練習実験報告

肖宇笑

May 21, 2024

Contents

Contents

Galvano Sepctrum

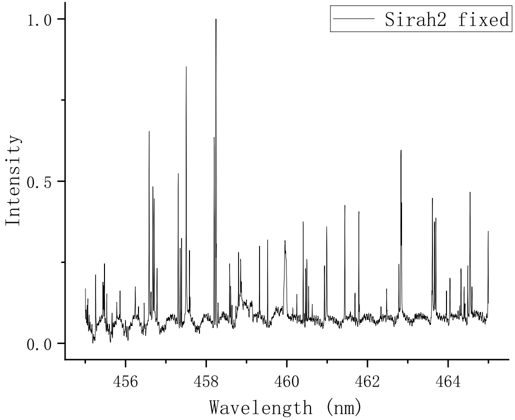

Fig. 1: Wavelen. correction

Galvano Sepctrum

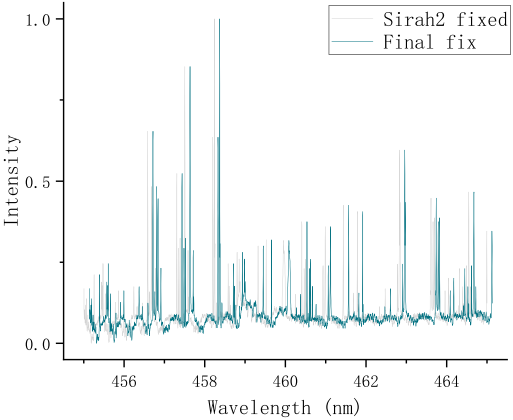

Fig. 1: Wavelen. correction

Galvano Sepctrum

Correction

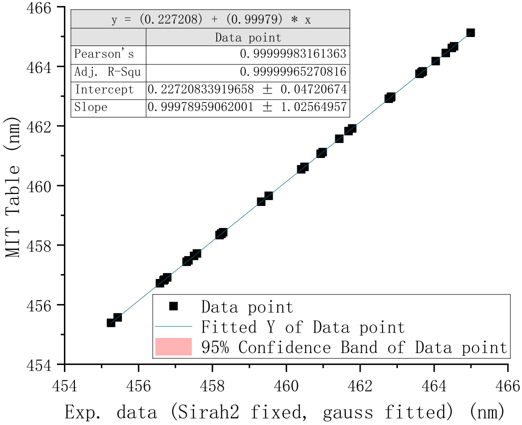

Fig. 2: Correction function

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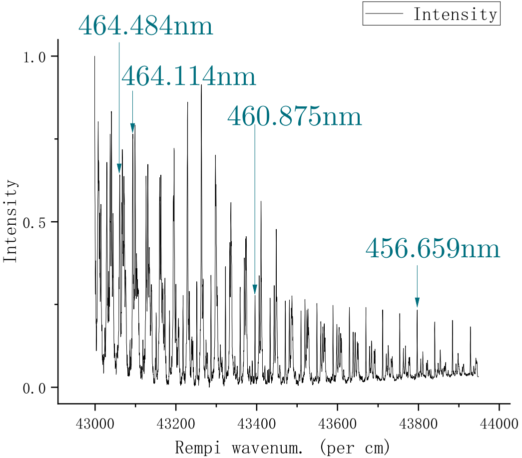
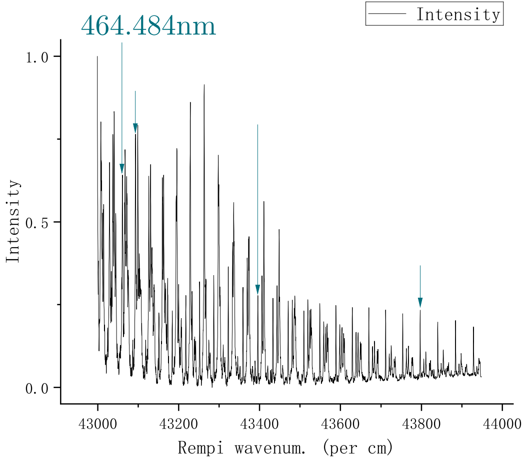
Selected peaks



