

Reference ionization and recombination cross section measurements

Alfred Müller

Institut für Atom- und Molekülphysik



Outline

I. Electron impact ionization of ions*

II. Dielectronic recombination*

colliding beams experiments
from few-electron systems to complex ions

* A. Müller, *Adv. At. Mol. Opt. Phys.* 55, 293 (2008)

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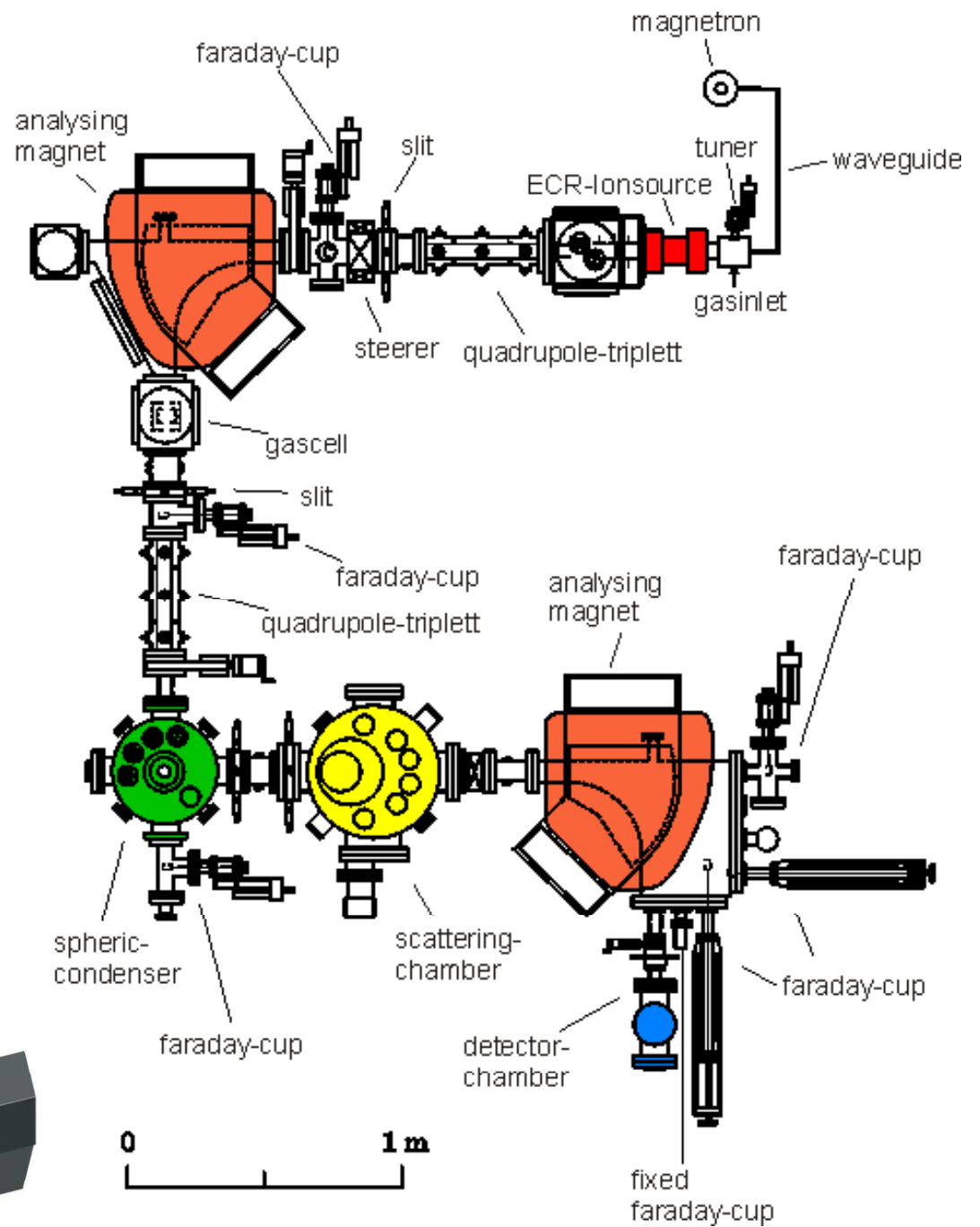
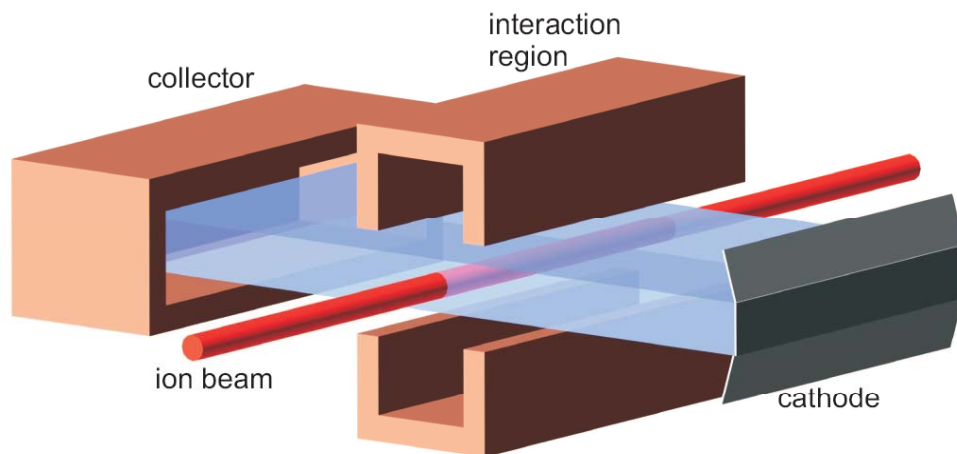
colliding beams experiments
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there is a lot of work to be done

