Electron impact excitation of O III

S. S. Tayal* and O. Zatsarinny†

*Department of Physics, Clark Atlanta University, Atlanta, GA 30314, USA
†Department of Physics and Astronomy, Drake University, Des Moines, Iowa 50311, USA

Synopsis The B-spline Breit-Pauli R-matrix method has been used to calculate electron excitation collision strengths for a wide range of transitions between the first 220 fine-structure levels of O III. The calculation includes levels of the 2s22p3, 2s2p3l, 2s2p23l, 2s2p23l, 2s2p23l, 2s2p23l, and 2s2p23l configurations. The present work considerably improves the existing calculations for oscillator strengths and collision strengths of O III.

Accurate transition rates and electron collision excitation rates of O III are important for the analysis and diagnostics of a wide range of astrophysical spectra. Electron scattering from O III has been performed by using highly accurate target wave functions and by including fine-structure effects in the close-coupling expansions directly. The present calculations have been carried out using the B-spline Breit-Pauli R-matrix (BSR) method [1]. The multi-configuration Hartree-Fock method in combination with B-spline expansions is employed for accurate representation of the target wave functions. This allows us to optimize the atomic wave functions for different states independently, resulting in a more accurate target description than those used in previous collision calculations.

Figure 1 shows collision strengths of the fine-structure 2s22p3 (3P0-3P1, 3P1-3P2) transitions in O III. High resolution at near-threshold energies is necessary for accuracy in rate coefficients at low energies. We will present detail comparison with available calculations. Generally, all recent R-matrix calculations [2-4] agree to within 10% for the thermally averaged collision strengths for the forbidden transitions among the five lowest levels of the ground 2s22p3 configuration. An exception is for the transitions from the lowest three 3P levels to the 1S0 level. Here our results support the most recent calculation by Story et al [4]. Note also that the calculations Palay et al [3] show intensive resonance structure at electron energies above 3 Ry not supported by the present calculations.

For higher lying states the agreement is more diverse. The comparison of effective collision strengths for a set of temperatures is presented in figure 2 where the ratios of our results with other calculations [2] are shown. About 80% of transitions to excited states are within 30%, though for some weak transitions the rate coefficients differ by several factors. The present calculations are the direct Breit-Pauli calculations whereas the results in the works of Aggarwal and Keenan [2] and Storey et al [4] obtained from nonrelativistic LS calculation using the intermediate coupling frame transformation.

Figure 1. Collision strengths for the 2s22p3 3P0 - 3P1 and 3P1 - 3P2 fine-structure transitions in O III.

Figure 2. Comparison of effective collision strengths in O III with other calculations. The ratios between the R-matrix calculation [2] and the present results are shown.

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References

1 E-mail: stayal@cau.edu
2 E-mail: oleg.zatsarinny@drake.edu