

Electron-Impact Ionization of Light Atoms and Ions

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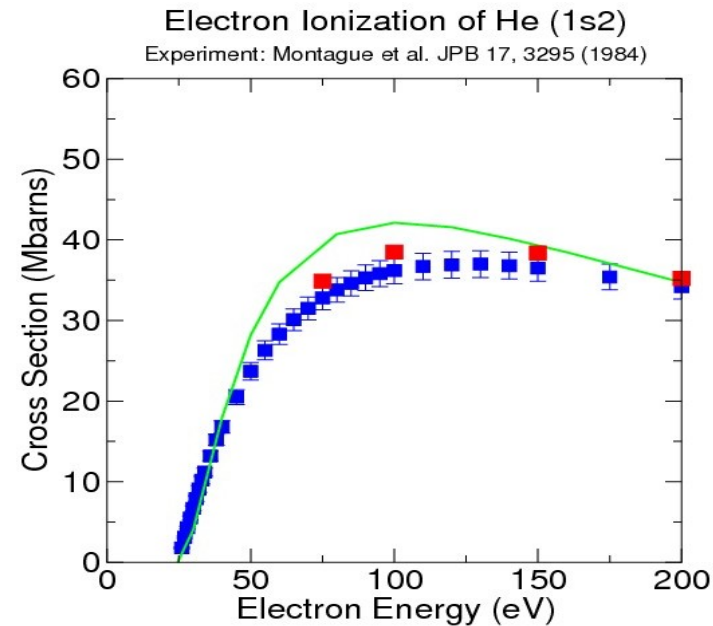
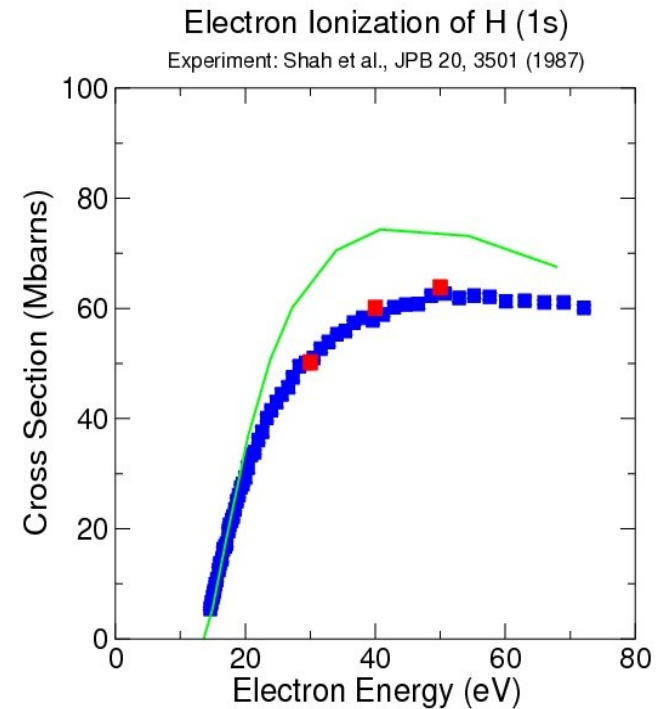
Introduction

Non-perturbative close-coupling and perturbative distorted-wave calculations have been carried out for the electron-impact ionization from the ground and excited states of many light atoms and ions.

