# VMI Photoelectron Spectroscopy Probing the Rotational Cooling Dynamics of Hot Trapped $OH^-$ Ions

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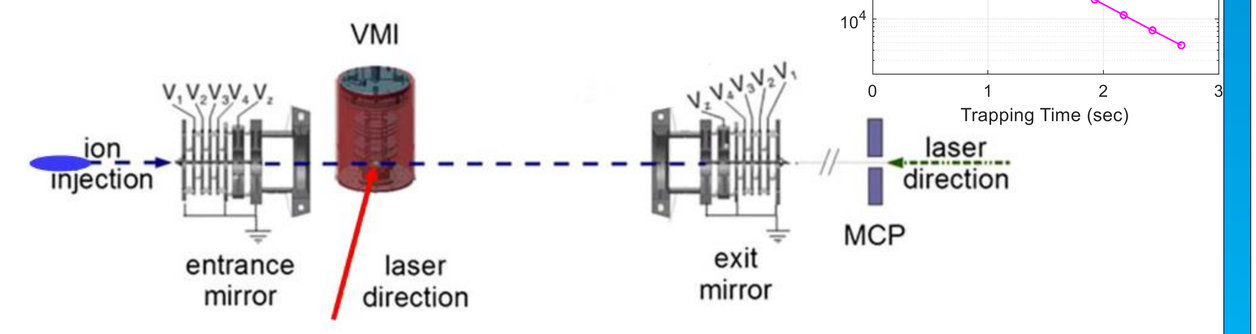
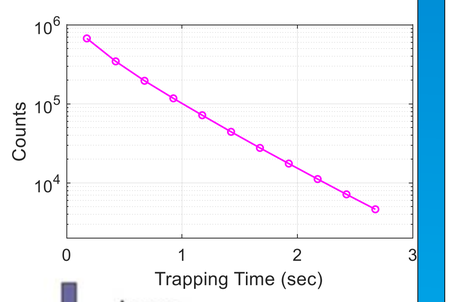
## Objective

- 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[6]

- 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

$$OH^-(^1\Sigma_2) + h\nu \rightarrow OH(^2\Pi_{3/2} \,\&\, ^2\Pi_{1/2}) + e^-$$

Prediction of photoelectron Spectra

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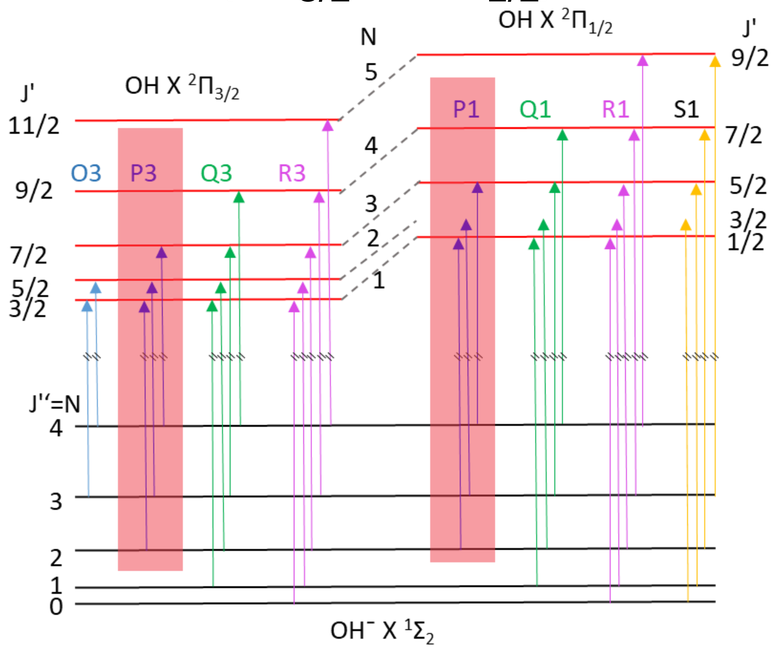
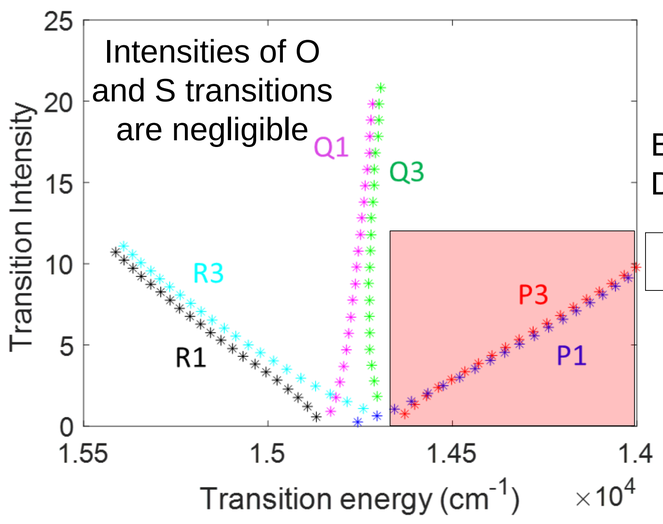
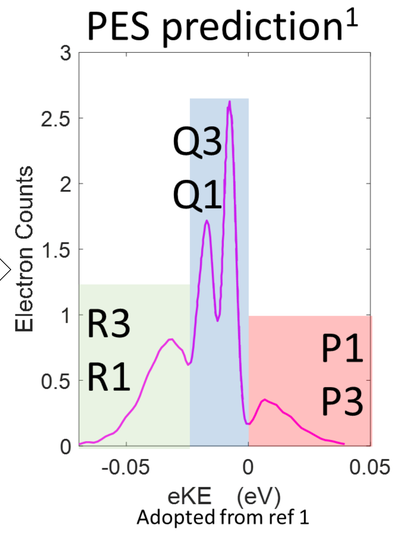
Photodetachment relative cross section model (J-dependent) (see ref 1 for details)




