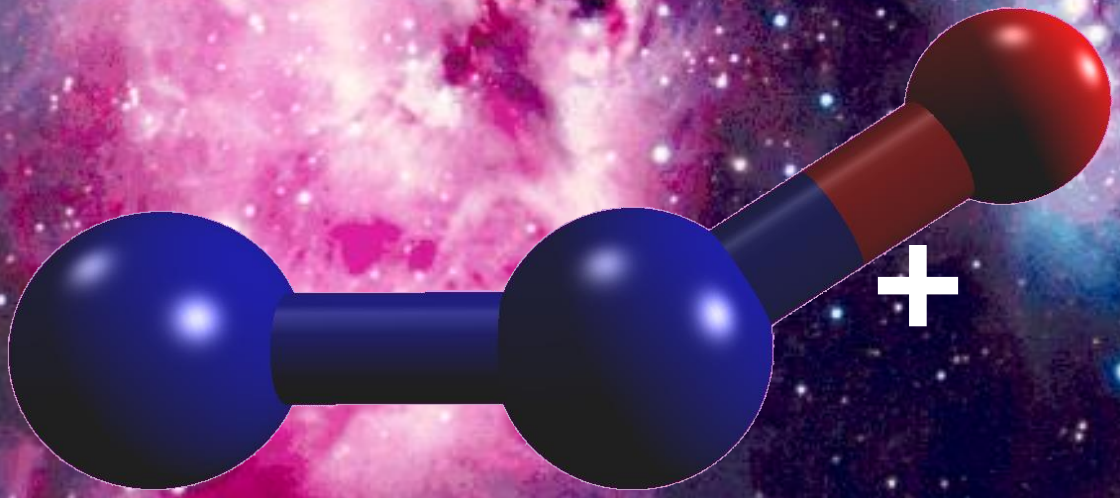
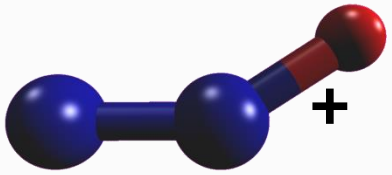
Vibrational Spectroscopy of $He\text{-}O_2H^+$ and O_2H^+



Hiroshi Kohguchi, Koichi Yamada, Pavol Jusko, Stephan Schlemmer, Oskar Asvany

Urbana-Champaign, June 2017

O_2H^+ detectable in space?



THE ASTROPHYSICAL JOURNAL, 697:601–609, 2009 May 20

IS HO_2^+ A DETECTABLE INTERSTELLAR MOLECULE?

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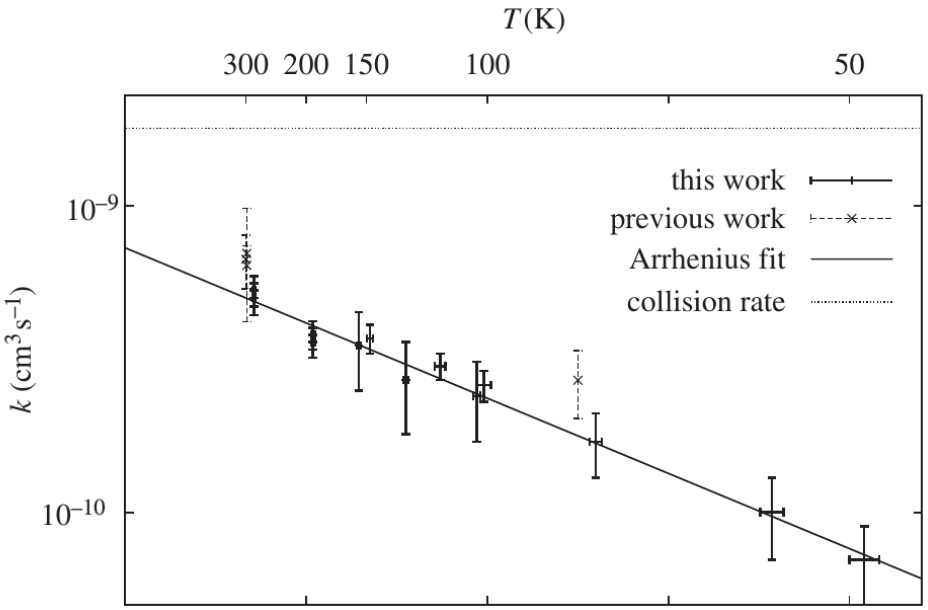
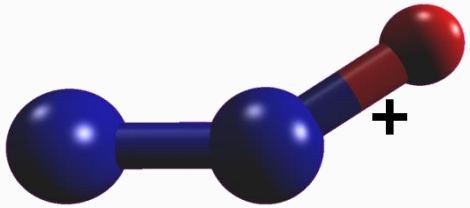
$H_3^+ + O_2 \rightarrow HO_2^+ + H_2$ near thermoneutral

