8th International Symposium
on Optical Materials

June 9-14, 2019

Book of Abstracts

Ossoliński National Institute,
Wroclaw, Poland

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High-resolution spectroscopy of $LiYF_4$-Ho in magnetic fields

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Lithium-yttrium double fluorites doped with rare-earth (RE) ions are multifunctional optical materials widely used in different branches of photonics. It should be mentioned that $LiYF_4:RE^{3+}$ crystals, for reasons not fully understood, demonstrate the narrowest inhomogeneously broadened lines. That is why they are also excellent model systems for studying various interactions and very fine effects. In particular, manifestations of the electron-nuclear hyperfine interactions and of the isotopic disorder in the lithium sublattice due to the presence of ^7Li and ^6Li isotopes (their natural abundances are 93% and 7%, respectively) were studied by high-resolution spectroscopy of $LiYF_4:Ho^{3+}$ singlecrystals.

In the present study, we have investigated broad-band high-resolution low-temperature optical spectra of $LiYF_4:Ho^{3+}$ in magnetic fields [1,2]. Absorption spectra in an external field 0.5 – 0.9 T parallel to the tetragonal crystallographic axis reveal strong mixing of wave functions of neighboring crystal-field levels, mediated by Zeeman and hyperfine terms in the Hamiltonian of a Ho^{3+} ion[1].

An effect of the hyperfine levels' anticrossing was observed in magnetic fields 20 – 180 mT. As far as we know, it was the first direct observation of the hyperfine level anticrossings in optical spectra. Analysis of the spectral envelopes corresponding to transitions between the electron-nuclear sublevels of crystal-field non-Kramers doublets and singlets of the Ho^{3+} ions, based on the microscopic model of the electronic $4f^{10}$ configuration, allowed us to retrieve information on the hyperfine structure of electronic singlets, nuclear quadroupole interactions, and random lattice strains[2].

Recently, we have observed the hyperfine structure and the hyperfine level anticrossings in the luminescence spectra of $LiYF_4:Ho^{3+}$. This finding opens the way for studying the hyperfine effects in the transitions between the excited crystal-field levels.

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References:

[1] Popova, M. N.; Boldyrev, K. N., High-resolution spectra of $LiYF_4:Ho^{3+}$ in a magnetic field, *Optical Materials* 63, **2017**,101-104.

[2] Boldyrev, K. N.; Popova, M. N.; Malkin, B. Z.; Abishev, N. M., Direct Observation of Hyperfine Level Anticrossings in Optical Spectra of a $^7LiYF_4:Ho^{3+}$ Single Crystal,*Phys. Rev. B* 99, **2019**,041105(R).