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# The Influence of Electric Quadrupole Interactions on $g$-Factor Measurements*

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Many $g$-factor measurements on excited states are made by using the large magnetic hyperfine fields of ions that are recoil-implanted into ferromagnetic hosts in a Coulomb excitation or nuclear reaction process. The observation of the angular shift $\Delta\theta$ in the time-integrated directional distribution $W(\theta)$ yields $\omega_B\tau$ from which the $g$-factor can be extracted. Since ferromagnetic hosts, *e.g.* Fe, Ni, have a cubic crystal structure, no attention is usually given to the possible presence of quadrupole interactions. Recent experiments,[1] however, have shown that an ion in a radiation-damaged cubic host (vacancies!) is subjected to reasonably large randomly oriented electrostatic gradients. The effect of the resulting quadrupole interaction on $g$-factor measurements can be taken into account by measuring the complete time-integrated directional distribution $W(\theta)$ for $-\pi/2 \leq \theta \leq \pi/2$ of the de-exciting gamma rays and by analyzing the data using the theory of Alder *et al.*[2] In such an analysis, in addition to the unknown magnetic interaction $\omega_B\tau$, the quadrupole strength $\omega_Q\tau$ must be treated as an unknown parameter. As an example, the influence of a randomly oriented quadrupole interaction on the directional distribution of gamma rays emitted from an $I=2^+$ state populated in a Coulomb excitation experiment in the presence of a constant transverse magnetic field resulting in a magnetic interaction parameter of $\omega_B\tau=0.1$ is plotted in Fig. 1 for various quadroupole strength $\omega_Q\tau$. If $\omega_Q\tau \ll \omega_B\tau$ and if $\omega_Q\tau \ll 1$ the $g$-factor can be determined from the observed angular shift $\Delta\theta$ from the equation

$$W(\theta)=\sum_k G_{kk}(\omega_Q)A_{kk}P_k[\cos(\theta-G_{kk}(\omega_Q)\omega_B\tau)]$$

where $G_{kk}(\omega_Q)$ is the attenuation coefficient for the random quadrupole interaction.

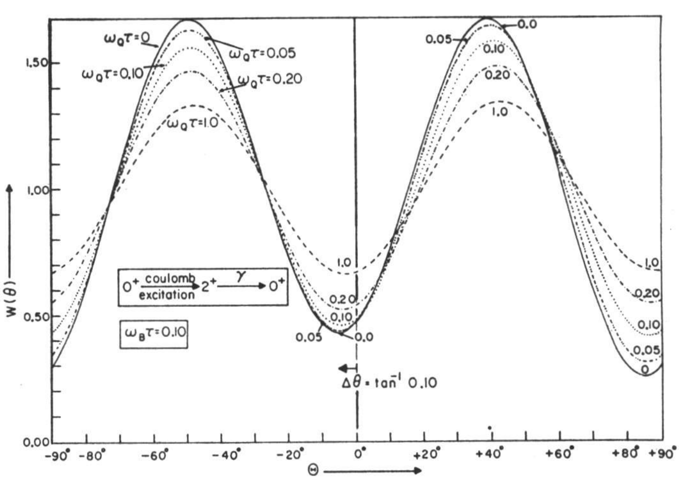


Fig. 1. The time-integrated directional distribution $W(\theta)$ of gamma rays emitted from an $I=2^+$ nuclear state excited in Coulomb excitation with a transverse magnetic field ($\omega_B\tau=0.1$) in the presence of a randomly oriented quadrupole interaction of various strength $\omega_Q\tau$.

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**References**

1) M. Behar and R. M. Steffen: Phys. Rev. Letters **29** (1972) 116.
2) K. Alder, E. Matthias, E. Schneider and R. M. Steffen: Phys. Rev. **129** (1963) 1199.