Photodissociation of Br_2 in the Range from 410 to 485nm Using Velocity Mapping Ion Imaging Technique

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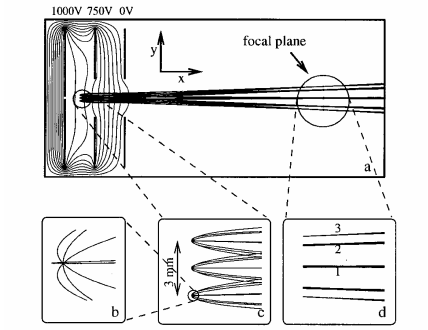
Abstract :

Pump and probe states selective raw image are shown. The polarized pumping laser varies between 410 nm to 485 nm in order to photodissociatie bromine molecules in the $^1\Pi_u(1_u)$ and $B(^3\Pi_u(0_u^+)$ absorption bands. Their correlation diagram are as shown. Then Br $(4p^5(^2P_{3/2}))$ and Br* $(4p^5(^2p_{1/2}))$ images are taken using 2+1 REMPI techniques probing at 266.65nm and 266.71nm and their two photon transitions are $5p(^4P^0_{3/2}) \leftarrow 4p^5(^2P_{3/2})$ and $5p(^4S^0_{3/2}) \leftarrow 4p^5(^2p_{1/2})$. These images are the projections of 3D distribution. In order to reconstruct these projections to original 3-D distributions, we treat them as cylindrically symmetry along the polarization direction of photolysis laser, and using inverse Abel transformation to obtain 3D speed and angular distributions.

Basic Principle :

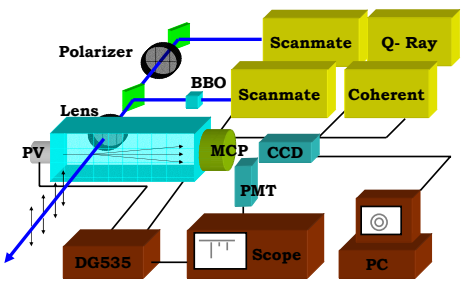
TOF-MS with inhomogeneous extraction field. Then the ions with the same V_y can be focused on the same point on the focal plane.



D. H. Parker, Rev. Sci. Instrum., Vol. 68, No. 9, 1997.

$$R = Nvt$$
$$t \propto [\frac{m}{qV}_R]^{1/2}$$
$$R \propto N[\frac{T}{qV}_R]^{1/2}$$

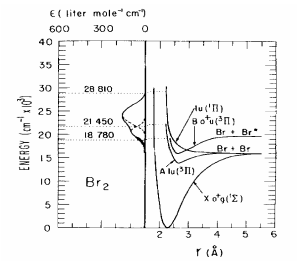
Experimental Setup :



Br_2 Photodissociation :

Br_2 → Br + Br ΔH =190.2 kJ/ mole
→ Br +Br* ΔH =234.2 kJ/ mole
→ Br* +Br* ΔH =278.2 kJ/ mole

Potential Energy Surface :



K. R. Wilson, J. Chem. Phys., Vol. 63, No. 10, 1975

Results :

The theoretically recoil speed of photofragments can be calculated by energy and momentum conservations. These equations are as following:

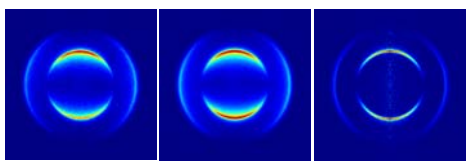
$$E_T = h\nu + E_{int}(Br_2) - D_0(Br\text{-}Br) - E_{s.o}(Br)$$
$$m_{Br(1)}v_{(1)} + m_{Br(2)}v_{(2)} = 0$$
(Br_2 +hν → Br(1) + Br(2))

When the photolysis wavelength is 460nm and probing laser is for Br REMPI, we can obtain peaks in speed distribution at 941.2 m/s and 573.2 m/s comes from Br + Br channel and Br + Br* products channel.

Using the polarized light the angular distribution of photofragments is described by the differential cross section.

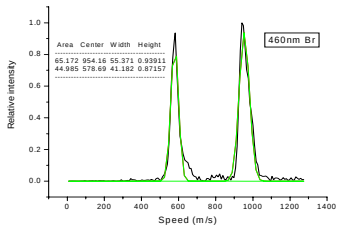
$$I(\theta,\phi) = \frac{d\sigma}{d\Omega} = \frac{\sigma}{4\pi}[1+\beta(\frac{3}{2}\cos^2\theta - \frac{1}{2})]$$

Inverse Abel Transformation :

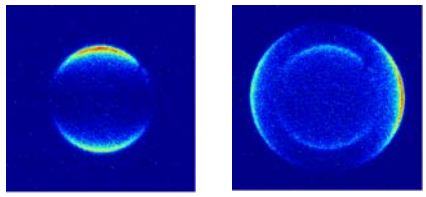


Raw Image Symmetrized Inverse Abel

3D Speed Distribution :

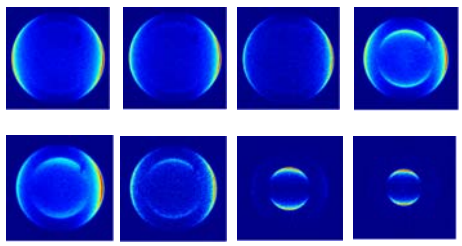


2+1 REMPI Transition Probability :

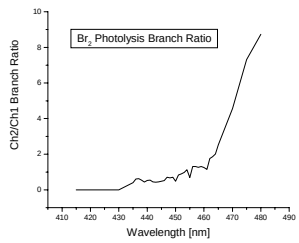


Br* : Br = 1.68 : 1

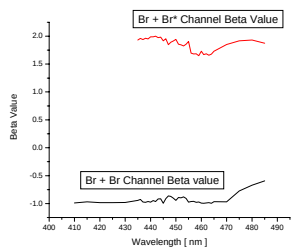
410 nm To 480 nm Ion Image :



Br_2 Photolysis Branch Ratio :



Beta Value In Different Dissociation Channel :



Conclusion & Future Work :

*** Curve crossing is weak in this model**
*** Find one way to get REMPI transition probability**
*** Find the magnification factor of our system**
*** Br_2 Experiment is good model to do further Br containing molecule**

Especially Thanks For These Two Insititutes Give Me This Opportunity To Learn About The New Technique For Solving Some Kinetic Problems In The Future.