probably not ….



Kluge et al., Phil. Trans. R. Soc. A, **370**, 5041 (2012)

Search for O_2H^+ spectra ...



- Oka searched in range 3100-3600 cm^{-1}, but did not find O_2H^+

  Hu, Purcell, and Oka, J. Mol. Spectrosc., **149**, 530 (1991)

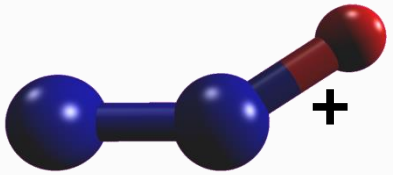
- Dopfer detected He-O_2H^+ and Ne-O_2H^+, and predicted ν_1 of O_2H^+ at 3020 ± 40 cm^{-1}

  A. Nizkorodov et al., Chem. Phys. Lett., **278**, 26 (1997)

- Good *ab initio* predictions for ν_1 available:

3022 cm^{-1}	Huang & Lee, J. Chem. Phys., **129**, 044312 (2008)
3028 cm^{-1}	S.L.W. Weaver et al., ApJ, **697**, 601 (2009)
3033 cm^{-1}	Jacox & Thomson, J. Phys. Chem. A, **117**,9380 (2013)
3039 cm^{-1}	S.Thorwirth, priv. comm.

How to produce O_2H^+ ?

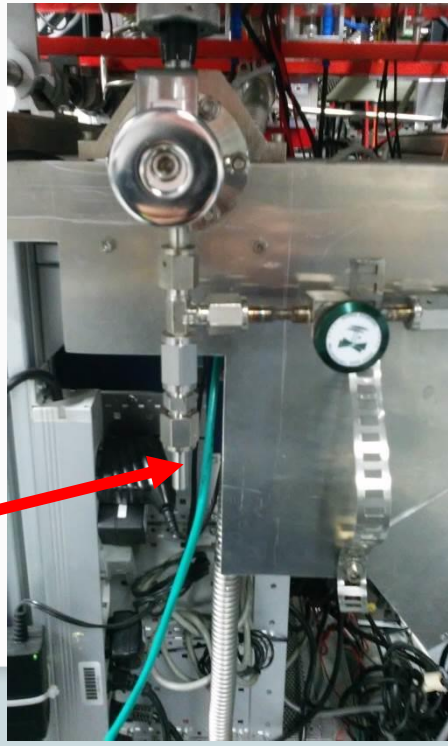


O_2 / H_2 mixture unsuitable, as O_2H^+ destroyed in collision with H_2 (we tried...)

Best precursor is hydrogen peroxide, H_2O_2

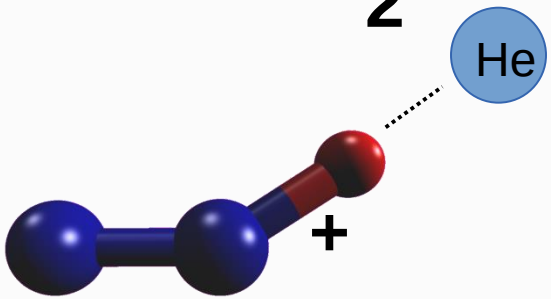
- H_2O_2 / H_2O not suitable due to water.
  Has to be distilled. Pure H_2O_2 explosive.

