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Field free alignment of hexapole state selected methyliodide

W.G. Roeterdink[1], **L. He**[2], **D. Ding**[3]

Institute of Atomic and Molecular Physics, Jilin University, Changchun 130012, PR China

Synopsis In this contribution we will discuss the field free laser induced spatial alignment of hexapole quantum state selected methyl iodide. We will demonstrate that we have control over the spatial alignment and can chose $\langle P_2(\cos\theta)\rangle$ between 0.7 and -0.1 coupled to $\langle P_4(\cos\theta)\rangle$ between 0.3 and 0.0. The effect of the relative orientation between a static electric field and a strong laser field on the structure of the field free rotational alignment revivals will be discussed.

In molecular frame dynamics studies the molecule needs to be oriented or aligned in the laboratory frame to a sufficient degree. Spatial alignment of molecules with intense laser pulses has been demonstrated for cold molecules in a molecular beam expansion [1]. However, the inherent problem of thermal averaging has a lowering effect on the maximum degree of alignment that can be achieved. Hexapole state selection can be used to prepare (a)symmetric top molecules in their lowest rotational state and the observed alignment increases to the max/min values of $\langle P_2(\cos\theta)\rangle$ 0.7 and -0.1 and $\langle P_4(\cos\theta)\rangle$ between 0.3 and 0.0.

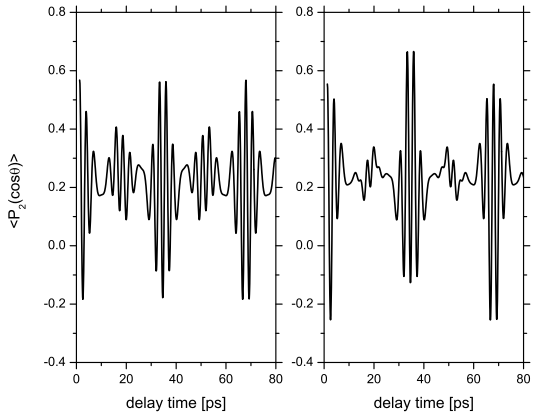

Figure 1. Revival structure of CH_3I, $|JMK\rangle = |1 \pm 1 \mp 1\rangle$ for the parallel configuration (left panel) and perpendicular configuration (right panel).

In the experimental configuration for ion (velocity map) imaging the extraction field of the time-of-flight detector is perpendicular to the laser polarization in order to preserve the cylindrical symmetry needed for Abel inversion of the obtained projected images. The state selected molecules have a spatially non-isotropic distribution and will be oriented and aligned along the direction of the static electric extraction field. The rotational wave packet revival transient is strongly dependent on the angle between the static electric extraction field and the polarization of the laser, see figure 1 [2]. The simulated revival structure is in good agreement with the experimental observed transient in the perpendicular geometry. Velocity map ion images are recorded at the peak positions at the half revival time (33.3 ps) and the full revival time (66.5 ps), see figure 2. In principal the cylinder symmetry around the laser polarization is broken due to the static electric field. However, our simulations show that at sufficient high laser intensities the symmetry is restored and that the requirements for the inverse Abel transform are fore filled.

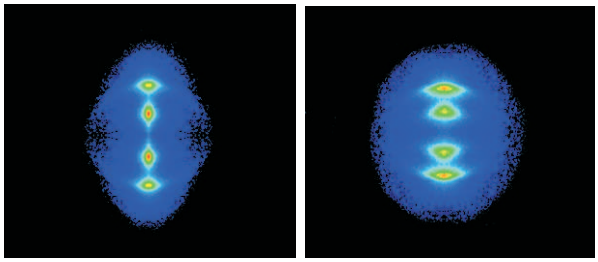

Figure 2. Velocity map ion images recorded at the half revival time where reaching a maximum alignment (left image) and the full revival time (right image).

The angular distribution observed in the ion images is a convolution of the recoil dynamics of the fragments and the spatial alignment of the parent molecule. The experimental obtained results will be discussed and compared to the simulated values.

References

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[2] L.He *et al* 2015 *In preparation.*

[1]E-mail: wim@jlu.edu.cn
[2]E-mail: helh13@mails.jlu.edu.cn
[3]E-mail: dajund@jlu.edu.cn