練習実験報告

肖宇笑

May 30, 2024

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Contents

Contents

Galvano Sepctrum

Fig. 1: Wavelen. correction

Galvano Sepctrum

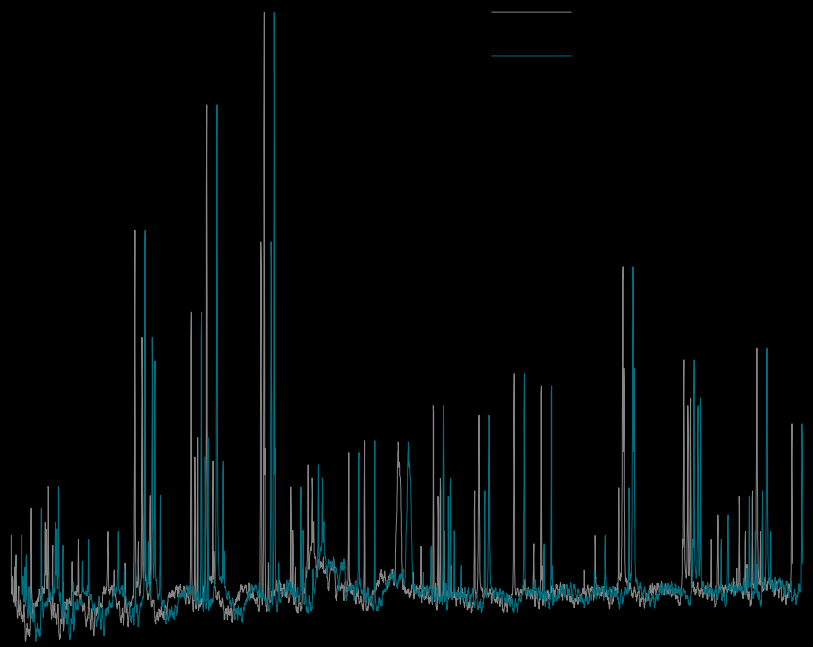


Fig. 1: Wavelen. correction

Galvano Sepctrum

Calibration

y = (0.227208) + (0.99979) * x	
	Data point
Pearson's	0.99999983161363
Adj. R-Squ	0.99999965270816
Intercept	0.22720833919658 ± 0.04720674
Slope	0.99978959062001 ± 1.02564957

