Measurements of Quadrupole-Interaction-Resolved NMR on Oriented ^{185}Pt, ^{189}Pt and ^{191}Pt in hcp-Co ◇

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The $_{77}$Ir, $_{78}$Pt, $_{79}$Au and $_{80}$Hg nuclei lie in the transition region between the well deformed rare earth nuclei and the spherical nuclei near $^{208}_{82}$Pb. Depending on the neutron number, the nuclear shapes may vary between prolate deformation, oblate deformation, triaxial deformation and γ-softness. The quadrupole moments of ^{191}Pt, ^{189}Pt, and ^{187}Pt – all isotopes have $I^\pi = 3/2^-$ – are negative pointing to a predominantly oblate deformation, whereas the quadrupole moment of ^{185}Pt ($I^\pi = 9/2^+$) is large and positive, proving the existence of a large prolate deformation of ^{185}Pt. Theoretical calculations yielded a smooth transition in the shape of odd-A Pt nuclei from a slightly deformed (nearly oblate) ^{195}Pt via triaxial $^{193-187}$Pt to a strongly deformed (nearly prolate) ^{177}Pt. With the long-term aim of a better understanding of this transition, more accurate values for the quadrupole moments would be desirable. Therefore we performed measurements of quadrupole-interaction-resolved nuclear magnetic resonance on oriented nuclei (QI-NMR-ON) on ^{185}Pt, ^{189}Pt, and ^{191}Pt.

In hcp-Co an electric quadrupole interaction (EQI) exists in addition to the magnetic hyperfine interaction. It causes the magnetic resonance to be split into a set of $2I$ subresonances — I is the nuclear spin — which are separated by $\Delta\nu_\mathrm{Q}$,

$$\Delta\nu_\mathrm{Q} = 3\nu_\mathrm{Q}/[2I(2I-1)], \qquad (1)$$
$$\nu_\mathrm{Q} = eQV_{zz}/h, \qquad (2)$$

where eQ is the spectroscopic quadrupole moment and V_{zz} is the principal component of the EFG tensor. The amplitudes of the subresonances depend on decay properties and on the Boltzmann factor. If at least two subresonances can be detected, $\Delta\nu_\mathrm{Q}$ and hence ν_Q can be determined directly. In cases, for which only the lowest subresonance (ν_1) can be observed, the quadrupole interaction can nevertheless be determined if the magnetic hyperfine interaction is known:

$$\nu_\mathrm{Q} = \frac{4I}{3}(\nu_\mathrm{M} - \nu_1). \qquad (3)$$

This is the case for ^{185}Pt and ^{189}Pt, for which the magnetic hyperfine splittings with respect to ^{191}Pt are known experimentally from NMR-ON measurements on ^{185}Pt, ^{189}Pt and ^{191}Pt in Fe.

For ^{191}Pt$\underline{\mathrm{Co}}^{(\mathrm{hcp})}$ the three subresonances could be resolved. This is shown in Fig. 1. For ^{189}Pt$\underline{\mathrm{Co}}^{(\mathrm{hcp})}$ and ^{185}Pt$\underline{\mathrm{Co}}^{(\mathrm{hcp})}$ only the ν_1-resonance could be measured. These are shown in Figs. 2 and 3.

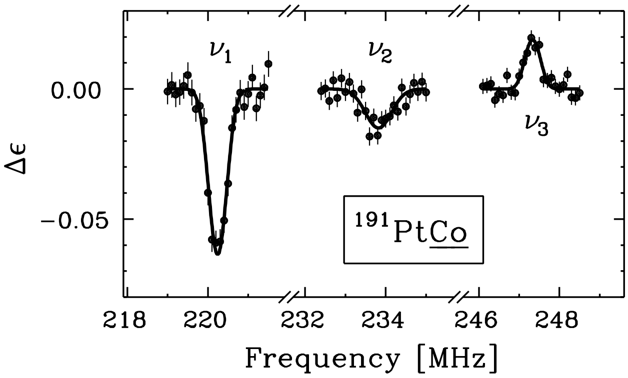

Fig. 1: QI-NMR-ON spectrum of ^{191}Pt$\underline{\mathrm{Co}}^{(\mathrm{hcp})}$.

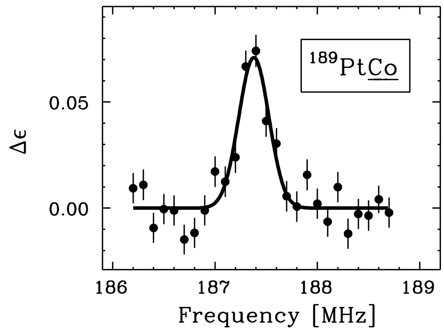

Fig. 2: ν_1-resonance of ^{189}Pt$\underline{\mathrm{Co}}^{(\mathrm{hcp})}$.

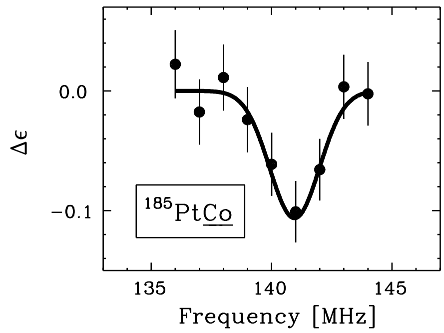

Fig. 3: ν_1-resonance of ^{185}Pt$\underline{\mathrm{Co}}^{(\mathrm{hcp})}$.

For the ratios of quadrupole moments we find

$$Q(^{189}\mathrm{Pt})/Q(^{191}\mathrm{Pt}) = +1.235(8),$$
$$Q(^{185}\mathrm{Pt})/Q(^{191}\mathrm{Pt}) = -4.46(13).$$

For ^{189}Pt our ratio is different from the the literature value obtained by Laser spectroscopy measurements.
A full description of this work is given in Ref. [1].

References

[1] G. Seewald *et al.*, Phys.Rev. **C57** (1998) 2165

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