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Laser Resonance Chromatography (LRC): A new methodology in superheavy element research

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Optical spectroscopy constitutes the historical path to accumulate basic knowledge on the atom and its structure. Former work based on fluorescence and resonance ionization spectroscopy enabled identifying optical spectral lines up to element 102, nobelium [1, 2]. Beyond nobelium, solely predictions of the atom's structure exist, which in general are far from sufficient to reliably identify atoms from spectral lines. One of the major difficulties in atomic model calculations arise from the complicated interaction between the numerous electrons in atomic shells, which necessitate conducting experiments on such exotic quantum systems. The experiments, however, face the challenging refractory nature of the elements, which lay ahead, coupled with shorter half-lives and decreasing production yields.
In this contribution, a new concept of laser spectroscopy of the superheavy elements is proposed. To overcome the need for detecting fluorescence light or for neutralization of the fusion products, which were employed up to date when lacking tabulated spectral lines, the new concept foresees resonant optical excitations to alter the ratio of ions in excited metastable states to ions in the ground state. The excitation process shall be readily measurable using electronic-state chromatography techniques [3, 4] as the ions exhibit distinct ion mobilities at proper conditions and thus drift at different speeds through the apparatus to the detector. The concept offers unparalleled access to laser spectroscopy of many mono-atomic ions across the periodic table of elements, in particular, the transition metals including the high-temperature refractory metals and the elusive superheavy elements like rutherfordium and dubnium at the extremes of nuclear existence.

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