A universal method has been developed in our group for measuring the spectra of molecular ions in a 22-pole radio frequency trap at low temperatures. It is based on laser induced inhibition of complex growth (LIICG)\(^1\). At low temperatures and high number densities of buffer gas, helium attaches to ions via ternary association. The formation of these weakly bound complexes, however, is inhibited following resonant absorption of the bare molecular ion.

The first successful measurements have been demonstrated on the \(A^2\Pi_u \rightarrow X^2\Sigma_g^+\) electronic transition of \(N_2^+\), with some thousand \(N_2^+\) ions, helium densities of \(10^{15} \text{ cm}^{-3}\), and storage times of 1 s. The reduction in the number of \(N_2^+ - \text{He}\) complexes is the result of an interplay between excitation, radiative and collisional cooling, ternary association, and collision induced dissociation, and is explained using a kinetic model.

The method is also applicable to larger molecular species. In this case internal conversion following electronic excitation produces internally "hot" ions, reducing the attachment of helium. The technique is universal because complex formation can be impeded over a wide wavelength range.