Contents

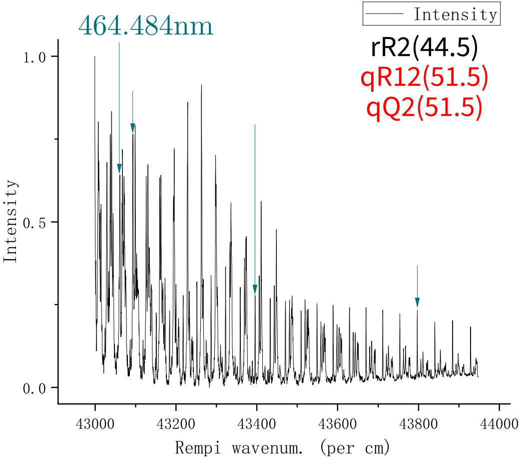
Contents

Peak 1



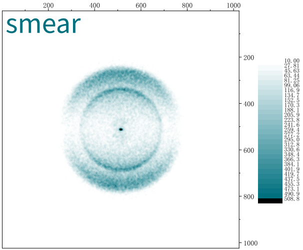
464.484nm
Intensity
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

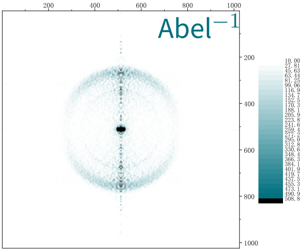
Peak 1

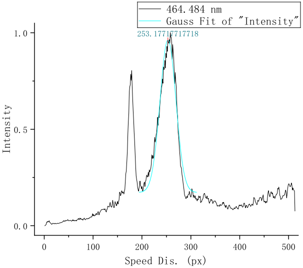


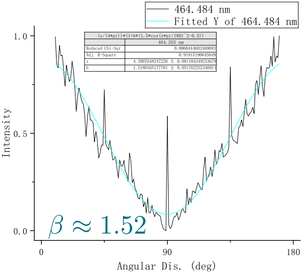
464.484nm
Intensity
rR2(44.5)
qR12(51.5)
qQ2(51.5)
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

Peak 1

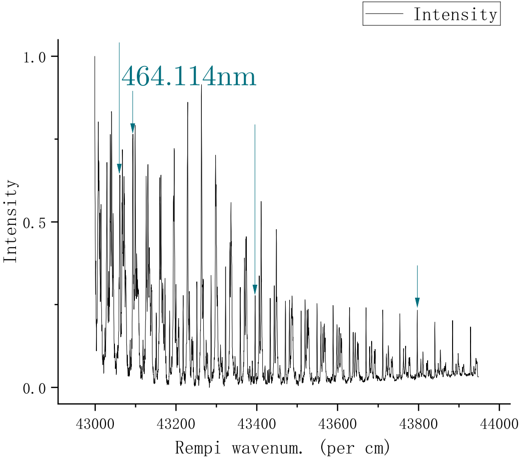

smear
200
400
600
800
1000
10.00
27.81
45.63
63.44
81.25
99.06
116.9
134.7
152.5
170.3
188.1
205.9
223.8
241.6
259.4
277.2
295.0
312.8
330.6
348.4
366.3
384.1
401.9
419.7
437.5
455.3
473.1
490.9
508.8


Abel^{-1}
200
400
600
800
1000
10.00
27.81
45.63
63.44
81.25
99.06
116.9
134.7
152.5
170.3
188.1
205.9
223.8
241.6
259.4
277.2
295.0
312.8
330.6
348.4
366.3
384.1
401.9
419.7
437.5
455.3
473.1
490.9
508.8


464.484 nm
Gauss Fit of "Intensity"
253.17717717718
Intensity
0.0
0.5
1.0
0
100
200
300
400
500
Speed Dis. (px)

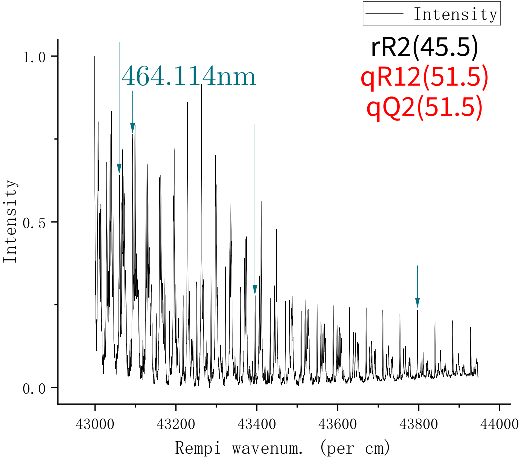

464.484 nm
Fitted Y of 464.484 nm
(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))
464.355 nm
Reduced Chi-Sqr 0.00604446033369693
Adj. R-Square 0.91915190645849
s 4.3907648247226 ± 0.081104349233679
b 1.5180165177701 ± 0.051762252346911
Intensity
0.0
0.5
1.0
0
90
180
Angular Dis. (deg)
$\beta \approx 1.52$

