košice
consultant: RNDr. Matúš Mihalik, PhD. - Institute of Experimental Physics Slovak Academy of Sciences Košice
study form: full time

Annotation: The transition metal oxides with distorted perovskite structure have been largely studied because these materials exhibit strong coupling between orbital, electronic, spin and lattice degrees of freedom. The atomic substitution at the dodecahedral sites in stoichiometric compounds has been already extensively studied. However, only recently, interest has turned on to the effect of the substitution at the octahedral sites, where the experimental studies have been mainly focused on the effect on the magnetic behaviour, and few on the multiferroic properties. The goal of the PhD. study will be to prepare the high quality single crystals of RMn1-xTixO3 (R = rare earth metal) substitutional systems by optical floating zone method and to study of their physical properties with emphasis to Jahn-Teller distortion and orbital ordering, construction of magnetic phase diagrams, study of the dielectric properties and subsequent seeking for the multiferroicity in these compounds. The student will be led through sample preparation and characterization, all necessary experiments, data analysis and the presentation of the obtained results. This will ensure that the person who finishes this study will have broad view on the field of experimental physics and will be able to continue the career in the basic research in several different fields.
Requirements for the applicant: Good basics on the field of magnetism, or inorganic chemistry.

Superfluid 3He-B as a model system for Q-bits
supervisor: RNDr. Peter Skyba, DrSc. - Institute of Experimental Physics Slovak Academy of Sciences Košice
study form: full time
Annotation: There exists a whole set of various states with coherent spin precession in superfluid 3He-B, which are cosidered to be the Bose-Einstein condensates of magnons i.e. the systems of excitations being in one quantum coherent state. Aim of this disertation is (i) to show that using NMR techniques these states can be used as a model system to study the properties of Q-bits, i.e. that these states manifest the properties of Q-bits, (ii) to study and to determine processes leading to the decoherence in these states, and (ii) to perfom an experiment with two mutualy interacting Q-bits created using the states with coherent spin precession in superfluid 3He-B.

The influence of temperature on electro-magnetic properties of soft magnetic composites
supervisor: doc. RNDr. Ján Füzer, PhD.
study form: full time
Annotation: The study is oriented on investigation of the NiFe and FeSi based composite materials with inorganic or organic nonconductive binder. Part of the work is the investigation of temperature dependences of the wideband complex permeability and energy losses in prepared soft magnetic composites and determination the influence of operating temperature on magnetization processes. The aim is optimization of preparation process of soft magnetic materials with required magnetic properties at middle-frequency ac magnetic fields and in temperature interval from -50ºC to 200ºC.