

The first ionization potential of astatine measured by in-source laser spectroscopy: a graphical approach for the analysis of Rydberg series

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The radioactive element astatine is the heavier homologue of iodine. It was discovered by Corson et al [1] who artificially produced it in a nuclear reaction. Since this discovery, two optical transitions were observed by McLaughlin in a absorption spectroscopy experiment [2]. We have recently performed in-source resonance laser ionization spectroscopy on astatine isotopes created in a proton-induced nuclear reaction at the ISOLDE radioactive isotope facility at CERN. By the discovery of new optical transitions, an efficient multi-photon ionization scheme was developed, which enabled the spectroscopy of highly excited Rydberg states close to the ionization limit. From the analysis of the observed series, the ionization potential of astatine was determined with a precision of better than 1 cm^{-1} . [3]

We present a new, more detailed spectrum of astatine Rydberg states, constituting of 7 series that converge to the ionization limit. A graphical method was applied to identify series members and to help to constrain series assignments. We will also discuss how this approach enables the extraction of the ionization potential from a spectrum, without requiring a detailed Rydberg-Ritz analysis.

References:

- [1] D. R. Corson, et al., Phys. Rev. **58**, 872-678 (1940).
- [2] R. McLaughlin, J. Opt. Soc. Am. **54**, 965-967 (1964).
- [3] S.Rothe et al., Nat. Commun. Accepted.