VELOCITY DEPENDENCE OF THE PENNING IONIZATION OF D ATOMS BY He (2^1S) AND He (2^3S) ATOMS

J. FORT, J.J. LAUCAGNE, A. PESNELLE, G. WATEL

Service de Physique Atomique
Centre d'Etudes Nucléaires de Saclay
B.P. N°2 - 91190 Gif-sur-Yvette (France)

A time-of-flight technique has been developed for the study of the velocity dependence of the cross section for Penning ionization of D atoms by metastable He atoms :

$$He\ (2^1S) + D \longrightarrow He\ (1^1S) + D^+ + e^-$$
$$He\ (2^3S) + D \longrightarrow He\ (1^1S) + D^+ + e^-$$

The same apparatus as in Ref. 1 (study of He^* + Ar interaction) is used. The D atoms are produced in a r.f. discharge operating at 260 MHz; the atoms are then slowed down by passing them through a small cylinder at the room temperature. The degree of dissociation of D_2 molecules measured in the experiment is roughly 70-80%. The D atom beam enters the interaction chamber; Penning ions produced by the collisions of He (2^1S) or He (2^3S) with D atoms are mass-analyzed and counted.

In the case of a short gate function and a slowly varying cross section, the ratio of the ion signal to the metastable signal $N^+_{IP}(\tau) / N^*(\tau)$ for the same flight path is given by : $\sigma_{eff}(\tau) + \sum_p (-1)^p \frac{\varepsilon_{1p}}{p} \approx \sigma_{eff}(\tau)$ /1/.

σ_{eff} is the effective cross section given by $\sigma_{eff}(v) = \int_0^\infty \frac{v_r}{v} g(v_t)\sigma(v_r)\, dv_t$ where $\vec{v}_r = \vec{v} - \vec{v}_t$ is the relative velocity and $g(v_t)$ is the density distribution of the D atom velocities.

The velocity dependence of the penning ionization cross section of D atoms by He(2^1S) is shown in Fig. 1.

Also, the first results show that penning ionization cross section for the reaction He(2^1S) + D is much larger than the cross section for He (2^3S)+ D. This result for the ratio of the cross sections is in better agreement with the theoretical predictions of Cohen and Lane /2/ than with the predictions of Fujii and al. /3/.

/1/ A. Pesnelle, A. Hourdin, G. Watel and C. Manus - J. Phys. B6, L326 (1973).

A. Pesnelle, G. Watel and C. Manus - J. Chem. Phys. to be published.

/2/ J.S. Cohen and N.F. Lane - J. Phys. B 6, L113 (1973).

/3/ H. Fujii, H. Nakamura and M. Mori - J. Phys. Soc. Japan 29, 1030 (1970).

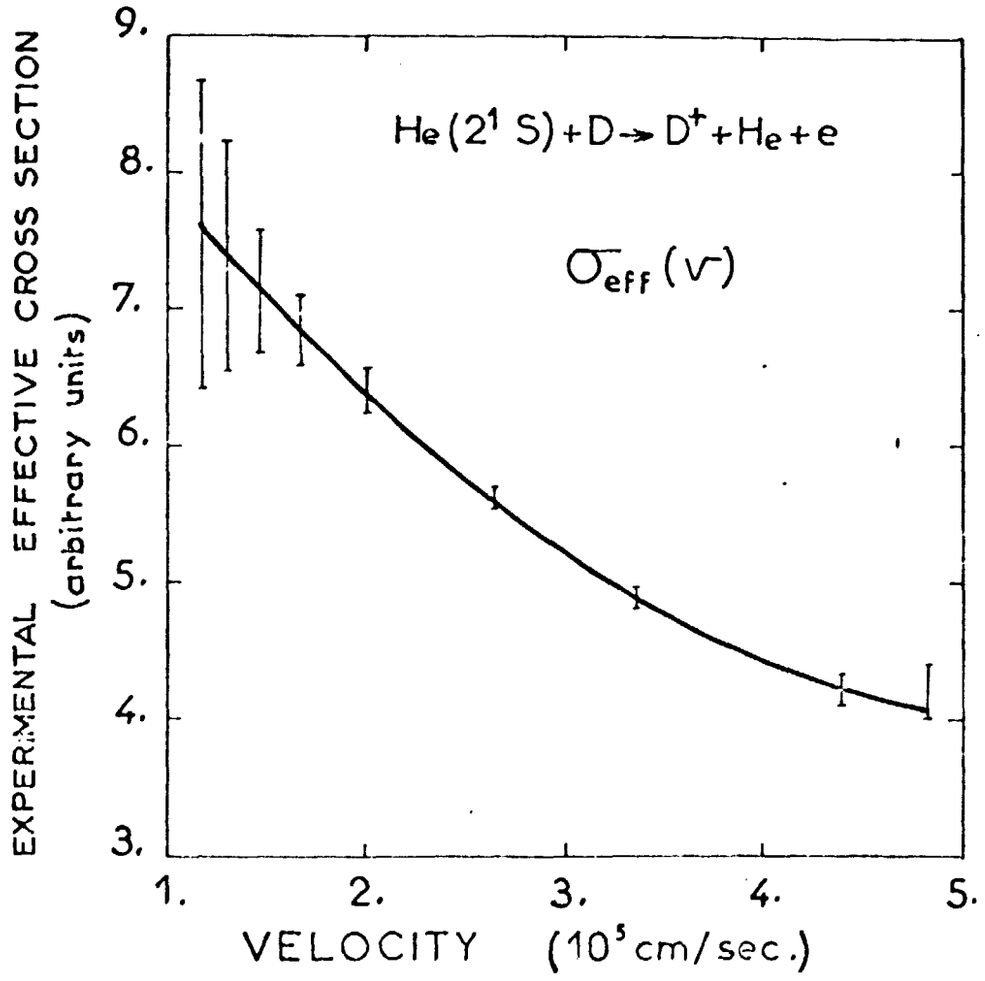

Fig. 1 : Effective Penning ionization cross section for $He(2^1S)$ + D interaction. v is the velocity of He^* atoms. —— present experimental $\bar{\sigma}_{eff}(v)$ cross section : a smooth curve has been drawn through about 200 points ; typical error bars are shown.