Peak 2

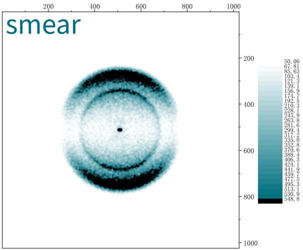


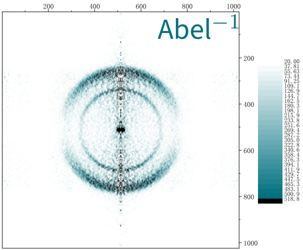
Intensity
464.114nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

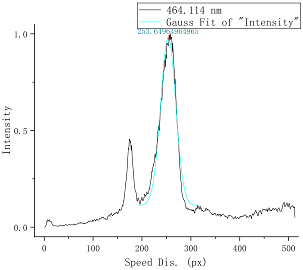
Peak 2

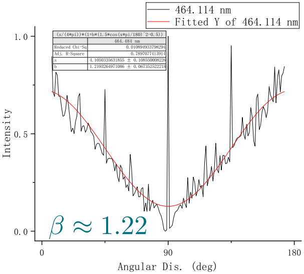

Intensity
rR2(45.5)
qR12(51.5)
qQ2(51.5)
464.114nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

Peak 2

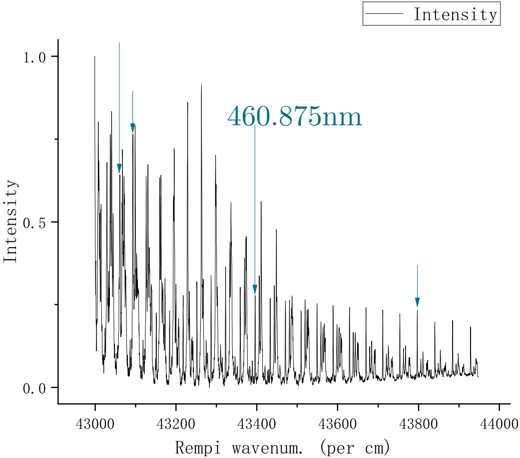

smear


Abel^{-1}


464.114 nm
Gauss Fit of "Intensity"
253.64964964965
Intensity
Speed Dis. (px)

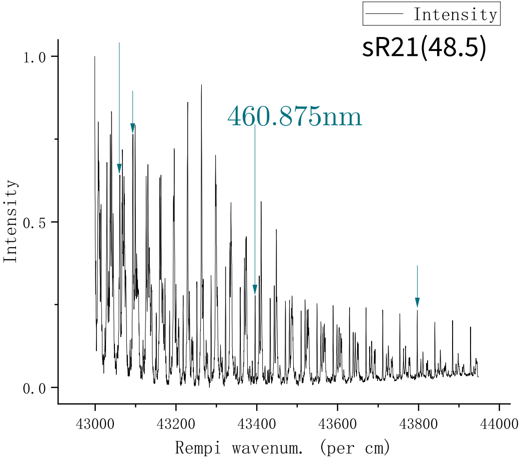

464.114 nm
Fitted Y of 464.114 nm
(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))
464.484 nm
Reduced Chi-Sq 0.010894933798294
Adj. R-Square 0.7897077413914
s 4.1050335631855 ± 0.108550008226
b 1.2193264971086 ± 0.067352522218
$\beta \approx 1.22$
Intensity
Angular Dis. (deg)

Peak 3



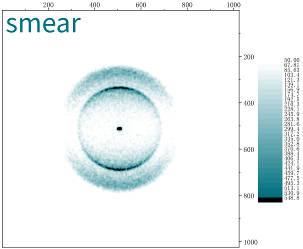
Intensity
460.875nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

