

Electron Scattering on Molecules: Partial Cross Sections

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Total cross sections for electron scattering on atoms and molecules in gas phase, if free from systematic errors, can be determined within 5% accuracy. This is thanks to a simple, beam attenuation method and an absolute determination of target density.

Partial cross sections, like vibrational and electronic excitation must be determined by cross-beam methods, in which geometry of the scattering region and target density are not known directly. Experimental data need normalization (and integration over 0-180° scattering angle). Therefore, declared accuracies of cross sections are not better than 20-25%.

Ionization cross sections are somewhat easier to be measured, but also in this case systematic errors due to non-complete collections of ions produced can alter cross sections. Finally, cross sections for dissociation into neutrals need special techniques and have been determined only for some specific targets, like O₂, N₂O [1] or CFH₃ – CF₄ series [2].

Semiempirical methods like Born approximation for vibrational cross sections, Bethe-Born binary encounter model for ionization [3] and electronic excitation [4] give some guidelines for evaluation of experimental inconsistencies. Additionally, electron diffusion coefficients determined in swarm experiments are extremely sensitive to partial (inelastic) cross sections. These mutual checks can produce self-consistent set of total and partial cross sections; unfortunately it was demonstrated only for relatively simple targets, like CH₄ [5].

In this paper, evaluation of experimental uncertainties on partial cross sections for selected molecules, like H₂, O₂, C₂H₂, NF₃ will be given. In this validation partial cross sections are compared to semi-empirical models and total cross sections constitute a reference limit for the sum check.

[1] L. R. LeClair and J. W. McConkey, *J. Chem. Phys.* 99 (1993) 4566

[2] S. Motlagh and J. H. Moore, *J. Chem. Phys.* 109 (1988) 432

[3] G. P. Karwasz, P. Możejko, M.-Y. Song, *Int. J. Mass Spectrom.*, 365/366 (2014) 232-237

[4] H. Tanaka *et al.* *Rev. Mod. Phys.* 88 (2016) 025004

[5] K. Fedus and G. P. Karwasz, *Eur. Phys. J. D* **68** (2014) 93