

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

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

B. D. Cannon

November 1990

Presented at the
Quantum Electronics and Laser Science Conference
Baltimore, Maryland
May 12-17, 1991

Work supported by
the U.S. Department of Energy
under contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Conf - 910595--10
PNL-SA-18840

PNL SA--18840

DE91 012869

Received by OSTI

JUN 04 1991

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Hyperfine Spectroscopy of ^{81}Kr and ^{85}Kr

B. D. Cannon, Pacific Northwest Laboratory

Mail Stop K3-58, P.O. Box 999, Richland, WA 99352

(509) 375-3827

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.

Hyperfine Spectroscopy of ^{81}Kr and ^{85}Kr

B. D. Cannon, Pacific Northwest Laboratory

Mail Stop K3-58, P.O. Box 999, Richland, WA 99352

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

B. D. Cannon, Hyperfine of Kr

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 .

Acknowledgments This work supported by the Director, Office of Energy Research, Office of Basic Energy Sciences, Chemical Sciences Division of the U.S. Department of Energy (DOE) under contract DE-AC06-76RLO 1830. Pacific Northwest Laboratory is operated for DOE by Battelle Memorial Institute.

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)	+785(16)
A($2p_7$)		-183.75(85)
B($2p_7$)		-116.7(43)
Isotope Shift of $1s_5$ - $2p_7$		+5975(19)
A($2p_6$)		-112.46(14)
B($2p_6$)		-154.0(36)
Isotope Shift of $1s_5$ - $2p_6$		+607(30)

