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III.c. Nuclear Electric Quadrupole Moment of the β-Emitter ^{20}F

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(Presented by H. Ackermann)

Polarized ^{20}F nuclei ($T_{1/2}=11.2$s, $I=2$) have been produced in a tetragonal MgF_2 single crystal by capture of polarized neutrons. NMR transitions have been observed via the β-decay asymmetry at an external magnetic field $H=4350$ Oe, where the static magnetic dipole and electric quadrupole interaction are of the same order of magnitude. The energy-level diagram (Fig. 1(a)) depends on the crystal orientation relative to $\boldsymbol{H}$, on the magnetic moment $\mu_I(^{20}\mathrm{F})$, on the quadrupole coupling constant (qcc), and on the asymmetry parameter η. In order to get a detectable NMR signal despite of the nonequidistance of the energy levels two rf fields have been applied simultaneously: the first one was frequency modulated saturating three of the four transitions $\Delta m_I=\pm 1$. The second rf field was swept in steps over the fourth transition (Fig. 1(b) shows an example).

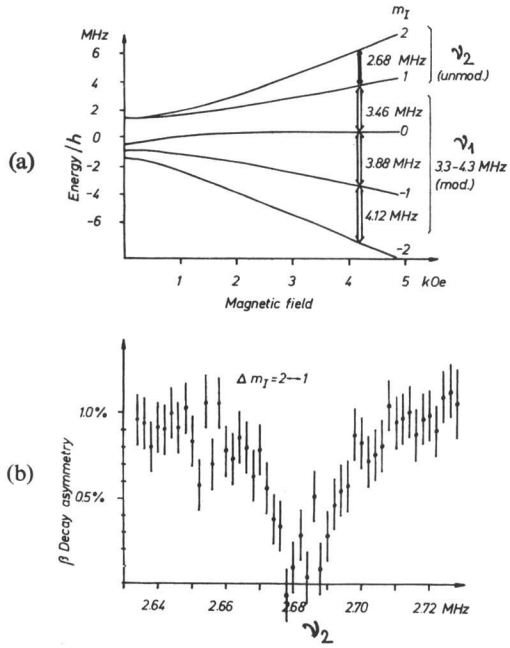

Fig. 1. (a) Energy levels of ^{20}F ($I = 2$) in tetragonal MgF_2 with the crystallographic axis parallel to the external magnetic field.
(b) Resonance signal: β-decay asymmetry versus the frequency ν_2. ν_1 was frequency modulated between 3.3 and 4.3 MHz.

Results:

From the four transition frequencies the qcc of ^{20}F in MgF_2 was calculated to $|e^2qQ/h|=$ 5.77(2)MHz. With the known qcc of the 197-keV state of ^{19}F in MgF_2[1] one obtains the ratio for the Q-moments $|Q(^{20}F)/Q(^{19}F, 197keV)|=0.58(2)$. Inserting the value for $Q(^{19}F, 197keV)=0.11b$[2] one gets finally $|Q(^{20}F)|=0.064(20)b$. This value agrees with shell-model calculations[3] yielding $Q_{calc}=+0.08b$.

References

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