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# VELOCITY DEPENDENCE OF THE PENNING AND ASSOCIATIVE IONIZATION CROSS SECTIONS OF Ar ATOMS BY He ($2^3S$) AND He ($2^1S$) ATOMS

A. PESNELLE, G. WATEL and C. MANUS

Service de Physique Atomique
Centre d'Etudes Nucléaires de Saclay; France.

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The velocity dependence of both the Penning and associative ionization cross section $\sigma_{PI}$ and $\sigma_{AI}$ of Ar atoms by He ($2^3S$) and He ($2^1S$) metastable atoms, and of their sum $\sigma_T = \sigma_{PI} + \sigma_{AI}$, is measured in the velocity range 1200-4500 m/sec (30-400 meV) in a crossed-beam experiment by a time-of-fmight technique. Characteristic cross-section ratios $\sigma_{AI}/\sigma_T$ and $\sigma_T$ (Singlet)/ $\sigma_T$ (Triplet) are reported along with the relative magnitude of the cross sections $\sigma_{AI}$, $\sigma_{PI}$, $\sigma_T$. The measurements clearly show a difference in the reaction mechanisms involving He ($2^3S$) and He ($2^1S$). This difference appears not only in the ratio $\sigma_{AI}/\sigma_T$, whose magnitude reaches 19% and 38% for He ($2^3S$) and He ($2^1S$) respectively at the velocity v = 1200 m/sec (30 meV), and in the ratio $\sigma_T$ (Singlet)/ $\sigma_T$ (Triplet), which increase from 0.5 to 3.8 for velocity decreasing from 4500 m/sec to 1200 m/sec, but also in the different shapes of the $\sigma_{AI}$ and $\sigma_{PI}$ cross sections for He ($2^3S$) and He ($2^1S$).

A theoretical interpretation for He ($2^3S$) + Ar, based on the model of Nakamura /1/, gives a total cross section $\sigma_{TI}$ (v) and partial cross sections $\sigma_{AI}$ (v) and $\sigma_{PI}$ (v) in good agreement with our experimental results, with a probability of autoionization of $He^* + Ar$ $\Gamma(R) = Ae^{-R/B}$ where A= 4000 a.u. and B = 0.360 a.u.

The He + $Ar^+$ potential curve which is thus derived exhibits a well depth of 16.5 meV and has a minimum located at about 5.8 a.u. /2/ These values are in good agreement with the well depth (18.3 meV - 5.7 a.u.) estimated by using the Ar + $He^+$ potential curve obtained from differential scattering measurements /3/ and scaling to the different polarisabilities of He and Ar. The well depth and its position are also in good agreement to the values (16.7 meV-5.7a.u.) estimated by adding the charge induced dipole term $-\alpha_{He}/2R^4$ to the He+ Ar potential curve derived by differential scattering /4/.

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