Stereodynamics in collisions of highly-charged ions with Ar dimers: asymmetric ion-pair formation
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Synopsis Stereodynamical effects are analyzed for multiple ionization of rare gas dimers by slow highly charged ions using the three-center Coulombic over-barrier model previously developed by the present authors.

More than ten years ago, we proposed a three-center Coulombic over-barrier model to describe sequential multiple ionization of a rare gas dimer BC collided by a slow highly charged ion \( A^{q+} \) [1]. In more recent works [2, 3], we modified the model so as to introduce the effect of partial screening during a collision for non-active target atomic site (either B or C) and also for projectile site (A) in respective steps of electron removal. The model predicts the population distribution over charge-states \((Q, Q')\) of dissociating ion pairs just after the collision. Measured result [4, 5] of the ion pair distribution in \( A^{q+} + Ar_2 \) collisions was reasonably reproduced in the model by taking a screening parameter as \( s = 0.3 \sim 0.4 \) [3].

In the present work, stereodynamical effects are examined in relation to the screening effect. We have calculated the ion pair formation cross sections as a function of the orientation angle, \( \cos \theta = d \cdot \hat{v} \), where \( d \) denotes a molecular axis vector from C to B with \( \hat{v} \) being the projectile beam velocity. In addition, to obtain a physical insight more clearly, we introduce a pair of atomic impact parameters \( b_B \) for \( A^{q+} + B \) and \( b_C \) for \( A^{q+} + C \) with molecular impact parameter \( b \) for \( A^{q+} + BC \).

Figure 2 shows the angular dependence of the cross sections \( \sigma(Q_{\text{near}}, Q_{\text{far}}) \) for \( (Q_{\text{near}}, Q_{\text{far}}) = (2,1), (1,2), (3,2), \) and \( (2,3) \). It is seen from the figure that the \( (2,1) \) population overwhelms \( (1,2) \), and similarly \( (3,2) \) overwhelms \( (2,3) \). All the curves in the figure are symmetric with respect to \( \cos \theta \). We see two maxima in \( (2,1) \) and \( (3,2) \) cross sections, and two cusps in \( (1,2) \) and \( (2,3) \) at \( \cos \theta = \pm 1 \). These behaviors come from the geometry of saddle point formation in the three-center Coulombic potential [2, 3].

References

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