THREE-BODY RECOMBINATION OF COLD ATOMS

Hiroya Suno*, Brett D. Esry*, Chris H. Greene† and James P. Burke, Jr.‡

*Department of Physics, Kansas State University, Manhattan, Kansas, USA
†Department of Physics and JILA, University of Colorado, Boulder, Colorado, USA
‡NIST, Gaithersburg, Maryland, USA

Three-body recombination processes are one of the main factors limiting the achievable density and lifetime of current generation Bose-Einstein condensates (BECs). Such processes are also important in nuclear physics and chemical dynamics.

In the present work, we shall study three-body recombination of cold helium atoms:

$$^4\mathrm{He} +^4 \mathrm{He} +^4 \mathrm{He} \rightarrow^4 \mathrm{He}_2 +^4 \mathrm{He}. \qquad (1)$$

This study extends previous work[1] where *ultra*-cold alkali atoms were treated. An extra difficulty comes from the fact that not only zero total angular momentum $J = 0$ states, but also $J > 0$ states should be taken into account because of their higher binding energy.

We will use a modified version of Smith-Whitten hyperspherical coordinates [2]. Using these coordinates, one can easily introduce the symmetrization effects for three identical bosons, so that the configuration space can be reduced by a factor of 3. Coupled equations in an adiabatic hyperspherical representation are then solved using the variational R-matrix method.

The interaction used is a sum of helium dimer potentials from A.R. Janzen and R.A. Aziz[3].

Our goal is to calculate the "event rate constant"

$$K_3 = \frac{\hbar k}{\mu}\sigma, \qquad (2)$$

or the "recombination length"

$$\varrho_3 = (\mu K_3/\hbar)^{1/4}, \qquad (3)$$

where σ is the cross section for three-body recombination, μ is the three-body reduced mass.

References

1. B.D. Esry et al., Phys. Rev. Lett., **83**, 1751 (1999)
2. B.K. Kendrick et al., J. Chem. Phys., **110**, 6673 (1999)
3. A.R. Janzen and R.A. Aziz, J. Chem. Phys., **103**, 9626 (1995)

E-mail: suno@phys.ksu.edu