NUCLEAR-STRUCTURE INFORMATION OBTAINED FROM LASER-SPECTROSCOPY OF NOBELIUM ISOTOPES

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The study of the hyperfine structure and the isotope shifts of spectral lines is known to bridge the fields of nuclear and atomic physics, enabling nuclear properties to be obtained in a comprehensive and model-independent way. These properties include the spin, magnetic dipole and electric quadrupole moments, and changes in the mean-square charge radii. Obviously, the establishment of such optical spectroscopy studies in the region of deformed nuclei on the shore of the 'island of stability of superheavy elements' would inevitably attract a high level of interest of both, nuclear physics and atomic physics communities. For atomic physics, for instance, already the observation of atomic transitions in these very heavy elements would provide a stringent test of modern atomic theories addressing relativistic and quantum electrodynamic effects.

Albeit strong efforts undertaken and the extensive optical spectroscopy research programs initiated in the last century, optical spectroscopy deemed to reach a barrier of applicability at the element einsteinium (Z = 99) and, more than a decade now, at fermium (Z = 100). Until recently, elements beyond fermium remained out of reach for such an approach, as they are typically produced at large accelerator facilities by heavy ion-induced fusion-evaporation reactions yielding low rates. The lack of any existing tabulated spectral lines for these elements represents another big hurdle, making an extensive search for atomic transitions within a spectral range proposed by state-of-the-art atomic model calculations necessary.

Laser spectroscopy of the element nobelium (Z = 102) has long been anticipated at GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt [1]. To this end, the so-called RAdiation Detected Resonance Ionization Spectroscopy (RADRIS) technique was employed. The fusion products of interest are separated from the primary beam by the Separator for Heavy Ion reaction Products (SHIP) and thermalized in a buffer-gas stopping cell. Those remaining in a positive charged state are accumulated on a catcher filament where they are neutralized. In a subsequent step, the fusion-product beam is turned off. Then, the accumulated atoms are evaporated from the filament, ionized in a two-step photoionization process by pulsed lasers and finally guided by suitable electric fields to a silicon detector where they are unambiguously identified via their unique radioactive decay fingerprint [2].

In August 2015, several atomic transitions in ^{254}No ($T_{1/2}$ = 51.2 s) were observed and characterized. The investigations were extended to the isotopes ^{253}No ($T_{1/2}$ = 97.2 s) and ^{252}No ($T_{1/2}$ = 2.4 s), which were produced at even lower rates than ^{254}No. In my talk I will summarize the pioneering work in this field of research and highlight the recent findings with a focus on the nuclear aspects of these studies.

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