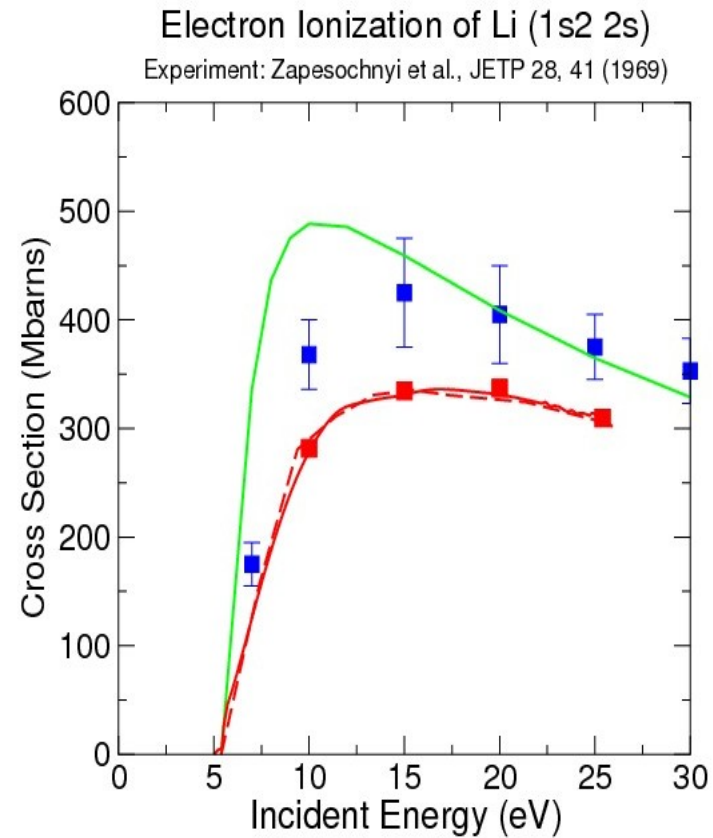
The atomic collision data will allow the ADAS codes to calculate accurate generalized collisional-radiative ionization coefficients at all temperatures in low to moderately dense plasmas.

Current Status

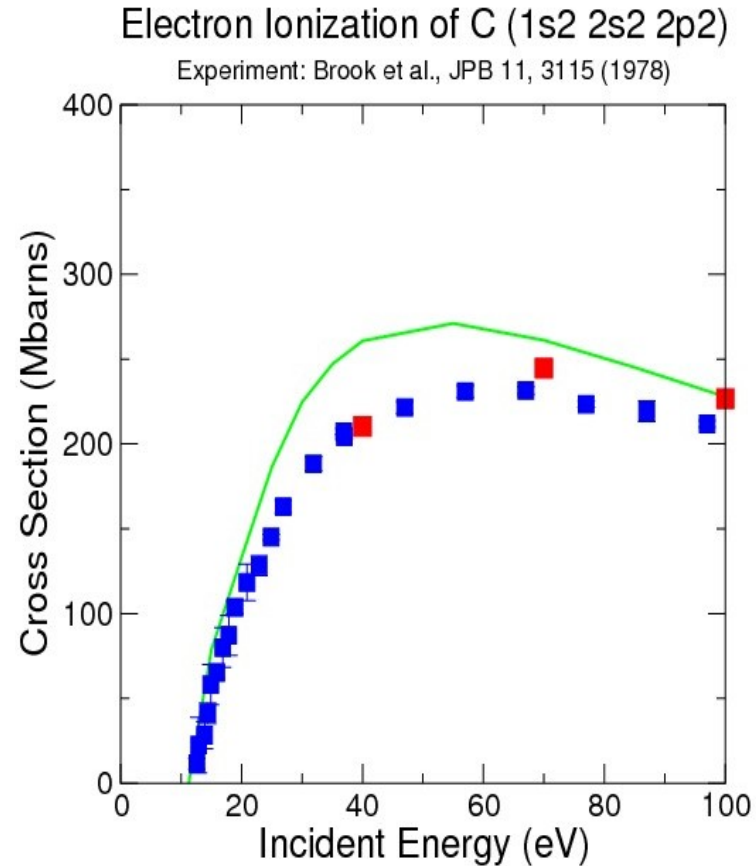
- H atom
TDCC for $1s$
M. S. Pindzola et al., Phys. Rev. A 54, 2142 (1996).
RMPS and TDCC for $nl(n < 5)$
D. C. Griffin et al., J. Phys. B 38, L199 (2005)
- He atom
CCC for $1s^2$ and $1snl(n < 5)$
Y. Ralchenko et al., ADNDT 94, 603 (2008)
- He⁺ ion
CCC for $1s$ and $nl(n < 5)$
I. Bray et al., J. Phys. B 26, L831 (1993)



