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Pressure-Dependent Base-Wavefunction Admixture andLifetime of R_1 State of $La_3Lu_2Ga_3O_{12}:Cr^{3+}$

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Abstract: As a key factor leading to the pressure-dependent R_1-line-shift reversal and R_1-state lifetime, at 10 K, the pressure-dependent variation of mixing-degree of $|t_2^2(^3T_1)e^4T_2\rangle$ and $|t_2^{32}E\rangle$ base-wavefunctions in the wavefunction of R_1 state of LLGG:Cr^{3+} has been calculated and analyzed. From this, the physical origin of the pressure-dependent R_1-line-shift reversal has been revealed. Furthermore, by using the pressure-dependent values of the sum of all square mixing-coefficients of $|t_2^2(^3T_1)e^4T_2\rangle$ in the wavefunction of R_1 state, the lifetimes of R_1 state of LLGG:Cr^{3+} at various pressures have been calculated, which are in good agreement with observed results. The quantum anticrossing effect between $t_2^{32}E$ and $t_2^2(^3T_1)e^4T_2$ levels due to both spin-orbital interaction and electron-phonon interaction is remarkable, which is related to the admixture of $|t_2^2(^3T_1)e^4T_2\rangle$ and $|t_2^{32}E\rangle$ as well as the low-high crystal-field transition.

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Key words: high-pressure effect, base-wavefunction mixing, R_1-state lifetime, quantum anticrossing, R_1-line-shift reversal, low-high crystal-field transition

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