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Why isn't the atmosphere completely ionized?

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We have carried out experiments on electron attachment and positive ion / negative ion neutralization at thermal energies using the VENDAMS method (variable electron and neutral density attachment mass spectrometry, which is an extension of the flowing-afterglow Langmuir-probe technique). The VENDAMS method allows us to determine rate coefficients for ion-ion mutual neutralization along with neutral product branching fractions. The method is limited at present to noble gas positive ions. A major advantage of the method is that electron attachment to labile molecules such as POCl_2 or C_2F_5 may be studied, if these molecules are present in the apparatus as products of the primary neutralization reaction. Measurements have been made on electron attachment to SF_2 , SF_3 , SF_4 , SF_5 , and SF_6 , for example, along with rate coefficients and neutral product distributions for SF_5^- and SF_6^- neutralization by Ar^+ [1] and for SF_4^- , SF_5^- , and SF_6^- neutralization by Ar^+ and Kr^+ at 300 K. These and other electron attachment and ion-ion neutralization results, measured over a temperature range 300-600 K, will be presented. In addition, we have identified a new plasma process in which electrons act as a third body to remove energy from an orbiting ion-ion complex, which enhances the neutralization rate coefficient. Details of this process, electron-catalyzed mutual neutralization, have been recently published,[2] and new results will be presented for various species.

Collaborators in this work: Nicholas S. Shuman, Albert A. Viggiano, Jeffrey F. Friedman, Connor M. Caples, Raymond J. Bemish, and Jürgen Troe.

[1] N. S. Shuman, T. M. Miller, and A. A. Viggiano, *J. Chem. Phys.* **133**, 234304 (2010).

[2] N. S. Shuman, T. M. Miller, R. J. Bemish, and A. A. Viggiano, *Phys. Rev. Lett.* **106**, 018302 (2011).