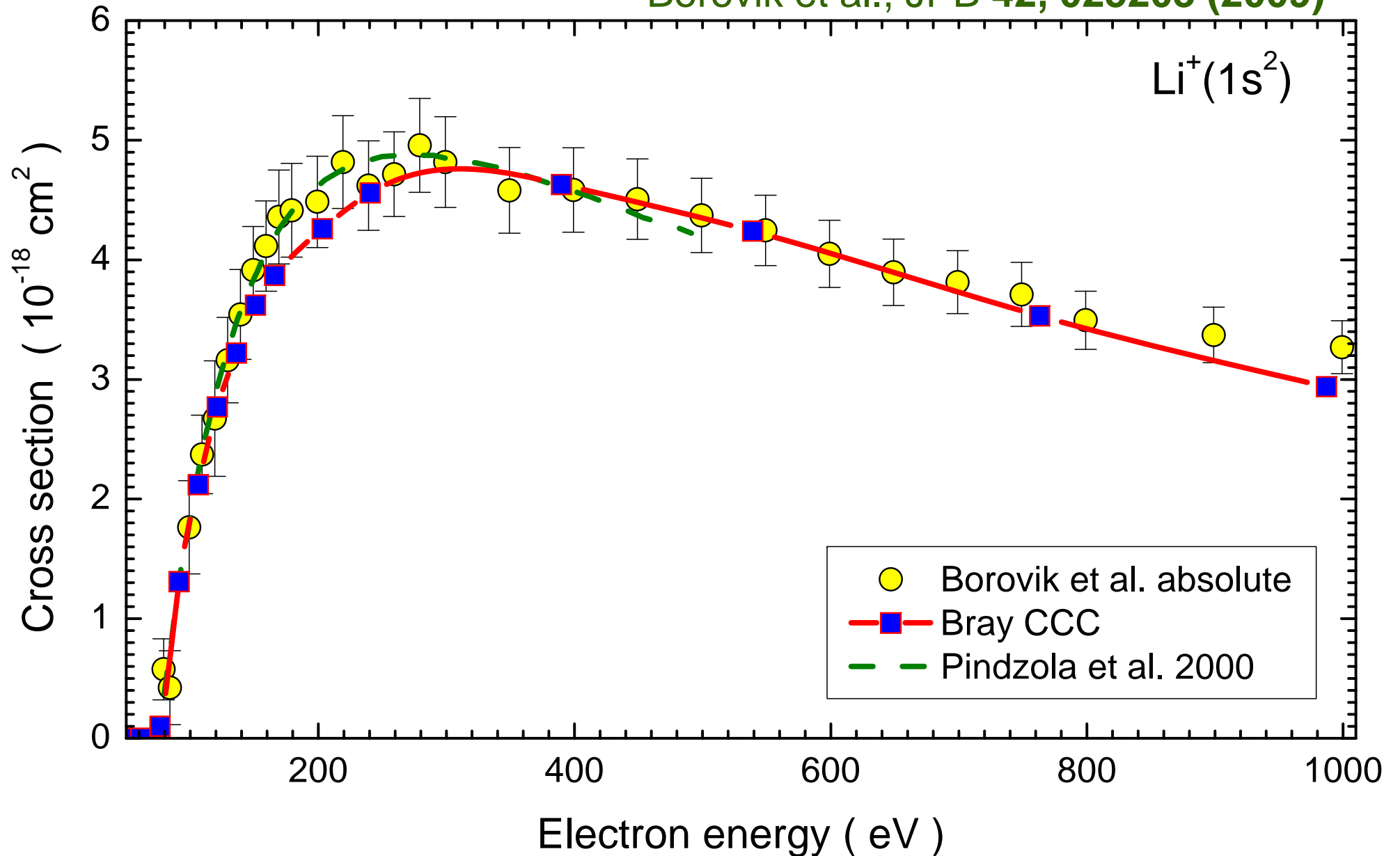
Electron impact ionization of ions

crossed beams of electrons and ions with well defined mass and charge



Electron impact ionization of Li⁺ ions

Borovik et al., JPB 42, 025203 (2009)



