Projectile electron losses in the collision with neutral targets*

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An important issue in the acceleration of U^{28+}at the forthcoming FAIR/GSI [1] is the projectile electron loss in the collision with the rest gas atoms(molecules). It can lead to degraded focusing and loss of the beam to the walls. These charge-changed fast ions strike the accelerator container walls and give rise to sputtering and activation of the surface. Evidently, it is important to study the interaction of highly charged heavy ions with neutral (rest gas) targets, for practical as well as theoretical reasons. It is a theoretical challenge to treat the many-electron (relativisic) scattering problem in a realistic nonperturbative way.

In the spirit of high energy Glauber theory we present a nonperturbative approach for the treatment of single and multiple electron losses of intermediate as well as relativistic highly charged ions colliding with neutral atom targets[2].

We introduce an average impact dependent probabilty p(b) as

$$p(b) = \frac{1}{n_0}\sum_n \frac{1}{M_n}\sum_{l,m}\int d^3k| < \vec{k}| \exp -i\chi(\vec{b},\vec{r})|nlm > |^2 \quad (1)$$

where $\chi(\vec{b},\vec{r})$ denotes the eikonal phase. The number of all possible values of l and m in a given shell n is denoted by M_n, n_0 is the number of shells, further details can be found in [2].

Now we can write the probability $W^{(N_e)+}$ for the loss of $N_e = N_p - N$ electrons, where N_p is the number of electrons of the highly charged ion ($N_p = 64$, in the case of our application to U^{28+}) as

$$W^{(N_e)+}(b) = \frac{N_p}{N!N_e!}p(b)^{N_e}(1-p(b))^N \quad (2)$$

The corresponding cross section is obtained by an integration over the impact parameter d^2b using the Laplace method [2]. In Fig. 1 (taken from [2]) we show the dependence of the multiple electron loss cross section on the number $N_e = N_p - N$ of electrons lost.

In our approach we used a parametrisation for p(b) where we have to fix two parameters [2]. This was done by fitting to the experimentally observed cross section [3] for $N_e = 14, 15$. The agreement is very good, in view of the approximations made.

It is our aim to calculate ionisation cross sections in a more detailed way using the LOSS code[4], which we intend to modify in order to include impact parameter depence as well as relativistic effects.

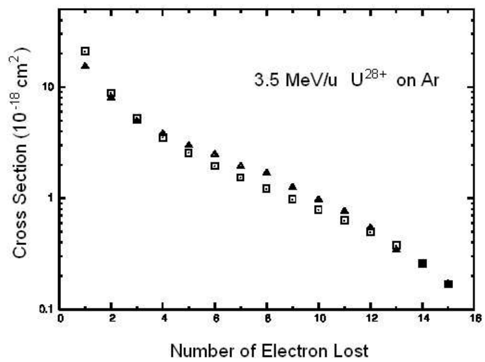

Figure 1: Dependence of the multiple electron loss cross section(in $10^{-18}cm^2$) on the number of loss electrons. triangles are the experimental data [3], squares are the result of our calculation [2]. For further explanation see text and[2].

References

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