Infrared absorption spectroscopy of the $^{14}N_2^+$ Meinel system 2-1 band

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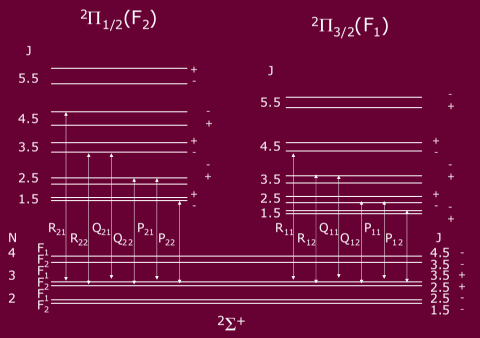
Introduction

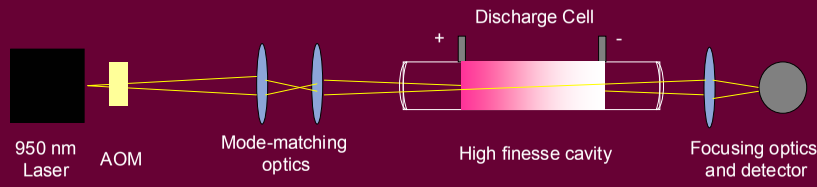
The $A^2\Pi_u$-$X^2\Sigma_g^+$ system of N_2^+ was first observed in auroral emissions by Meinel in 1950[1]. Although the N_2^+ band system has been reinvestigated since this first spectral study[2,3], no laboratory spectrum of the 2-1 vibronic band has been obtained. We have observed the 2-1 band of N_2^+ in a positive column discharge cell with continuous-wave cavity ringdown spectroscopy (cw-CRDS).

The $X^2\Sigma_g^+$ state of N_2^+ is split by spin-rotation interaction and Hund's case b applies for the angular momentum coupling. The $A^2\Pi_u$ state displays Λ-type doubling and Hund's case a applies. P, Q, and R-type vibronic transitions are allowed.

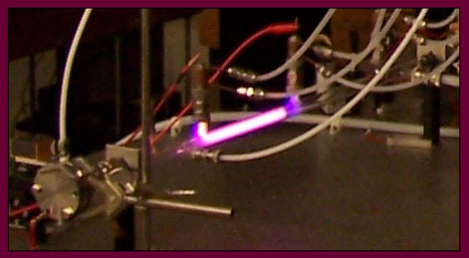


Experiment

We use continuous-wave cavity ringdown spectroscopy to investigate the vibronic spectra of molecular ions. The output of a cw external cavity tunable diode laser is coupled into a high finesse cavity formed from two highly reflective mirrors. A piezo changes the length of the cavity, and the light couples to the cavity when in resonance. The light is diverted with an acousto-optical modulator (AOM) when resonance is achieved, and the intensity exponentially decays with a rate proportional to the cavity absorption.



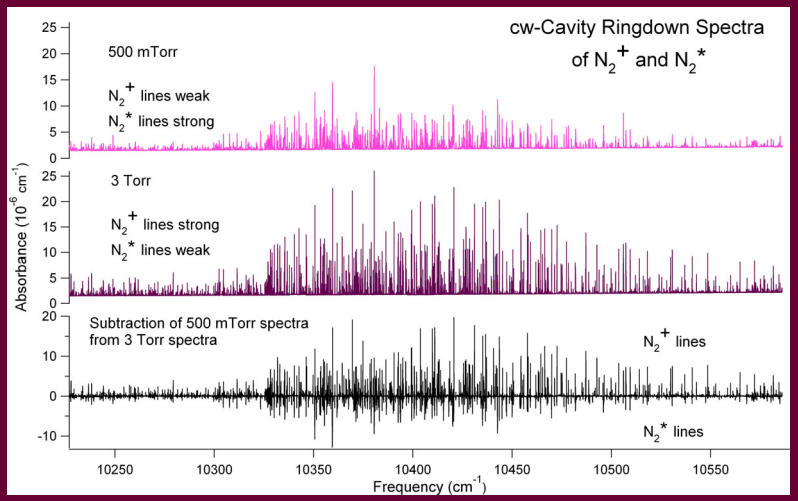
In this experiment, the N_2^+ ions were produced in a DC positive column discharge cell. Argon purge gas (300 mTorr) protected the ringdown mirrors.



Discharge Parameters

Total pressure = 500; 3000 mTorr
Discharge voltage = 3100 V
Discharge current = 70 mA

Spectra and Results



Relative frequency calibration was achieved using a spectrum analyzer, and a picometer resolution wavemeter was used for mode hop correction. A Herriott cell was used to record a water spectrum for absolute frequency calibration. N_2^+ spectral parameters were determined through a least-squares analysis.

Spectral Parameters determined for the N_2^+ 2-1 vibronic band (in cm^{-1}).

$B_{v'}$	1.697	$B_{v''}$	1.903
$D_{v'}$	5.9×10^{-6} *	$D_{v''}$	5.9×10^{-6} *
$A_{v'}$	-74.690	$\gamma_{v''}$	9.1×10^{-3} *
$A_{Dv'}$	-8.0×10^{-5} *		
$p_{v'}$	5.0×10^{-3} *	1 σ RMS	0.057
$q_{v'}$	-3.3×10^{-4} *	N_{max}	27
$T_{v'v''}$	10558.084	# Lines	99

* Parameter fixed to the literature value.[2]

Ongoing Work

More than 20 additional N_2^+ lines involving higher N states are assigned and require further analysis of the centrifugal distortion constants. As many as 460 lines of N_2^* have also been tentatively assigned, but these assignments are based on the predicted frequencies with no intensity information. We will calculate the intensities for these lines and finalize the assignments for both N_2^* and N_2^+.

References

1. Meinel 1950, *ApJ* 112, 502
2. Ferguson et al. 1992 *J. Mol. Spec.* **153**, 599
3. Earls 1935, *Phys. Rev.* **48**, 423

Acknowledgements

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