Electron-impact excitation of the Ne$^{2+}$ O-like ion

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Synopsis A large-scale 554 level R-matrix Intermediate Coupling Frame Transformation (ICFT) calculation is presented to provide a comprehensive electron-impact excitation data set for all transitions to higher $n$ shells.

Previous R-matrix calculations for Ne$^{2+}$ performed using the JAJOM program of Saraph [1] to transform $LS$-coupled K-matrices into level-level collision strengths exhibit large spurious structure in the cross sections at higher electron energies, which may affect Maxwellian averaged rates even at low temperatures [2]. There is an absence of comprehensive excitation data between the excited states that may provide newer diagnostics to compliment the more established lines. To resolve these issues, we performed a small-scale 56-level Breit-Pauli and a large-scale 554 level R-matrix Intermediate Coupling Frame Transformation (ICFT) calculation [3] that extends the scope and validity of earlier JAJOM calculations both in terms of the atomic structure and scattering cross sections. Our results provide a comprehensive electron-impact excitation data set for all transitions to higher $n$ shells. The fundamental atomic data is subsequently used within a collisional radiative framework to provide the line ratios across a range of electron temperatures and densities of interest in astrophysical observations.

Breit-Pauli (BP) results (56-states) for electron impact excitation of this O-like ion are compared with a much more elaborate and larger calculation (554-states) performed using the intermediate-coupling frame transformation (ICFT) R-matrix method for transitions between the low lying levels of Ne III. The effective collision strengths for lines in the Ne III spectra are obtained by averaging the electron collision strengths, for a wide range of incident electron energies, over a Maxwellian distribution of velocities. Figure 1, shows the Ne III density sensitive energy intensity ratio

$$R_2 = \frac{N_4 A_{4-1}/\lambda_{4-1}}{N_2 A_{2-1}/\lambda_{2-1}}$$

for the BP and ICFT results compared to the corresponding $R_2$ ratio for Ar III. A comprehensive set of results will be presented at the meeting.

![Figure 1](image_url) Figure 1. $R_2$ line ratio as a function of electron density for electron temperatures of (a) 5000 (b) 8000 (c) 15000 and (d) 30000K. The solid black line shows the results using the 554 level ICFT R-matrix calculation and the dot-dashed blue line shows the result using the 56 level Breit-Pauli R-matrix calculation. The dashed red line is the corresponding $R_2$ line ratio for Ar III [4].

References

[1] Saraph H E 1978 Comput. Phys. Commun. 15 247
[2] McLaughlin B M and Bell K L 2000 J. Phys. B: At. Mol. Opt. Phys. 33 597
[3] Griffin D C, Badnell N G and Pindzola M S 1998 J. Phys. B: At. Mol. Opt. Phys. 31 3713
[4] Munoz Burgos J M, Loch S D, Ballance C P and Boivin R F 2009 Astronomy and Astrophysics 500 1253

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