D5 Perturbed Angular Correlations of Gamma-Rays in Ferrites with Garnet Structure

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Molecular field theory and free-ion approximation are used to interpret data on internal magnetic fields acting on rare-earth nuclei in ferrimagnetic iron garnets. The validity of the model is checked by a number of angular correlation experiments on the following radioactive decays: $^{169}Yb \rightarrow {}^{169}Tm$, $^{171}Er \rightarrow {}^{171}Tm$, $^{166}Ho \rightarrow {}^{166}Er$, $^{154}Eu \rightarrow {}^{154}Gd$ and $^{140}La \rightarrow {}^{140}Ce$. The following characteristics of the internal field were studied and discussed: 1. direction, 2. magnitude, 3. dependence on externally-applied magnetic field, and 4. temperature dependence.

It was found that the model describes the magnitudes of internal fields at room temperature with an accuracy set by present knowledge of nuclear magnetic moments of excited states and the values of the exchange fields acting on rare-earth ions in iron garnets.

The external magnetic field and the exchange field were not equally efficient in producing the internal magnetic field. In heavier rare-earths, where these two fields act in opposite directions on nuclei, it is possible to annul the z-component of the internal field by applying sufficiently strong external field H^0_{ext}. The values of H^0_{ext} are quoted for all heavier rare-earth ions at a room temperature. The effect is demonstrated on the case of Tm^{3+} ion in garnet.

The perturbed angular correlation method was used to investigate the details of the internal field inversion occuring at the compensation temperature of garnets. The effect of a temperature hysteresis of the internal magnetic field is found and discussed.

The electron spin-lattice relaxation time was extracted from the experimental determination of time-dependent attenuation factors for all investigated cases. In the case of Gd ion a series of anomalies were found, suggesting a partly static magnetic interaction of this ion in garnet.

References

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