ANTIPROTON ANNIHILATION IN LOW-ENERGY ANTIHYDROGEN SCATTERING BY SIMPLE ATOMS AND MOLECULES

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The ATHENA and ATRAP projects are continuing their work on antihydrogen at CERN after their successful preparation of antihydrogen in 2002. See, for example, [1,2]. We have already carried out calculations of cross sections for very low-energy hydrogen antihydrogen ($\mathrm{H\bar{H}}$) scattering [3] but this did not take into account antiproton annihilation.

Antiproton annihilation in what would otherwise be elastic scattering is brought about by the strong interaction and the cross section for it is thus much larger than for positron-electron annihilation, which is brought about by the electromagnetic interaction. Experimentalists would like to have more information about it to be able to understand its role in bringing about loss of $\mathrm{\bar{H}}$.

Recently, we carried out calculations of antiproton annihilation cross sections for $\mathrm{H\bar{H}}$ scattering [4] using the complex potential of Kohno and Weise [5] to represent the strong interaction between the proton and the antiproton. This is a largely phenomenological potential but it takes into account the isospin invariance of the strong interaction and effects due to the singlet or triplet spin state of the nuclei.

The results we obtained for the annihilation cross section and the change in the elastic cross section due to the strong interaction are similar at very low energies to the results obtained by Jonsell *et al.* [6] by a scattering length calculation using the effective range expansion method of Trueman [7]. They are significantly smaller than the values obtained by Voronin and Carbonell [8] using a coupled channel method and a complex strong interaction potential.

We are in the process of calculating antiproton annihilation cross sections and the change in the elastic cross section for very low-energy $\mathrm{He\bar{H}}$ scattering using a complex potential. A scattering length calculation by Jonsell *et al.* [9] indicates that the annihilation cross section is significantly larger than in the case of $\mathrm{H\bar{H}}$. It is important that this result should be confirmed as a high annihilation cross section is likely to give rise to unacceptable loss of $\mathrm{\bar{H}}$ if ultra-cold He is used to cool $\mathrm{\bar{H}}$. We will report on this at the conference.

As the high annihilation cross section value obtained by Jonsell *et al.* casts doubt on the possibility of using He to cool $\mathrm{\bar{H}}$, attention is turning to $\mathrm{H_2}$. We hope to be able to present preliminary results for $\mathrm{H_2\bar{H}}$ at the conference.

References

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