X-ray Transitions for Decelerated Bare and H-like Uranium Ions Studied at the ESR Electron Cooler

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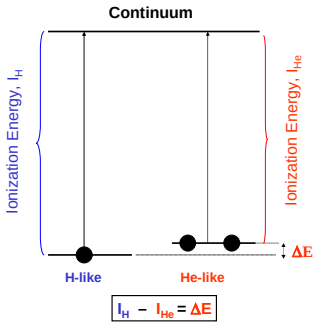
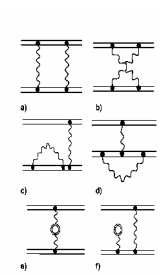
Electron-Electron Interaction in Strong Fields





Two-Electron Contribution: 2246.0 eV

a,b) Non-Radiative QED
+1.3 eV [U^{90+}]
0.06%

c,d) Two-Electron Self Energy
-9.7 eV [U^{90+}]
0.4%

e,f) Two-Electron Vacuum Polarization
+2.6 eV [U^{90+}]
0.1%

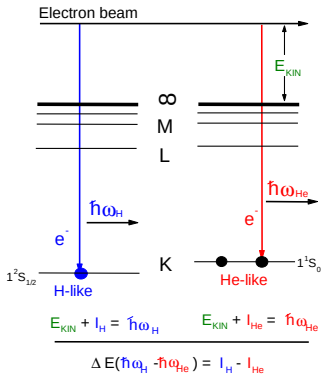
Z=92

ΔE: *Two-Electron Contribution to the Ionization potential in the He-like System*: ***Second order in α***

GOAL:
Measurement of the 2eQED for Uranium at the ESR

Accuracy:
2 eV; ΔE/E ≈ 0.1%

THE METHOD

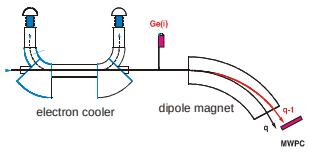


Schematic presentation of the RR process of free electrons into the initially bare and H-like ions. The energy difference $\Delta E = E_H - E_{He}$ gives exactly the two electron contribution to the ionization potential in He-like ions.

Advantage of relative measurment:
All one electron contributions cancel out

The Experiment

0 deg spectroscopy at the electron cooler



No Doppler broadening

practically, no uncertainties introduced by the geometry of the set-up

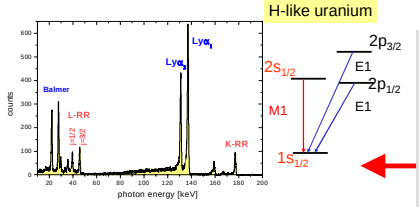
X-ray projectile coincidences

The relative measurement can be performed in sequential steps by changing frequently between bare and H-like uranium

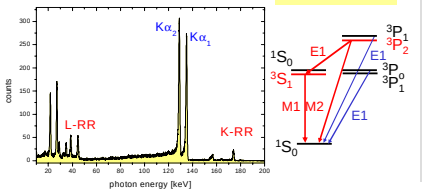
Application of the deceleration mode of the ESR

→ strongly reduced bremsstrahlung uncertainty in β not critical

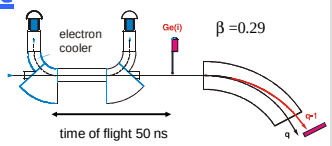
H-like uranium

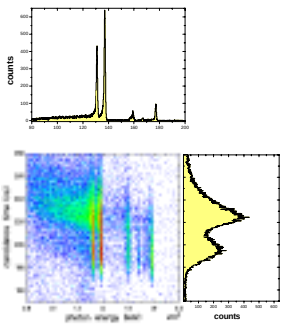


He-like uranium



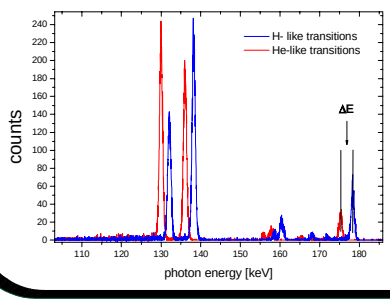
X-ray spectra for initially bare and H-like uranium as observed for decelerated ions at the electron cooler of the ESR storage ring. The x-ray spectra are measured in coincidence with down-charged uranium ions. For data accumulation, a effective beam time of 4 days have been used.





Two dimensional Scatter plot of the observed x-ray emission versus the coincidence time. The latter refers to the time difference between photon and particle detection. The pronounced structure observed in the time spectrum allows us to disentangle between photon emission which has occurred inside the electron cooler section and such events where the emission takes place just in front of the x-ray detector.

X-ray spectra of H- and He-like uranium as measured at the ESR cooler. For accumulation, a time condition has been used.



Preliminary result for the splitting ΔE is 2248 ± 9 eV

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