- Li atom
CCC, RMPS, and TDCC for $1s^2l$
J. Colgan et al., Phys. Rev. Letts. 87, 213201 (2001)
CCC for $1s^23l$
J. Schweinzer et al., ADNDT 72, 239 (1999)
Results needed for $1s^24l$
- Li⁺ ion
RMPS and TDCC for $1s^2$
M. S. Pindzola et al., Phys. Rev. A 61, 052712 (2000)
Results needed for $1s2l$, $1s3l$, and $1s4l$
- Li²⁺ ion
TDCC for $1s$
Colgan et al., Phys. Rev. A 66, 012718 (2002)
RMPS and TDCC for $nl(n < 5)$
D. C. Griffin et al., J. Phys. B 38, L199 (2005)
- Be atom
RMPS and TDCC for $1s^22s^2$ and $1s^22s2p$
J. Colgan et al., Phys. Rev. A 68, 032712 (2003)
Results needed for $1s^22s3l$ and $1s^22s4l$
- Be⁺ ion
RMPS and TDCC for $1s^22l$
J. Colgan et al., Phys. Rev. A 68, 032712 (2003)
Results needed for $1s^23l$ and $1s^24l$
- Be²⁺ ion
RMPS and TDCC for $1s^2$ and $1s2s$
J. Colgan et al., Phys. Rev. A 68, 032712 (2003)
Results needed for $1s2p$, $1s3l$, and $1s4l$



- C atom
TDCC for $1s^2 2s^2 2p^2$
M. S. Pindzola et al., Phys. Rev. A 62, 045705 (2000)
Results needed for $1s^2 2s^2 2p^3 l$ and $1s^2 2s^2 2p^4 l$
- C⁺ ion
RMPS and TDCC for $1s^2 2s^2 2p$ and $1s^2 2s^2 2p^2$
J. A. Ludlow et al., Phys. Rev. A 78, 052708 (2008)
Results needed for $1s^2 2s^2 3l$ and $1s^2 2s^2 4l$
- C²⁺ ion
CCC, RMPS, and TDCC for $1s^2 2s^2$ and $1s^2 2s^2 2p$
S. D. Loch et al., Phys. Rev. A 71, 012716 (2005)
Results needed for $1s^2 2s^3 l$ and $1s^2 2s^4 l$
- N atom
Results needed
- N⁺ ion
Results needed
- N²⁺ ion
Results needed
- O atom
Results needed
- O⁺ ion
TDCC for $1s^2 2s^2 2p^3$
S. D. Loch et al., Phys. Rev. A 67, 042714 (2003)
Results needed for $1s^2 2s^2 2p^2 3l$ and $1s^2 2s^2 2p^2 4l$
- O²⁺ ion
Results needed