Include Boltzmann Distribution




**Only P3 and P1 Transitions are targeted in the experiment**

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**References:**

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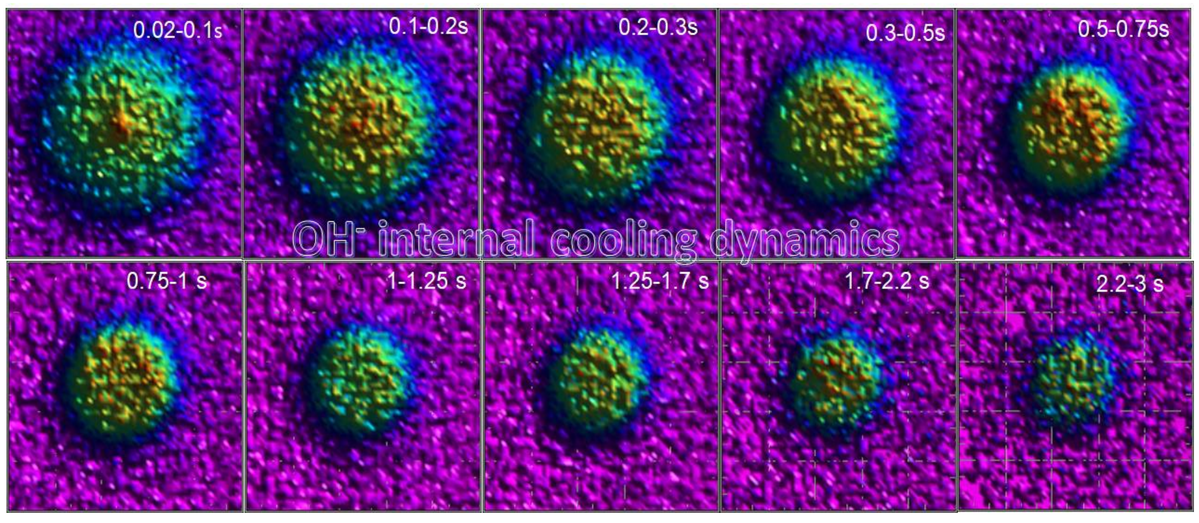
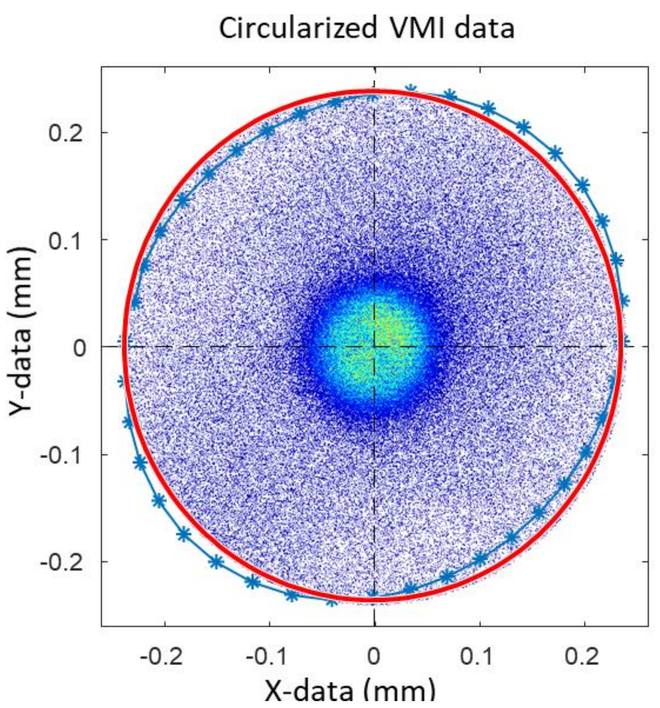
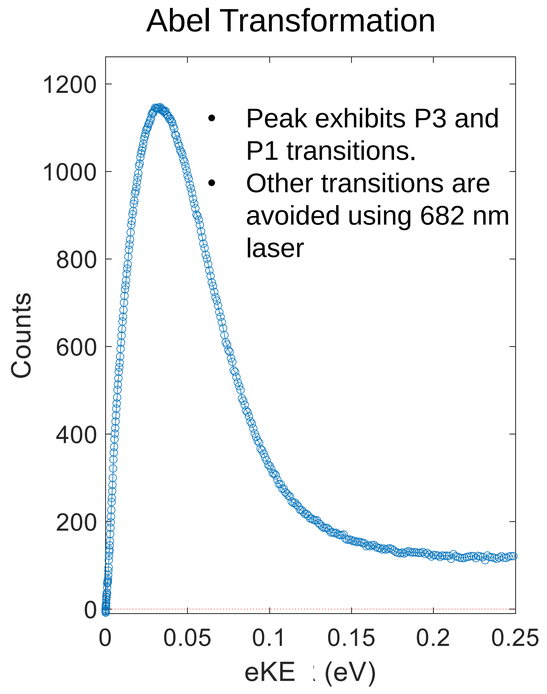
## Experimental Measurement and Analysis




