Progress in molecular science strongly depends on inventions and advances in innovative experimental tools such as specific light sources, molecular beams, imaging detectors, etc. In the center of this contribution are cryogenic radio frequency ion traps and recent breakthroughs made with such devices.

In the introduction of my talk, I give a short review of this versatile technique. Pushing the trap temperature down to 2.6 K and using He buffer gas pulses with densities above $10^{16}$ cm$^{-3}$ opened up new applications. Efficient cooling allowed us to record high resolution spectra of He-H$_3^+$, to identify C$_{60}^+$ as carrier of diffuse interstellar bands, and to obtain routinely IR spectra of mass selected ions. Cryogenic traps (e.g. the well-known 22-pole or the linear wire-quadrupole trap) have been used to probe the structures of doubly charged benzene [1] and to provide evidence for C$_{60}^+$ being a carrier of diffuse interstellar bands [2].

This contribution discusses the steep temperature dependence of the reaction FeO$^+$ + H$_2$, and presents IR spectra of the H$_2$-FeO$^+$ collision complex [3]. Using the cryogenic ion trap ISORI in Prague [1,3], rate coefficients for the collision system FeO$^+$ + H$_2$ + He have been measured from room temperature to below 3 K. The results provide insight into lifetimes and bottlenecks impeding almost completely formation of the exothermic Fe$^+$ + H$_2$O$^+$ product at room temperature. A breakthrough has been the in situ synthesis and characterization of the reaction intermediate [(H$_2$)FeO]$^+$.

References: