Searching the Ir^{17+} ion electronic structure for transitions extremely sensitive to drifts of the fine-structure constant

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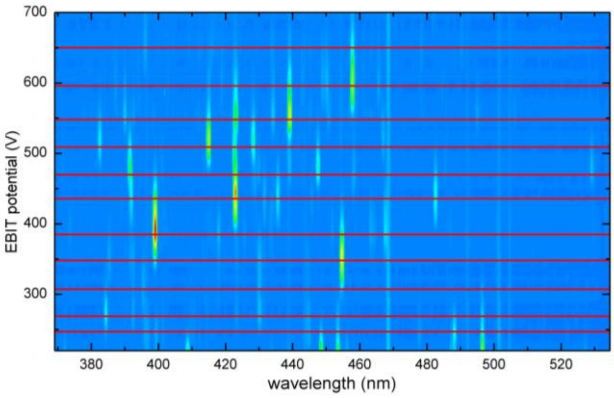
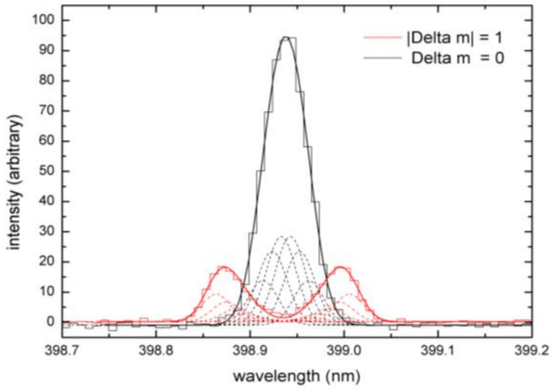
The fine-structure constant α as a fundamental parameter in the Standard Model of particle physics is deemed constant. However, astronomical observations hinting at a temporal variation of α on the level of 10^{-19}/year, below present-day laboratory sensitivity [1], have been reported [2]. Testing such a drift in the laboratory requires transitions with both higher sensitivity to α and clock accuracy. Forbidden optical transitions in highly charged ions can provide both [3,4]. The most α-sensitive stable atomic system predicted is Ir^{17+} [4]. Its electronic structure (60 bound electrons) is insufficiently understood. Therefore, we investigate this ion with the Heidelberg-Electron Beam Ion Trap (HD-EBIT). Charge states are identified by their characteristic ionization energies as well as by mapping its E1/M1 transitions both in the optical (left figure) and vacuum-ultraviolet range. The relevant wavelengths will be measured with an aimed accuracy of sub-ppm (right figure). This is needed for our planned laser spectroscopic experiments under sympathetic ion cooling in a cryogenic Paul trap [5] aiming at quantum logic readout of their respective frequencies and obtaining $d\alpha/dt$ with a fractional uncertainty better than 10^{-19}.





Left: Composite map of the visible spectra of Ir ions in different charge states (indicated by red lines) while scanning the electron beam energy. **Right:** Detail of an Ir^{16+} transition using a polarization filter to distinguish groups of Zeeman components split under the strong magnetic field of the HD-EBIT.

References:
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