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# Spin dynamics and low symmetry effects in $Gd^{3+}$ EPR spectra of single crystal of $EuAlO_3$

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$RAlO_3$ (R = rare earth) single crystals, characterized by perovskite structure at and below room temperature, are interesting due to their phosphorescence and luminescence properties as well as for their use as laser materials. They also have the potential to provide high capacitance replacement for silicon dioxide gate dielectrics. A relevant detailed EPR study of the $Gd^{3+}$ ion in a $LaNbO_4$ crystal was reported by Misra and Andronenko [1], which is also characterized by a low ($C_2$) point symmetry of the $Gd^{3+}$ ion, similar to that in $La_2Si_2O_7$ [2].
Europium aluminate ($EuAlO_3$) is dielectric Van Vleck paramagnetic and its paramagnetism is due to the admixture, to the ground state, of levels of the $^7F_1$ term split by the orthorhombic field into three singlets (281,359, and 479 $cm^{-1}$). The influence of this term $^7F_1$ on $Gd^{3+}$ EPR linewidth was investigated [3], however, low symmetry effects were not considered that time.

Electron paramagnetic resonance (EPR) studies on a single crystal of Van Vleck compound $EuAlO_3$ with the $Gd^{3+}$ ion substituting for the $Eu^{3+}$ ion, were carried out at X-band (9.4 GHz) over the 77 – 400 K temperature range. At these temperatures the single crystals of $EuAlO_3$ had the space symmetry group $D_{4h}^{16}$ and rare-earth ions located at the $Gd^{3+}$ sites had the point symmetry group $C_S$. The asymmetry exhibited by the $Gd^{3+}$ EPR line positions for the orientations of the external magnetic field about the Z and Y magnetic axes in the ZY plane was ascribed to the existence of monoclinic site symmetry at the site of the $Gd^{3+}$ ion, as confirmed by the significant values of the spin-Hamiltonian (SH) parameters $g_{yz}$, $b_2^{-1}$, $b_4^{-m}$ (m = 1, 3), $b_6^{-m}$ (m = 1, 3, 5), estimated by fitting all EPR line positions observed at room temperature for the orientation of the magnetic field in the magnetic ZX and ZY planes using a rigorous least-square fitting procedure.
The novel features of the EPR study of the $Gd^{3+}$ ion in $EuAlO_3$ crystal presented in this paper are as follows:

(i) The SH parameters ($b_n^m$) for the $Gd^{3+}$ ion situated at a $Eu^{3+}$ site have been estimated accurately at 77 and 295 K. Additional set of EPR lines was observed, most likely from $Eu^{2+}$ ions.
(ii) Temperature dependence of $Gd^{3+}$ linewidth was investigated and interpreted in the terms of "life-time" broadening.
(iii) It was found, that dynamical dipolar and exchange interactions of impurity $Gd^{3+}$ ions and host $Eu^{3+}$ ions are responsible for EPR $Gd^{3+}$ linewidth broadening.

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[2]. Misra S. K. and Andronenko S. I., A variable temperature X-band EPR study of the $Gd^{3+}$ ion in a $La_2Si_2O_7$ crystal characterized by monoclinic site symmetry, Applied Magnetic Resonance, 2007, 32(3), 377-384.
[3]. Andronenko S.I., Koroleva L.N., Bondar' I.A., and Ioffe V.A., Influence of levels of the $^7F_1$ term of $Eu^{3+}$ on the ESR spectra of $Gd^{3+}$ in $EuAlO_3$, Sov. Phys. Solid State, 1982, 24(5), 881 – 882.