

This Week's Citation Classic

Rapp D & Englander-Golden P. Total cross sections for ionization and attachment in gases by electron impact. I. Positive ionization. *J. Chem. Phys.* **43**:1464-79, 1965. [Lockheed Missiles and Space Co., Palo Alto, CA]

Very accurate measurements were made on a series of electron-impact ionization processes, which served as a data base for theory, as well as an absolute standard for calibrating other experiments to an absolute base. 'Consistency checks' to indicate the validity of assumptions were emphasized. [The **SC**[®] indicates that this paper has been cited over 370 times since 1965.]

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"During the early 1960s, a great deal of experimental research was carried out on collision processes between electrons, atoms, ions, and molecules. Much of this work was inspired or supported by the expanding programs in space sciences, especially those related to the earth's ionosphere. Most of the work that was done was aimed at using new, innovative, and exotic methods for making crude measurements on processes that were difficult to study. As a result, data began to accumulate on a wide variety of processes, but most of the data were very approximate. Furthermore, it was difficult to assess the possible errors in most of the data, and divergences between different investigators often greatly exceeded their assigned error bars. One of the main reasons for this was the prevailing preoccupation with crude excursions into uncharted territory. Our work represented a totally different attitude in that we aimed at building up a base of accurate data on related fundamental processes. Such a data base provided a reservoir of information for testing of theories, as well as a set of basic standards that could be used for normalizing other experiments to an absolute basis, thus accounting for the article's frequent citation. What is perhaps most important about our paper is that we emphasized the use of 'consistency checks' which consisted of ancillary experimental data to indicate the validity of assumptions made about the

collection efficiencies and other instrumental factors. This was in contrast to many experiments where the equipment was turned on and data taken without adequate probing of the vagaries that so often plague experiments with charged particles at low energies.

"It is remarkable that we were given the opportunity to do the work reported. During a period when the main 'justification' for doing work in electronic and ionic physics was that it 'helped the space scientists,' we were extremely fortunate in having an enlightened management at Lockheed who gave us a laboratory and said: 'Go do something useful.' As the years have passed, and research dollars have shrunk, the funding agencies have moved in the direction of requiring more proposals, justifications, milestone charts, work plans, relationships to national needs, practical implications, and other trends that stifle research. The ironic thing is that every effort to control and regiment research to 'get one's money's worth' from the funds seems to produce less value in the result. In our effort, there was no time wasted on writing proposals, making unnecessary justifications, relating our work to the corporate image, or going through the many gyrations that researchers face today. I believe that the best way to get research done is to hire a few bright-eyed, enthusiastic types and give them free reign. The only regret I have is that I didn't adequately appreciate what a great opportunity I had at Lockheed in six years of uninhibited immersion in research (1959-65).

"In a recent paper, K. Stephan, H. Helm, and T.D. Mark¹ reported measurements of mass analyzed partial ionization cross sections. The influence of our work on this more recent research was two-fold. First, Stephan, Helm, and Mark placed great emphasis on consistency checks and studied these extensively. Second, they normalized their relative data against our absolute data to obtain absolute cross sections for mass analyzed ions."

1. **Stephan K, Helm H & Mark T D.** Mass spectrometric determination of partial electron impact ionization cross sections of He, Ne, Ar, and Kr from threshold to 180 eV. *J. Chem. Phys.* **73**:3763-78, 1980.