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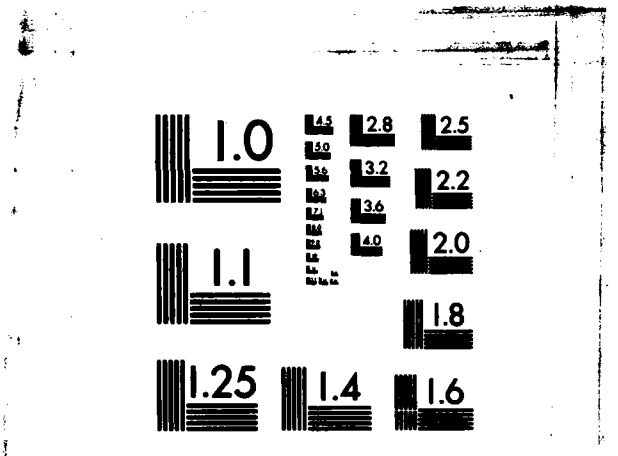

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Experiments leading toward measurements of the photodestruction of nitromethane have been initiated. Photodissociation of H_2^+ has been observed and preliminary experiments on the photodetachment and photodissociation of CH have been carried out. The absorption spectrum of nitromethane in the wavelength range 350 to 190 nm has been measured with 0.001 nm resolution. A feasibility study of induced fluorescence experiments to determine the spectra of polyatomic free radicals has been carried out. An improved detector system has been installed in the apparatus and performance tests are underway.

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EXPERIMENTAL STUDIES IN MOLECULAR FRAGMENTATION: PROCESSES, ENERGETICS AND DIAGNOSTICS

Contract N00014-83-K-0134

Annual Report

For the period 1 January 1983 through 31 December 1983

Principal Investigator

John L. Kohl

Prepared for

The Office of Naval Research

December 1983

Smithsonian Institution
Astrophysical Observatory
60 Garden Street
Cambridge, MA 02138

The Smithsonian Astrophysical Observatory
is a member of the
Harvard-Smithsonian Center for Astrophysics

The ONR Technical Officer for this grant is Dr. Bobby R. Junker, Code 421, Office of Naval Research, 800 N. Quincy Avenue, Arlington, Virginia 22217

ABSTRACT

Experiments leading toward measurements on the photodestruction of nitromethane have been initiated. The photodissociation of H_2^+ has been observed and preliminary experiments on the photodetachment and photodissociation of CH have been carried out. The absorption spectrum of nitromethane in the wavelength range 350 to 190 nm has been measured with 0.001 nm resolution. A feasibility study of induced fluorescence experiments to determine the spectra of polyatomic free radicals has been carried out. An improved detector system has been installed in the apparatus and performance tests are underway.

INTRODUCTION

This status report describes the progress of our program for the period January 1, 1983 to December 31, 1983, under Contract N00014-83-K-0134.

During this period an abstract was submitted and a presentation was made to the XIII International Conference on the Physics of Electronic and Atomic Collisions which was held July 27 through August 2, 1983. A copy of the abstract is included as Attachment A.

There have been no changes in personnel. Dr. Larry Gardner is continuing to spend 90% of his time (i.e., 100% of productive time) on this contract.

Attachment B lists the Principal Investigator's scientific activities and their sources of support.

PRESENT PROGRESS

We have carried out extensive development tests in order to ascertain our ability to generate beams of the negative ions of nitromethane and its fragments. To date we have observed beams of the following molecular ions using nitromethane vapor as the source gas in our present ion source:

$$CH_3NO_2^-;\ CH_2NO_2^-;\ CHNO_2^-;\ CNO_2^-;\ NO_2^-;\ NO^-;\ CNO^-;\ CH_3^-;\ CH^- \ .$$

The beam currents obtained have, in general, been sufficient for carrying out photodissociation experiments on the photodetached neutral for all of these but $CH_3NO_2^-$. It remains likely that a source optimization or development effort (described in our 1982 proposal) will be required before measuring photodissociation cross sections for CH_3NO_2 using the fast beams technique.

We have demonstrated the feasibility of photodissociation experiments with our apparatus using the molecular ion H_2^+ and a coaxial laser beam with photon wavelengths in the red (620 to 640 nm). We have observed the H^+ fragment using the parallel plate analyzer to select it out of the primary H_2^+ beam. We have also observed neutral H fragments away from the beam axis using an array of discrete particle multipliers. The results of this were presented at the XIII International Conference on the Physics of Electronic and Atomic Collisions.

We have carried out feasibility studies on induced fluorescence experiments. Details of these experiments were included in our 1983 proposal.

We have carried out measurements on the absorption spectrum of nitromethane vapor in the wavelength range 350 to 190 nm with 0.001 nm resolution. We see no difference in the shape of the absorption spectrum from that reported by Taylor, et al. (Int. J. Chem. Kinetics 12, 231 (1980)). We find only a diffuse spectrum, which indicates a high probability for the

occurrence of dissociation after photon absorption.

Some additional measurements have been made on the photodetachment of CH^- for photon wavelengths from about 590 nm to 640 nm. This work was preliminary to an initial photodissociation experiment on CH. This latter experiment required improvements in our ion accelerator. Those improvements have been implemented, and a revised experiment on the photodissociation of CH will be carried out in the near future.