Conclusion so far

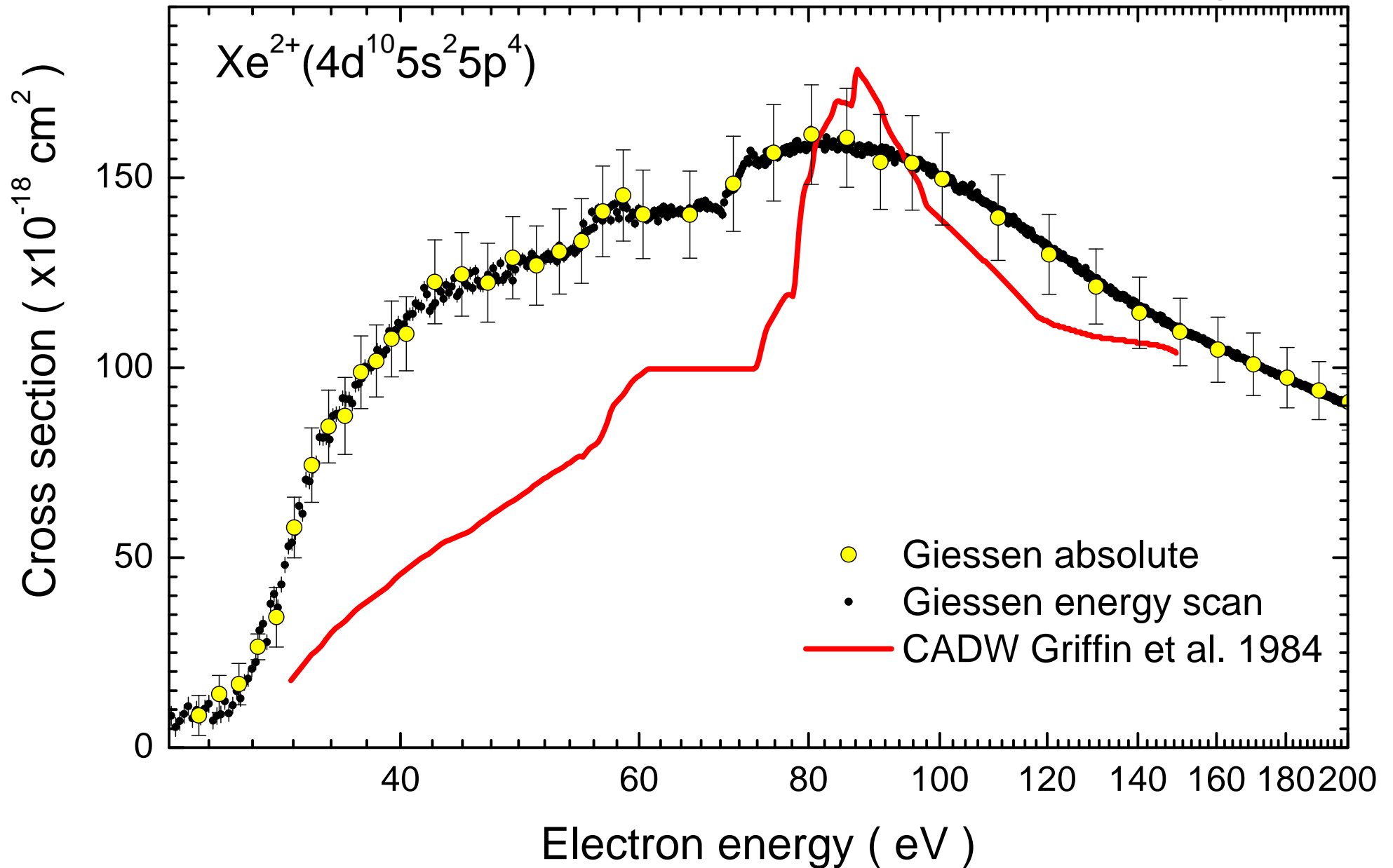
Present state of the art theory can predict
cross sections for

direct single ionization of few-electron ions

with high accuracy

Ionization of complex ions: Xe^{2+}

A. Borovik et al., work in progress



