Nuclear spin and moments of ^{73}Kr and odd–even staggering in the radii of light krypton isotopes

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Nuclear spectroscopy measurements in the region of neutron-deficient krypton isotopes have indicated that pronounced shape changes and instabilities occur when the nuclei approach the $N = Z$ line. This is confirmed by isotope shift measurements on krypton [1] yielding an increasing inverted odd–even staggering of the radii [2] from ^{82}Kr ($N = 46$) to ^{74}Kr ($N = 38$). We have now completed the published data by measuring the hyperfine structure and isotope shift of ^{73}Kr. This is also interesting in context with a recent β-decay study [3]. The feeding of excited states in ^{73}Br gave strong arguments for the ground-state spin and parity of ^{73}Kr to be $3/2^-$, in contrast to the adopted assignment of $5/2^-$.

The experimental method is based on collinear fast beam laser spectroscopy in connection with highly efficient detection. State selective charge-exchange neutralization on caesium vapour populates efficiently the metastable $4p^5\,5s[3/2]_2$ atomic state. The excitation by laser light at 760 nm optically pumps the atoms to the $4p^6$ ground state. This optical pumping is detected by selective ionization of the metastable atoms in collisions with chlorine molecules in a 10^{-3} mbar gas atmosphere. The ionized fraction of the beam is deflected onto a tape system equipped with scintillation counters for the detection of the β-decays of ^{73}Kr ($T_{1/2} = 26$ s). In the same way, the neutral fraction of the beam is monitored for normalizing to non-statistical beam fluctuations.

The spectrum plotted in Fig. 1 together with the fitted hyperfine structure pattern is well resolved. The revised spin assignment of $I = 3/2$ is clearly confirmed by this measurement, and the magnetic dipole and electric quadrupole moments can be determined from the hyperfine structure. The preliminary analysis yields a magnetic moment of $\mu_I(^{73}\mathrm{Kr}) = +0.912(7)\,\mu_N$. It remains to be explained how the positive sign is compatible with a negative-parity state of spin 3/2. The relatively small spectroscopic quadrupole moment, $Q_\mathrm{s} = +0.63(8)$ b, corresponds to a large intrinsic moment with the strong-coupling projection factor for $I = 3/2$.

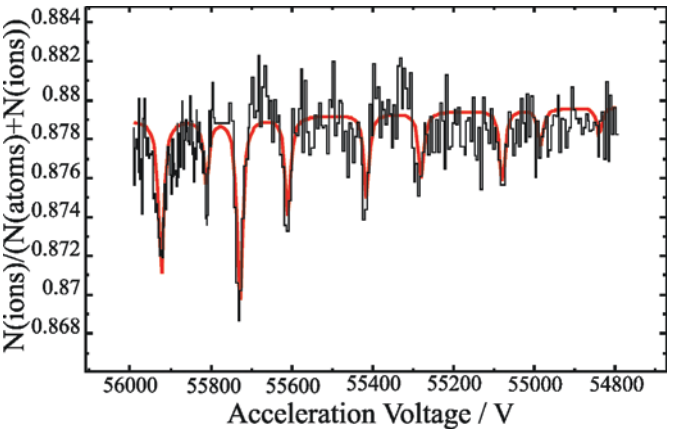

Fig. 1. Experimental hyperfine spectrum of ^{73}Kr. The ion count rate (N(ion)) is normalized to the total beam intensity $N(\mathrm{ion}) + N(\mathrm{atom})$.

In addition to the nuclear moments the isotope shift with respect to ^{86}Kr has been measured. The data show an exceptionally large mean square charge radius of ^{73}Kr compared to the even-A neighbours. The previously discussed odd–even staggering [2] increases further towards $N = Z$ and indicates strong deformation for the ground state of ^{73}Kr.

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