We have also upgraded the fragment detector system used in the experiment. A channelplate detector with a coarse discrete anode array has been installed in the experimental apparatus. This detector system will allow us to make measurements of photodissociation cross sections. Our goal, however, is eventually to replace the anode of this detector with one which will also allow us to measure accurate fragment impact positions and times. Until such an anode is prepared and the electronics needed to operate it are acquired, we will gain operating and design experience using the coarse anode system.

FAST NEUTRAL BEAM MEASUREMENTS OF MOLECULAR PHOTODISSOCIATION

Attachment A

L. D. Gardner and J. L. Kohl

Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138 U.S.A.

We are using a new technique to measure photodissociation cross sections for neutral molecules that is especially promising for chemically unstable species. The experimental arrangement (see Fig. 1) produces negative ions of the molecule of interest which are accelerated, mass analyzed and subsequently undergo photodetachment by a coaxial pulsed laser beam. The fast neutral beam of molecules so prepared is then photodissociated by a second pulsed laser beam which is perpendicular to the molecular beam. Fragments from the photodissociation can be detected away from the beam axis with either an array of discrete secondary electron type particle multipliers or a single large area position sensitive particle detector such as a channelplate with a multiple anode array.[1,2] The detection of all fragments from a single dissociation event together with measurements of their impact positions on the detector and the time of detection, permit the mass of each fragment as well as the kinetic energy of each fragment to be determined.

To date we have constructed the apparatus and made measurements on the photodetachment of several molecular and atomic ions.[3] Additional measurements on the photodetachment of CH^- and OH^- will be reported here. Recently, to test the apparatus, we have observed the photodissociation of excited states of H_2^+ using a pulsed Nd:YAG pumped dye laser that is operated near 640 nm. Fast neutral fragments, i.e., H atoms, are detected away from the beam axis with an array of discrete particle multipliers. Charged fragments, i.e., H^+ ions, are deflected out of the beam by a low resolution parallel plate electrostatic analyzer, and are detected with a particle multiplier. Efforts to record both the H^+ and H fragments in coincidence are underway.

Experiments are also being carried out on the photodissociation of the CH radical through its predissociating $C^2\Sigma^+$ state.[4] This state can be reached from the CH ground state with photon wavelengths near 314 nm.[5] Progress on these experiments will be reported.

This work was supported by the Smithsonian Institution through its Scholarly Studies Program and by the Office of Naval Research Contract N00014-83-K-0134 to the Smithsonian Astrophysical Observatory.

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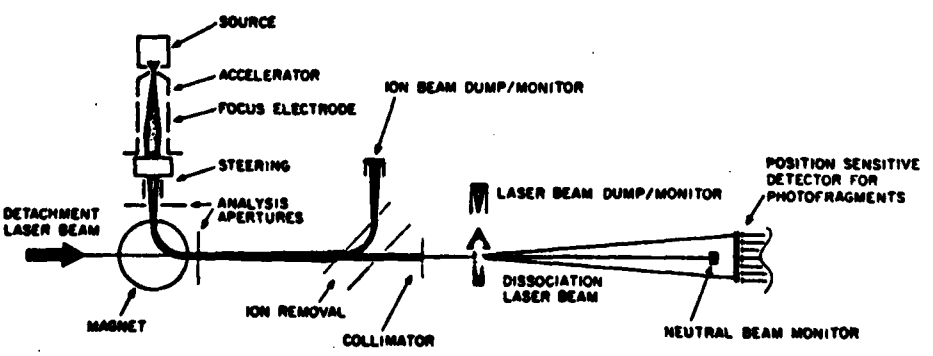


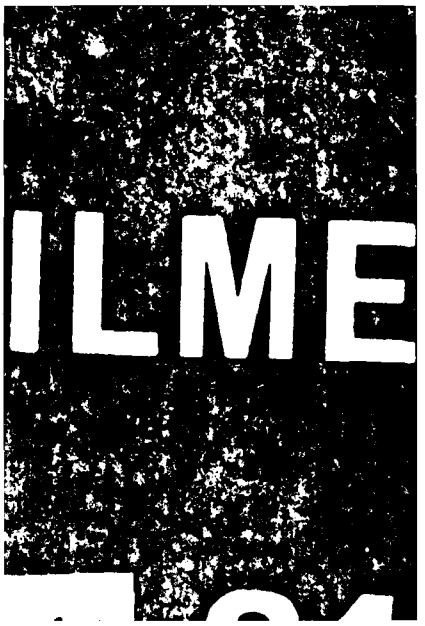
Fig. 1: Schematic of the Experiment.

Time Allocation for John L. Kohl

PROGRAM STATUS/AGENCY	CONTRACT/GRANT	POSITION	TIME ALLOCATION
Active/ONR	Contract N00014-83-K-0134 "Experimental Studies in Molecular Fragmentation: Processes, Energetics and Diagnostics"	Principal Investigator	10%
Active/DOE	Contract DE-AC02-80ER10631 "Measurements of Ionization Balance Parameters in Atomic Ions"	Principal Investigator	33%
Active/NASA	Grant NGL 22-007-006 "Theoretical and Experimental Studies in UV Solar Physics"	Co-Investigator	10%
Active/NASA	Grant NAG5-613 "Coronagraphic Observations and Analyses of the Ultraviolet Solar Corona"	Principal Investigator	35%
	Other professional activities		12%

Attachment B

December 1983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