Breit-Pauli electron-impact excitation collision strengths for transitions in O III

Breit-Pauli electron-impact excitation collision strengths for transitions in O III

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Synopsis Collision strengths for electron impact excitation of fine-structure transitions between the first 202 fine-structure levels of O III have been calculated using the Breit-Pauli B-spline R-matrix method. The close-coupling expansion includes levels of the $2s^22p^2$, $2s2p^3$, $2s^22p^33l$ *(l=0-2)*, $2s^22p^34l$ *(l=0-2)* and $2s2p^23l$ configurations. The present results considerably improve the existing oscillator strengths and collision strengths for O III.

Emission lines from oxygen ions have been observed in different astrophysical objects for many years, and the knowledge of the radiative and collision atomic parameters of oxygen ions in different ionization stages is crucial in modeling and understanding of processes occurring in the planetary nebulae and H II regions. The reliable theoretical study of low-energy electron scattering requires an accurate target description and a sufficient number of target states in the close-coupling expansion to achieve convergence and to account for cascade to lower levels. The purpose of the work reported here, therefore, is to perform elaborate and extensive calculations for the electron scattering from O III by using highly accurate target wave functions and by including fine-structure effects in the close-coupling expansion directly to make sure that relativistic effects are adequately accounted in the scattering calculation. The present calculations have been carried out with the B-spline Breit-Pauli R-matrix (BSR) code [1]. One of the distinct features of this code is the use of flexible term-dependent orbital sets in the description of both the target states and scattering system. 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 calculation.

Figure 1 represents collision strengths for the fine-structure $2p^2\ ^3P_0$-$^3P_1$ and $2p^2\ ^3P_1$-$^3P_2$ transitions in O III. A fine-energy grid has been used to resolve resonances in the near threshold energy region. The resonances make significant contributions to thermally averaged collision strengths, especially in the lower temperature region. Generally, all recent R-matrix calculations [2-4] agree to within 10% for the thermally averaged collision strengths for the forbidden transitions among the lowest five levels of the ground $2p^2$ configuration.

For highly excited 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 calculation [2] are shown. We have attempted to account for important physical effects. The Rydberg series of resonances converging to several excited levels are found to enhance collision strengths substantially.

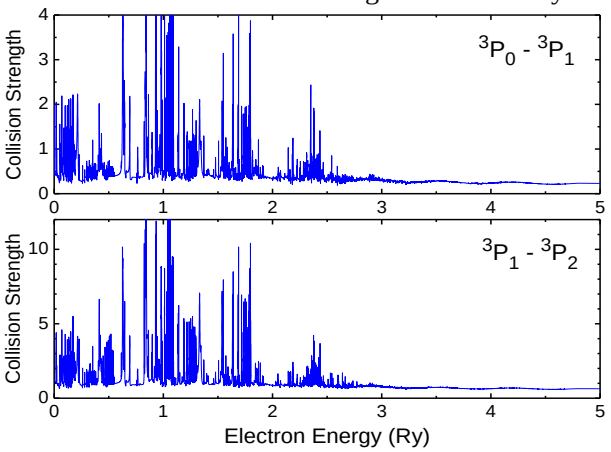

Figure 1. Collision strength for the fine-structure $2p^2\ ^3P_0$-$^3P_1$ and $2p^2\ ^3P_1$-$^3P_2$ transitions in O III.

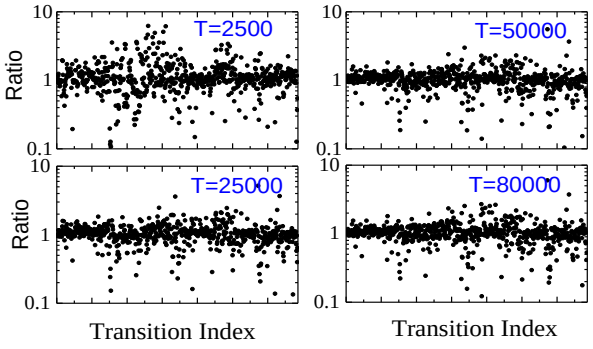

Figure 2. Comparison of our effective collision strengths with the R-matrix calculation [2].

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