The mechanism of dissociative excitation processes in collisions of He^+ ions with N_2, and O_2 molecules

Malkhaz R Gochitashvili[1], Ramaz A Lomsadze[1], Roman Ya Kezerashvili[2,3] and Michael Schulz[4]

[1]Tbilisi State University, Tbilisi, 0179, Georgia
[2]Physics Department, New York City College of Technology, The City University of New York, Brooklyn, NY 11201, [3]The Graduate School and University Center, The City University of New York, NY 10016, United States of America,
[4]Missouri University of Science and Technology, Rolla, MO 65409, United States of America.

Synopsis Absolute cross sections for dissociative excitation processes of He^+ - O_2 and He^+ - N_2 pairs are determined. In the case of He^+ - O_2 pair the high-intensity oxygen ionic line has been observed. In the case of He^+ - N_2 pair the linear polarization of the helium atomic and nitrogen ionic lines have been measured. The experimental results are interpreted qualitatively in terms of quasidiatomic approximation.

In this work, for the He^+ - O_2 collision pair the absolute cross sections for dissociative excitation processes of oxygen atomic and ionic lines are determined. The high-intensity oxygen ionic line OII (83.4 nm) has been observed. In the case of He^+-N_2, the pair emission cross-section and the linear polarization of the atomic HeI lines (λ=388.9nm, transition 3p $^3P_0$→2s ^3S; λ=587.6nm, transition 3d ^3D → 2p ^3P) and nitrogen ionic NII (λ=500.1-500.5nm, transition 3d $^3F_0$→ 3p ^3D) lines have been measured for a broad range of collision energies (1-10keV). A high degree of polarization P = - 20% was observed in the case of the helium line (fig.1). Such a great negative value of the degree of polarization indicates that $m_L = \pm 1$ sublevels of the excited state 3^3P of helium atom are preferably populated. An expression for the first Stoke's parameter has been derived on the basis of the general approach developed by Macek and Jaecks [1].

$$P = \frac{I_{//} - I_{\perp}}{I_{//} + I_{\perp}} = \frac{15(\sigma_0 - \sigma_1)}{41\sigma_0 + 67\sigma_1} \qquad (1)$$

where $I_{//}$ and $I_{\perp}$ denote the measured intensities of radiation with the electric field vector parallel and perpendicular to the incident ion beam, respectively; σ_0 and σ_1 stand for the cross sections for a population of sublevels with $m_L = 0$ and $m_L = \pm 1$, respectively. Considering that the experimentally observed value of P is –20% one obtains from (1) that $\sigma_1 / \sigma_2 \approx 15$. Such a large value of this ratio indicates that $m_L = \pm 1$ sublevels of the excited helium atom are preferably populated.

The analysis of the experimental results indicates that the electron density formed in He* during the collision is oriented perpendicularly with respect to the incident beam direction. A strong correlation is revealed between inelastic channels of the formation of excited helium and nitrogen particles. The experimental results are interpreted qualitatively in terms of quasidiatomic approximation.

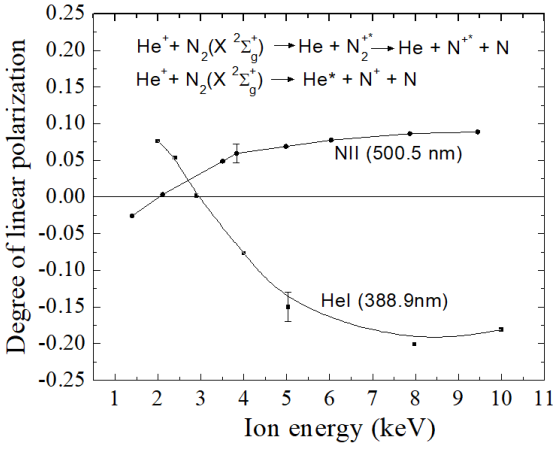

Figure 1. Energy dependence of degree of polarization.

References

[1] J.Macek, D. H. Jaecks Phys Rev A 4 2288, (1971)

* E-mail: malkhaz.gochitashvili@tsu.ge

† E-mail: schulz@mst.edu