

DISSOCIATION DYNAMICS OF SMALL MOLECULES UNDER STRONG LASER FIELD

A. Diner¹, A. Natan², U. Lev¹, I. Ben-Itzhak^{1,3}, O. Heber¹, D. Schwalm^{1,4}, Y. Silberberg², D. Zajfman¹

¹Department of Particle Physics

²Department of Physics of Complex Systems

Weizmann Institute of Science, Rehovot, 76100 Israel

³J.R. Macdonald Laboratory, Department of Physics, Kansas State University, Manhattan, Kansas 66506, USA

⁴Max-Planck Institut für Kernphysik, Heidelberg, Germany

Dissociation under ultrashort intense laser fields differs from the process occurring in the presence of a weak field by two main characteristics. In the strong field regime, the force exerted by the laser on the molecule is comparable to the intermolecular forces. In addition, this force is varying on a time scale comparable to that of the molecular vibration. The combination of these two effects results in “Dynamic potential energy curves”.

In recent years, a few groups investigated the dissociation of H_2^+ -beam targets experimentally (see, for example, [1-3]) to complement the numerous studies using H_2 [4]. These experiments used different pulse durations and intensities in order to investigate the effect of these parameters on the kinetic energy release and angular distribution of the dissociating fragments.

In the current work we present a new experimental system which enables further the investigation of the dynamics of the dissociation process. Our experimental setup includes an amplified Ti-Sapphire femtosecond laser [intensity range of 10^{13} - 10^{15} W/cm²], a 4-f pulse shaper, and a fast (keV) ion beam with a coincidence three-dimensional momentum imaging system.

The use of a pulse shaper opens new possibilities for controlling the laser pulse both in the frequency and in the time domain. Using this, we measured the dissociation of H_2^+ by an intense laser pulse with a spectral π phase step located at the centre of its spectrum. In the time domain, applying a π

phase step at the central wavelength results in the fastest transient available, producing a narrow zero intensity dip in the centre of the pulse envelope, the time duration of which is of the order of a vibration time of H_2^+ (~14fs).

By comparing the energy release profile and the angular distribution of the fragments of H_2^+ to that of its isotope D_2^+ , where they later differ only in mass, hence in the vibration period but not in the potential energy curves, we gain insight to the dissociation dynamics of H_2^+ in particular, and of small molecules in general.

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