§2. One- and Two-Electron Transitions in Slow Collisions of Ions with Helium

Fritsch, W. (Bereich Theoretische Physik, Hahn-Meitner-Institut Berlin, D-14091 Berlin, Germany)

Tawara, H.

In our ongoing project of determining electron transitions in slow ion-atom collisions, we have studied a few systems within the semiclassical close-coupling method with atomic orbitals.

Be^{2+} - He

For Be^{2+} - He collisions, there is no information available in the literature to date. We have determined the cross sections for single electron transfer into the n=2–4 states of Be^{+}, for double electron transfer into Be $1s^2 2\ell 2\ell'$ states, and for single electron excitation, at energies of 1 - 100 keV/u. Electron transfer into the Be^{+} $2p$ state is found to be the dominant channel as one would expect from energy considerations. Around energies of 10 keV/u, however, the $2s$ state is also very strong. The results of this work are summarized in Figure 1, they are presented in more detail and discussed in ref. [1] which is part of a Topical Issue, prepared under the auspices of IAEA, on processes of Be and B ions in fusion plasmas.

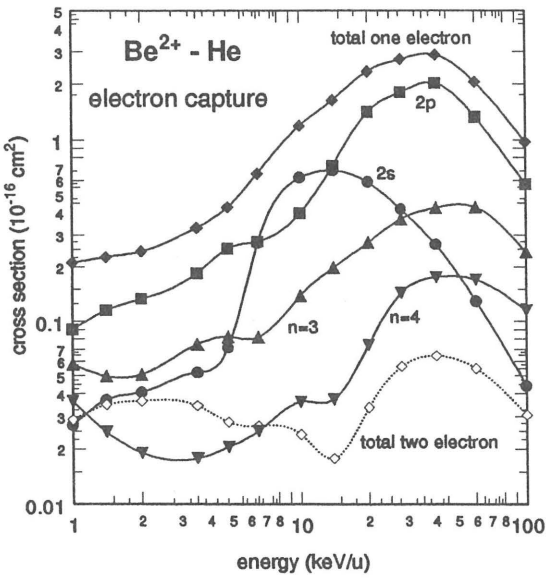

Figure 1: Transfer cross sections in Be^{2+} - He collisions, to Be^{+} $2s$ (•) and $2p$ (■) states, and to the n=3 (▲) and the n=4 shell (▼). Total one-electron transfer cross sections (♦) and an assessment of two-electron transfer cross sections (◊) are also given.

Be^{4+} - He

Earlier work [2] on this system has been augmented by considering transitions, in single electron transfer, to n=6–8 states. These transitions lead to emission of visible light, they are hence important for plasma diagnostics methods. In contrast to the earlier study [2], a *one*-electron model has been used that allows to consider more final states with still acceptable numerical expense. Since the ratio of partial transfer cross sections σ_n/σ_{n-1} is nearly the same in the one- and in the two-electron model, the calculated transfer cross sections from the one-electron description can be adjusted, on an absolute scale, by comparing with the ratios, for low-n states, from the two-electron description. In this work, we also assess the transfer process from a metastable He 2^1S state since this process is expected to contribute appreciably to the measured line emission in a fusion plasma environment. This work is near completion.

C^{5+} - He

An earlier description of this system [3] has been improved with respect to the model potential description of the ion. The calculated total single electron transfer cross sections are seen to agree closely with data below 1 keV/u [4]. There is no data for checking the calculated partial cross sections in the one-electron transfer channel. For the weak channels of two-electron transfer to C^{3+} $2\ell 2\ell'$ states, however, there is very good agreement with the data base [5, 6], even on the level of the population of magnetic substates. The calculated differential cross sections for two-electron transfer show many structures at low energies. When averaging over a finite angular resolution of 1 mrad, however, these cross sections agree rather well with data [7]. This work [8] is near completion.

References

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