

### §3. Slow Collisions between Plasma Impurity Ions and H or He Atoms: a Review

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We have reviewed [1] recent progress in theoretical studies of slow collisions between light plasma impurity ions and atomic hydrogen or helium. There have been more than 30 new studies in the past two years which have not been reviewed before. As highlights in these investigations we note the following:

- a few investigations on lowly charged systems for which total transfer cross sections *cannot* be derived from equicharged systems;
- a few studies have been undertaken at very low, near-thermal energies;
- some of these investigations include the determination of transfer cross sections into high- $n$  shells of the ions; this has been done, in one instance, even with a molecular-orbital expansion;
- in some investigations which include large basis sets, the target gas has been investigated also in an initially excited state; the scaling of cross sections in these systems, which is based on classical CTMC work, has been confirmed, except at low energies;
- there is more work now on electron excitation in these systems; structures in the excitation cross section at low energies appear now to be confirmed by a few independent calculations.

We also note the limitations in these studies, e.g. difficulties to determine ionization cross sections reliably, or generally cross sections at very low energies. For some specific systems, there is conflicting information from various groups.

This review also presents some new work from our collaboration, notably on the  $\text{Be}^{4+}$ -He collision system. As an example, we show in Figure 1 the calculated partial transfer cross sections into high- $n$  shells of the ion from this new one-electron calculation and from an earlier two-electron calculation

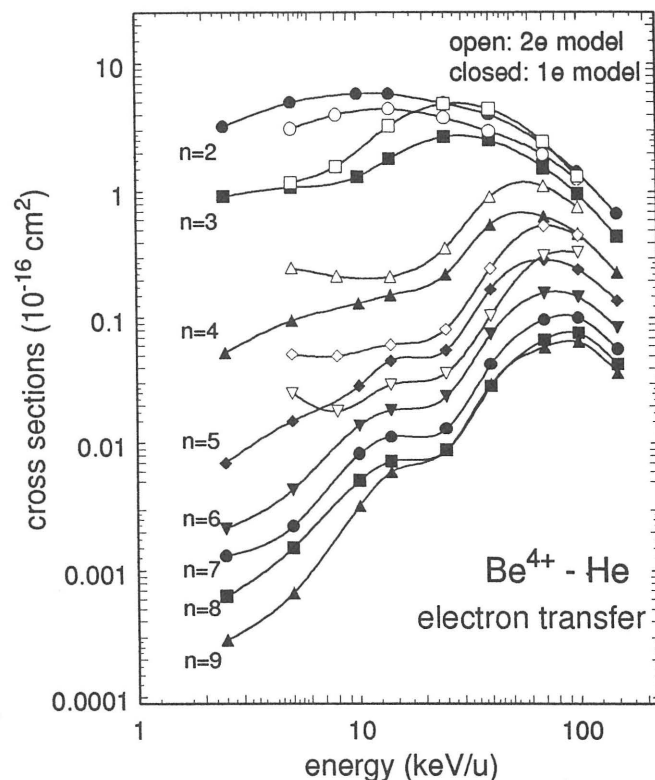


Figure 1: Calculated electron transfer cross sections to  $\text{Be}^{3+}$   $n$  shells in  $\text{Be}^{4+}$ -He collisions, from close-coupling calculations with two-electron AO expansions [2] (open symbols), and with one-electron AO expansions (this work and [3], closed symbols). Note that these latter results from the one-electron model are not yet corrected for the presence of a 2nd electron, they need to be raised by a factor of 1.5.

[2]. The general features from both calculations are about the same, except that the cross over between the curves for  $n=2$  and  $n=3$  in the two-electron calculation does not occur in the one-electron calculation. Also, there is a slightly different behavior between the curves for  $n=4-6$  at low energies. There are also results for transfer and for excitation from an initially excited He atom.

Lately, we have started work on electron transfer in collisions between  $\text{N}^{7+}$  and H or He. We will report results in the next issue within this series.

#### References

- [1] Fritsch, W., Tawara, H., NIFS-DATA-39 (1997) 89.
- [2] Fritsch, W., Nucl. Inst. Meth. in Physics Research B 98 (1995) 246.
- [3] Fritsch, W. *Proc. 8th Int. Conf. on the Physics of Highly Charged Ions*, Omiya 1996, Physica Scripta, in press.