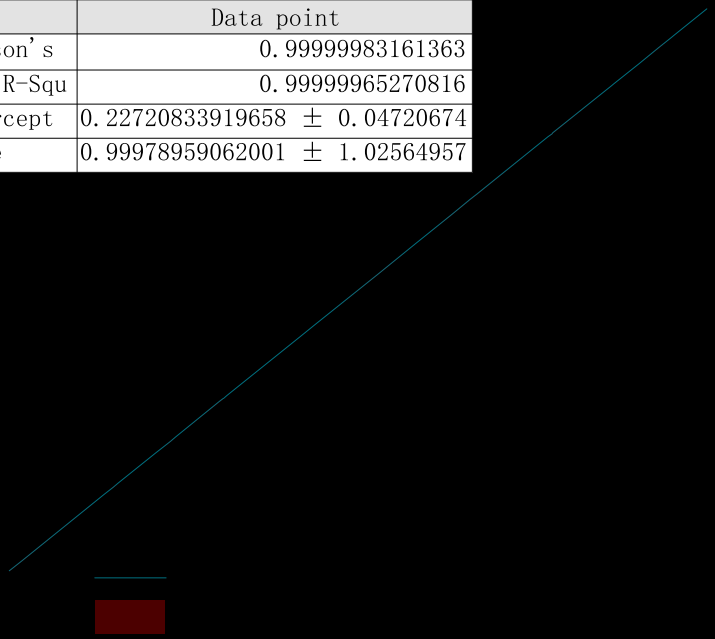
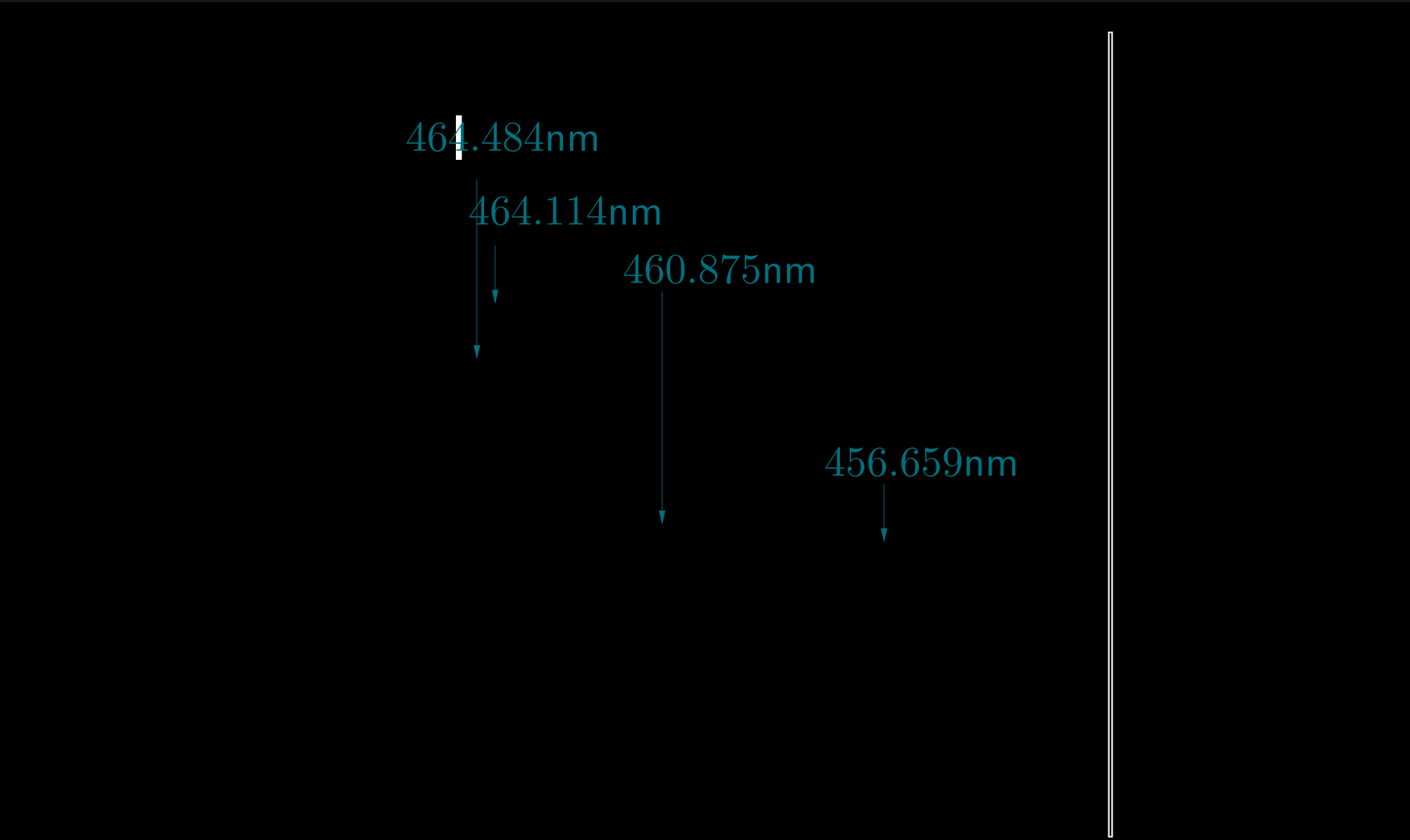


