VMI Photoelectron Spectroscopy Probing the Rotational Cooling Dynamics of Hot Trapped OH⁻ Ions

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Objective

• The goal is to probe in vacuo time dependent rotational relaxation dynamics of hot molecular ions such as OH⁻ via spontaneous emission.

• Relaxation rate can be measured from time dependent intensity of rotational lines which is experimentally challenging.¹

• Previous work were able to detect either spectroscopy at a single temperature or dynamics at cryogenic temperature.¹⁻⁵

• Use an Electrostatic Ion Beam Trap (EIBT) equipped with in trap VMI spectrometer to probe rotational cooling dynamics.⁶⁻⁷

Experimental Set-up

• Hot OH⁻ ions are trapped inside Electrostatic Ion Beam Trap (EIBT).
• Trapped ions are photodetached using CW 682 nm laser.
• Photoelectron spectra (PES) are collected using VMI in coincidence with the MCP detector outside the EIBT.

The Detachment Process and Theoretical Model

OH⁻ (¹Σ₂⁺) + hv → OH (²Π₃/2 & ²Π₁/2) + e⁻

Prediction of photoelectron Spectra

Photodetachment relative cross section model (J-dependent) (see ref 1 for details)

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Rotational Cooling and fitting to Model

Time Range: 0.35 – 0.60 sec
R² = 0.96 ; T = 2437 ± 112 K

Rotational Levels Cooling*

Conclusion & Future Direction

• Rotational relaxation dynamics were measured between 0-3 seconds.
• Rotational temperature of hot ions has been estimated.
• Work in progress* towards rate coefficients calculation.

References:

⁹ abhishek.shahi@weizmann.ac.il

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Experimental Measurement and Analysis

Raw VMI DATA → Circularization and Centering → Abel Transformation → Background Subtraction → Calibration to eKER

Circularized VMI data

Abel Transformation

• Peak exhibits P3 and P1 transitions.
• Other transitions are avoided using 682 nm laser

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