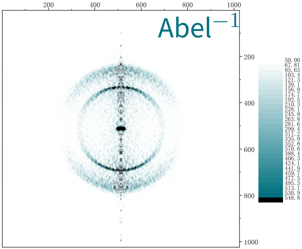
Peak 3

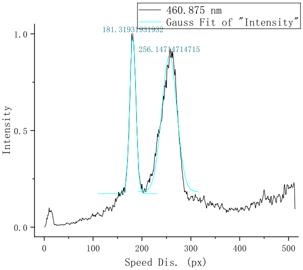


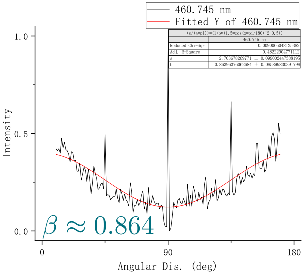
Intensity
sR21(48.5)
460.875nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

Peak 3



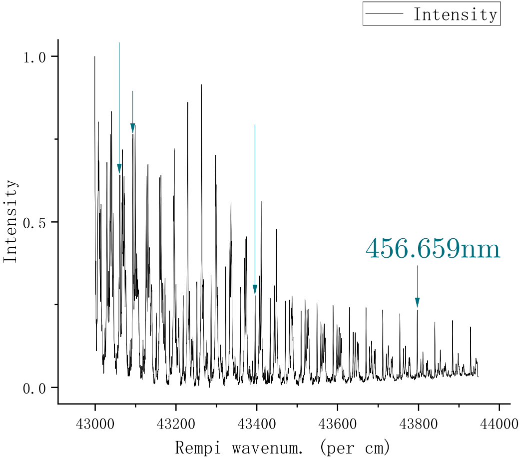




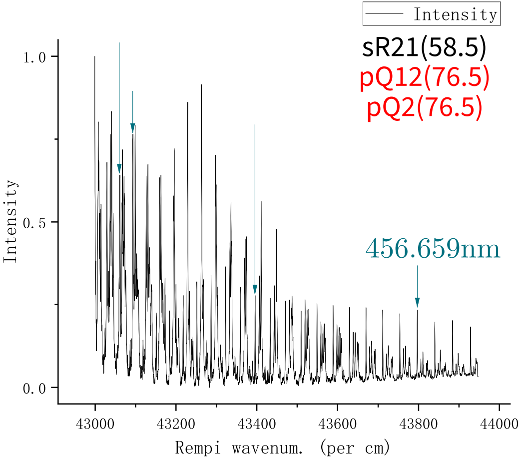


$\beta \approx 0.864$

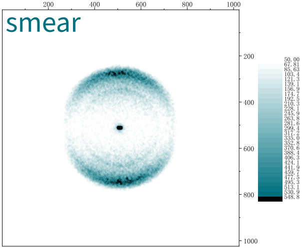
Peak 4

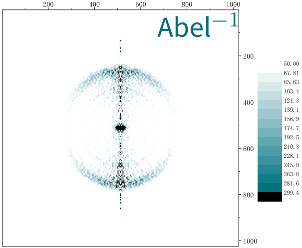

Intensity
1.0
0.5
0.0
456.659nm
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)
Intensity

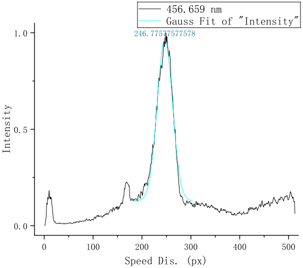
Peak 4

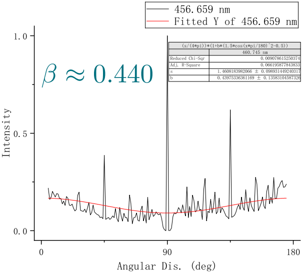

Intensity
sR21(58.5)
pQ12(76.5)
pQ2(76.5)
456.659nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

Peak 4


smear
200
400
600
800
1000
200
400
600
800
1000
50.00
67.81
85.63
103.4
121.3
139.1
156.9
174.7
192.5
210.3
228.1
245.9
263.8
281.6
299.4
317.2
335.0
352.8
370.6
388.4
406.3
424.1
441.9
459.7
477.5
495.3
513.1
530.9
548.8


Abel^{-1}
200
400
600
800
1000
200
400
600
800
1000
50.00
67.81
85.63
103.4
121.3
139.1
156.9
174.7
192.5
210.3
228.1
245.9
263.8
281.6
299.4


456.659 nm
Gauss Fit of "Intensity"
246.77577577578
Intensity
1.0
0.5
0.0
0
100
200
300
400
500
Speed Dis. (px)


