Stereo-dynamical ion-pair formation in collisions of highly-charged ions with Ar_2

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Synopsis Multiple ionization process of a rare gas dimer collided with a slow highly charged ion is investigated with the three-center Coulombic over-barrier model previously developed by the present authors. To reveal stereodynamical effects, we calculate the cross sections for asymmetric ion-pair formation as a function of the orientation angle. We distinguish the *near* and *far* atomic sites, as well as the *forward* and *backward* ions, produced as a result of Coulomb explosion.

Multiple ionization process of a rare gas dimer BC collided with a slow highly charged ion A^{q+} is investigated with the three-center Coulombic over-barrier model previously developed by the present authors [1, 2]. To reveal stereodynamical effects, we calculate asymmetric ion-pair formation cross sections $\sigma(Q_{\rm B}, Q_{\rm C})$ as a function of the orientation angle. In recent works, we have modified the model so as to introduce the effect of *partial screening* for "non-active" target atomic site (either B or C) during a collision in respective steps of electron removal [1]. We have also calculated the ion-pair formation cross sections by considering both projectile and target screening [2].

The present work is stimulated by the investigation at GANIL, where the *azimuthal* angle dependence is observed around the beam axis as an orientation effect [3, 4]. On the other hand, in the present work, we investigate the *polar* angle θ dependence. We assume that $B^{Q_{\rm B}+}$ ion is emitted in forward directions with $C^{Q_{\rm C}+}$ ion in backward directions, *i.e.*, $(\theta_{\rm B}, \varphi_{\rm B}) = (\theta, \varphi)$ and $(\theta_{\rm C}, \varphi_{\rm C}) = (\pi - \theta, \pi + \varphi)$ with $\cos\theta \geq 0$ and $0 \leq \varphi \leq 2\pi$, where $\cos\theta \equiv \hat{\boldsymbol{d}} \cdot \hat{\boldsymbol{v}}$ defined by the beam vector $\boldsymbol{v}$ and the dimer axis vector $\boldsymbol{d}$.

Figure 1 indicates the cross-section ratio $r_{31/22} \equiv (\sigma_{31} + \sigma_{13})/\sigma_{22}$ in the region of $0 \leqq \cos\theta \leqq 1$. When $\theta = \pi/2$, the incident ion collides perpendicularly with the target. At this angle, the ration $r_{31/22}$ is almost $3 \sim 7$ in the figure, which gives reasonable agreement with the experimental result [4]. On the other hand, the ratio shows peculiar behavior in the forward directions as $\cos\theta \simeq 1$. Asymmetric cross-sections σ_{31} and σ_{13} are never populated in pararell incidence ($\theta = 0$). Note that we only consider the *way-in* process in the present model. To get physical insites more clearly, we make the logarithmic plot by taking an appropriate variable $n \equiv \log_2(1 - \cos\theta)^{-1}$ as the horizontal axis.

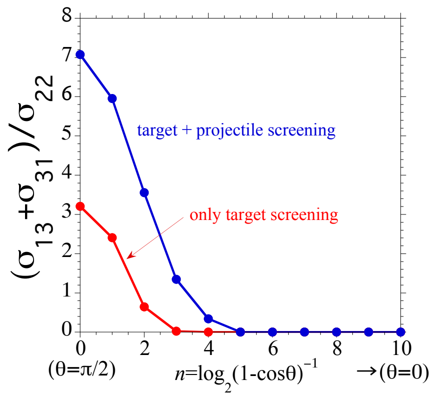

Figure 1. Orientation dependence of cross-section rario, $(\sigma_{31} + \sigma_{13})/\sigma_{22}$.

References

[1] T. Ohyama-Yamaguchi and A. Ichimura 2011 *Physica Scripta* **144** 014028.

[2] T. Ohyama-Yamaguchi and A. Ichimura 2017 *J. Phys. Conf. Ser.* **875** 102031.

[3] Matsumoto *et al.* 2010 *J. Phys. Rev. Lett.* **105** 263202.

[4] Iskandar *et al.* 2018 *Phys. Rev. Lett.* **98** 012701.

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