練習実験報告

肖宇笑

May 25, 2024

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Contents

Galvano Sepctrum

REMPI scan

- Selected peaks
- Radius and angular distributions
- Peak assignments
- Speed correction

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Galvano Sepctrum

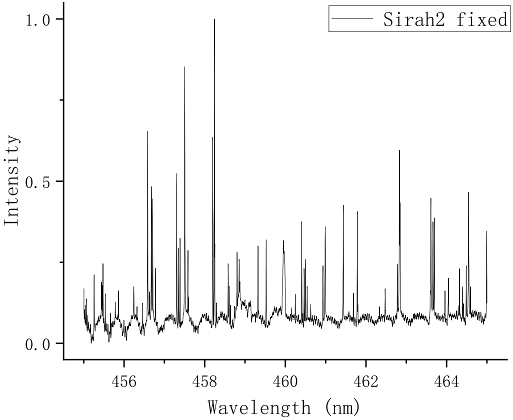

Fig. 1: Wavelen. correction

Galvano Sepctrum

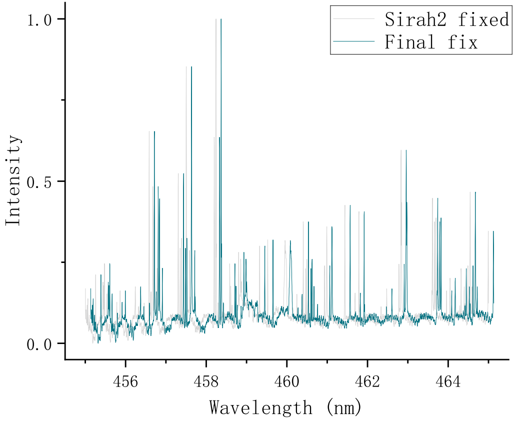

Fig. 1: Wavelen. correction

Galvano Sepctrum

Correction

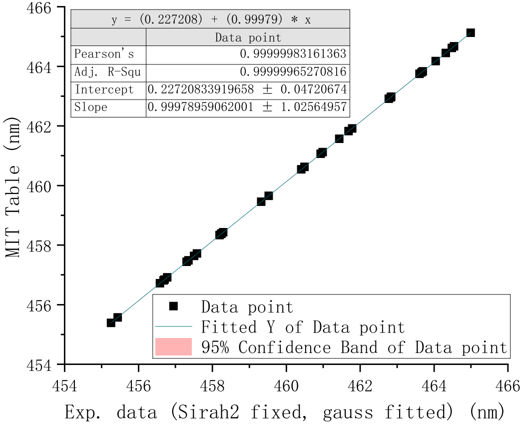

Fig. 2: Correction function

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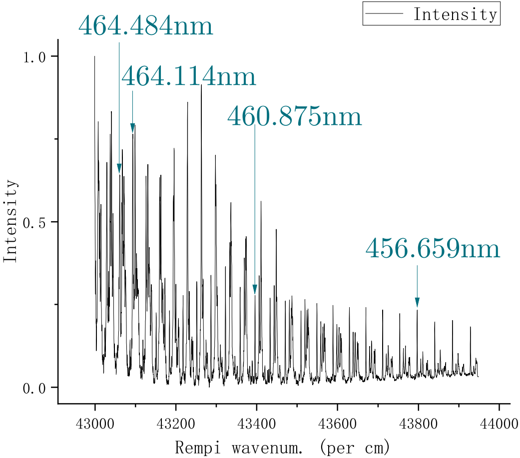
Selected peaks



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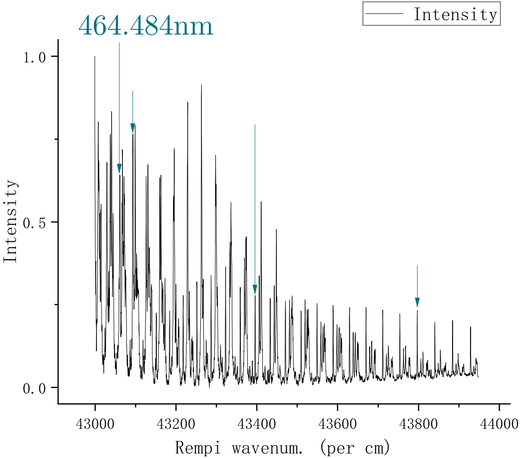
Selected peaks

