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HYPERFINE SPECTROSCOPY OF ^{81}KR AND ^{85}KR

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Abstract

Hyperfine constants and isotope shifts for ^{81}Kr and ^{85}Kr measured by saturation spectroscopy and two-color two-photon excitation will be reported and discussed.

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Hyperfine constants and isotope shifts were measured for the $1s_5 - 2p_9$ and $1s_5 - 4d'_4$ transitions in ^{81}Kr and for the $1s_5 - 2p_9$, $1s_5 - 2p_7$, and $1s_5 - 2p_6$ transitions in ^{85}Kr in a weak glow discharge. A single-frequency dye laser was used to do saturation spectroscopy with fluorescence detection for all but one transition. For the $1s_5 - 4d'_4$ transition, two-color two-photon excitation was done with a single-frequency dye laser and a frequency-narrowed GaAlAs diode laser. This two-photon excitation gave the narrowest lines, the largest signal-to-noise ratio, and least background of any of the transitions studied in this work. The freedom to resonantly enhance selected ^{81}Kr lines and diminish the much stronger lines from the even krypton isotopes aided identification and assignment of the ^{81}Kr spectra (See Figure 1).

Table I shows the hyperfine constants and isotope shifts I measured for these two isotopes. My results on ^{85}Kr agree quite well with those of Gerhardt et al. [1] on the one transition they studied. There are no published hyperfine constants or isotope shifts for ^{81}Kr. This data confirms that the ^{81}Kr nuclear spin is +7/2 and determines its magnetic dipole moment and electric quadrupole moment. The ^{81}Kr and ^{85}Kr nuclear magnetic dipole moments are, respectively, 20% and 3% larger than that for the

stable isotope ^{83}Kr. In contrast, the nuclear quadrupole moments of ^{81}Kr and ^{85}Kr are 150% and 70% larger than that for ^{83}Kr. These quadrupole moments imply significant changes in the shape of the ^{81}Kr and ^{85}Kr nuclei from that of ^{83}Kr.

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References:

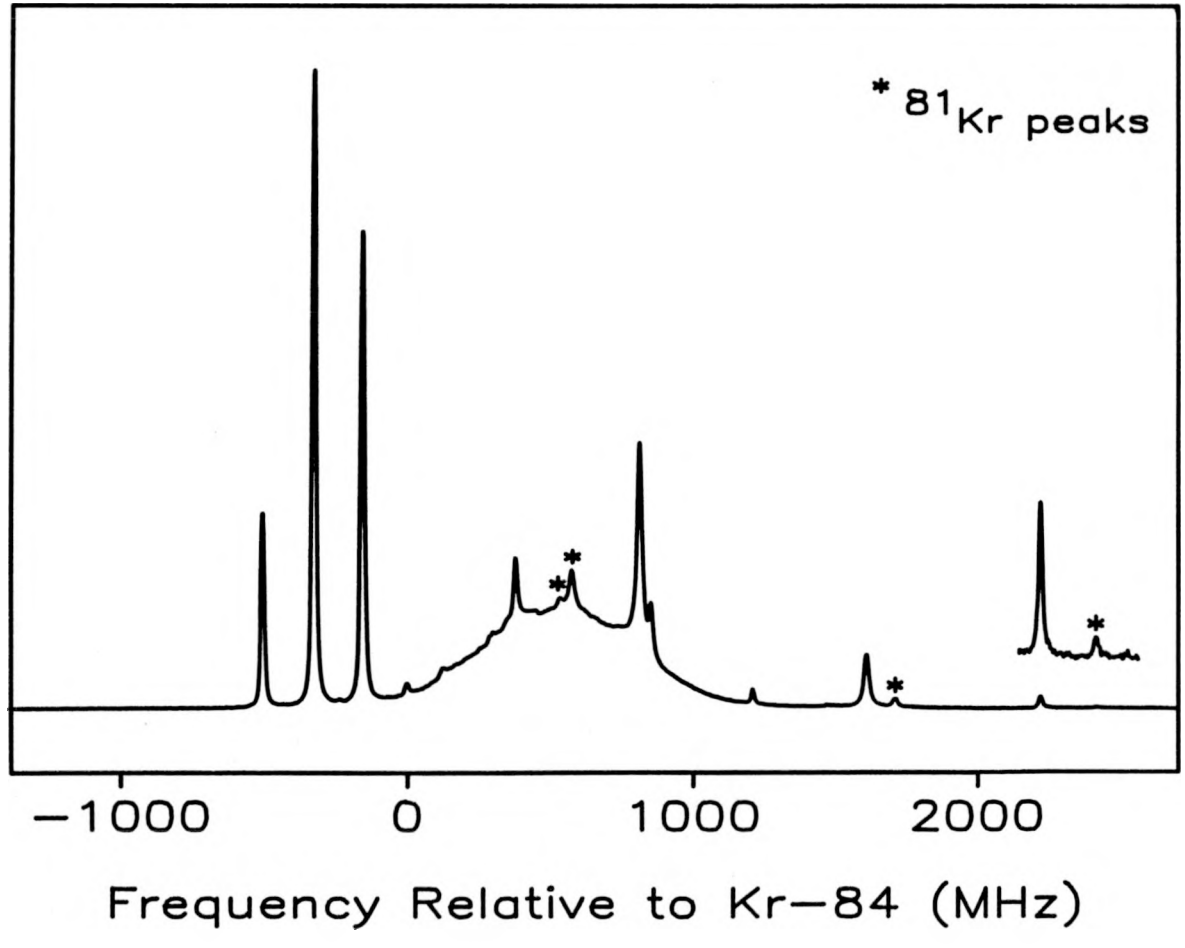
[1] H. Gerhardt, F. Jeschonnek, W. Makat, E. Matthias, H. Rinneberg, F. Schneider, A. Timmermann, R. Wenz, and P.J. West, Hyperfine Interactions **9**, p. 175-179 (1981)

Captions

Figure 1 Two-color two-photon excitation spectrum of the $1s_5$-$4d'_4$ transition in a krypton sample containing approximately 0.5% ^{81}Kr. A frequency-narrowed diode laser is tuned to the $1s_5$ F=11/2 to $2p_9$ F=13/2 hyperfine line in ^{81}Kr and a single-frequency dye laser is scanned over the $2p_9$-$4d'_4$ transition. The unmarked peaks are due to stable krypton isotopes.

Table I Hyperfine coupling constants and isotope shifts relative to ^{83}Kr for the rare radioactive isotopes ^{81}Kr and ^{85}Kr measured in this work. All values are in MHz and the values in parentheses are one standard deviation error estimates in terms of the last digits shown.

	^{81}Kr	^{85}Kr
$A(1s_5)$	-294.02(27)	-252.81(8)
$B(1s_5)$	-1117.2(48)	-775.8(20)
$A(4d'_4)$	-88.19(19)	
$B(4d'_4)$	-1147.2(55)	
Isotope Shift of $1s_5$-$4d'_4$	-184.0(27)	
$A(2p_9)$		-107.56(10)
$B(2p_9)$		-743.6(19)
Isotope Shift of $1s_5$-$2p_9$	-88.6(50)	+78.5(16)
$A(2p_7)$		-183.75(85)
$B(2p_7)$		-116.7(43)
Isotope Shift of $1s_5$-$2p_7$		+59.75(19)
$A(2p_6)$		-112.46(14)
$B(2p_6)$		-154.0(36)
Isotope Shift of $1s_5$-$2p_6$		+60.7(30)


* 81Kr peaks
−1000
0
1000
2000
Frequency Relative to Kr−84 (MHz)