456.659 nm
Fitted Y of 456.659 nm
$\beta \approx 0.440$
(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))
460.745 nm
Reduced Chi-Sqr 0.009078615250374
Adj. R-Square 0.066195877843833
s 1.4608183982066 ± 0.098931449240317
b 0.43975336361169 ± 0.135831045873326
Intensity
1.0
0.5
0.0
0
90
180
Angular Dis. (deg)

Contents

Contents

Peak assignments

464.484nm $\approx 43058.49\text{cm}^{-1}$	464.114nm $\approx 43092.81\text{cm}^{-1}$	460.875nm $\approx 43395.69\text{cm}^{-1}$	456.659nm $\approx 43796.34\text{cm}^{-1}$
px $= 253.177$	px $= 253.650$	px $= 181.319$ & 256.147	px $= 246.776$
$rR2$ 44.5 $qR12$ 51.5 $qQ2$ 51.5	$rR2$ 45.5 $qR12$ 51.5 $qQ2$ 51.5	$sR21$ 48.5	$sR21$ 58.5 $pQ12$ 76.5 $pP2$ 76.5

Notice

Colored assignments are mismatched, and will not be used to calculate.

Contents

Contents

Speed correction

y trans. energy of NO

	E_{total}	$E_{\text{bond}}(\text{O}-\text{NO})$[1]	$E_{\text{int.}}(\text{NO})$
Peak 1 464.484nm	$43\,058.49\text{cm}^{-1}$	$25\,128.57\text{cm}^{-1}$	$\Delta E_v(1 \rightarrow 0) + E(J = 44)$
Peak 2 464.114nm	$43\,092.81\text{cm}^{-1}$		$\Delta E_v(1 \rightarrow 0) + E(J = 45)$
Peak 3 460.875nm	$43\,395.69\text{cm}^{-1}$		$\Delta E_v(1 \rightarrow 0) + E(J = 48)$
Peak 4 456.659nm	$43\,796.34\text{cm}^{-1}$		$\Delta E_v(1 \rightarrow 0) + E(J = 58)$

[1] Rémy Jost et al. *The Journal of Chemical Physics* **105**.3 (July 1996).

Speed correction

y trans. energy of NO

	E_{total}	$E_{\text{bond}}(\mathrm{O{-}NO})^2$	$E_{\text{int.}}(\mathrm{NO})$
Peak 1 $464.484\,\mathrm{nm}$	$43\,058.49\,\mathrm{cm}^{-1}$		$2341.932\,775\,0\,\mathrm{cm}^{-1} + E(J = 44)$
Peak 2 $464.114\,\mathrm{nm}$	$43\,092.81\,\mathrm{cm}^{-1}$		$2341.932\,775\,0\,\mathrm{cm}^{-1} + E(J = 45)$
Peak 3 $460.875\,\mathrm{nm}$	$43\,395.69\,\mathrm{cm}^{-1}$	$25\,128.57\,\mathrm{cm}^{-1}$	$2341.932\,775\,0\,\mathrm{cm}^{-1} + E(J = 48)$
Peak 4 $456.659\,\mathrm{nm}$	$43\,796.34\,\mathrm{cm}^{-1}$		$2341.932\,775\,0\,\mathrm{cm}^{-1} + E(J = 58)$

[2] Rémy Jost et al. *The Journal of Chemical Physics* **105**.3 (July 1996).
[3] J. Danielak et al. *Journal of Molecular Spectroscopy* **181**.2 (1997), pp. 394–402.

Speed correction

y trans. energy of NO

	E_{total}	$E_{\text{bond}}(\mathrm{O{-}NO})$[2]	$E_{\text{int.}}(\mathrm{NO})$
Peak 1 $464.484\mathrm{nm}$	$43\,058.49\mathrm{cm}^{-1}$		$2341.932\,775\,0\mathrm{cm}^{-1} + E(J = 44)$
Peak 2 $464.114\mathrm{nm}$	$43\,092.81\mathrm{cm}^{-1}$		$2341.932\,775\,0\mathrm{cm}^{-1} + E(J = 45)$
Peak 3 $460.875\mathrm{nm}$	$43\,395.69\mathrm{cm}^{-1}$	$25\,128.57\mathrm{cm}^{-1}$	$2341.932\,775\,0\mathrm{cm}^{-1} + E(J = 48)$
Peak 4 $456.659\mathrm{nm}$	$43\,796.34\mathrm{cm}^{-1}$		$2341.932\,775\,0\mathrm{cm}^{-1} + E(J = 58)$

Vib. energy level[3]

$$E_v = \omega_e\left(v + \tfrac{1}{2}\right) - \omega_e x_e\left(v + \tfrac{1}{2}\right)^2 + \omega_e y_e\left(v + \tfrac{1}{2}\right)^3.$$

[2] Rémy Jost et al. *The Journal of Chemical Physics* **105**.3 (July 1996).

