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Ionization mechanisms in CRRES chemical releases. 2. Strontium photoionization and Ba^+/Sr^+ collisional ionization cross-section calculations

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Résumé / Abstract

Two particular collision processes involving electron transfer are investigated that may have impact on the analyses of ion flux data obtained in the CRRES G-1 and G-11b, upper atmospheric chemical release experiments. Ion pair production (σ_{1p}) and charge exchange ionization (σ_{CE}) cross sections are calculated as a function of collision energy for reactions between Ba/Sr atoms and O atoms and O^+ ions, respectively, using two-state approximation theories. The cross sections for each process are calculated for both the ground and metastable states of the metal atoms. At a collision energy of 9.5 eV attained in the G-1 and G-11b CRRES releases, the calculations indicate that $\sigma_{1p} = 1.3 \times 10^{-16}$ cm^2 and $\sigma_{CE} = 2\text{-}6 \times 10^{-16}$ cm^2 for reactions involving $Ba(^1S_0)$. The cross sections for the analogous Sr reactions are approximately 1.2×10^{-6} cm^2 and $2\text{-}8 \times 10^{-17}$ cm^2, respectively. In addition, Sr photoionization from ^3P_j metastable states is investigated. Although we calculate a 29-s photoionization time constant from these states, a kinetic analysis indicates the metastable states cannot accumulate an appreciable equilibrium population in full solar exposure. Thus photoionization from the Sr ^3Pj levels does not significantly contribute to the total ion inventory.

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