Electronic Spectroscopy of Organic Cations at 20 K in a 22-Pole RF Ion Trap

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Electronic spectra of organic cations of astrophysical relevance have been measured at 20 K in a 22-pole radiofrequency trap. The species are produced in an electron impact source, mass-selected by a quadrupole and introduced into a 22-pole RF ion trap. There the vibrational and rotational degrees of freedom are equilibrated to around 20 K by collisions with cryogenically cooled helium atoms. The electronic spectra are measured via a 2-color, 2-photon excitation-dissociation scheme. In this, the bound-bound transition of the cold, mass-selected ion is sought by a tunable laser, whereas the second laser's UV photons induce fragmentation. The trap is then opened and a further quadrupole mass-selects the fragment ions which are counted as function of the first laser's wavelength being scanned. That the internal temperature of the ions is 20-25 K is proved from the rotational structure and the lack of hot bands around the origin bands of ions such as dimethyl diacetylene, $C_6H_6^+$, and diacetylene, HC_4H^+.

Among the electronic spectra thus obtained are of polyacetylene cations, $HC_{2n}H^+$ (n=2-8), protonated polyacetylene cations, $HC_{2n}H_2^+$ (n=3,4), and cyanogen cations. Studies of the higher excited electronic states of the polyacetylene cations show that the lifetimes can be sufficient that such transitions can also be relevant for comparison with astronomical absorptions through diffuse interstellar clouds.

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