PRAMANA
—journal of
physics

Vol. 50, No. 6,
June 1998
pp. 555–561

Total cross sections for electron scattering from well-known and exotic molecules

K N JOSHIPURA
Department of Physics, Sardar Patel University, Vallabh Vidyanagar 388 120, India

Abstract. In this review paper, scattering of intermediate to high energy electrons on well-known as well as exotic molecular targets is considered. The 'additivity rule' and its modifications for calculating various total cross sections are discussed against the background of an extensive experimental data. The theory succeeds at high impact energies ($E_i > 100$ eV). Tentative upper and lower limits of e-molecule ionization cross sections are identified. Fitting formulas to represent total cross sections as functions of energy are also given.

Keywords. Electron scattering; total cross-sections; additivity rule.

PACS No. 34.80

1. Introduction

Study of the collisions of electrons with molecules has been a traditional but active area of research. There have been many more experimental investigations in this regard as compared with theoretical ones. The sustained interest in this field is due to its relevence in various pure and applied sciences [1]. The present paper discusses various approximations, called the 'additivity rules' employed to calculate the different total cross-sections (TCS) of e-molecule scattering at intermediate to high impact energies E_i. These approximations have been found to be useful in interpreting the corresponding measurements, if they exist. They can provide reliable high energy data in the absence of measurements in many cases.

At low energies, typically up to about 10 eV, the e-molecule scattering is dominated by anisotropic and long-range dipole and/or quadrupole interactions. With an increase in energy the ionization and excitation channels also open up and the rotational-vibrational channels gradually become weaker. Many experiments performed in this energy domain measure total (complete) cross sections which include elastic as well as non-elastic contributions. It is meaningful to calculate total elastic cross sections $Q_{\rm el}(E_i)$ and total inelastic cross sections $Q_{\rm inel}(E_i)$ separately, with the latter quantity being comparable to total ionization cross sections $Q_{\rm Ion}(E_i)$. We calculate these quantities by starting with the relevent atomic scattering amplitudes.

Although the above theory has so for been applied to a large number of molecules, our focus here is on (a) 10-electron targets viz., HF, H_2O, NH_3 and CH_4 along with Ne and, (b) 18-electron targets like F_2, H_2S, C_2H_6 etc., along with Ar. Many of these molecules have been experimentally studied by Zecca *et al* [2–4], Szmytkowski *et al* [5], Garcia *et al*