

## Scaling behavior of K-shell ionization in heavy ion collisions beyond the monopole approximation

*Monday, 19 September 2016 18:00 (2 hours)*

The purpose of the present work is to obtain a simple expression for estimation of the probability of K-shell ionization in heavy ion collisions. The transition amplitudes were calculated numerically and approximated by a simple analytical expression. It allows obtaining the process probability in a closed analytic form as well. In the present work we focus on the case of asymmetric collisions, when the charges of colliding nuclei noticeably differ. In this case the commonly used monopole approximation is not sufficient, since it is known to be consistent with accurate calculations for small internuclear distances and symmetrical collisions. The nonperturbative wave functions are constructed from monopole states, which are calculated using the dual kinetically balanced B-spline basis set method. The process probability is found to decrease by ~30% for large values of the ratio of nuclei charges.

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**Session Classification:** Poster Session and Coffee