THE NEWLY SET-UP SPECTROSCOPIC MOLECULAR BEAM APPARATUS: APPLICATIONS TOWARDS MULTIPHOTON RESONANCE

J. JAKOB, V. GRIGORIAN, S. SCHWETJE, M. A. KAUFMANN, A. A. BREIER, G. W. FUCHS and T. F. GIESEN, *Laborastrophysik, Universität Kassel, Heinrich-Plett-Straße 40, 34132 Kassel, Germany*

Reconciling high spectral resolution and high sensitivity simultaneously is a daunting task. Employing the double resonance technique using a combination of microwave (MW) and infrared (IR) radiation, we have previously shown that we can transfer the precision of the MW radiation into vibrationally excited states and therefore improve the spectral resolution by up to three orders of magnitude.[1]

Now, we present a new molecular beam apparatus that allows high-resolution infrared and optical spectroscopy of cold neutral molecules, detected via resonant multiphoton ionization time-of-flight (REMPI-ToF) mass spectroscopy. A pulsed nozzle produces cold molecules in an adiabatically expanding supersonic jet. Two skimmers reduce the molecular flow to a molecular beam. We use a high-power (up to 1.5 W) continuous-wave optical parametric oscillator (cwOPO) from *Qioptiq* for a narrowband excitation ahead of the REMPI-ToF detection. The narrow linewidth of the cwOPO (10 - 20 kHz) in the mid-infrared (2.7 - 4 μm) and it's frequency-stability ($\pm$ 3 MHz) ensures for ro-vibrational resolution. The subsequent detection with REMPI provides excellent detection sensitivity even for extremely small samples in addition to mass selectivity.

In a future perspective, multiphoton excitation via IR light and MW radiation in the form of three-wave mixing (3WM) schemes[2] or by photo-electron circular dichroism (PECD)[3], will allow to distinguish the enantiomers of chiral molecules in a cold molecular beam.

[1] J. Jakob, "High-Resolution Infrared-Microwave Two-Photon Spectroscopy", Master's Thesis, Laboratory Astrophysics - Universität Kassel (2021)

[2] doi:10.1063/1.5097406, M. Leibscher; T. F. Giesen; C. P. Koch, "Principles of enantio-selective excitation in three-wave mixing spectroscopy of chiral molecules", J. Chem. Phys., **151**, 014302 (2019)

[3] doi:10.1002/cphc.201402643, C. Lux; M. Wollenhaupt; C. Sarpe; T. Baumert, "Photoelectron Circular Dichroism of Bicyclic Ketones from Multiphoton Ionization with Femtosecond Laser Pulses", ChemPhysChem, **16**, 115-137 (2014)

p-number: p191 **Submitted on Thu, 15 Jun 2023 15:49:38 +0200**