- Urea-H_2O_2 (powder) is perfect:
  Releases H_2O_2 upon heating



How to take spectra of O_2H^+ in trap?

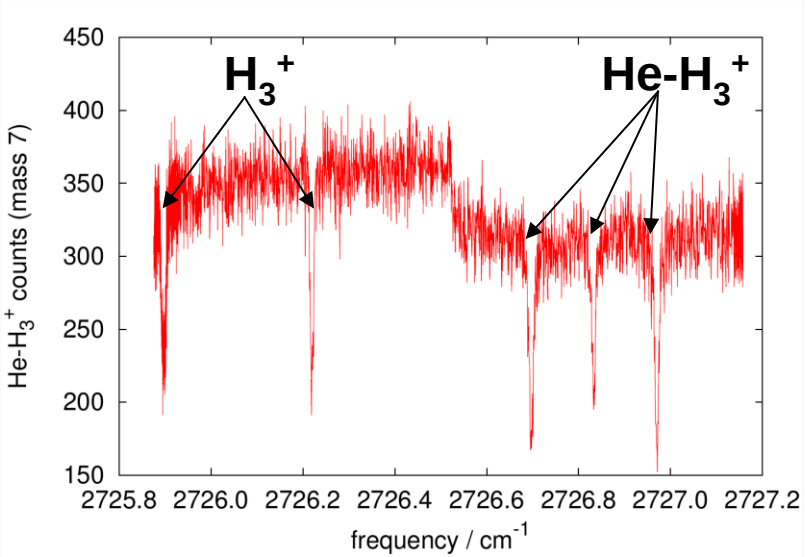
Tag it with He!



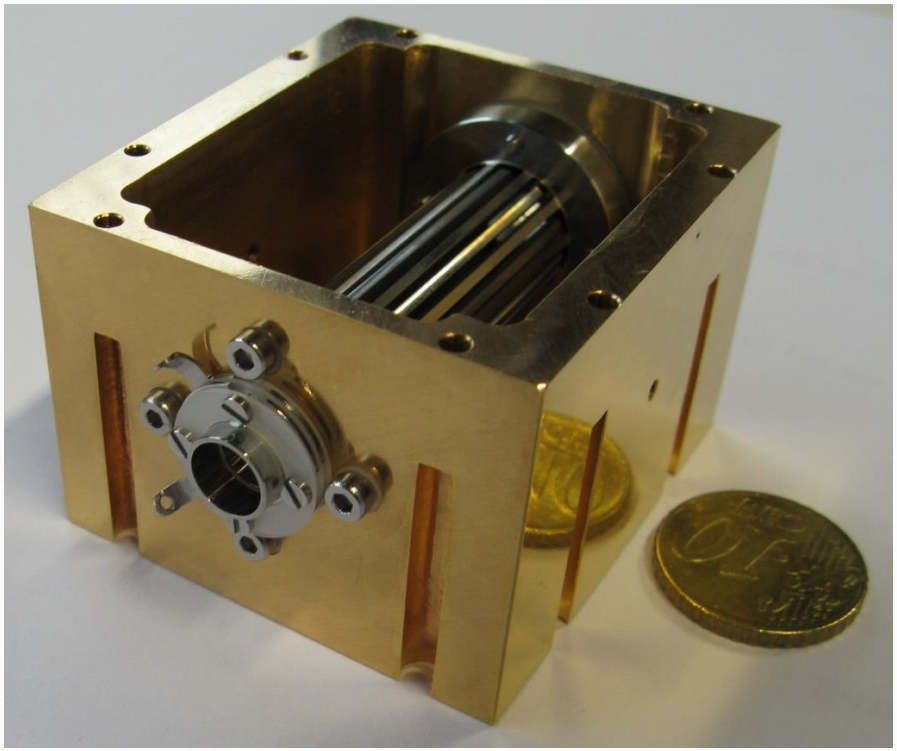
2 possibilities in one spectrum:

