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Atomic Site-Sensitive Processes in Slow Ar^{9+}-Ar_2 Collisions

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Synopsis Electron capture processes for low energy Ar^{9+} ions colliding on argon dimer targets are investigated, focusing attention on charge sharing between the two argon atoms as a function of the molecular orientation and the impact parameter. Confrontation between experimental results and MC-COBM simulations have been investigated to provide access to atomic site sensitivity of the different fragmentation processes by measuring the angular correlation between the scattered projectile and the recoiling fragments.

Investigating an elementary reaction involving highly charged ions and molecules is a challenging subject: intramolecular charge redistribution after the collision may usually prevent the access to the primary process. Taking advantage of the low electron mobility in a dimer target, we present here a comparison between experimental and theoretical results giving access to the atomic site sensitivity for the collision system Ar^{9+}-Ar_2 at low energy regime.

The projectile scattering angle ϕ_{proj} is expected to be closely related to the impact parameter vector $\vec{b}$ in the molecular frame. For molecule orientations transverse to the projectile beam, the molecular frame is defined unambiguously by the angle $\phi_{Ar^{A+}}$, were Ar^{A+} is the most charged fragment (fig.1(d)). This angle is obtained by measuring in coincidence the position and time of flight of both ionic fragments. The transverse momentum transferred to the dimer center-of-mass during the collision is also inferred from these data sets, giving direct access to projectile scattering angle ϕ_{proj}. Then, the correlation between these two angles can be obtained by calculating the angular distributions in ϕ_{diff}=$\phi_{Ar^{A+}}$-ϕ_{proj}.

A preference for charge-asymmetric dissociation channels is observed [1], with a strong correlation between the projectile scattering angle and the molecular ion orientation as shown in the figure 1. This measurements provide clear evidence that projectiles distinguish each atom in the dimer and that electron capture from the closest atom to the projectile is favored. Monte Carlo simulations combined with Classical Over-the-Barrier Model (MC-COBM), by considering the Ar_2 dimer target as two independent Ar atoms fixed in space, are successfully compared to the data (fig.1). They give a new insight into the dynamics of the collision by providing, for the different fragmentation channels, the two-dimensional probability maps p($\vec{b}$) [2].

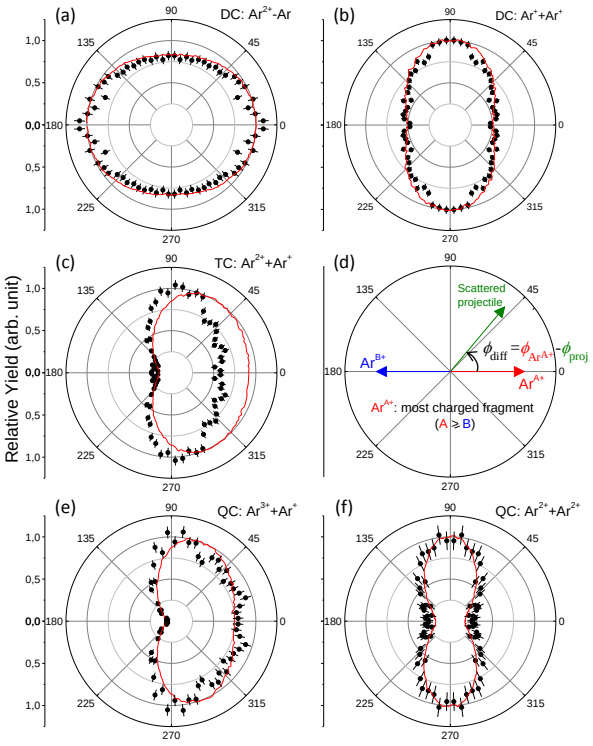

Figure 1. Angular distributions in ϕ_{diff} for the double, triple and quadruple electron capture and associated fragmentation channels. Experimental results (black dots) are compared to the MC-COBM calculations (red lines).

References

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