



Contribution ID: 85

Type: **Poster**

Precise determination of the ionization potential of astatine by in-source laser spectroscopy

Thursday, 24 May 2012 18:10 (20 minutes)

On-line in-source laser resonance ionization spectroscopy of the exclusively radioactive element astatine was performed at CERN/ISOLDE, representing the first ever laser spectroscopy on that heaviest halogen element. An efficient ionization scheme was developed and the first precise determination of the ionization potential of astatine was carried out. Due to the absence of long-lived isotopes of astatine, on-line production at the ISOLDE isotope separator facility at CERN was required. During an initial measurement campaign, the ionization potential was located within a range of 100 cm⁻¹ by photoionization threshold spectroscopy. This work was a prerequisite for the precision spectroscopy of high lying Rydberg states which was performed by scanning one of the RILIS lasers across the corresponding wavelength range. The observed Rydberg levels converge towards the ionization potential which was determined as 75151(1) cm⁻¹. This closes the gap in the list of measured IPs from hydrogen ($Z = 1$) to rutherfordium ($Z = 104$). The efficient ionization scheme for astatine will enable further precision in-source spectroscopy of isotope shifts and hyperfine structure as well as the study of beta delayed fission of the isotopes 194-199At.

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Session Classification: Poster Prize Presentations

Track Classification: Production and manipulation of RIB