TUNNELING RATES OF ROVIBRATIONAL STATES OF METASTABLE $^4He_2^{2+}$

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The rovibrational states bound to the metastable electronic ground state of He_2^{2+} decay by tunneling through the potential energy barrier. The mean lifetimes and kinetic energy release upon dissociation for the heteronuclear $^3He^4He^{2+}$ isotope have been reported recently[1]. The measured values were in agreement with calculated high angular-momentum states (l around 14), and it was suggested that these states are populated by the mechanism creating the parent $^3He^4He^+$ in the ion source. However, the measurements were not sensitive to low angular momentum states and thus the width of the angular momentum distribution remains to be determined. To address this question we conducted similar measurements, of the mean lifetimes and kinetic energy release upon dissociation for the homonuclear $^4He_2^{2+}$ isotope, for which both low and high angular momentum states are within the high sensitivity range of our experimental setup (50-500 ns), as shown in figure 1. Note that the v=0 states within the measurement window have very low angular momentum, while the v=1 and v=2 states have angular momentum of 17-19ħ and 26-27ħ respectively.

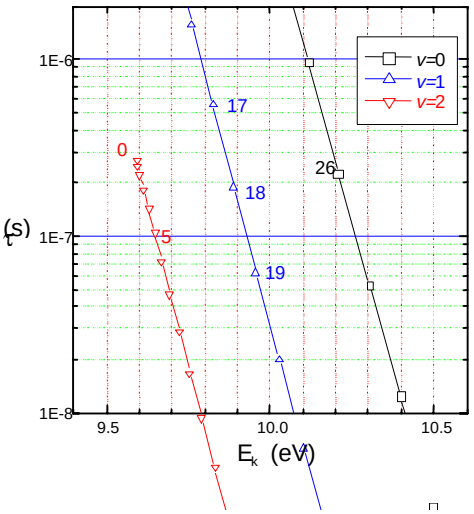

Figure 1: Calculated mean lifetimes, τ, and KER values for many rovibrational states of $^4He_2^{2+}$.

The experiment is done using 3D imaging of the dissociating fragments as described in detail by Bouhnik *et al.*[2]. One experimental change was needed to separate between He^+ + He^+ ion pairs from unimolecular dissociation and those from prompt dissociation during the collision. This was accomplished by placing a very small collimator, 0.3 mm in diameter, after the electrostatic deflector and by blocking the center of the imaging detector, as shown schematically in figure 2. This angular discrimination allowed only ion pairs from unimolecular dissociation to be detected, though not all of them. The measured results are consistent with v=1 states (l ~18).

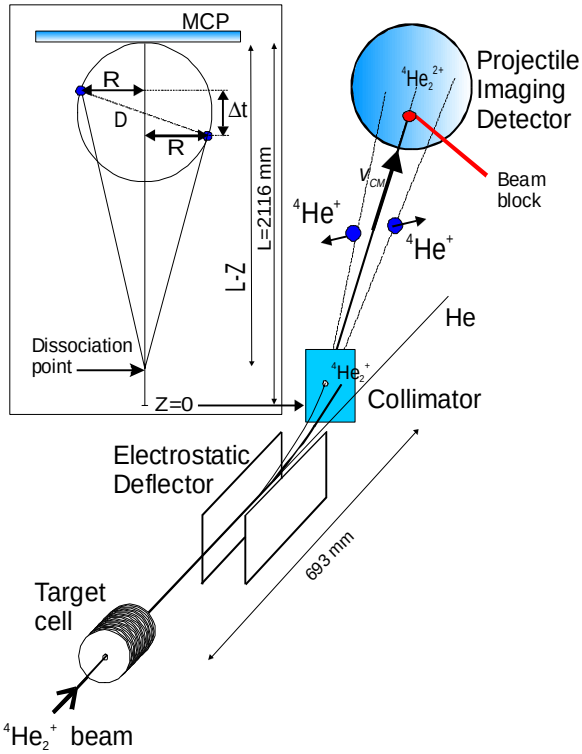

Figure 2: Schematic view of the experimental setup.

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References:

1. I. Ben-Itzhak *et al.*, submitted to J. Phys. B (2001).

2. J.P. Bouhnik *et al.*, Phys. Rev. A **63**, 0325xx (2001).

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