Electron Ionization of C^{3+}

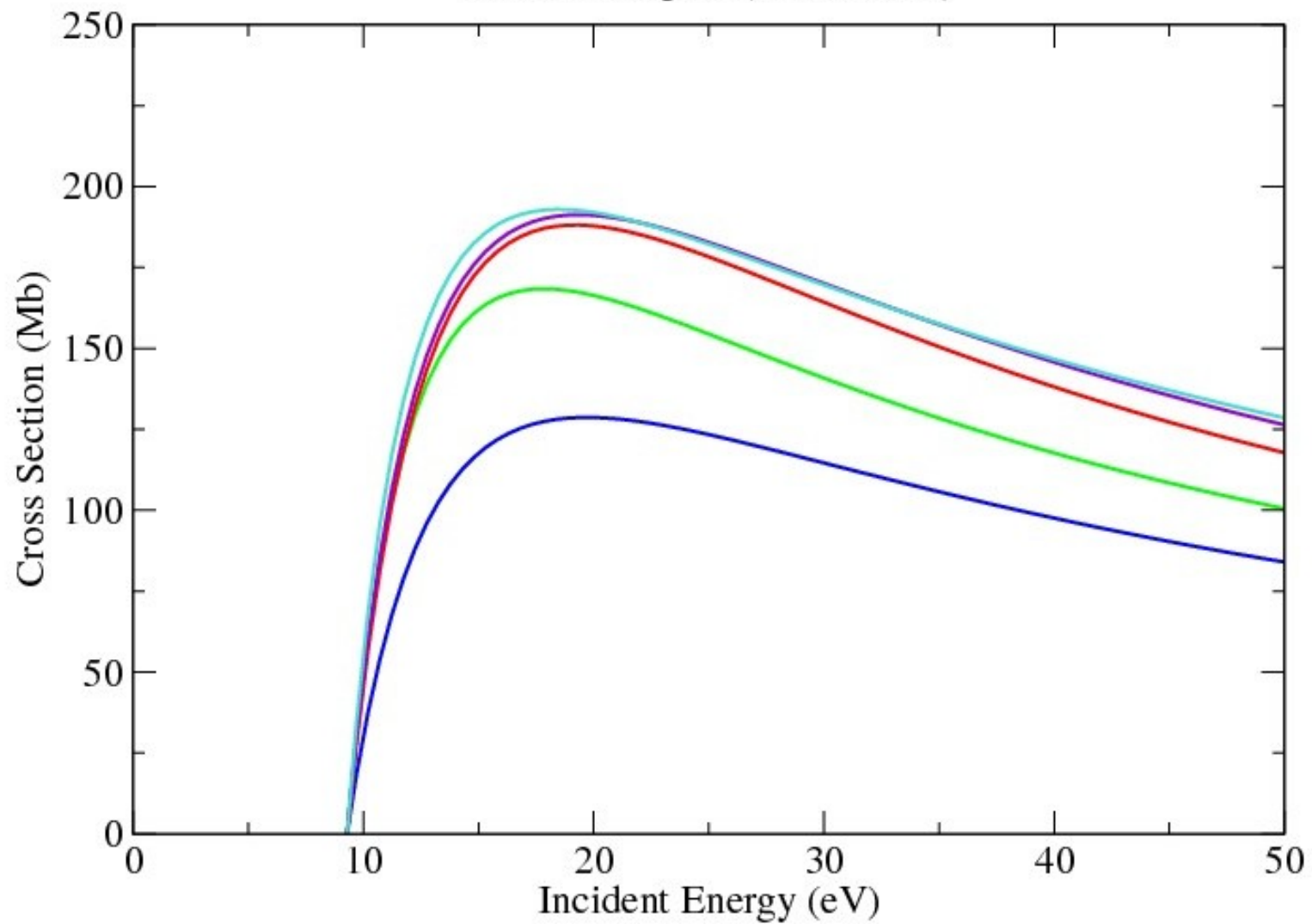
Perturbative distorted-wave (CADW) and non-perturbative close-coupling (RMPS) calculations were carried out for electron-impact ionization of the $1s^25l$ excited configurations of C^{3+} , see M. S. Pindzola, C. P. Ballance, and S. D. Loch, Phys. Rev. A 83, 062705 (2011).

Both the CADW and RMPS calculations need fairly high ejected electron angular momenta to converge the cross sections.

In the end, reasonable agreement is found between the CADW and RMPS cross sections.

