ACCESSING HIGHER VIBRATIONAL STATES OF He_2^+ THROUGH MULTI-STEP EXCITATION

M. HOLDENER, F. MERKT, *Department of Chemistry and Applied Biosciences, ETH Zürich, Wolfgang-Pauli-Strasse 10, 8093 Zürich, Switzerland*

The precise measurement of highly excited vibrational states of small molecular systems such as H_2^+, H_2 and He_2^+ is of significant interest as benchmark to *ab-initio* quantum-chemical calculations [1]. In the case of He_2^+, only the first few vibrational levels of the electronic ground state $X^+\ {}^2\Sigma_u^+$ were precisely measured [2,3]. In this poster presentation, we propose a method to access the higher vibrational states of He_2^+ $X^+\ {}^2\Sigma_u^+$ using a multi-step excitation scheme. Our approach involves the production of a molecular beam of He_2 in the long-lived metastable a ${}^3\Sigma_u^+$ state [4] through an electric discharge. We then utilize a high-intensity laser to promote the system to the electronic state c ${}^3\Sigma_g^+$ in an excited vibrational level with v in the range $3-5$. This state predominantly decays radiatively to the a ${}^3\Sigma_u^+$ state with $v' = v$ because of favorable Frank Condon factors. A second laser is then employed to induce a transition from the vibrationally excited metastable state a ${}^3\Sigma_u^+(v')$ to the ion state $X^+\ {}^2\Sigma_u^+(v^+ = v')$. This method offers the prospect of studying the structure and dynamics of highly excited vibrational levels of He_2^+ that are typically challenging to access.

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[2] doi:10.1103/PhysRevLett.124.213001, Luca Semeria *et al.*, Phys. Rev. Lett., **124**, 213001 (2020)
[3] doi:10.1063/1.5051089, Paul Jansen *et al.*, J. Chem. Phys., **149**, 154302 (2018)
[4] doi:10.1063/1.455993, Cary F. Chabalowski *et al.*, J. Chem. Phys., **90**, 2504-2512 (1989)