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Absolute elastic differential cross sections for PF₃ molecule by electron impact: A comparative study with XF₃ (X = B, C, N and CH) molecules

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Synopsis We report absolute electron elastic scattering differential cross sections (DCSs) from PF₃ molecules. The crossed-beam method was used in conjunction with the relative flow technique (using helium as the reference gas) to obtain absolute values. Very good agreement between the experimental DCSs and those calculated with the IAM-SCAR method has been found for the higher impact energy (above 50 eV). We have also compared the measured DCSs for PF₃ with experimental results for other fluorine compounds, XF₃ (X = B, C, N and CH), as well as with those derived from the calculated atomic fluorine cross sections multiplied by a factor of 3.

We found for the first time an atomic-like behavior in the elastic scattering of electrons from the halomethanes, CH₃F, CH₃Cl, CH₃Br, and CH₃I [1], by comparing with that for the corresponding noble gases, Ne, Ar, Kr, and Xe, respectively. This comparison suggested that the halogen atoms dominated the angular distributions of the elastic scattering for high impact energies (above 50 eV). Similar behavior were observed for isoelectronic systems such as GeH₄ and Kr [2].

More recently, we have shown this atomic-like effect in the electron elastic scattering from fluorine compounds such as XF₃ (X = B, C, N, and CH) [3] and YF₄ (Y = C, Si, and Ge) [4] for energies above 50 eV. Furthermore, the angular distribution of elastically scattered electrons from XF₃ and YF₄ molecules for energies above 50 eV have been found to be well reproduced by the calculated DCS for atomic-fluorine multiplied by a factor of 3 and 4, respectively. These results suggested that the elastic scattering for high impact energies is virtually dominated by the outer fluorine atoms surrounding the central atom. This also evidenced that atomic-like effects persist in electron-molecule scattering systems.

In this study, we have measured the elastic DCSs for PF₃ molecules and results have been compared with the IAM-SCAR calculations [5] as well as with the previously reported for XF₃ molecules [3] to verify the atomic-like effect in the fluorine compound molecules.

The experiment was performed at Sophia University using an original crossed-beam apparatus [6]. The total energy resolution was about 50 meV (FWHM). The relative flow technique was used to obtain absolute DCS values. Estimated uncertainties of the DCSs are about 15%.

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Figure 1 shows the measured angular distribution of the elastic DCS for PF₃ at 100 eV impact energy together with the present IAM-SCAR calculated values and those corresponding to XF₃ molecules. The present experimental results also confirm the atomic-like effect of the elastic scattering DCSs for the PF₃ molecule.

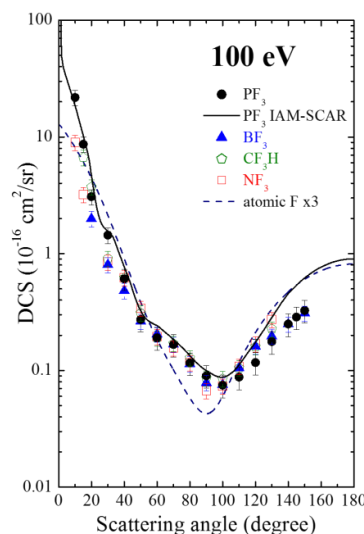


Figure 1. Angular distributions of DCSs for XF₃ (X = B, CH, N, and P) molecules at 100 eV impact energy, together with the IAM-SCAR calculation for PF₃ and DCS of fluorine atom multiplied by a factor of 3.

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