VUV spectroscopy of Ir^{17+} transitions most sensitive to variation of the fine structure constant

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The current laboratory upper limit for the variation of the fine structure constant, $\dot{\alpha}$, is at $\dot{\alpha} / \alpha < -(1.6 \pm 2.3) * 10^{-17}$ year^{-1} [1]. Theoretical searches for the highest sensitivities to $\dot{\alpha}$ have identified the optical hole transitions in Ir^{17+} as ideal candidates for experiments aimed at improving this value [2]. The 4f-5s level crossing brings some of them within the range accessible by optical lasers. However, theory cannot predict their intricate level structure as accurately as needed. Preparatory experiments for level identification are therefore required for future laser spectroscopy work in the cryogenic Paul trap CryPTEx [3]. In our investigation of the level structure of Ir^{17+} we produce and excite Ir^{10+} to Ir^{23+} ions in an electron beam ion trap (EBIT). The transitions in the vacuum ultra-violet (VUV) range, from 40 eV to 240 eV, are studied using a grating spectrometer. Transitions in the optical range are simultaneously recorded with a second spectrometer. By the appearance and disappearance of groups of lines (see figure), depending on the electron beam energy, the different charge states are clearly distinguished, and their ionization potentials inferred. Strong transitions fed from various metastable levels and the presence of the 4f-5s level crossing induces spectra with features challenging state-of-the-art predictions. Our systematic study will support further theoretical work on these hitherto unexplored and interesting electronic systems.

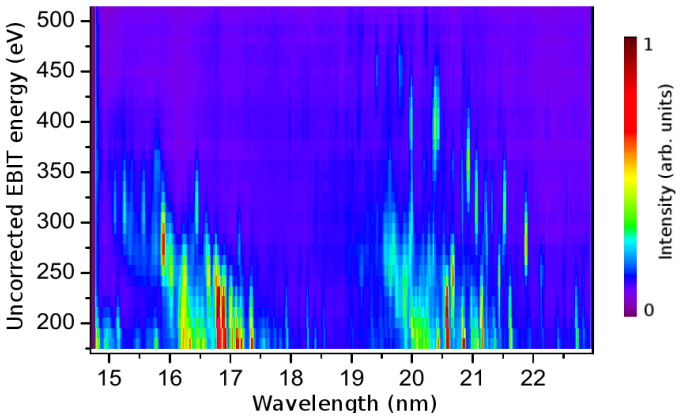

Figure: Composite VUV spectra acquired as a function of electron beam energy.

References:
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