Assumptions, expectations general wisdom

Theory is expected to provide better predictions for more highly charged ions in an iso-electronic sequence

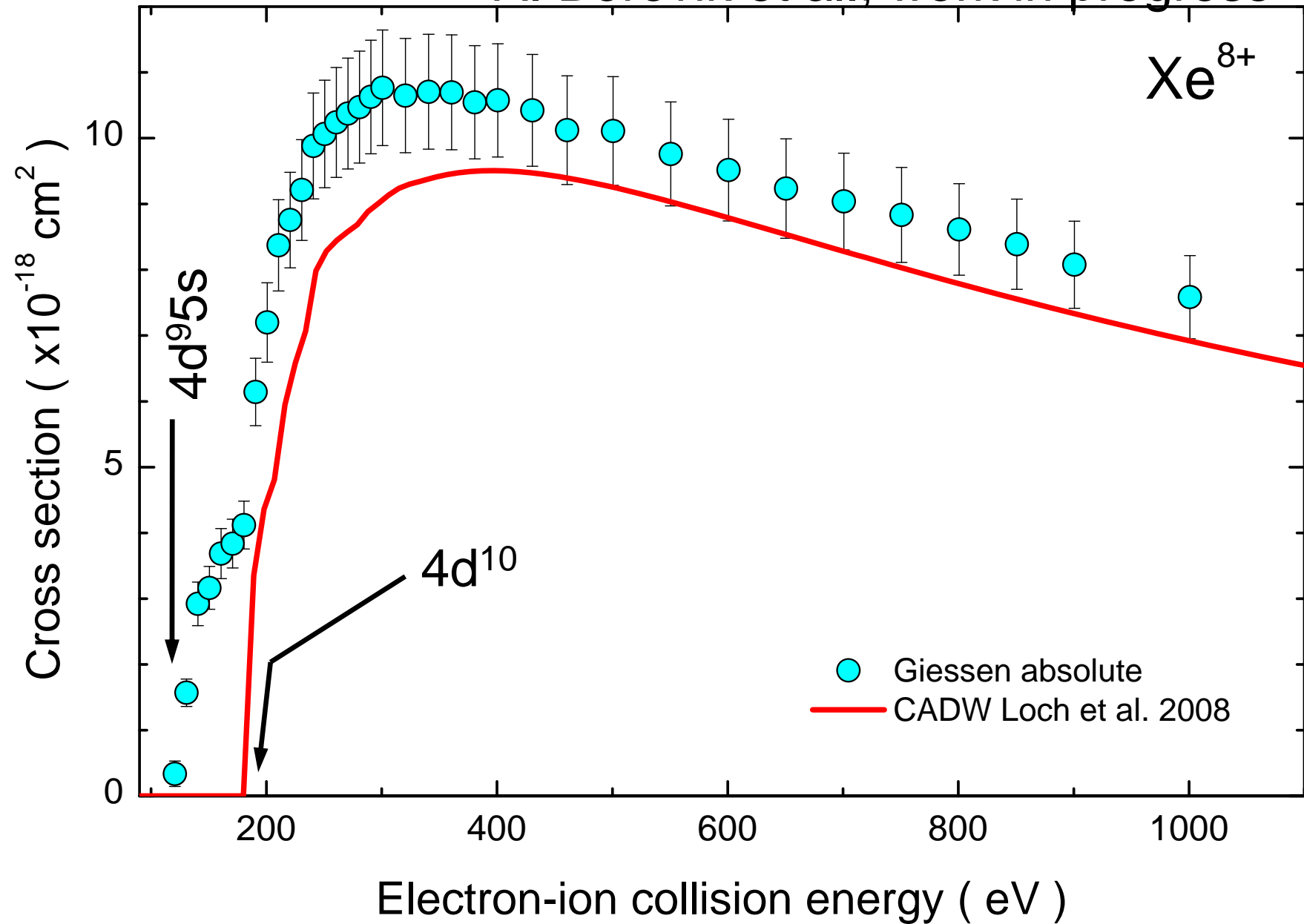
Assumptions, expectations general wisdom