- predissociation spectra of **He-O_2H^+**
- State-dependent attachment of He: spectra of naked **O_2H^+**

Savic et al., Mol. Phys., **113**, 2320 (2015)



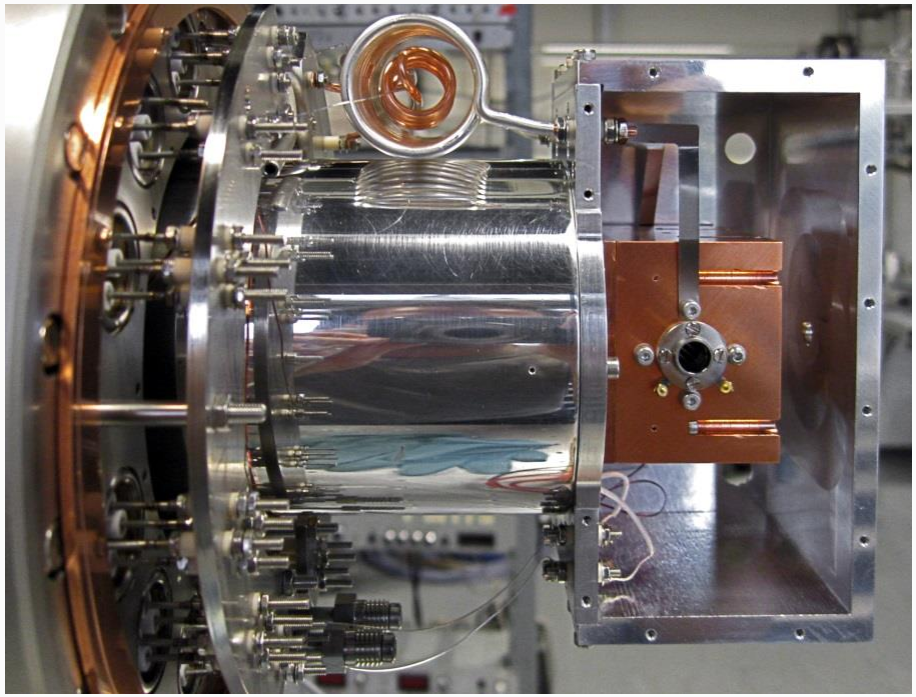