Radius and angular distributions

Peak assignments

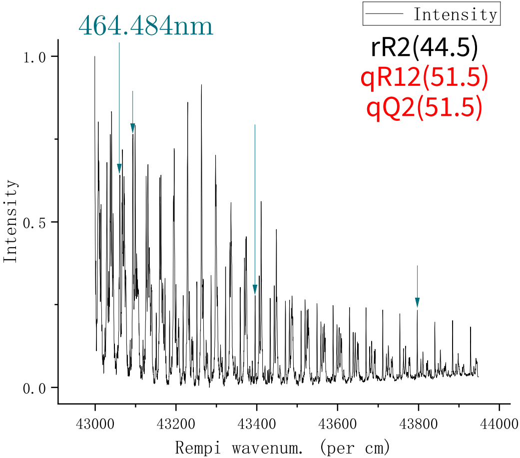
Speed correction

Peak 1



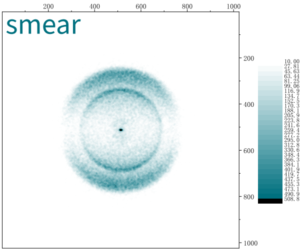
464.484nm
Intensity
1.0
0.5
0.0
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

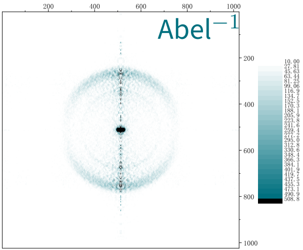
Peak 1

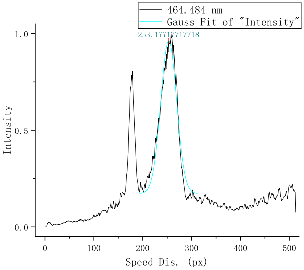


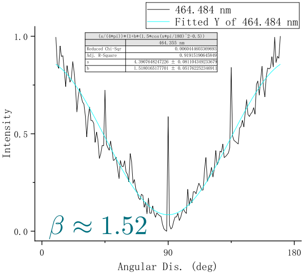
464.484nm
Intensity
rR2(44.5)
qR12(51.5)
qQ2(51.5)
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

Peak 1

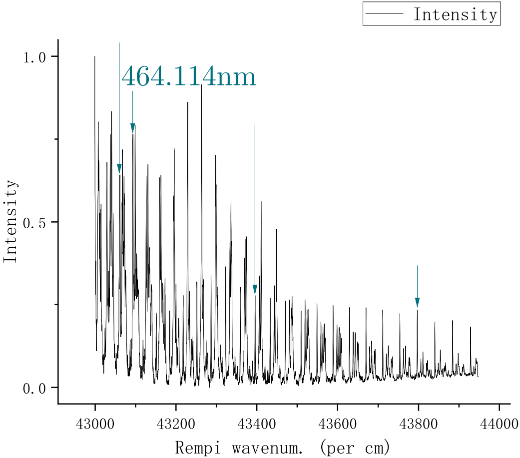

smear


Abel^{-1}


464.484 nm
Gauss Fit of "Intensity"
253.17717717718
Intensity
Speed Dis. (px)

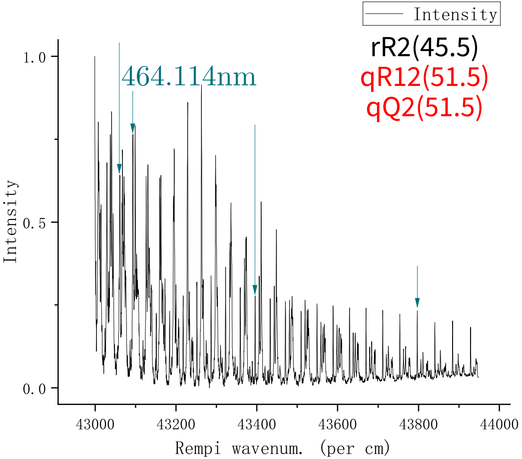

464.484 nm
Fitted Y of 464.484 nm
(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))
464.355 nm
Reduced Chi-Sqr 0.0060444603369693
Adj. R-Square 0.91915190645849
s 4.3907648247226 ± 0.081104349233679
b 1.5180165177701 ± 0.051762252346911
$\beta \approx 1.52$
Intensity
Angular Dis. (deg)

Peak 2



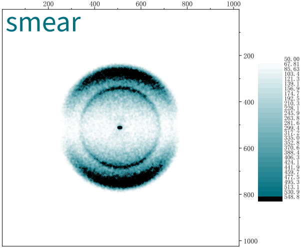
Intensity
464.114nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