Theory is expected to provide **better predictions for more highly charged ions** in an iso-electronic sequence

DW calculations for the direct and the excitation-autoionization contributions should be **good for highly charged ions**

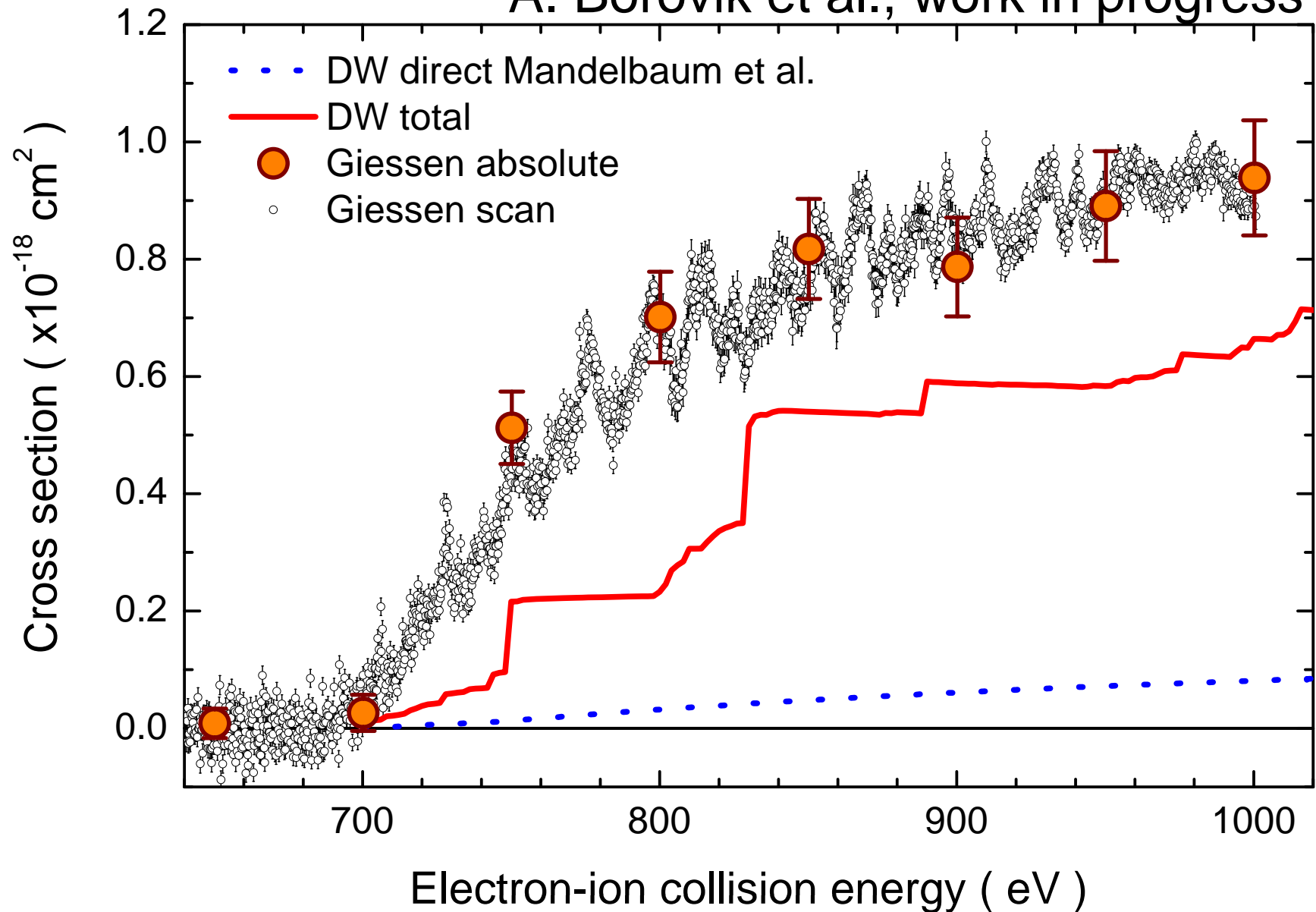
Electron impact ionization of Xe^{8+}

A. Borovik et al., work in progress



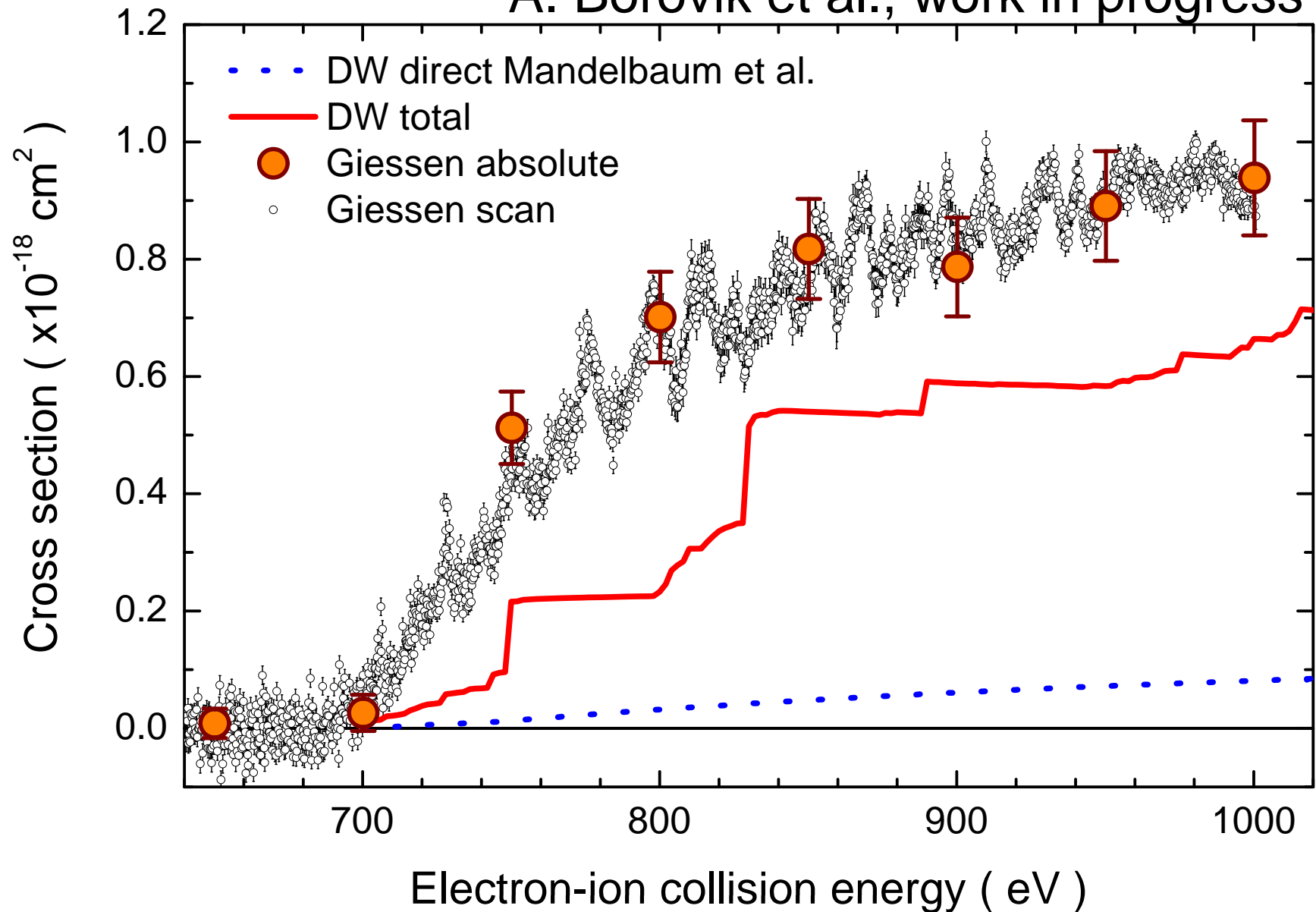
Ionization of a highly charged ion: Xe^{22+}

