Integral cross sections of the dipole-allowed excitations of nitrogen studied by fast electron scattering and X-ray scattering

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Synopsis The integral cross sections (ICSs) of the electron scattering of nitrogen molecule are of great importance to the understanding of many different aspects of atmospheric physics. Based on the generalized oscillator strengths (GOSs) of these dipole-allowed transitions crosschecked by the high-energy electron scattering and high-resolution X-ray scattering, their ICSs are obtained systematically from the threshold to 5000 eV for the first time with the aid of the *BE*-scaling method, and the corresponding ICSs at the moderate and high energies are the only available data to the best of our knowledge.

As the primary atmosphere constituent of Earth and some satellites such as Titan and Triton, the inelastic cross sections of nitrogen by electron scattering, especially the ICSs, are of great importance to the understanding of many different aspects of atmospheric physics, such as the determination of the sample electron spectra for different electron environments at different altitudes of the atmosphere of Earth and the heating mechanisms of Titan's upper atmosphere. So the determination of the ICSs of nitrogen has been a subject of continuously increasing interests both experimentally and theoretically.

Recently, based on the scaled plane-wave Born models Kim has developed the *BE*-scaling method to calculate the ICSs of the dipole-allowed excitations of atoms and molecules [1,2]. Based on our present and previous GOSs of nitrogen measured by the high-energy electron scattering [3] and high-resolution X-ray scattering [4], the ICSs of the dipole-allowed excitations of nitrogen are obtained systematically from the threshold to 5000 eV for the first time [3], and the corresponding ICSs at the moderate and high energies are the only available data to the best of our knowledge.

It is clear from Fig.1 that the present ICSs for b(1-3) and b(4)+b'(0) are in good agreement with the recent ones of Malone *et al*. [5], while the ICSs of Malone *et al*. [6] at 60 eV and Ajello *et al*. [7] at 100 eV are lower than the present ones. As for the ICSs of Zipf and Gorman [8], they are larger than the other results below 60 eV and lower than our results at $E_0 >$ 60 eV although it is expected that the present *BE*-scaling results are more reliable at higher incident electron energies.
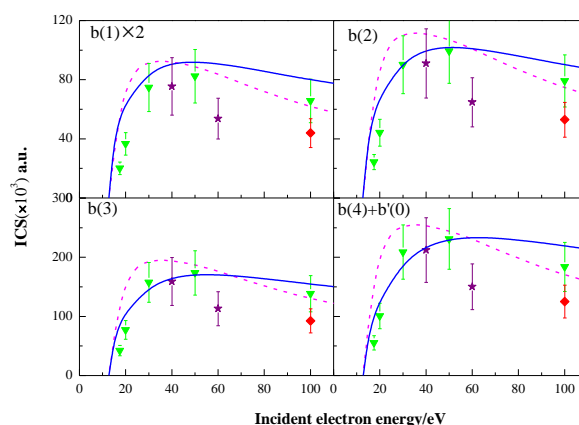

Fig.1 The ICSs for b(1-3) and b(4)+b'(0). The blue solid line is the present *BE*-scaling result [3]. The green triangle is the result of Malone *et al*. [5]; the violet star is the result of Trajmar *et al*.[6]; the red diamond is the result of Ajello *et al*. [7]; the pink dash line is the result of Zipf and Gorman [8] updated by Malone *et al*. [5].

In summary, the present ICSs of nitrogen is accurate, which can serve as the basics input parameters of the theoretical models to simulate the processes in planetary atmosphere and explain the astronomical observations.

References

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