[3] J. Danielak et al. *Journal of Molecular Spectroscopy* **181**.2 (1997), pp. 394–402.

Speed correction

y trans. energy of NO

	E_{total}	$E_{\text{bond}}(\mathrm{O{-}NO})^4$	$E_{\text{int.}}(\mathrm{NO})$
Peak 1 $464.484\,\mathrm{nm}$	$43\,058.49\,\mathrm{cm}^{-1}$		$5814.033\,\mathrm{cm}^{-1}$
Peak 2 $464.114\,\mathrm{nm}$	$43\,092.81\,\mathrm{cm}^{-1}$	$25\,128.57\,\mathrm{cm}^{-1}$	$5965.969\,\mathrm{cm}^{-1}$
Peak 3 $460.875\,\mathrm{nm}$	$43\,395.69\,\mathrm{cm}^{-1}$		$6239.696\,\mathrm{cm}^{-1}$
Peak 4 $456.659\,\mathrm{nm}$	$43\,796.34\,\mathrm{cm}^{-1}$		$8004.278\,\mathrm{cm}^{-1}$

[4] Rémy Jost et al. *The Journal of Chemical Physics* **105**.3 (July 1996).
[5] J. Danielak et al. *Journal of Molecular Spectroscopy* **181**.2 (1997), pp. 394–402.
[6] Colin M. Western. *Journal of Quantitative Spectroscopy and Radiative Transfer* **186** (2017), pp. 221–242.

Speed correction

y trans. energy of NO

	E_{total}	$E_{\text{bond}}(\mathrm{O-NO})$[4]	$E_{\text{int.}}(\mathrm{NO})$
Peak 1 $464.484\mathrm{nm}$	$43\,058.49\mathrm{cm}^{-1}$	$25\,128.57\mathrm{cm}^{-1}$	$5814.033\mathrm{cm}^{-1}$
Peak 2 $464.114\mathrm{nm}$	$43\,092.81\mathrm{cm}^{-1}$		$5965.969\mathrm{cm}^{-1}$
Peak 3 $460.875\mathrm{nm}$	$43\,395.69\mathrm{cm}^{-1}$		$6239.696\mathrm{cm}^{-1}$
Peak 4 $456.659\mathrm{nm}$	$43\,796.34\mathrm{cm}^{-1}$		$8004.278\mathrm{cm}^{-1}$

Rot. energy level[5]

Simulated data generated by PGOPHER[6].

[4] Rémy Jost et al. *The Journal of Chemical Physics* **105**.3 (July 1996).

[5] J. Danielak et al. *Journal of Molecular Spectroscopy* **181**.2 (1997), pp. 394–402.

[6] Colin M. Western. *Journal of Quantitative Spectroscopy and Radiative Transfer* **186** (2017), pp. 221–242.

Speed correction

y trans. energy of NO

$E_{\text{int.}}(\mathrm{O})$ [7]	$E_{\text{trans}}(\text{total}) \approx 2.875464 E_{\text{trans}}(\mathrm{NO})$ $= E_{\text{total}} - E_{\text{bond}}(\mathrm{O{-}NO}) - E_{\text{int.}}(\mathrm{O}) - E_{\text{int.}}(\mathrm{NO})$	$E_{\text{trans}}(\mathrm{NO})$ $= \frac{1}{2} m(\mathrm{NO}) v^2(\mathrm{NO})$
$^3P_2$ ($0\mathrm{cm}^{-1}$)	$11081.356\mathrm{cm}^{-1}$ $10964.609\mathrm{cm}^{-1}$ $10794.143\mathrm{cm}^{-1}$ $9398.766\mathrm{cm}^{-1}$	$1923.847\mathrm{cm}^{-1}$ $1903.578\mathrm{cm}^{-1}$ $1873.983\mathrm{cm}^{-1}$ $1631.730\mathrm{cm}^{-1}$
$^3P_1$ ($158.625\mathrm{cm}^{-1}$)	$10922.731\mathrm{cm}^{-1}$ $10805.984\mathrm{cm}^{-1}$ $10635.518\mathrm{cm}^{-1}$ $9240.141\mathrm{cm}^{-1}$	$1896.308\mathrm{cm}^{-1}$ $1876.039\mathrm{cm}^{-1}$ $1846.444\mathrm{cm}^{-1}$ $1604.191\mathrm{cm}^{-1}$
$^3P_0$ ($226.977\mathrm{cm}^{-1}$)	$10854.379\mathrm{cm}^{-1}$ $10737.632\mathrm{cm}^{-1}$ $10567.166\mathrm{cm}^{-1}$ $9171.789\mathrm{cm}^{-1}$	$1884.441\mathrm{cm}^{-1}$ $1864.172\mathrm{cm}^{-1}$ $1834.577\mathrm{cm}^{-1}$ $1592.324\mathrm{cm}^{-1}$