A. Borovik et al., work in progress



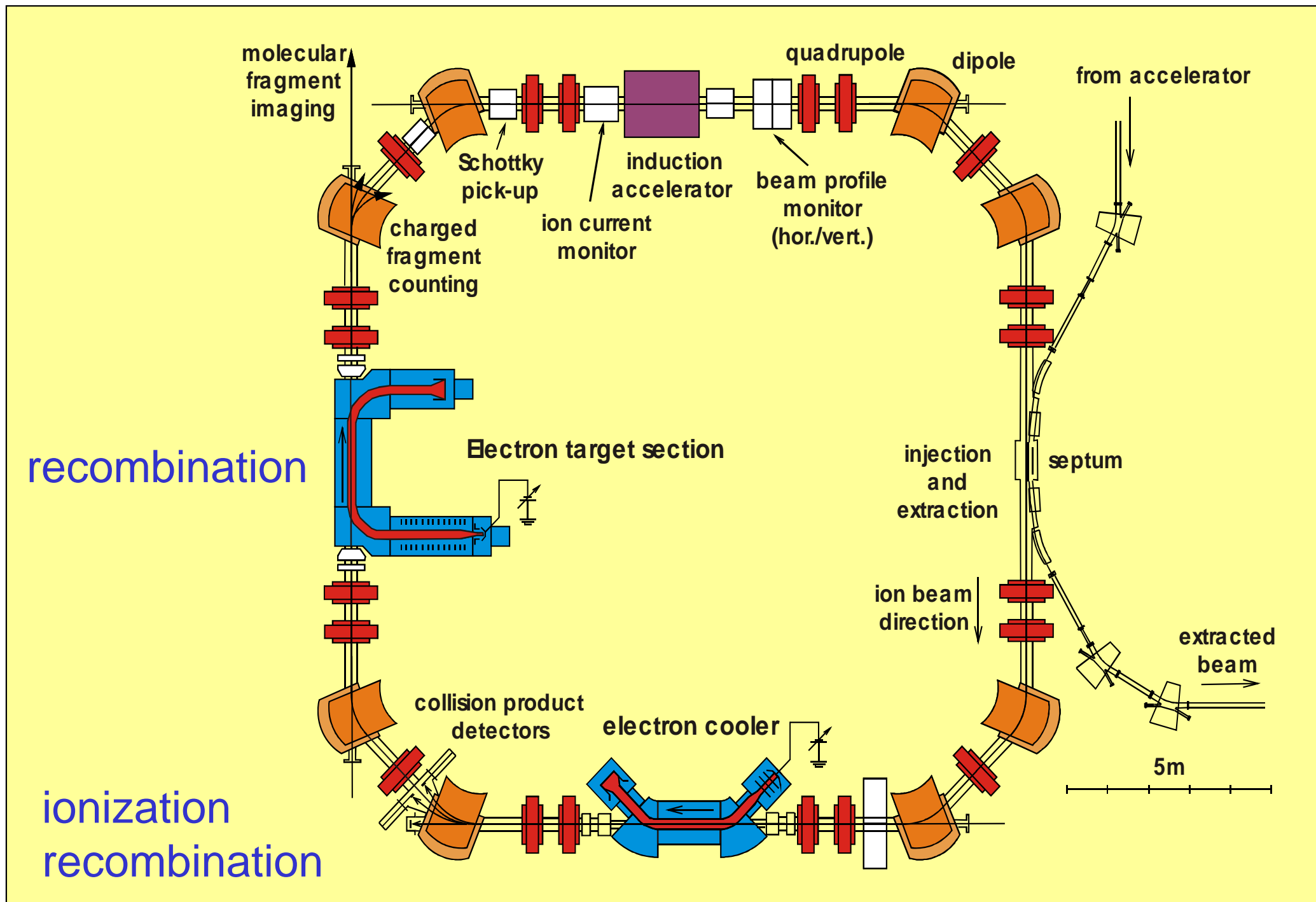
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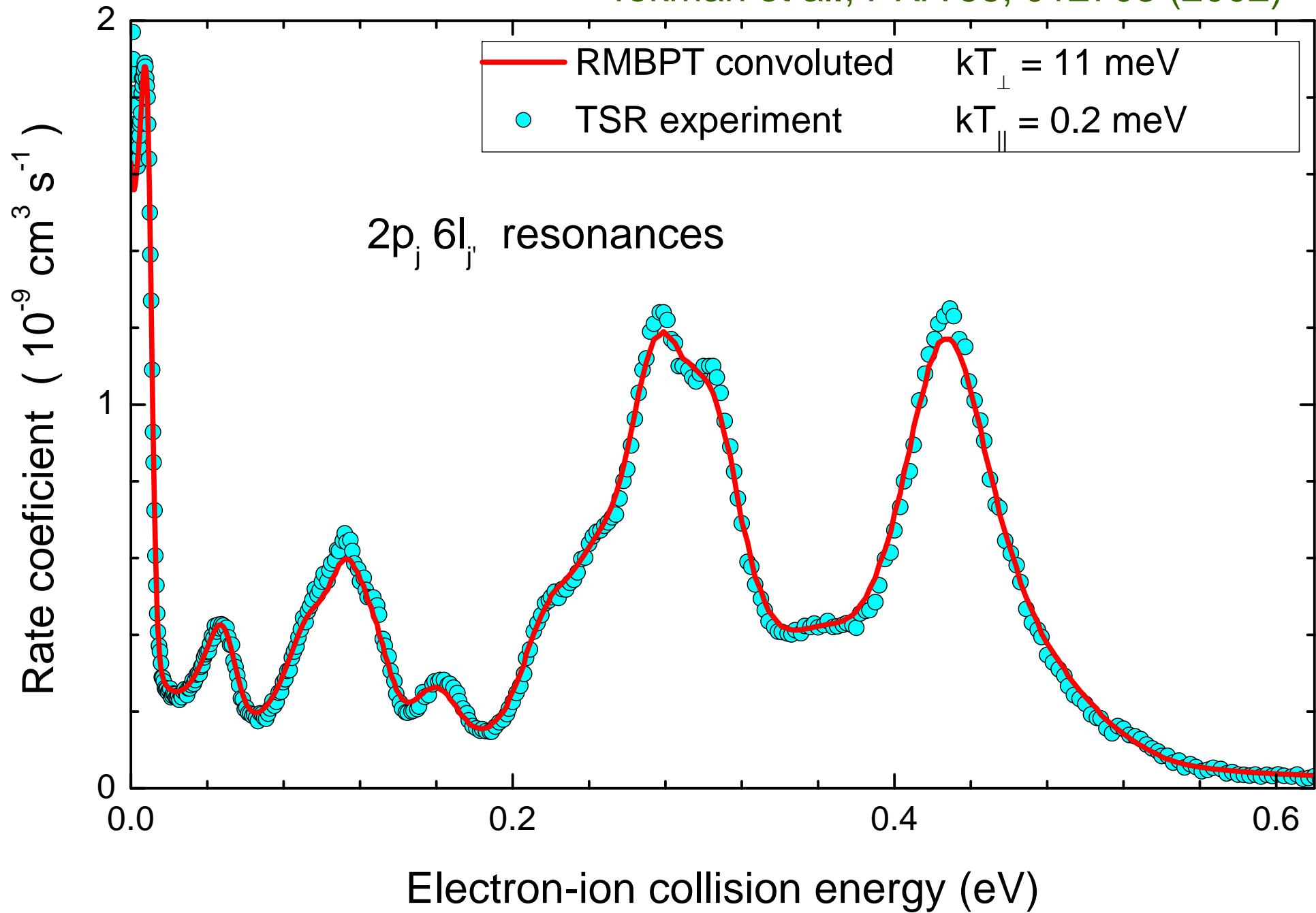
Similar discrepancies found for other highly charged ions

Merged-beam electron-ion recombination



Recombination of Li-like ions: F^{6+}

Tokman et al., PRA 66, 012703 (2002)



Recombination of few-electron ions

Theoretical treatment of individual resonance groups with large computational effort can deliver satisfying results

