Measurements of the Spectroscopic Quadrupole Moments of Neutron Deficient Ir Isotopes and Shape Coexistence in ^{186}Ir ◇

G. Seewald, E. Hagn, B. Hinfurtner, E. Zech, D. Forkel-Wirth [a], R. Eder [a], and ISOLDE Collaboration
[a] PPE Division, CERN, CH-1211 Geneva 23, Switzerland

1. Summary

The spectroscopic quadrupole moments of the neutron deficient radioactive Ir isotopes ^{184}Ir, ^{186g}Ir, ^{186m}Ir, ^{187}Ir, ^{188}Ir and ^{189}Ir were measured with the technique of quadrupole-interaction-resolved NMR on oriented nuclei (QI-NMR-ON). The ratio of quadrupole moments of the 2^- isomeric state ^{186m}Ir and the 5^+ ground state ^{186g}Ir points to different nuclear deformations in these states. For the unambiguous measurement of ground state spins a new method was developed. The application to ^{184}Ir yielded $I = 5$.

2. Experimental Method and Results

Radioactive Hg precursors of the Ir isotopes were prepared at ISOLDE by bombarding a liquid Pb target with 1 GeV protons and implanted into hexagonal Co single crystals. The samples were cooled to temperatures of $\sim$ 5 - 10 mK with a ^{3}He-^{4}He-dilution refrigerator with a top-loading facility.

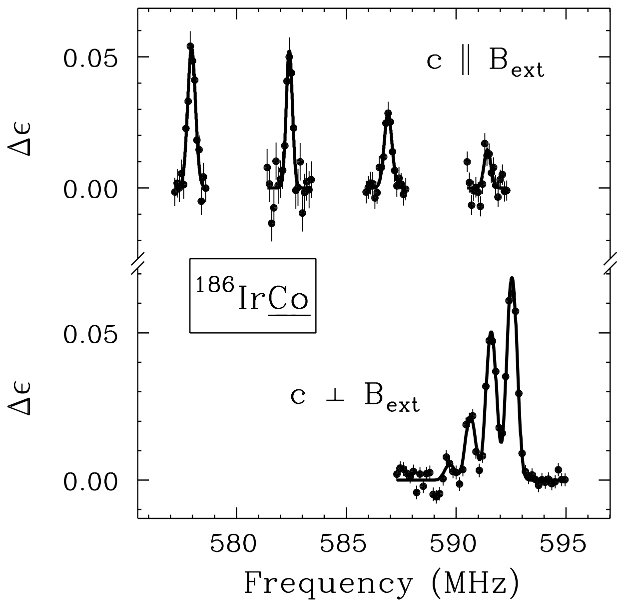

Fig. 1: QI-NMR-ON resonance of ^{186g}Ir in hcp-Co for magnetization parallel (top) and perpendicular (bottom) to the c-axis.

For Ir in hcp-Co, the electric field gradient (EFG) consists of a lattice contribution (axial symmetric with respect to the crystallographic c-axis) and a collinear contribution (axial symmetric with respect to the direction of the electronic magnetization). Thus, the quadrupole splitting which is superimposed to the magnetic hyperfine splitting is by a factor of $\approx$ -4 different for magnetization parallel and perpendicular to the c-axis. The quadrupole subresonances are separated by $\Delta\nu_Q = 3\nu_Q/[2I(2I-1)]$, where $\nu_Q = e^2qQ/h$ is the quadrupole interaction frequency. Here I is the nuclear spin, eq is the EFG and Q is the spectroscopic quadrupole moment.

As an example, fig. 1 shows QI-NMR-ON spectra of ^{186g}Ir. Similar measurements were performed for ^{184}Ir, ^{186m}Ir, ^{187}Ir, ^{188}Ir and ^{189}Ir.

The dependence of the intrinsic quadrupole moments on the atomic number A is shown in fig. 2.

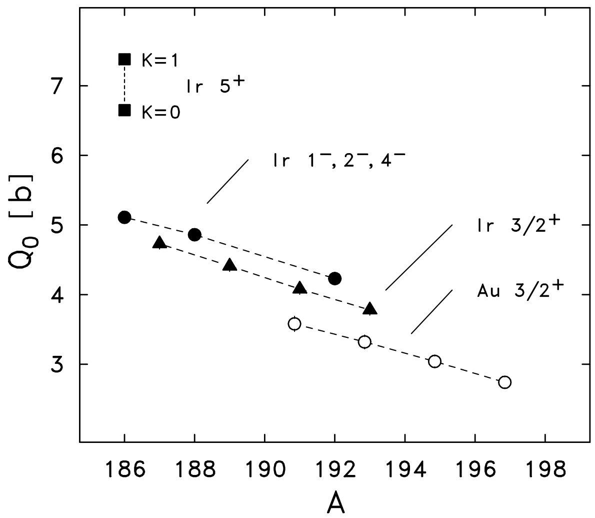

Fig. 2: Intrinsic quadrupole moments of Ir and Au isotopes.

The deformation parameter β_2 can be calculated using the well-known rotational-model relationship. The results are $\beta_2(^{186m}\mathrm{Ir}) = +0.17$ and $\beta_2(^{186g}\mathrm{Ir}) \geq +0.22 \ldots +0.25$. Thus – despite of the very small energy difference between isomer and ground state of < 1.5 keV – the deformation of ^{186g}Ir is considerably larger than the deformation of ^{186m}Ir. This is probably connected with the specific properties of the $\pi 1/2^-[541]$ proton intruder state coming down from the $\pi h_{9/2}$ orbital: Because of the large negative energy dependence of the $\pi 1/2^-[541]$ single particle energy with deformation, a larger ground state deformation is favored.

A full description of this work is given in ref. [1].

References

[1] G. Seewald, E. Hagn, B. Hinfurtner, E. Zech, D. Forkel-Wirth, R. Eder and ISOLDE Collaboration, Phys. Rev. Lett. **77** (1996) 5016

◇ Work supported by the DFG under the contract number Ha 1282/3-3