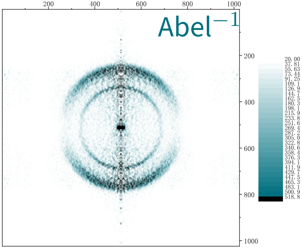
Peak 2

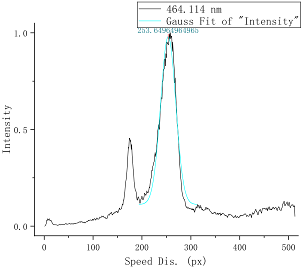


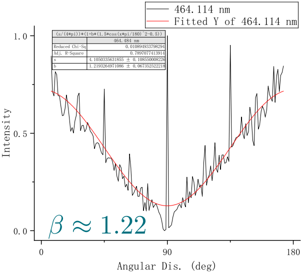
Intensity
rR2(45.5)
qR12(51.5)
qQ2(51.5)
464.114nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

Peak 2

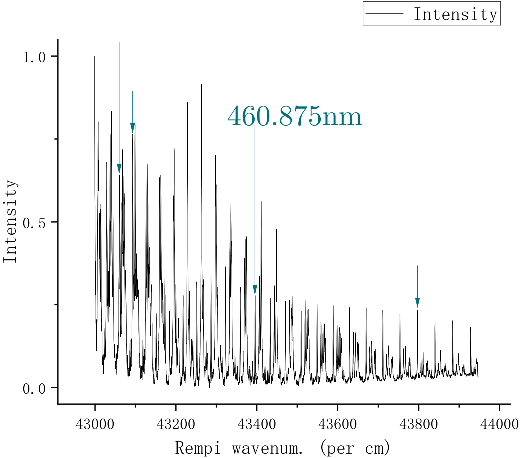

smear
200
400
600
800
1000


Abel^{-1}
200
400
600
800
1000


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

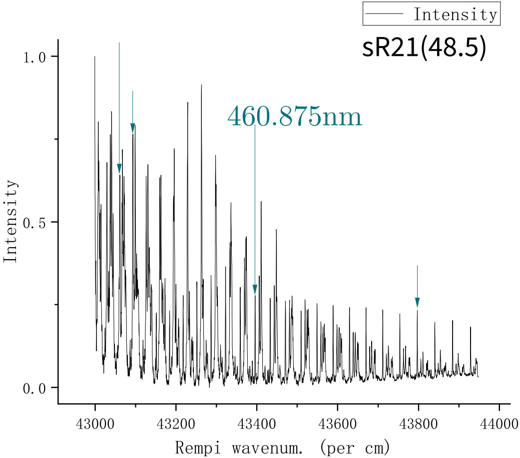

464.114 nm
Fitted Y of 464.114 nm
(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))
464.484 nm
Reduced Chi-Sq 0.010894933798294
Adj. R-Square 0.7897077413914
s 4.1050335631855 ± 0.108550008226
b 1.2193264971086 ± 0.067352522218
$\beta \approx 1.22$
Intensity
Angular Dis. (deg)

Peak 3



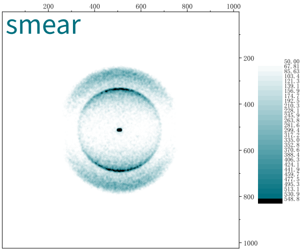
Intensity
460.875nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

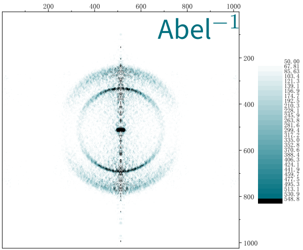
Peak 3

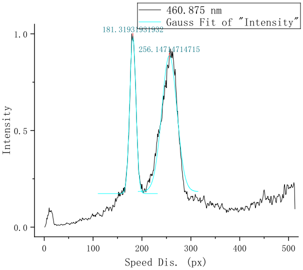


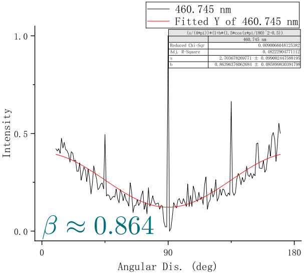
Intensity
sR21(48.5)
460.875nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