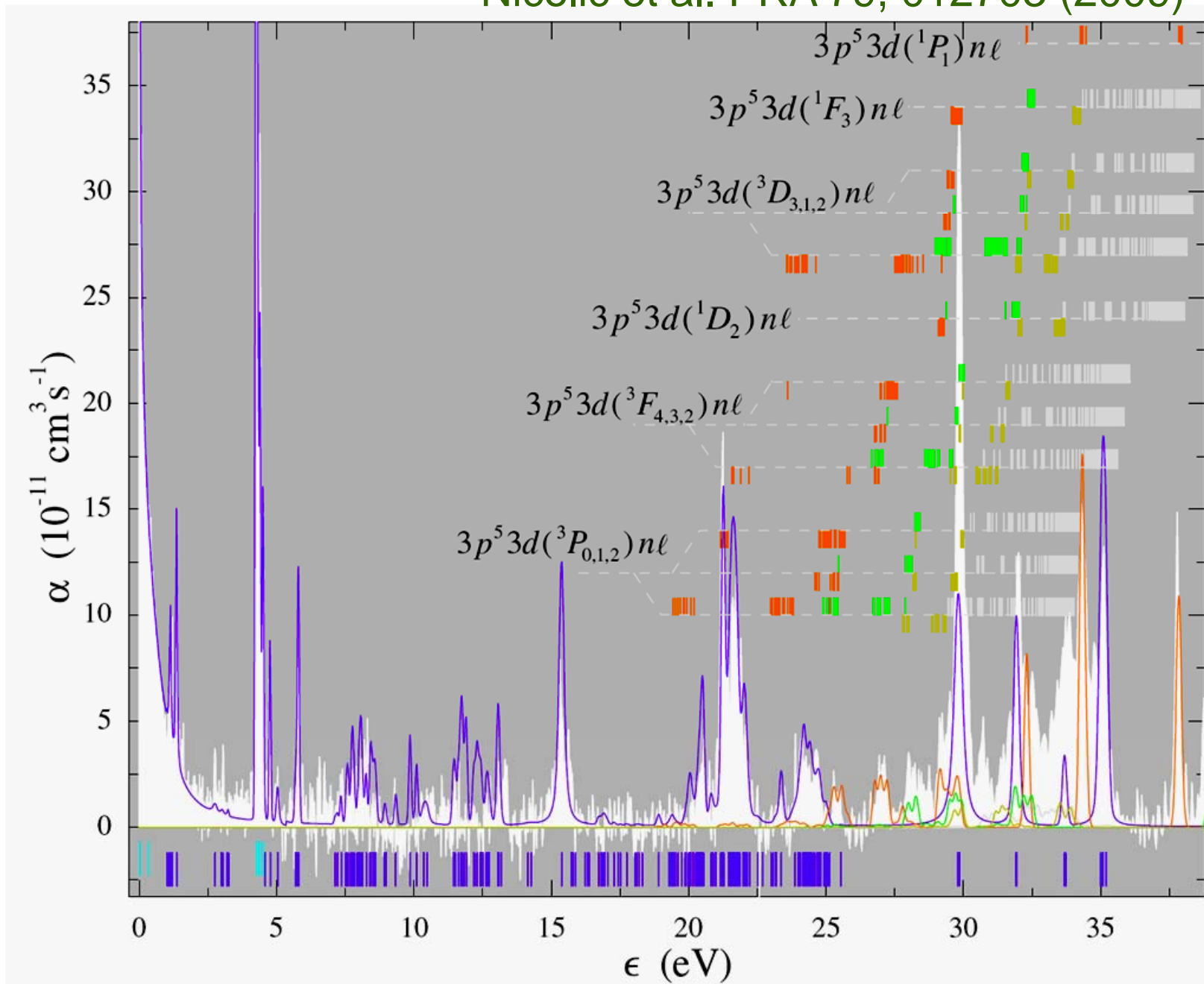
Recombination of few-electron ions

Theoretical treatment of individual resonance groups with large computational effort can deliver satisfying results

This cannot be extended to whole series of (Rydberg) resonances

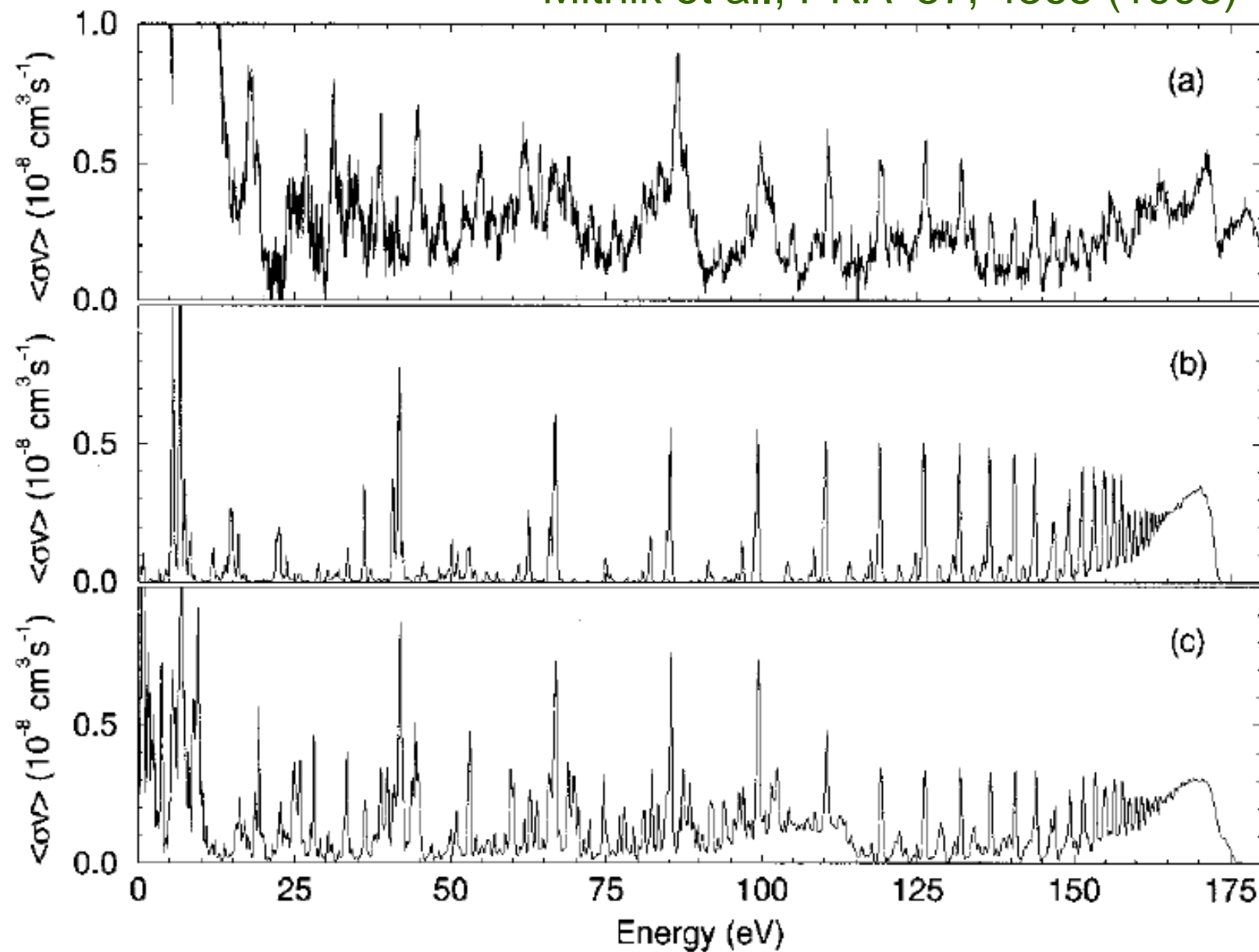
Recombination of M-shell ions: Ti^{4+} ($3s^2 3p^6$)

