CONDENSED MATTER PHYSICS

The study of quantum processes in selected low-dimensional magnets in mesoporous silica with different dimensionality.
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consultants: RNDr. Róbert Tarasenko, PhD., prof. RNDr. Vladimír Zeleňák, DrSc.
study form: full time
Annotation: The work will be devoted to experimental study of selected low-dimensional systems encapsulated in mesoporous silica with different pore size and morphology. The influence of used silicon on quantum processes in selected low-dimensional systems in which exchange paths are mediated by hydrogen pathways will be investigated systematically. Silicas of varying pore size and morphology can affect the geometry of hydrogen bonds and consequently exchange interactions. Experimental measurements of thermodynamic, magnetic quantities and electron paramagnetic resonance will be performed on selected low-dimensional magnetic systems encapsulated in mesoporous silica, which will be compared with unencapsulated magnetic systems. The magnetic systems studied will be based on 3d ions.

Influence of low-frequency vibration modes and presence of Boson peak on transport, relaxation and thermodynamic properties in selected amorphous systems.
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consultants: RNDr. Vladimír Tkáč, PhD., Dr.h.c. prof. RNDr. Alexander Feher, DrSc.
study form: full time
Annotation: This work is focused on experimental study of selected types of amorphous materials in order to identify possible correlation between low-frequency vibration modes and the position of the Boson peak in heat capacity and in Raman spectra. These effects will be compared with the vibration spectrum obtained by numerical DFT calculations on nanoclusters of suitable size and topology. Transport properties will be experimentally studied by thermal conductivity measurements. The low temperature thermal conductivity is characterized by the presence of a plateau whose origin is attributed to the resonance scattering of the phonons on localized vibration modes. The thermal conductivity analysis will be realized in order to identify the types of scattering and relaxation processes. It will be necessary for the student to acquire practical skills on low-temperature experimental apparatuses and software skills that are necessary for experimental data description.

Superfluid 3He-B as a model system for Q-bits.
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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 perform an experiment with two mutualy interacting Q-bits created using the states with coherent spin precession in superfluid 3He-B.