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Quadrupolar susceptibility of LiTmF4 crystal and the nature of forbidden 3H6(Γ 2) - 3F2(Γ2) transition

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Abstract

The narrow low intensity line with maximum at λ-1 = 15104 cm-1 and width δ=0.7 cm-1 at T=4.2 K have been detected in absorption spectrum of regular LiTmF4 crystal. The observed line belongs to transition from ground state 3H6(Γ2) to lowest level Γ2 of 3F2 term of Tm3+ (4f12) ion. The perturbation, which induces Γ2-Γ2 transition, does not break S4 symmetry of Tm3+ sites (axes S4 ↑↑ OZ). The perturbation of this kind is the interaction of Tm3+ 4f-electrons with electric field, created by quadrupolar moments of lattice ions, which are induced, in turn, by incident electromagnetic wave. To calculate the components of the quadrupolar moment tensors for ions in LiTmF4 single crystal, we have formulated and solved the system of self-consistent linear equations. We take into account interactions between all induced dipolar and quadrupolar moments and their interactions with electric fields of incident waves. The calculated transition probabilities per second (given in brackets) are in qualitative accordance with experimental data: P(ĒW↑↑ OZ)=0.07 s-1 (0.04 s-1); P(ĒW ⊥ OZ)=0.02 s-1 (0.01 s-1).

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Keywords

Absorption spectrum, Forbidden f-f transition, Quadrupolar polarizabilities of ions