

Imaging Hyperfine Depolarization of Electronically Excited Nitric Oxide

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When an angular momentum \mathbf{J} is shaken by a nuclear spin \mathbf{I} , the polarization of \mathbf{J} is relaxed. This phenomenon, termed “hyperfine depolarization”, has been studied extensively for atomic and molecular systems [1]. In the case of molecules, rotation has been participated as \mathbf{J} to give molecular-axis alignment. Here, we visualize the depolarization of electronically excited nitric oxide ($A^2\Sigma^+$) induced by coupling with the nuclear spin of ^{14}N , by implementing time-resolved Coulomb explosion imaging by using nanosecond ultraviolet pump pulse and femtosecond intense probe pulse [2].

The angular distribution has been extracted from recorded images of N^+ fragments, as shown in Fig. 1 (a). The temporal evolution of the angular distribution is given in Figs. 1 (b)–(f). To analyze the experimental results, we have considered coherent excitation of multiple hyperfine levels, of which the energy diagram has been shown in Fig. 2. We have confirmed that the present formulation is consistent with the spherical-tensor representation given in the previous study [1]. Here the angular distribution is represented with time-independent and dependent state-multipole moments, as shown in Figure 3. Then we can reconstruct the density matrix in the coupled representation (total angular momentum) basis $|F, M_F\rangle$, from the experimental results.

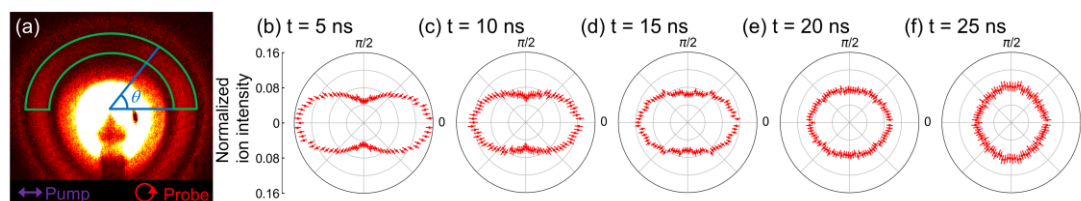


Figure 1: (a) Spatial distribution of N^+ fragments, (b)–(f) temporal evolution of the fragment angular distribution.

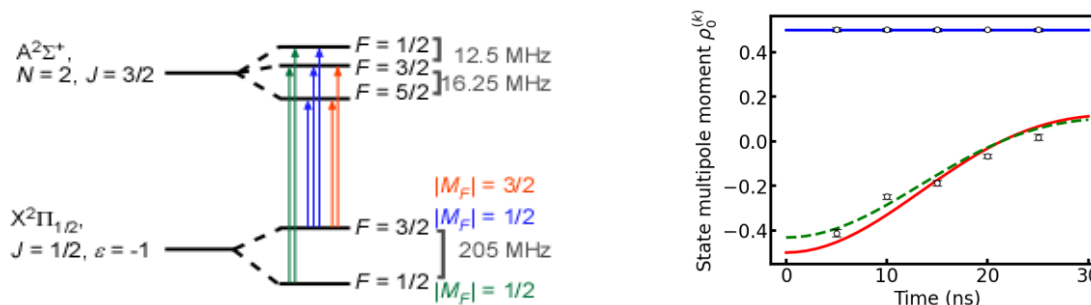


Figure 2: Energy-level diagram of nitric oxide. Figure 3: Determined state-multipole moments.

[1] A. J. Orr-Ewing and R. N. Zare, *Annu. Rev. Phys. Chem.* **45**, 315 (1994).

[2] K. Mizuse, N. Chizuwa, D. Ikeda, T. Imajo, and Y. Ohshima, *Phys. Chem. Chem. Phys.* **20**, 3303 (2018).