reaching cryogenic temperatures …



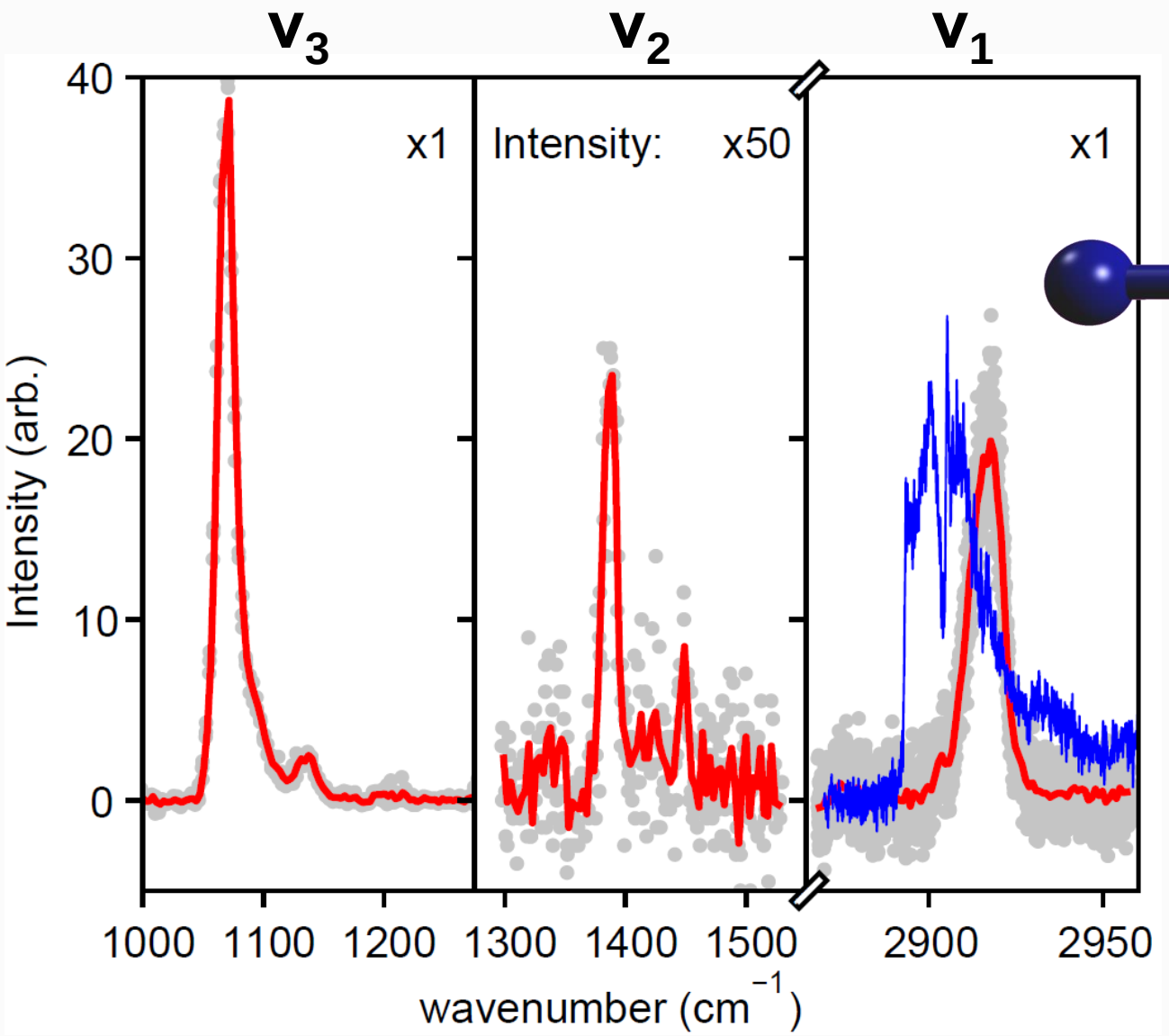
22-pole ion trap

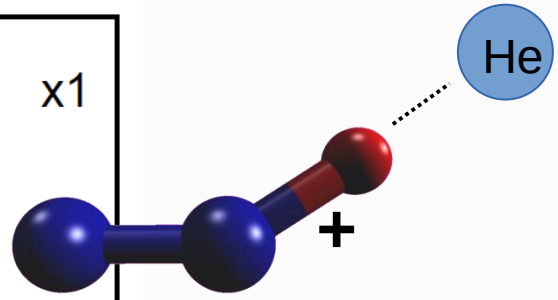
Phys Scr. T59, 256 (1995)

Rev. Sci. Instr. 81, 076102 (2010)



