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Superhyperfine structure in the EPR spectra and optical spectra of impurity f ions in dielectric crystals: A review

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Abstract

The results of observation and simulation of the superhyperfine (ligand hyperfine) structure (SHFS) of the electron paramagnetic resonance (EPR) spectra of rare-earth and uranium impurity ions in dielectric crystals have been systematized. The resolved SHFS of the EPR spectra of doped cubic crystals (with the fluorite and perovskite structures) has been observed for orientations of a constant magnetic field along the crystallographic axes. Most attention has been paid to tetragonal double fluorides LiRF4 (R = Y, Lu, Tm), in which the SHFS of the EPR spectra has also been found for intermediate orientations of the magnetic field. For the LiYF4: Nd3+ single crystal, the splitting of optical spectral lines due to the interaction of Nd3+ ions with nuclear magnetic moments of the nearest neighbor fluorine ions has been observed for the first time. The Van Vleck paramagnet LiTmF4: U3+ is characterized by the SHFS with clearly distinguishable components due to the interaction of uranium ions both with nuclei of the fluorine ions and with enhanced magnetic moments of the thulium nuclei. The SHFS envelopes of the EPR spectra of Yb3+, Ce3+, Nd3+, and U3+ ions in LiYF4 and LiLuF4 crystals are well reproduced by numerical calculations based on the microscopic model using only three fitting parameters: the width of transitions between the electron-nuclear sublevels of the complex containing the paramagnetic ion and nuclei of the ligands and two constants of covalent bonding of the f electrons with 2s and 2p electrons of the nearest neighbor fluorine ions. © 2013 Pleiades Publishing, Ltd.

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