§3. Experimental Studies of Positron Scattering by Various Polyatomic Molecules

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This study is part of the project name Positron-gas scattering related to positron plasma .

Slow positrons are produced by moderation of high speed β^+ particles produced by a radioactive isotope or as pair creation positrons using high-energy particles. These low-energy positrons or monoenergetic positron beams are produced using various moderator types from positron sources of extremely wide energy spreads. Recently, Surko *et al* produced extremely slow positrons using a solid neon moderator and trapped them via inelactic scattering with N_2 gases. This penning trap method was accomplished at their laboratory and achieves accumulations of more than 10^8 positrons in a few minutes from a 90 mCi ^{22}Na source. 1) This technique is most useful in the production of positron plasmas.

In this report, we confine to the experimental studies of positron scattering by various polyatomic molecules. Our positron scattering studies for many molecules have been carried out as comparative studies with electron scattering.2)

For the positron source, we used a ^{22}Na radioactive isotope. Although a 3mm spaced set of W ribbons has been used for a moderator in many experiments, we confirmed recently that a seven-layer W mesh type is better than the ribbon type moderator. Some experimental results for positron and electron scattering for our group are reviewed.3) Our experimental method, using a weak intensity radioactive isotope, has also been reported in detail elsewhere.

A list of the molecules whose positron and electron total cross section (TCS) measurements were done in the period between March 2000 and April 2001 is as follows: 1,3-difluorobenzene 1,3-$C_6H_4F_2$ (+,-), chlorine Cl_2 (-), allylene C_3H_4 (+, -), allyl chloride C_3H_5Cl (+, -), allene C_3H_4 (+, -), 1,3-Trifluoromethylbenzene $C_6H_4(CF_3)_2$ (+, -), 1,1,1-Trifluoroethane $C_2H_3F_3$ (+, -), CF_4 (+Ps), 1,4-Difluorobenzene 1,4-$C_6H_4F_2$ (-), dichlorobenzene CH_2Cl_2 (Ps), $CHCl_3$ (+,-), 4-Fluorobenzaldehyde C_6H_4CHOF (-) and CCl_4 (+,-). The symbols +,- and Ps stand for positron, electron and positronium. Positron and electron TCS data for 1,3-$C_6H_4F_2$ and 1,1,1-Trifluoroethane $C_2H_3F_3$ is shown in Fig. 1. The TCS measurements are for 0.7-600eV positrons and 0.8-600eV electrons.

The data for the isomers of C_3H_4, allene and allylene has been published together with the theoretical work of M. Kimura, and the differential cross section (DCS) measurements of the Sofia Univ. Group.4) The TCS measurement results for 1,1,1- Trifluoroethane $C_2H_3F_3$ will be presented.5)

As for accuracy in the TCS measurements, statistical errors due to the weak intensity slow positron beam amounted to 2 or 3 % with the sum total error, except for the error due to the forward scattering, being 5-10%. The forward scattering correction has been performed to the TCS data where the corresponding DCS data is available.

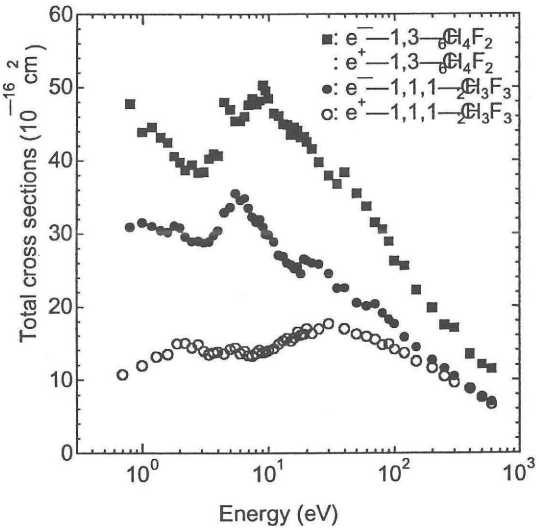

Fig. 1. Positron and electron TCSs for 1,3-$C_6H_4F_2$ and 1,1,1-Trifluoroethane $C_2H_3F_3$ molecules

References

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