Nicolic et al. PRA 79, 012703 (2009)



Recombination of U^{28+} ($5s^2 5p^2$)

Mitnik et al., PRA 57, 4365 (1998)



exp.

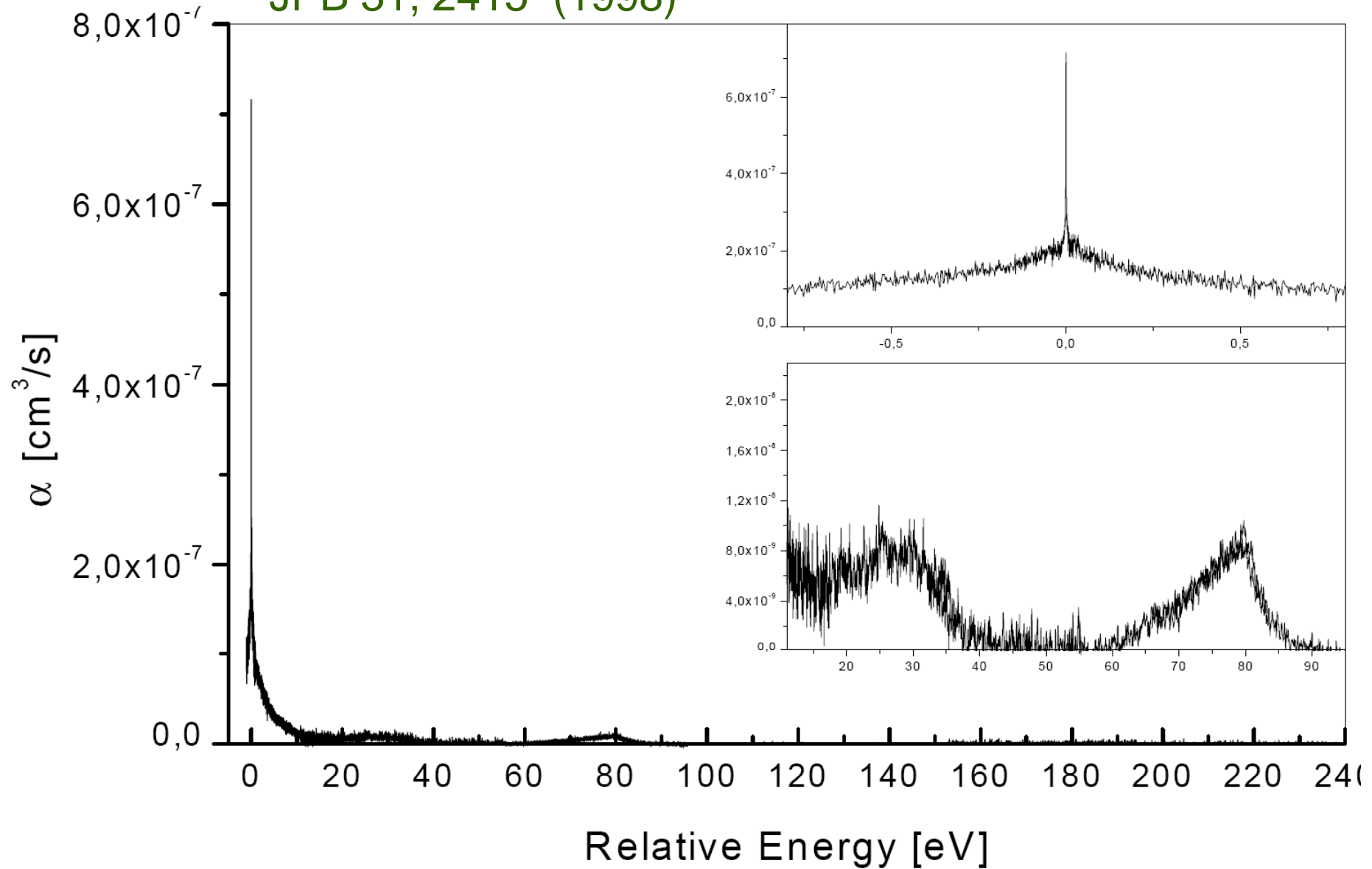
theo. g.s.

theo. meta-
stable state

Recombination of Au^{25+} ($4f^8$)

Hoffknecht et al.,
JPB 31, 2415 (1998)

Huge cross sections
no individual resonances
in spite of high resolution



Summary and plans for the future

Total cross sections for **single ionization** and for **recombination of few-electron ions** are quite well understood; theoretical data of benchmark quality are (becoming) available

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Understanding of collisions and structure of **complex ions** is a **challenge** for experiment and theory

Summary and plans for the future

Total cross sections for **single ionization** and for **recombination of few-electron ions** are quite well understood; theoretical data of benchmark quality are (becoming) available

Understanding of collisions and structure of **complex ions** is a **challenge** for experiment and theory

We plan to carry out storage ring **recombination** and crossed beams **ionization experiments** with W^{q+} ions

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And others occasionally