Quadrupole susceptibility of Gd-based filled skutterudites

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It is shown that quadrupole susceptibility can be detected in Gd compounds contrary to our textbook knowledge that Gd^{3+} ion induces pure spin moment due to the Hund's rules in an LS coupling scheme. The ground-state multiplet of Gd^{3+} is always characterized by $J=7/2$, where J denotes total angular momentum, but in a j-j coupling scheme, one f electron in $j=7/2$ octet carries quadrupole moment, while other six electrons fully occupy $j=5/2$ sextet, where j denotes one-electron total angular momentum. For realistic values of Coulomb interaction and spin-orbit coupling, the ground-state wavefunction is found to contain significant amount of the j-j coupling component. From the evaluation of quadrupole susceptibility in a simple mean-field approximation, we point out a possibility to detect the softening of elastic constant in Gd-based filled skutterudites.