EVIDENCE FOR DOUBLY CHARGED NEGATIVE FLUORINE IONS FROM
ELECTRON BOMBARDMENT OF CF_3Cl

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In recent years accelerator scientists have expressed a growing interest in multiply charged negative ions because of their potential use in tandem accelerators. In such machines the ions are first accelerated as negative ions, stripped to a multiply charged positive species and then the positive ion is further accelerated. Stuckey and Kiser¹ have reported the observation of doubly charged negative ions of oxygen and the halogens using an omegatron for mass analysis. Since early theoretical analysis² indicated that the lifetimes for such species would be less than 10^{-9} sec. and since Fremlin³ pointed out that there may be alternative explanations of the omegatron observations doubt existed as to the actual existence of multiply charged negative ions. More recently Baumann, et al⁴ using a Penning ionization source and a 60° magnetic sector instrument for mass analysis observed some peaks which correspond to a mass half of the negative ion X^- . This peak could be due to X^{--} or it could be a metastable peak due to the dissociation of $\text{X}_2^- \rightarrow \text{X}^- + \text{X}$ before reaching the analyzing magnet. In order to distinguish between these processes they used a stage of electrostatic deflection for the beam as it exited from the magnetic sector and definitely established the existence of X^{--} in a

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number of elements.

We would like to report some related observations that we have made in studying the electron bombardment of CF_3Cl which is the one of the molecule that Stuckey and Kiser used in their omegatron measurements. The instrument that we used is a coincidence mass spectrometer using quadrupole mass filters for mass analysis. In such a system no confusion from metastable ions is expected. A near monoenergetic beam of electrons (40 mV FWHM) whose energy could be varied from a few eV to 200 eV was used to bombard the gaseous target molecules. The instrument⁴ was designed for study of ion-pair processes by detecting mass analyzed positive and negative ions in coincidence. Positive or negative ions could also be studied individually. Figure 1 gives a typical negative ion mass spectrum using 100 eV electrons to bombard CF_3Cl . The peak corresponding to mass 9.5 is clearly evident and we attribute this to F^{--} . This peak was observed to increase in intensity with increasing electron bombarding energy from 30 eV to 100 eV. It was not present when CF_4 was used as a target gas. These results confirm the results of Baumann, et al.⁵ On the other hand they differ in some respects with the omegatron experiments in that we did not observe Cl^{--} from CF_3Cl and we did not detect F^{--} from CF_4 . Furthermore our results indicate that the F^{--} ion must be formed in an excited state by some indirect process in which a singly charged negative ion reacts with either the parent molecule or some fragment of it.

This work was done under the auspices of the U. S. Atomic Energy Commission.

References

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Figure Caption

Negative ion mass spectra of CF_3Cl bombarded with 100 eV electrons.

The three pronounced peaks correspond to F^{--} , F^- and Cl^- .

NEGATIVE ION INTENSITY
arbitrary units