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Direct measurements of anticrossings of the electron-nuclear energy levels in LiYF4:Ho3+ with submillimeter EPR spectroscopy

Shakurov G., Vanyunin M., Malkin B., Barbara B., Abdulsabirov R., Korableva S.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

The electron paramagnetic resonance (EPR) spectra of impurity Ho 3+ ions in monocrystals LiYF4:Ho3+ (0.1 and 1%) with the natural abundance of 6Li (7.42%) and 7Li (92.58%) isotopes, and in the sample 7LiYF4:Ho 3+ (0.1%) isotopically pure in 7Li were taken at the temperature 4.2 K in the frequency range of 165-285 GHz. Resonance transitions between crystal field sublevels (the ground non-Kramers doublet and the nearest excited singlet) of the 5I8 term were detected. The refined set of crystal field parameters and the effective constant of the magnetic hyperfine interaction were determined from the detailed analysis of the recorded spectra at frequencies varied by 0.05 GHz. The fine structure of EPR lines with intervals of about 300 MHz observed in the sample LiYF 4:Ho3+ (0.1%) can be interpreted as a result of the isotopic disorder in the Li sublattices. Direct information about energy gaps at the anticrossing points of the electron-nuclear sublevels of the ground doublet was obtained. These gaps are induced by the hyperfine interaction that mixes doublet and singlet states and by random crystal fields. Weak EPR signals from distorted single ion and pair centers of impurity Ho3+ ions were resolved. From a comparison of the measured and simulated spectra, estimates of spectral parameters of the dimer centers have been obtained.