Predissociation spectra of $He\text{-}O_2H^+$

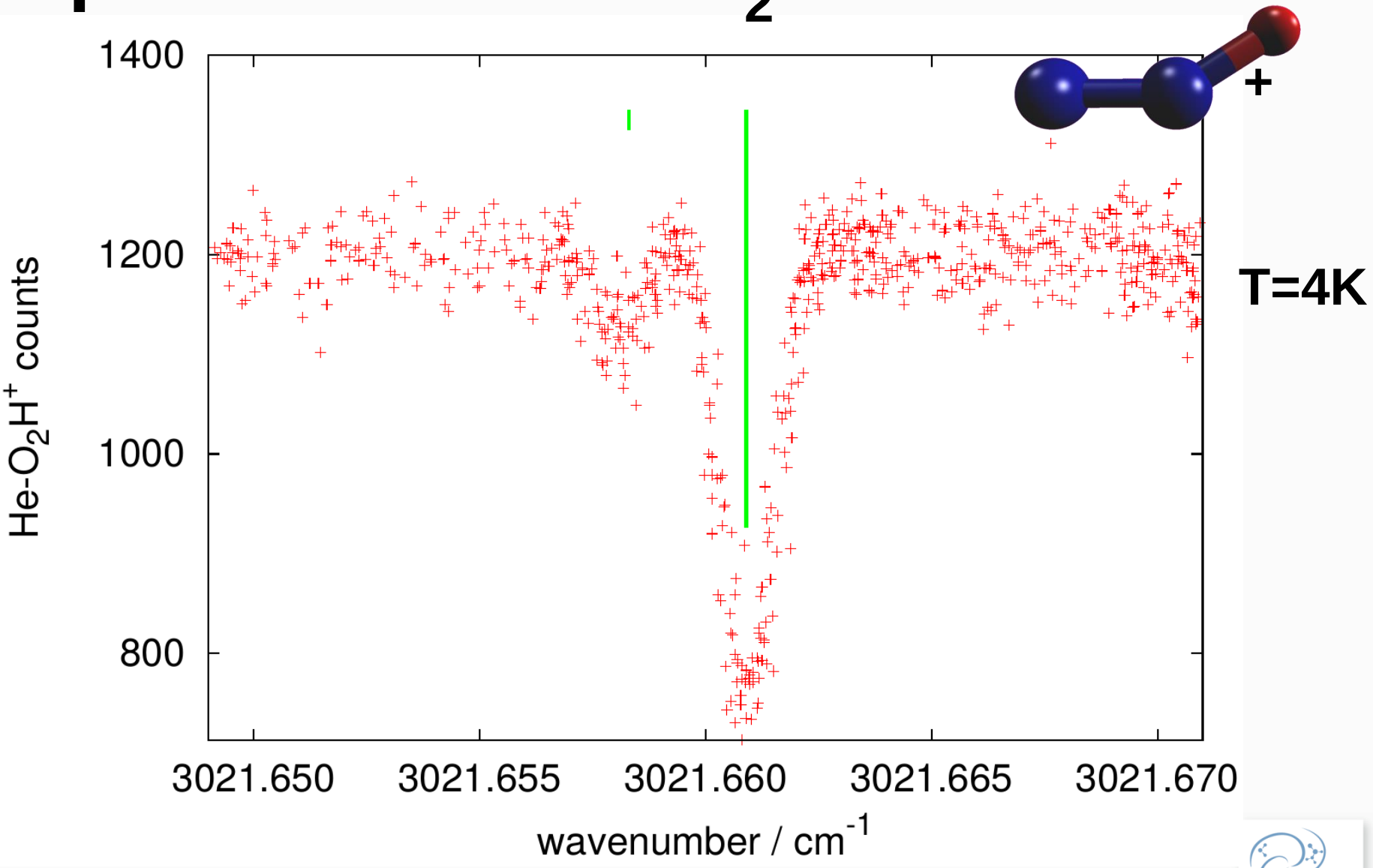




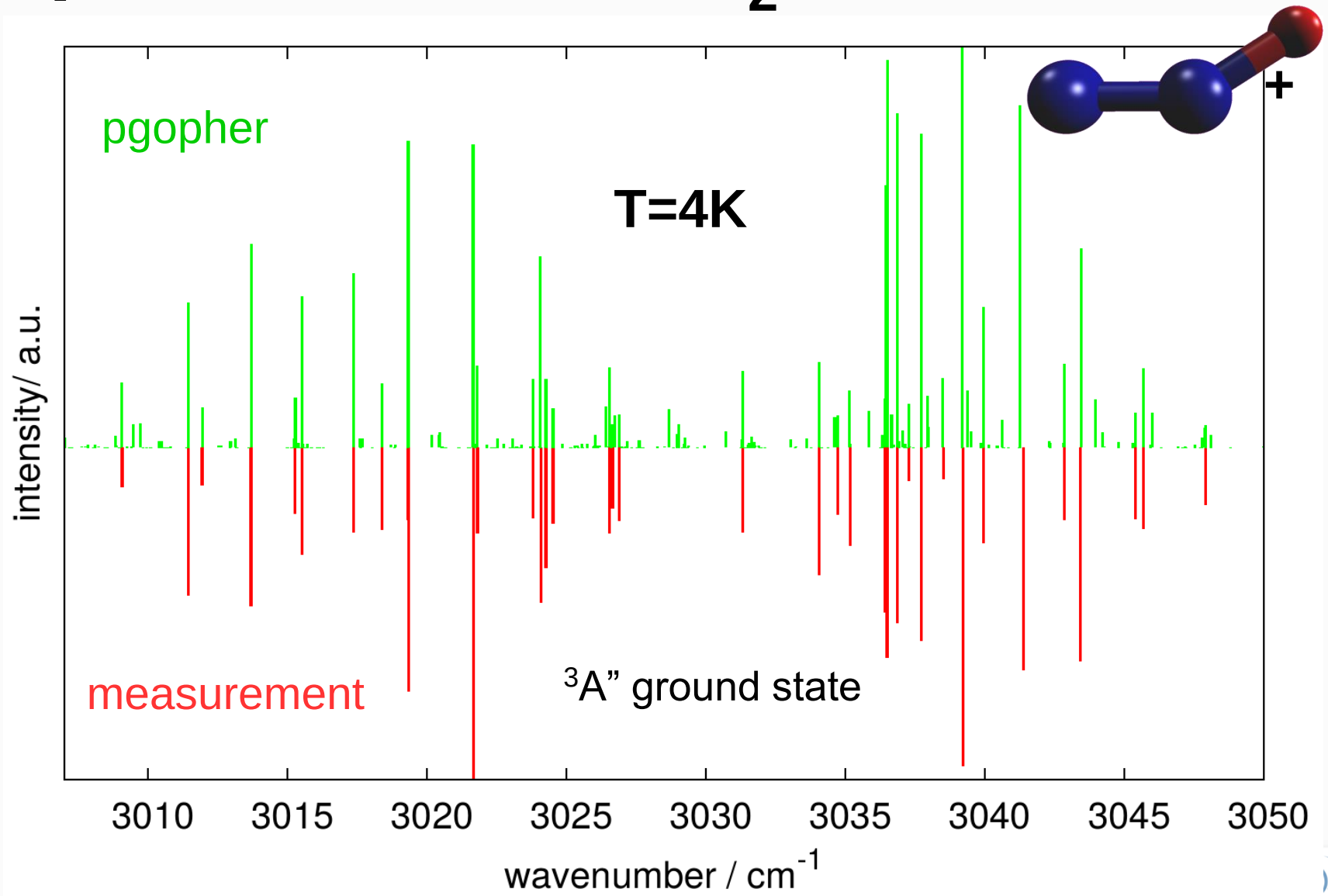
T=4K

Nizkorodov et al.,
Chem. Phys. Lett., **278**, 26 (1997)

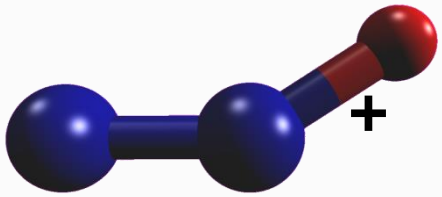
Spectra of naked O_2H^+



Spectra of naked O_2H^+



Summary



- **First vibration-rotation features of the ν_1 band of O_2H^+**
- **Band center at 3017 cm^{-1}, analysis ongoing**
- **Rotational spectrum predicted, but not measured (will be repeated..)**

thanks to:
electronical & mechanical workshops
FELIX facility
Funding: SFB 956

4 K trap machine COLTRAP