Oscillator strengths and integral cross sections of the valence-shell excitations of HCl studied by fast electron scattering

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Synopsis   Oscillator strengths and integral cross sections (ICSs) of HCl are of great importance for the understanding of many different aspects of atmospheric physics. Based on the generalized oscillator strengths (GOSs) of the valence-shell excitations of HCl measured by the high-energy electron scattering, the optical oscillator strengths (OOSs) have been obtained by extrapolating the GOSs to the limit of the squared momentum transfer $K^2 \to 0$. Furthermore, the ICSs of the valence-shell excitations from the threshold to 5000 eV have been obtained systematically with the aid of the BE-scaling method.

Hydrogen chloride (HCl) and its dynamic parameters are important in a number of practical applications, including etching and plasma processing [1], interstellar and atmospheric photochemistry [2, 3, 4]. For example, HCl was detected on Venus for the first time by Connes *et al*. [5] in 1967. Although HCl is a minor constituent of the Venusian atmosphere, it plays an important role in the photochemistry and atmospheric evolution. The OOSs of HCl have been used to explain the exceptionally large $[D]/[H]$ isotopic ratio in the Venusian atmosphere [6]. Furthermore, from the viewpoint of fundamental research, as a typical heteronuclear diatomic molecule, HCl is used to test the theoretical methods and calculational codes strictly [7]. So the determination of the oscillator strengths and ICSs of HCl has been a subject of continuously increasing interests both experimentally and theoretically.

In this work, the GOSs of the valence-shell excitations of HCl have been determined at an incident electron energy of 1500eV and an energy resolution of 70meV. Besides, the OOSs have been obtained by extrapolating the GOSs to the limit of the squared momentum transfer $K^2 \to 0$ and the ICSs of the valence-shell excitations from the threshold to 5000 eV have been obtained systematically with the aid of the BE-scaling method [8, 9]. Present GOSs and ICSs of the $C^1\Pi_1$ ($\nu' = 0$) excitation of HCl are shown in the Fig.1.

In summary, the GOSs, OOSs and ICSs of the valence-shell excitations of HCl have been determined by fast electron impact, and the GOSs and ICSs are the only reported data, to the best of our knowledge. The present reported dynamic parameters of HCl can serve as the basics input parameters of the theoretical models to simulate the processes in planetary atmosphere and explain the astronomical observations.
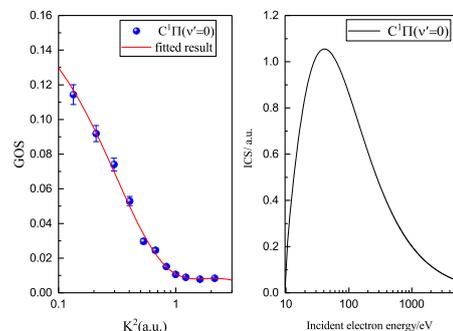

Figure 1. The present GOSs and ICSs of the $C^1\Pi_1$ ($\nu' = 0$) excitation of HCl.

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