Quantum control of molecular photodissociative reactions using a two-color field

Rajesh K Kushawaha[1]*
[1]Physical Research Laboratory Ahmedabad India 380009
kushawaha@prl.res.in*

Quantum control of molecular photodissociative reactions of ionized N_2, CO, and CO_2 are studied using Velocity Map Imaging Spectrometer and a two-color field. The fundamental frequency, along with the second harmonic (800 + 400 nm) at different phases, with the two different polarization schemes viz, Parallel Two-Color (PTC) and Orthogonal Two-Color (OTC), is employed for measuring the ion yields and photoelectron momentum distributions. The yield of the parent ion and its charged fragments as a function of the phase difference between the two-color field has been studied thoroughly. We observed that the yield of fragments is sensitive to two-color intensity ratio and relative phase.

Recently, we demonstrated the Quantum control of molecular reactions using femtosecond laser parameters [1, 2]. In the current study, we present the control of fragment yield with 132 attosecond time resolution using a two-color field [3]. The two-color field allowed us to control the photo-reaction yield by modulating the tunnel electron trajectories. Further, we studied the effect of the two-color field on the photoelectron momentum distribution. The asymmetry parameter is analyzed for understanding the two-color effect, and Coulomb effect on photoelectron momentum distributions.

Tunnel electron trajectories simulation is performed to explain the observed photofragments and photoelectron yields. Interestingly, we revealed that the two-color field modulates the revisiting tunnel electron trajectories, which affect the yield of the dissociative reaction. Our finding gives us a new scheme for Quantum control of molecular reactions.

References:

1. Rituparna Das, Deepak K Pandey, Swetapuspa Soumyashree, P Madhusudhan, Vinitha Nimma, Pranav Bhardwaj, Muhammed Shameem KM, Dheeraj K Singh, Rajesh K Kushawaha, Strong-field ionization of CH 3 Cl: proton migration and association, Phys. Chem. Chem. Phys.,**24**, 18306-18320 (2022).
2. Rituparna Das, Deepak K Pandey, Vinitha Nimma, P Madhusudhan, Pranav Bhardwaj, Pooja Chandravanshi, Muhammed Shameem KM, Dheeraj K Singh, Rajesh K Kushawaha, Strong-field ionization of polyatomic molecules: ultrafast H atom migration and bond formation in the photodissociation of CH_3OH, Faraday Discuss., **228**, 432-450 (2021)
3. P Madhusudhan, Rituparna Das, Pranav Bhardwaj, Muhammed Shameem KM, Vinitha Nimma, Swetapuspa Soumyashree, & Rajesh K Kushawaha, Strong-field ionization of N2 and CO molecules using two-color laser field, J. Phys. B: At. Mol. Opt. Phys. **55** 234001 (2022)