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

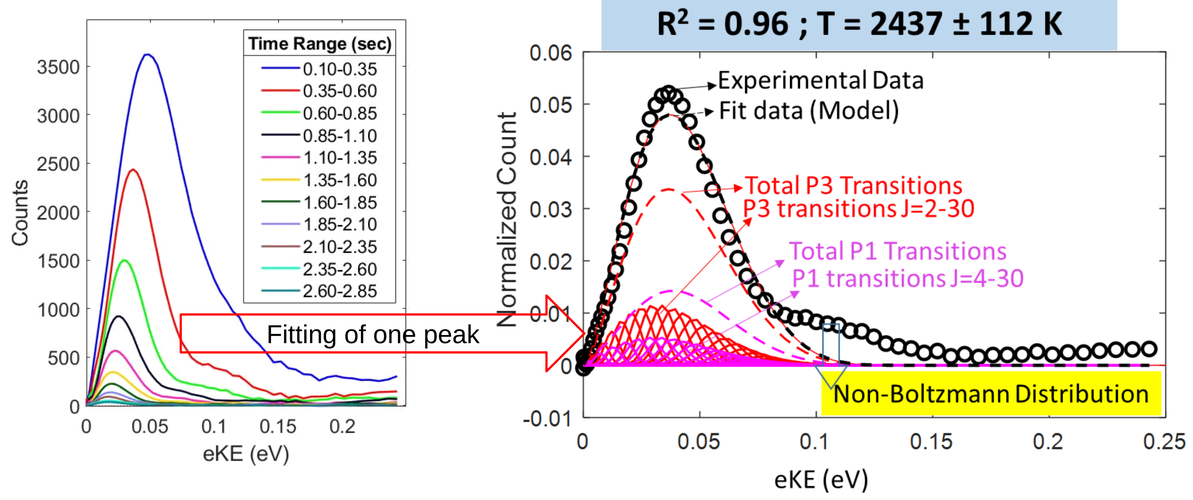


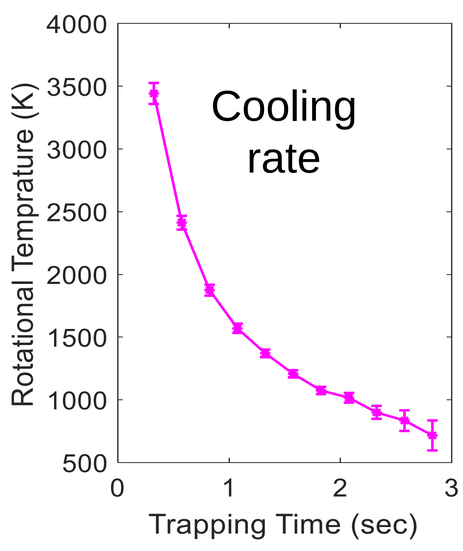

## Rotational Cooling and fitting to Model

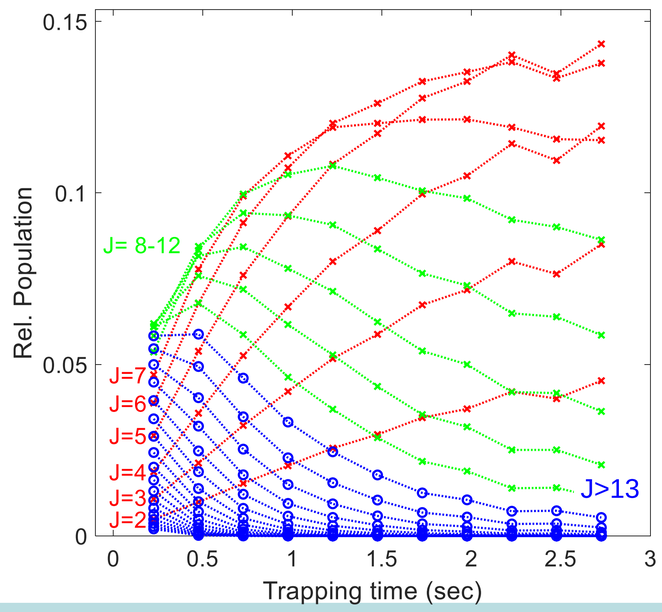
Time Range: 0.35 – 0.60 sec

**$R^2$ = 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.