DISSOCIATIVE RECOMBINATION OF O_2^+ AND THE GREEN AIRGLOW

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Dissociative recombination (DR) and of O_2^+ have been investigated using the ion storage ring CRYRING at the Manne Siegbahn Laboratory at Stockholm University. DR of O_2^+ plays an important role in atmospheric physics and chemistry, in particular in the F-region (above 140 km) where it gives rise to the 557.7 nm green airglow (arising from the O(^{1}S) - O(^{1}D) transition). The green airglow has a long history of controversy. In 1997 two important steps forward were taken. The O(^{1}S) quantum yield for DR of O_2^+ populating a broad vibrational distribution was measured for an electron energy of nominally 0 eV using the ASTRID storage ring and an imaging technique [a]. Despite the complication with using vibrationally hot O_2^+, it was possible to deduce an O(^{1}S) quantum yield of 0.05 for DR of O_2^+ (v = 0). A new mechanism was suggested [b] and showed to quantitatively give a yield in quite good agreement with experiment. Three experimental improvements were implemented in the present work. An ultracold electron beam allowed cross sections and quantum yields to be measured at an energy resolution of about 1 meV, a specially designed ion source supplied O_2^+ in its zeroth vibrational level, and an image intensifier was added to our three-dimensional imaging detector. The use of an image intensifier strongly reduced background events arising from collisions of O_2^+ in the rest gas. Thus, for the first time one experiment combines absolute cross section measurements with quantum yield determinations as a function of electron energy for vibrationally cold O_2^+. A thermal rate coefficient of 2.0×10^{-7} cm^{3}s^{-1} at 300 K was obtained. The O(^{1}S) quantum yield shows a strong dependence on the electron energy.

[a] D. Kella, L. Vejby-Christensen, P. J. Johnson, H. B. Pedersen, and L. H. Andersen, Science 276, 1530 (1997); ibid. 277, 167 (1997)

[b] S. L. Guberman, Science 278, 1276 (1997)