Colloquium on Solid-State Physics

Department of Physics
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Thursday, 25th November 2021, 17.15 h
Lecture Hall III, Department of Physics, Garching

Rare earth spin ensemble at millikelvin temperatures: development, difficulties and potential

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Abstract:
Rare-earth-doped crystals offer a great variety of their potential applications in quantum information processing and quantum communications, which range from optical and microwave quantum memories to circuit QED and microwave-to-optics frequency converters. Some of the above listed applications require ultra-low temperature environment, i.e. temperatures below 0.1 K. Most of the experiments with erbium-doped crystals have been carried out at the temperatures above 1.5 K. Therefore, only little information is known about erbium coherence properties at millikelvin temperatures and the real dynamics of the processes governing it.
In this talk, I will discuss the optical decoherence processes in isotopically purified $^{167}Er:Y_2SiO_5$[1], $^{166}Er:^{7}LiYF_4$[2] and $^{167}Er:^{7}LiYF_4$[3] crystals by performing 2- and 3-pulse echo experiments and electromagnetically induced transparency at the temperatures below 1 K and at weak and moderate magnetic fields (< 300 mT). It will be shown that the deep freezing of the crystal results in an increase of optical coherence time by one order of magnitude compared to the case of 1.5 K and of 200 mT, taken as a reference point. Further, a deeper insight into decoherence mechanisms in spin ensembles will be given, including the detailed analysis of the phonon mediated processes.

References

[1] N. Kukharchyk *et. al.*, arXiv:1910.03096
[2] N. Kukharchyk *et. al.*, New J. Phys. **20**, 023044 (2018)
[3] N. Kukharchyk *et. al.*, Opt. Express **28**, 29166-29177 (2020)

There will be coffee, tea, and cookies in front of the lecture hall at 17.00 h