Reactive and inelastic processes
in $\text{Na}_2(v, j = 0) + \text{Na}$ collisions at ultralow energies

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There is a growing number of experiments aimed at producing large quanti-
ties of cold and ultracold molecules in traps. The major problem in forming a
molecular Bose-Einstein condensate is the instability due to collisional processes.
Little is however known about molecular inelastic and reactive collisions at the
ultralow translational energies encountered in traps [1, 2].

Accurate studies of molecular collisions at thermal energies are now performed
in several laboratories with sophisticated theoretical methods but only a few
concern the low and ultralow energy range. Using quantum mechanical scattering
methods based on hyperspherical democratic coordinates, we have undertaken
the study of collisions between alkali molecules and alkali atoms at ultracold
temperatures. In this work, we considered the $\text{Na}_2 + \text{Na}$ system for which an
ab-initio potential energy surface of quartet symmetry is available [3].

Our methodology permits to obtain elastic, inelastic and reactive cross sec-
tions and rate coefficients. We focused our attention on the quenching of the
$v = 1, 2, 3$ ($j = 0$) vibrorotational states. The partial wave with total orbital
angular momentum $J = 0$ has been computed. Reactive encounters contribute
to quenching more than the inelastic ones. At energies lower than 100 $\mu$K, the
quenching rates are much larger than the elastic ones. The effect of the three-
body part of the potential surface has also been studied.

[1] R. Wynar, R.S. Freeland, D.J. Han, C. Ryu, D.J. Heinzen, Science 287, 1016
(2000).