THE ROLE OF NUCLEAR SPINS IN PHOTOIONIZATION: ISOTOPE-RESOLVED MEASUREMENT OF THE HIGH, ODD-PARITY, AUTOIONIZING RYDBERG STATES OF KRYPTON

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Using a Fourier-transform-limited, tunable vacuum-ultraviolet laser system with a 50MHz bandwidth[a] in conjunction with an ultra-high-vacuum spectrometer, observation of the autoionizing Rydberg series up to principal quantum number $n \sim 300$ by photoionization spectroscopy allowed the determination of the $^2\mathrm{P}_{1/2}$ ionization threshold for $^A\mathrm{Kr}$ (with $A = 80$, 82, 83, 84, 86), as well as measurement of the relative isotope shifts. The average $^2\mathrm{P}_{1/2}$ ionization energy, weighted by natural abundances, amounts to (118284.7269 $\pm(0.011)_{\mathtt{stat}}$ $\pm(0.027)_{\mathtt{abs}}$) cm^{-1}. For ^{83}Kr, an accurate determination of the hyperfine ionization thresholds with $F^+ = 4$ and $F^+ = 5$ was made and the magnetic dipole hyperfine coupling constant $A_{1/2}$ of the $^2\mathrm{P}_{1/2}$ spin-orbit excited state of Kr^+ was found to be -0.0385(5) cm^{-1}. The presence of a nonzero nuclear spin (I=9/2) in ^{83}Kr profoundly alters the appearance of the photoionization spectrum. Hyperfine-induced J mixing and stroboscopic resonances lead to characteristic spectral patterns that could be fully explained by multichannel quantum defect theory using the method previously developed to analyze similar patterns observed in the spectrum of autoionizing Rydberg states of Xe.[b]

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[a] Th. A. Paul and F. Merkt, *J. Phys. B: At. Mol. Opt. Phys.*, **38**, 4145 (2005)
[b] H. J. Wörner, M. Grütter, E. Vliegen and F. Merkt, *Phys. Rev. A*, **71**, 052504 (2005)