

## DETERMINATION OF THE ORTHO-TO-PARA RATIO OF $\text{H}_3^+$ IN A CRYOGENIC ION TRAP

PHILIPP C SCHMID, THOMAS SALOMON, OSKAR ASVANY, STEPHAN SCHLEMMER, I.  
*Physikalisches Institut, Universität zu Köln, Köln, Germany.*

A clean sample of ortho (o) and para (p)  $\text{H}_3^+$  is prepared in a cryogenic 22-pole ion trap by removing one of the two nuclear spin species. This isolation is reached on time scales below one second by a selective excitation of the  $\nu_2$  vibrational mode of  $\text{H}_3^+$  addressing a rotational state associated with one of the two species. In subsequent collisions of the excited  $\text{H}_3^+$  with Helium buffer gas the vibration-to-translation (V-T) energy transfer produces fast  $\text{H}_3^+$  of the addressed spin configuration which then leaves the trap via a small electrostatic barrier. Rotationally inelastic collisions ensure that all species belonging to one nuclear spin state are visiting the state which is subject to laser excitation. Following this protocol the o/p-ratio of  $\text{H}_3^+$  coming from the ion source is determined to be 1:1, as expected. In the presence of normal hydrogen, n- $\text{H}_2$ , as an additional collision gas in the cryogenic ion trap the o/p-ratio of  $\text{H}_3^+$  reaches a stationary value close to 1:3. This ratio can be rationalized by the ordering of the lowest energy states of o- $\text{H}_3^+$  and p- $\text{H}_3^+$  as will be discussed. This work shows that nuclear spin specific but also structural isomer specific preparation and analysis is now possible in cryogenic ion traps thanks to LOS. With this aid, action spectra of isomer mixtures can be disentangled and it will become possible to determine isomer branching ratios of chemical reactions, as well as to study state-specific reactions like for the fundamental  $\text{H}_3^+ + \text{H}_2$  collision system considered in this work. Using a clean sample of p- $\text{H}_2$  as a collision gas will allow us to even determine state-to-state rate coefficients for this reaction. These rate coefficients are most important for the o/p-ratio of  $\text{H}_3^+$  in space.