ELECTRONIC SPECTROSCOPY OF CARBON CHAINS OF ASTROPHYSICAL RELEVANCE

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Electronic spectra of radicals and ions containing carbon chain skeleton are measured in the laboratory using a number of spectroscopic techniques. The species are selected because of their astrophysical relevance: possessing allowed electronic transitions in the optical range, where absorption measurements through diffuse interstellar clouds have been made. Initial survey spectra are obtained by observation of the absorption of mass-selected species in 6 K neon matrices. Examples of this are the detections of the electronic transitions of protonated coronene and $C_7H_7^+$ isomers. This information is then used to search for the relevant transitions in the gas phase using a number of sensitive laser techniques. In the gas phase the species are produced at low temperatures, $20-80$ K, using slit jet supersonic expansions through which a discharge runs. The absorptions are detected by cavity ring-down and degenerate four wave mixing methods; the latter approach providing certain advantages. Using a two color degenerate four wave approach both double resonance labeling of rotational levels and mapping of the ground state vibrational manifold is achieved, such as for C_4H, $X\,^2\Sigma^+$. Using a combination of the above techniques the electronic transitions of H_2CCC could be identified in the gas phase and these match with two broad diffuse interstellar bands, implying the first identification of such a carrier. Electronic absorptions of mass-selected cations constrained in a 22-pole radio-frequency trap are measured. The vibrational and rotational degrees of freedom are equilibrated to around 20 K by collisions with cryogenically cooled helium. The transition of the ion is then detected by a two color excitation$-$dissociation scheme. Examples of this are polyacetylene cations, revealing that not only the lowest energy transitions but higher ones are of relevance to astronomical observations. The spectra are also without overlapping features of other species as is encountered in the measurements through discharge plasmas. Comparison of the spectroscopic data on $HC_{2n}H^+$ n=2,3 cations with astronomical measurements indicates that magnetic dipole transitions and velocity broadenings in the astronomical data have to be considered.