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TANDEM MASS SPECTROMETER WITH OCTOPOLE ION TRAP FOR PHOTODISSOCIATION SPECTROSCOPY OF CLUSTER IONS

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We have constructed an apparatus for photodissociation spectroscopy of cluster ions using a tandem quadrupole mass spectrometer with an octopole ion trap. The performance of the apparatus has been examined by measuring the photodissociation spectrum of CH_3I^+.

Figure 1 shows a schematic diagram of the apparatus. Cluster ions are produced in a supersonic expansion from a pulsed nozzle. A rotatory disk (stainless steel) is situated parallel to the expansion axis just beyond the nozzle exit. The fundamental output of a Nd:YAG laser (1064nm) is focused onto the disk to induce a plasma in the expansion for the ionization. The first quadrupole filter isolates the ions of a specific mass. The mass-selected ions are deflected through 90° by a quadrupole ion bender1) to be merged coaxially with a laser beam. The ion bender is made up of four quadrant electrodes (aluminum alloy) with the electrode radius of 37.8 mm and the gap radius of 32.9 mm. The ions are then introduced to an octopole ion trap.2) The octopole ion trap consists of eight molybdenum rods (1000 mm in length and 3.2 mm in diameter) arranged on a circle, having inner diameter of 12.5 mm. Alternate rods are supplied with opposite phases of a radio frequency signal (13.56 MHz, 0–65 V peak-to-peak). The photodissociation laser beam propagates coaxially along the octopole, irradiating the ions

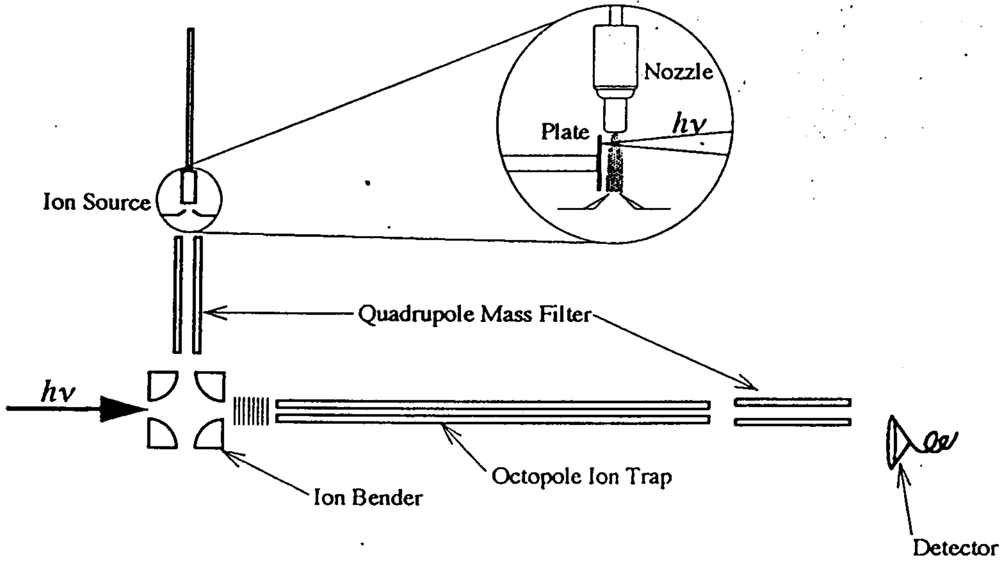

Fig. 1. Schematic diagram of the apparatus.

trapped in the octopole. After exiting the ion trap, the resultant fragment ions are mass-analyzed by the second quadrupole filter and detected by a secondary electron multiplier. The photodissociation spectra are obtained by recording the yield of the fragment ions as functions of the laser wavelengths.

Prior to the application of the apparatus to cluster ions we have measured the photodissociation spectrum of CH_3I^+. The A-X transition of CH_3I^+ has been extensively studied by several groups. The lifetime of the A state is sufficiently long to resolve vibrational and rotational structures of this state. The parent CH_3I^+ ion is selected by the first quadrupole mass filter. Unfocused output of an optical parametric oscillator (Spectra Physics, MOPO-730) pumped by the third harmonics of a Nd:YAG laser (Spectra Physics, GCR-250) is used as the photodissociation laser. The photofragment CH_3^+ ion is transmitted by the second quadrupole filter. Figure 2 indicates a part of the A-X spectrum of CH_3I^+ obtained by monitoring the yield of CH_3^+. The spectrum shows resolved vibrational structure due to the transition to the (v_1, v_2, v_3) = (0, 0, 10) and (0, 1, 5) levels, which is consistent with the previously reported ones.3)

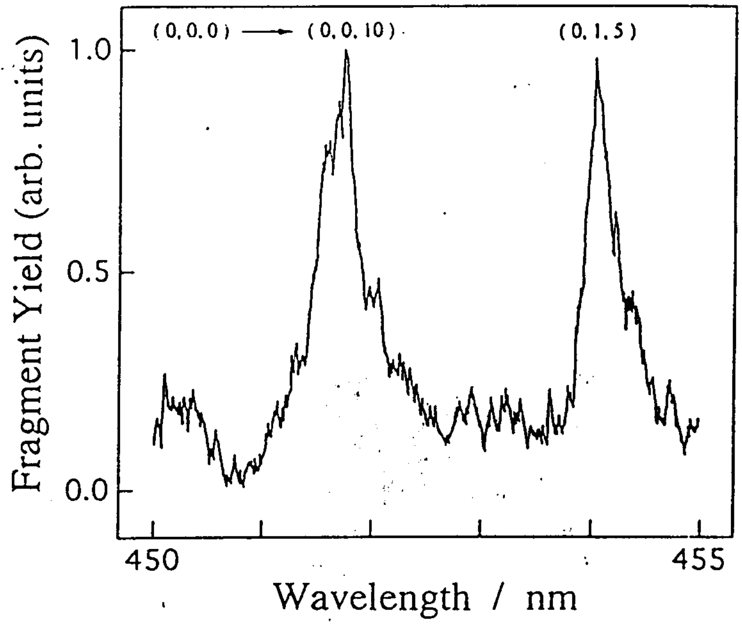

Fig. 2. Photodissociation spectrum of CH_3I^+.

The laser-induced plasma method is applicable to most species which can be seeded in the carrier gas for producing (cold) cluster ions in the gas phase. The use of the *long* octopole ion trap combined with the quadrupole mass filters has an advantage in that we can make a large overlap between the ion beam and the laser beam. By employing this apparatus to measure photodissociation spectra of cluster ions, we hope to obtain detailed information on vibronic (rovibronic) structures, and to determine the geometry of the ions. Measurement of the spectrum of naphthalene dimer cation is now underway.

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2) K.Okuno, *J. Phys. Soc. Jpn.*, 55, 1504 (1986).
3) K.Walter, R. Weinkauf, U. Boesl, and E. W. Schlag, *J. Chem. Phys.*, **89**, 1914 (1988).