

# Electron penetration into the nucleus and its effect on the quadrupole interaction

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A series expansion of the interaction between a nucleus and its surrounding electron distribution provides terms that are well-known in the study of hyperfine interactions: the familiar quadrupole interaction and the less familiar hexadecapole interaction. If the penetration of electrons into the nucleus is taken into account, various corrections to these multipole interactions appear. The best known correction is a scalar term related to the isotope shift and the isomer shift. For magnetic hyperfine interactions, the corresponding term is the Fermi contact interaction. This contribution discusses a related tensor correction, which modifies the quadrupole interaction if electrons penetrate the nucleus: the quadrupole shift. We describe the mathematical formalism and provide first-principles calculations of the quadrupole shift for a large set of solids. Fully relativistic calculations that explicitly take a finite nucleus into account turn out to be mandatory. Our analysis shows that the quadrupole shift becomes appreciably large for heavy elements. Implications for experimental high-precision studies of quadrupole interactions and quadrupole moment ratios are discussed.

This contribution is a summary of a recently published extensive paper [1], updated with results from experimental follow-up work [2].

References: [1] K. Koch, K. Koepernik, D. Van Neck, H. Rosner, S. Cottenier, Physical Review A 81 (2010) 032507 [2] D. Dewald, J. Grabow, in preparation