LOW ENERGY ELECTRON ATTACHMENT TO SF_6 AT SUB-MEV RESOLUTION USING A NEW, TUNABLE LASER PHOTOELECTRON METHOD

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Electron attachment to sulfur hexafluoride is studied using a new photoelectron source of ultralow energy electrons with sub-millielectron volt resolution. Vacuum ultraviolet laser radiation produced through nonlinear optical techniques is used to photoionize xenon at and above its $^2P^o_{1/2}$ ionization limit [1]. The resulting photoelectrons interact with sulfur hexafluoride admixed to the xenon. The electron energy (*via* the laser wavelength) is continuously scanned from 0 to 127 meV, with a resolution of 0.1-0.5 meV at threshold. Computational modeling indicates that the attachment cross section is well described by the Wigner threshold law at electron energies less than about 5 meV. Data at higher energies are best described by the Wigner *s*-wave form, or by a Klots form.[2] Cusps are clearly observed at the ω_6, ω_1, and ω_3 vibrational modes of SF_6. While the ω_1 and ω_3 cusps have their maxima at the spectroscopic energies of 97.1, and 117.6 meV, respectively; the ω_6 cusp has its maximum at 46 meV, nearly three meV *higher* than its spectroscopic value of 43.2 ± 0.4 meV. Possible explanations are considered, such as a low-*l* angular-momentum barrier, or an overtone mode of SF_6 excited by the collision. The exact cause of this shift is not understood at present.

Experimental results for the attachment $e(\epsilon) + SF_6 \rightarrow SF_6^-$ are shown in Fig. 1, and compared with recent data of Klar, *et al.* [5] who used a metastable rare-gas ionization technique. Cross sections are obtained by normalization of the lineshape to the thermal attachment rate constant. There is seen to be good overall agreement between the two results in the energy range 0.1-10 meV, while present data lie above those of Ref. 5 at $\epsilon > 10$ meV. Results will also be presented for the vibrationally-enhanced attachment process $e(\epsilon) + SF_6(\omega{=}0) \rightarrow SF_6^-(\omega_n)$, where n=6,1,3.

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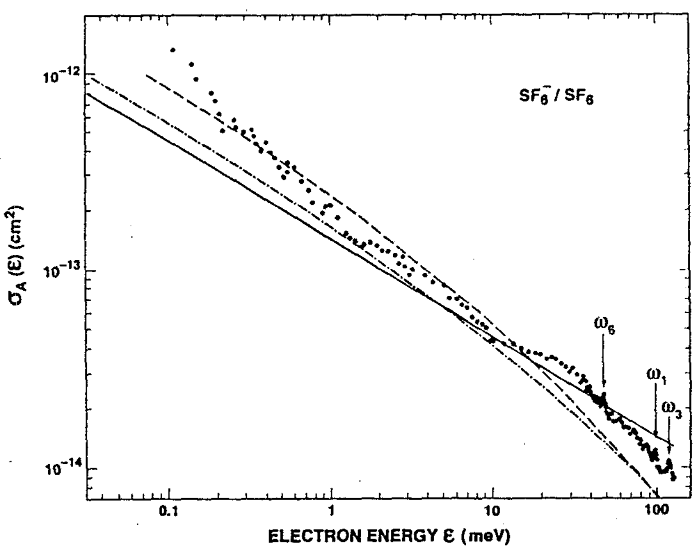

Figure 1. Cross section for electron attachment to SF_6 over the energy range $0.10 \leq \epsilon \leq 127$ meV. Experimental data are shown as solid circles. Solid line is the Wigner *s*-wave cross section form given by $\sigma_A(\epsilon) = 4.54 \times 10^{-15}\, \epsilon^{-1/2}$ cm^2 for attachment to a cool (~50K) SF_6 target. Chain curve (-·-·) is the Klots form using β=0.228 (ϵ in meV, and corresponding to the polarizability for SF_6 of 44.1 a_o^3), and long dashed line (----) are data from Ref. 5 with β=0.405. Arrows indicate the vibrational cusps.

References

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