Attempts to Produce H 2 S by Charge Exchange

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The 2 S state of atomic hydrogen is a possible basis for producing 50% polarized protons. Continuing along the line of MADANSKY[2]) and co-workers, we attempted to produce, and subsequently to ionize, metastable atomic hydrogen by charge exchange in hydrogen gas. By operating in the energy range 150–600 ev, it was hoped to get more protons from the metastable charge exchange process than from the competing ground state process. It was hoped that the ground state stripping cross section would have dropped well below its maximum value, while the metastable stripping cross section remained high.

Rough measurements of the ground state stripping cross section are listed below:

600 ev	$= 2 \times 10^{-17}$ cm^2/atom	Accuracy –
300 ev	2×10^{-17} cm^2/atom	a factor of 2
150 ev	1×10^{-17} cm^2/atom	

Thus the cross section has not dropped appreciably from the constant value of 4.20×10^{-17} cm^2 that extends from 4 to 9 kev [1][3]).

Results for the metastable double charge exchange process showed nothing within the sensitivity of the apparatus. The sensitivity at 600 ev, the worst case, would have shown an effect if $\sigma_{+0} = \sigma^*_{+0}$ and $\sigma_{0+} = \frac{1}{2}\sigma^*_{0+}$.

Next studied was the metastable production process alone. It was not possible to detect any metastable beam above the threshold of sensitivity of the apparatus – one metastable atom for 20 ground state atoms. Further work with a Lyman – α photon counter also showed no buildup of a metastable beam.

A reason for the negative results is suggested by the work of FITE *et al.* [2]. For metastable hydrogen atoms of about 0.3 ev energy in hydrogen gas, a de-excitation cross section of 0.7×10^{-14} cm^2 was found.

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[3]) Numbers in brackets refer to References, page 135.

If a similar value holds in the region of 150–600 ev, where the electron pick up cross section is about 10^{-16} cm^2, more than one metastable atom for every 100 incident protons could not be expected.

REFERENCES

[1] Allison, Samuel K., Revs. Modern Phys. *30*, 1137 (1958).
[2] Fite, Wade L., Brackmann, Hummer, Stebbings, Phys. Rev. *116*, 363 (1959).