High Resolution Infrared Spectroscopy of Molecular Ions of Astrophysical Interest

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Ion spectroscopy has been closely related to astrophysics throughout history. Indeed, molecular ions were some of the first species detected in space through their vis-UV (e.g. CH\textsuperscript{+}) or microwave (e.g. HCO\textsuperscript{+}) emissions and are key intermediates in the formation of complex molecules in space. However, until the 70’s no laboratory spectrum of microwave or infrared transitions of molecular ions had been reported. The infrared spectroscopy of molecular ions blossomed in the 80’s and 90’s led by the pioneering identification of the H\textsubscript{3}\textsuperscript{+} spectrum in the laboratory by T. Oka through the combined use of a cooled glow discharge and a difference frequency laser spectrometer designed by Alan Pine, which was the first truly high resolution wide band tunable mid-infrared coherent source. Today more than 160 molecular species have been detected in space. Of those only 22 are cations, and only 6 anions. Current or recent observations of star forming regions with highly sensitive ground-based telescopes and satellites both in the IR and far-IR regions have renewed the interest on the spectra of these exotic species. At the Molecular Physics Department of IEM-CSIC we are currently investigating the mid-IR spectra of some molecular ions with much higher frequency accuracy than was attainable in the pioneering studies of Oka, Amano, Saykally, and many others, using a set-up not too different from that of Amano. In this talk I will present some of our recent studies in this field, like the laboratory re-investigation of the v\textsubscript{1} band of NH\textsubscript{3}D\textsuperscript{+} \cite{1}, that has confirmed the identification of this ion in space \cite{2}, and the new data on the vibration rotation spectrum of \textsuperscript{36}ArH\textsuperscript{+} and \textsuperscript{38}ArH\textsuperscript{+} \cite{3}, recently detected in the Crab Nebula.

\cite{1} J. L. Doménech et al., Astrophys. J. 771, L11 (2013)
\cite{2} J. Cernicharo et al., Astrophys. J. 771, L10 (2013)
\cite{3} M. Cueto et al., Astrophys. J. 783, L5 (2014)