Peak 3

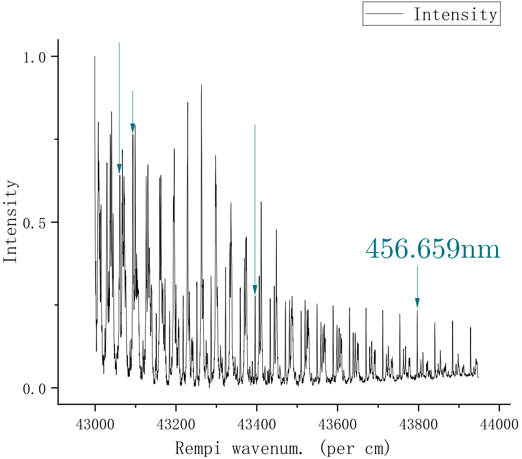

smear
200
400
600
800
1000


Abel^{-1}
200
400
600
800
1000


460.875 nm
Gauss Fit of "Intensity"
181.31931931932
256.14714714715
Intensity
Speed Dis. (px)

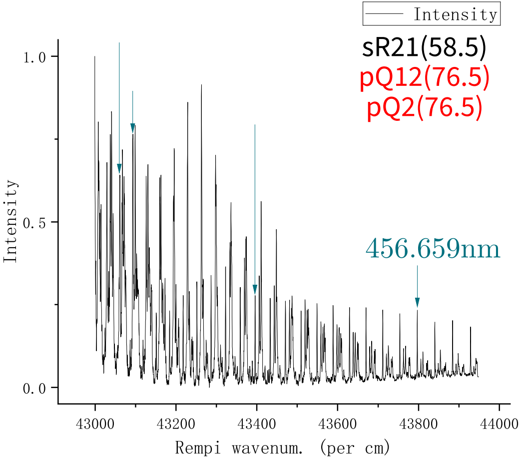

460.745 nm
Fitted Y of 460.745 nm
(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))
460.745 nm
Reduced Chi-Sqr 0.0090066048125382
Adj. R-Square 0.48222904771112
s 2.703678269771 ± 0.099002447588195
b 0.86396376062684 ± 0.085899830391798
Intensity
Angular Dis. (deg)
$\beta \approx 0.864$

Peak 4



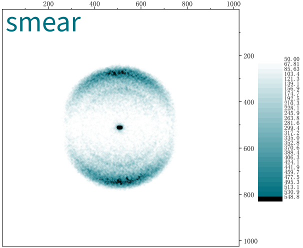
Intensity
1.0
0.5
0.0
Intensity
456.659nm
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

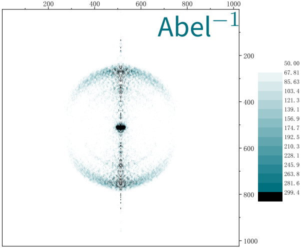
Peak 4

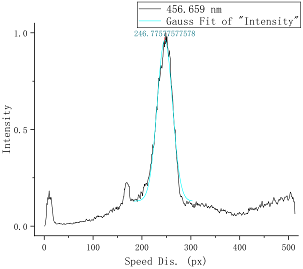


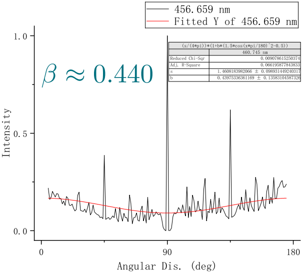
Intensity
sR21(58.5)
pQ12(76.5)
pQ2(76.5)
456.659nm
1.0
0.5
0.0
Intensity
43000
43200
43400
43600
43800
44000
Rempi wavenum. (per cm)

Peak 4


smear
200
400
600
800
1000


Abel^{-1}
200
400
600
800
1000


456.659 nm
Gauss Fit of "Intensity"
246.77577577578
Intensity
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 ± 0.13583104587326
Intensity
Angular Dis. (deg)

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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.

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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	$43\,058.49\text{cm}^{-1}$		$\Delta E_v(1 \to 0) + E(J = 44)$
Peak 2 464.114nm	$43\,092.81\text{cm}^{-1}$		$\Delta E_v(1 \to 0) + E(J = 45)$
Peak 3 460.875nm	$43\,395.69\text{cm}^{-1}$	$25\,128.57\text{cm}^{-1}$	$\Delta E_v(1 \to 0) + E(J = 48)$
Peak 4 456.659nm	$43\,796.34\text{cm}^{-1}$		$\Delta E_v(1 \to 0) + E(J = 58)$