[7] Charlotte Emma Moore and Jean W. Gallagher. “Tables of spectra of hydrogen, carbon, nitrogen, and oxygen atoms and ions”. 1993.

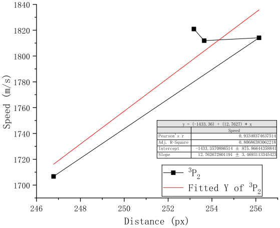
Speed correction

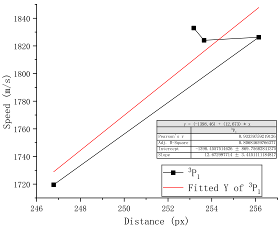
y Trans. speed of NO

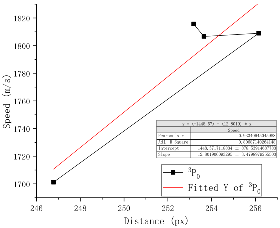
$E_{\text{int.}}(\mathrm{O})$	$v(\mathrm{NO}) = \sqrt{\frac{2E_{\text{trans}}(\mathrm{NO})}{m(NO)}}$	Δy
$^3P_2$ (0cm^{-1})	1832.932m s^{-1}	253.177
	1824.013m s^{-1}	253.650
	1826.228m s^{-1}	256.147
	1719.564m s^{-1}	246.776
$^3P_1$ (158.625cm^{-1})	1820.893m s^{-1}	253.177
	1811.916m s^{-1}	253.650
	1814.145m s^{-1}	256.148
	1706.726m s^{-1}	246.776
$^3P_0$ (226.977cm^{-1})	1815.681m s^{-1}	253.177
	1806.678m s^{-1}	253.650
	1808.914m s^{-1}	256.147
	1701.165m s^{-1}	246.776

Speed correction

y Trans. speed of NO



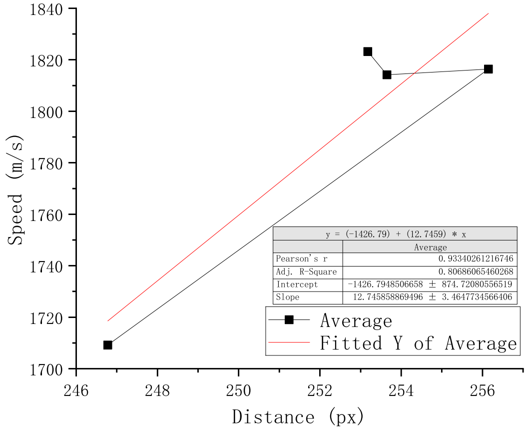




$12.76\,\mathrm{m\,s^{-1}}$/px @ $^3P_2$ $12.67\,\mathrm{m\,s^{-1}}$/px @ $^3P_1$ $12.80\,\mathrm{m\,s^{-1}}$/px @ $^3P_0$

Speed correction

y Trans. speed of NO



$$\frac{dv}{d\,\text{px}} = 12.75\,\mathrm{m\,s^{-1}}/\text{px} \text{ @ Average}$$

Reference

[1] J. Danielak et al. *Journal of Molecular Spectroscopy* **181**.2 (1997), pp. 394–402.

[2] Rémy Jost et al. *The Journal of Chemical Physics* **105**.3 (July 1996).

[3] Charlotte Emma Moore and Jean W. Gallagher. “Tables of spectra of hydrogen, carbon, nitrogen, and oxygen atoms and ions”. 1993.

[4] Colin M. Western. *Journal of Quantitative Spectroscopy and Radiative Transfer* **186** (2017), pp. 221–242.

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