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Ionisation of noble gas atoms and H_2O by antiproton impact

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Synopsis A time-dependent convergent close-coupling approach to antiproton collisions with noble gas atoms and H_2O has been developed using a fully multielectron treatment of the targets. Integrated cross sections for single ionisation have been calculated in a wide range of impact energies from 5 keV up to 2 MeV. Obtained results are in good agreement with experiment.

We investigate single ionisation of noble gas atoms and H_2O by antiprotons in the incident energy range from 5 keV to 2 MeV. Electron-electron correlations play a key role in the dynamics of these collisions. Presently available theories [1, 2] calculate single and multiple ionisation cross sections using effective one-electron approaches neglecting the electron-electron correlations [3].

We have developed a time-dependent convergent close-coupling (CCC) approach to antiproton collisions with multielectron targets which is capable of taking into account the electron-electron correlations. To this end we model the target structure as six p-electrons above an inert Hartree-Fock core. Only one-electron excitations from the outer p-shell are considered. The use of a Laguerre basis makes it possible to take into account all excitation and ionisation channels in a systematic manner. For H_2O we use a neonisation method recently proposed by Montanari and Miraglia [4]. This method describes the ten-electron water molecule as a dressed Ne-like atom in a pseudospherical potential.

In figure 1 we present our calculated total single-ionisation cross section in comparison with the experiment and other calculations for the Ne atom. As one can see, the CCC results are in very good agreement with the experiment at all energies. Two types of independent-particle model calculations of Kirchner et al [1] and CDW-EIS calculations of Montanari and Miraglia [2] yield similar results, which are slightly higher than the experiment. The method has also been applied to the other noble gases and the simplified model of H_2O mentioned above [6]. Agreement between our results for the heavier noble-gas targets and experiment is slightly worse than for the lighter targets. For heavier targets it is likely that for a better agreement with experiment one needs a multiconfigurational treatment of the target structure.

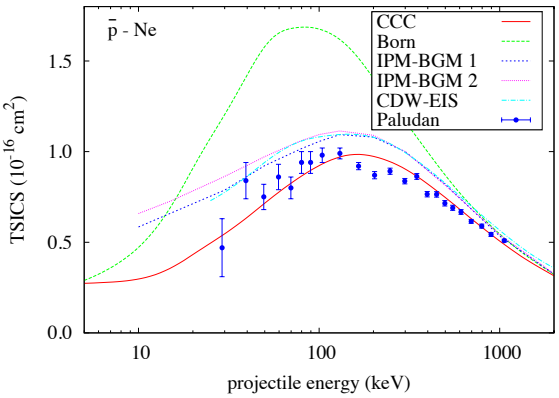

Figure 1. Integrated single-ionisation cross section for $\bar{p}$-Ne collisions. The present CCC and Born results are compared with the experimental measurements of Paludan et al. [5], independent-particle calculations of Kirchner et al. [1] with response (IPM-BGM 1) and with no response (IPM-BGM 2), and CDW-EIS calculations of Montanari and Miraglia [2].

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