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

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

$E_{\text{int.}}(\text{O})$ [7]	$E_{\text{trans}}(\text{total}) \approx 2.875464 E_{\text{trans}}(\text{NO})$ $= E_{\text{total}} - E_{\text{bond}}(\text{O}-\text{NO}) - E_{\text{int.}}(\text{O}) - E_{\text{int.}}(\text{NO})$	$E_{\text{trans}}(\text{NO})$ $= \frac{1}{2} m(\text{NO}) v^2(\text{NO})$
$^3P_2$	11081.356cm^{-1}	4375.588cm^{-1}
	10964.609cm^{-1}	4334.685cm^{-1}
	10794.143cm^{-1}	4344.824cm^{-1}
(0cm^{-1})	9398.766cm^{-1}	3870.489cm^{-1}
$^3P_1$	10922.731cm^{-1}	4320.423cm^{-1}
	10805.984cm^{-1}	4279.520cm^{-1}
	10635.518cm^{-1}	4289.659cm^{-1}
(158.625cm^{-1})	9240.141cm^{-1}	3815.324cm^{-1}
$^3P_0$	10854.379cm^{-1}	4296.653cm^{-1}
	10737.632cm^{-1}	4255.749cm^{-1}
	10567.166cm^{-1}	4265.888cm^{-1}
(226.977cm^{-1})	9171.789cm^{-1}	3791.553cm^{-1}

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

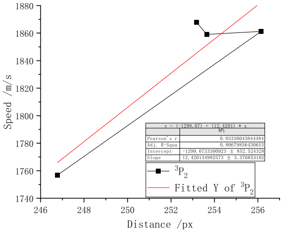
Speed correction

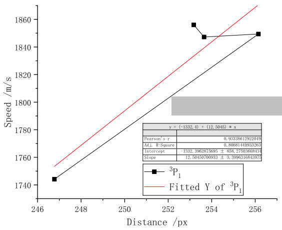
y Trans. speed of NO

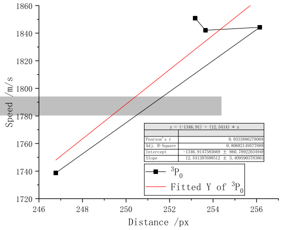
$E_{\text{int.}}(\mathrm{O})$	$v(\mathrm{NO}) = \sqrt{\frac{2E_{\text{trans}}(\mathrm{NO})}{m(\mathrm{NO})}}$	Δy
$^3P_2$ ($0\,\mathrm{cm}^{-1}$)	$1867.845\,\mathrm{m\,s^{-1}}$	253.177
	$1859.094\,\mathrm{m\,s^{-1}}$	253.650
	$1861.267\,\mathrm{m\,s^{-1}}$	256.147
	$1756.732\,\mathrm{m\,s^{-1}}$	246.776
$^3P_1$ ($158.625\,\mathrm{cm}^{-1}$)	$1856.033\,\mathrm{m\,s^{-1}}$	253.177
	$1847.226\,\mathrm{m\,s^{-1}}$	253.650
	$1849.413\,\mathrm{m\,s^{-1}}$	256.148
	$1744.168\,\mathrm{m\,s^{-1}}$	246.776
$^3P_0$ ($226.977\,\mathrm{cm}^{-1}$)	$1850.920\,\mathrm{m\,s^{-1}}$	253.177
	$1842.089\,\mathrm{m\,s^{-1}}$	253.650
	$1844.282\,\mathrm{m\,s^{-1}}$	256.147
	$1738.726\,\mathrm{m\,s^{-1}}$	246.776

Speed correction

y Trans. speed of NO



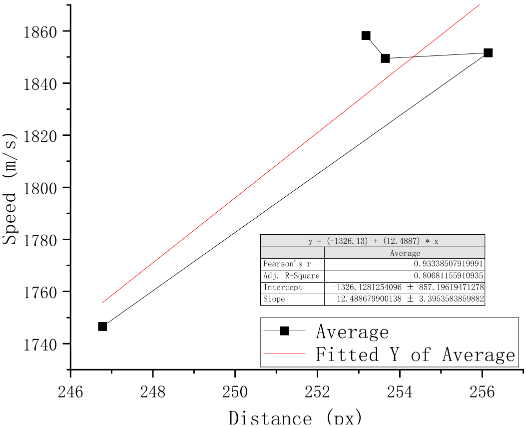




$12.42\mathrm{m\,s^{-1}}$/px @ $^3P_2$ $\quad$ $12.54\mathrm{m\,s^{-1}}$/px @ $^3P_1$ $\quad$ $12.50\mathrm{m\,s^{-1}}$/px @ $^3P_0$

Speed correction

y Trans. speed of NO



$12.49\,\mathrm{m\,s^{-1}}$/px @ Average

Reference

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