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Field dependence of spin-lattice relaxation of Nd3+ ions in y3Al5O12 crystals

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Abstract

Our studies involve measuring spin-lattice relaxation times for Nd3+ ions in yttrium-aluminum garnets over the temperature range 4-50 K at 9.25 and 36.4 GHz for different orientations of the external magnetic field in relation to the crystallographic axes. The temperature dependence of the relaxation rate is described by T1 -1=ATn + b exp(-ΔAT), where n varies from sample to sample, with n=1 for "perfect" samples (i.e., with the longest relaxation times). Here A is approximately 130 cm-1, which is the energy of the excited Kramers doublet of the neodymium ion closest to the ground state, and this makes it possible to interpret the second term in T1 -1 as the contribution of two-stage relaxation proceeding through the intermediate level Δ. A strong field dependence of these processes has been discovered: when the frequency was increased fourfold, the relaxation rate increased by a factor of 10. The effect is a specific manifestation of the degeneracy of the excited level, breaking of the symmetry of the crystalline field due to lattice defects, and the prevalence of deformations of a certain type in the spin-lattice interaction.