XXIX International Conference on Photonic, Electronic, and Atomic Collisions (ICPEAC2015) IOP Publishing
Journal of Physics: Conference Series **635** (2015) 032101 doi:10.1088/1742-6596/635/3/032101

Screening effect during a collision in multiple ionization of rare gas dimers by highly charged ions

Tomoko Ohyama-Yamaguchi* [1] **and Atsushi Ichimura†** [2]

* Tokyo Metropolitan College of Industrial Technology, Shinagawa, Tokyo 140-0011, Japan

† Institute of Space and Astronautical Science, JAXA, Sagamihara, Kanagawa 252-5210, Japan

Synopsis Three-center, many electron dynamics is analyzed in multiple ionization of Ar_2 by highly charged ions. It is found that the dissociating ion-pair distribution is sensitive to a screening parameter during a collision.

Much attention has been called to the Coulomb explosion of molecules in collisions with slow (velocities of $v \ll 1$ atomic unit) highly charged ions. Recent progress of measurement techniques permits us to obtain the dissociating ion pair distribution produced in the collisions. Such findings are of great interest from the viewpoint of multi-center multi-electron dynamics. In contrast with covalent molecules, however, little effort has been devoted to rare gas dimers.

About ten years ago, we proposed a three-center Coulombic over-barrier model to describe sequential multiple ionization of rare gas dimer BC with highly charged ion A^{q+} [1]. In a recent work [2] we modified the model so as to incorporate the effect of partial screening for non-active target atomic site (B or C) in respective steps of electron removal during a collision. The measured result [3, 4] of ion pair distribution up to four electron removal in $Ar^{9+} + Ar_2$ collisions was best reproduced with the model by taking a screening parameter of $s = 0.4$ (see figure 1).

In the present work, we further consider the effect of screening in projectile site A^{q+} so as to make a consistent framework. The three charges in the three center Coulomb potential

$$U(\boldsymbol{r}) = -\frac{q_{\rm A}}{|\boldsymbol{r}-\boldsymbol{R}_{\rm A}|} - \frac{q_{\rm B}}{|\boldsymbol{r}-\boldsymbol{R}_{\rm B}|} - \frac{q_{\rm C}}{|\boldsymbol{r}-\boldsymbol{R}_{\rm C}|}$$

are effectively taken as

$$\begin{aligned} q_{\rm A} &= q - (Q_{\rm B}+Q_{\rm C})(1-s), \\ q_{\rm B} &= Q_{\rm B}+1, \\ q_{\rm C} &= (1-s)Q_{\rm C}, \end{aligned}$$

for the active electron at site B, and

$$\begin{aligned} q_{\rm A} &= q - (Q_{\rm B}+Q_{\rm C})(1-s), \\ q_{\rm B} &= (1-s)Q_{\rm B}, \\ q_{\rm C} &= Q_{\rm C}+1, \end{aligned}$$

for the active electron at site C.

The projectile screening is likely to weaken the charge asymmetry in the ion pair distribution. The experimental result is found to be reproduced by a parameter s smaller than 0.4.

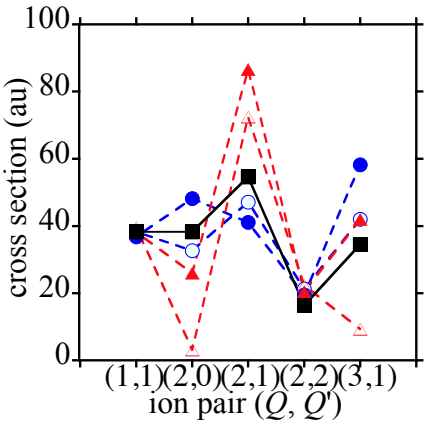

Figure 1. Ion pair (Q, Q') formation cross sections in $A^{9+} + Ar_2$ collisions. Calculation results with $s = 0.3$ and $s = 0.4$ are denoted by open (closed) triangles and open (closed) circles, respectively, where the screening effects only in the target (both in the target and projectile) are considered. The closed squares denote the experimental result [3].

References

[1] T. Ohyama-Yamaguchi and A. Ichimura, *Nucl. Instrum. Methods* B **205**, 620 (2003).

[2] T. Ohyama-Yamaguchi and A. Ichimura, *Physica Scripta* T **144**, 014028 (2011); *ibid.* T**156**, 014043, (2013).

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

[4] W.Iskandar *et al.*, *Phys. Rev. Lett.* **113**, 143201 (2014).

[1] E-mail: yamaguti@s.metro-cit.ac.jp
[2] E-mail: ichimura@isas.jaxa.jp