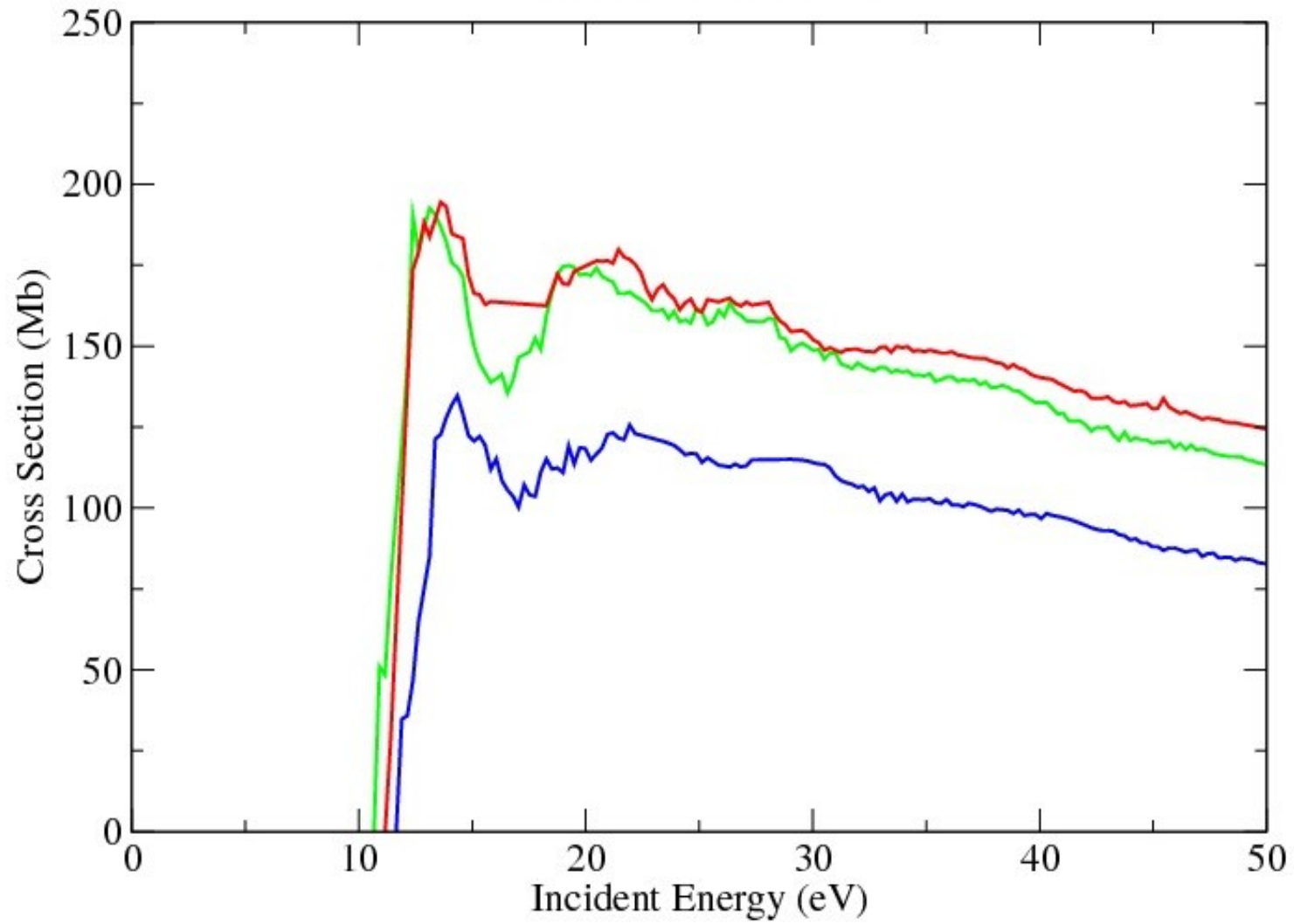
C+3 (1s2 5s)

CADW convergence (l=6,8,10,12,14)



C+3 (1s2 5s)

RMPS convergence (l=6,8,10)



Summary

Previously, we carried out non-perturbative close-coupling calculations for the electron-impact ionization of the excited states of B, B⁺, and B²⁺, see T. G. Lee, S. D. Loch, C. P. Ballance, J. A. Ludlow, and M. S. Pindzola, Phys. Rev. A 82, 042721 (2010).

Currently, we are carrying out non-perturbative close-coupling calculations for the electron-impact ionization of the excited states of C, C⁺, and C²⁺.

For both the B and C isonuclear sequences, the excited state ionization cross sections will be used to obtain temperature and density dependent generalized collisional-radiative ionization coefficients needed for the modeling of astrophysical and laboratory plasmas, see H. P. Summers and M. G. O'Mullane, (Nuclear Fusion), eds. R. E. H. Clark and D. H. Reiter, (Springer Press), 399 (2005).