Fig. 2: Correction function

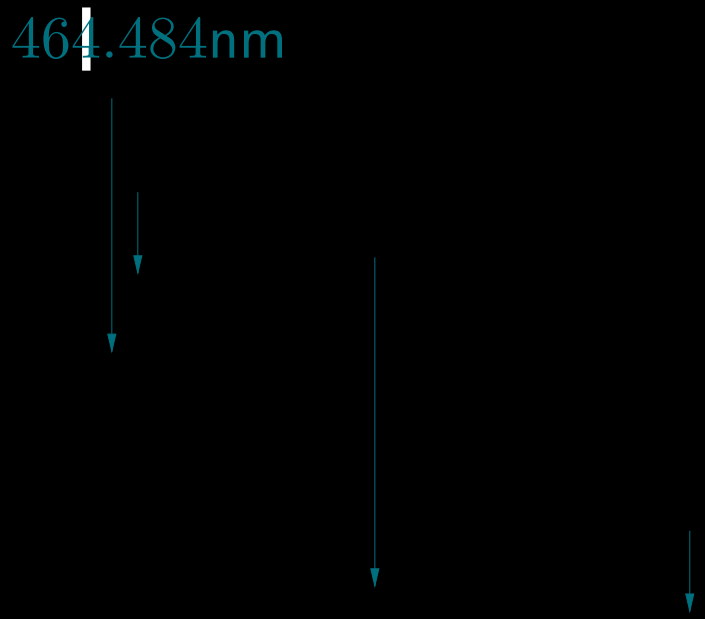
Contents

Contents

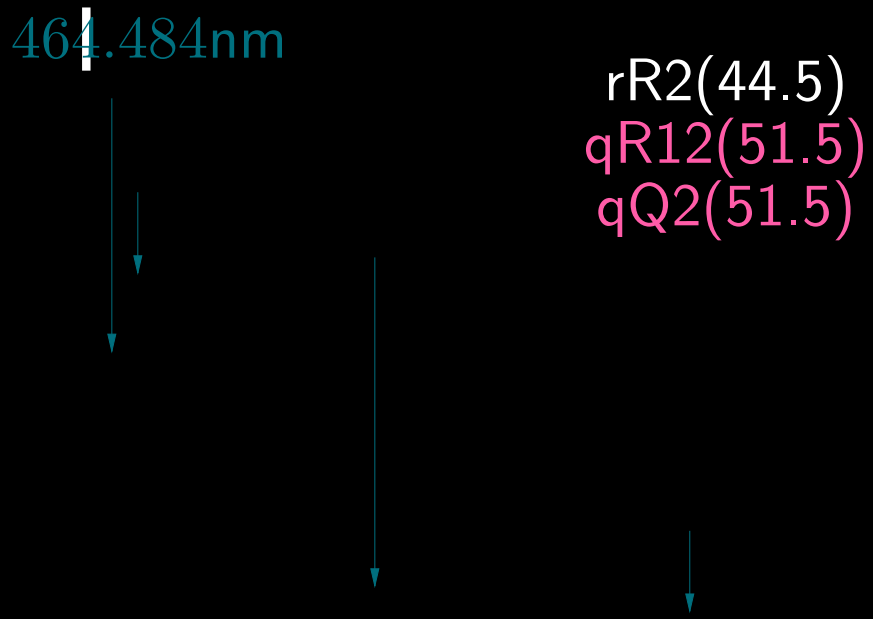
Selected peaks



Peak 1



Peak 1



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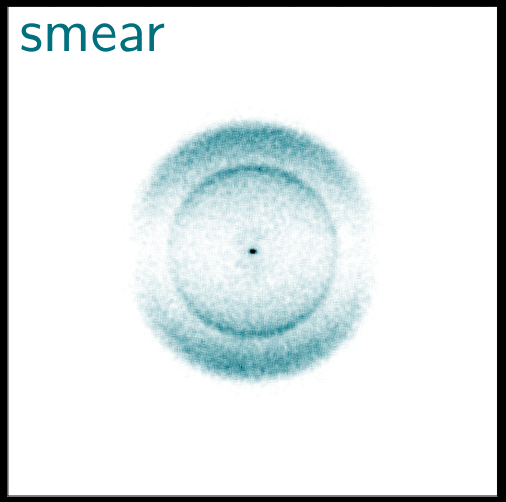
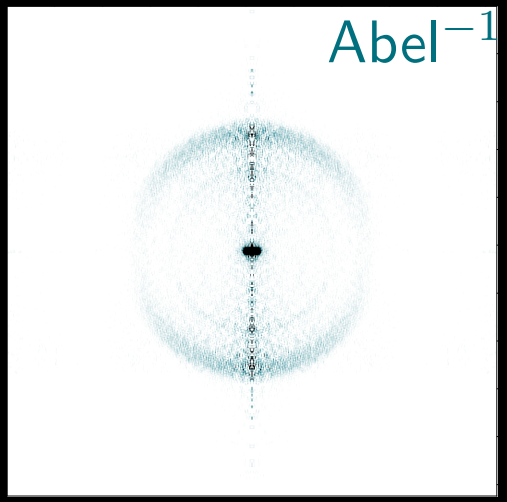
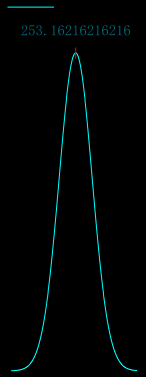
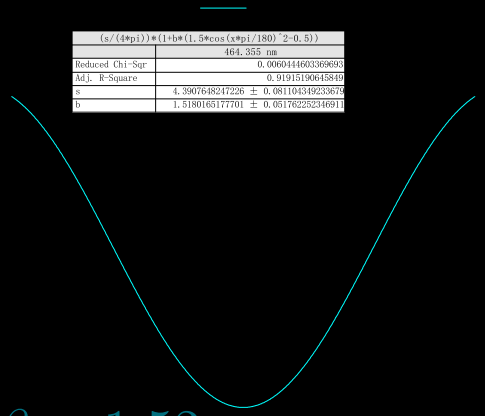




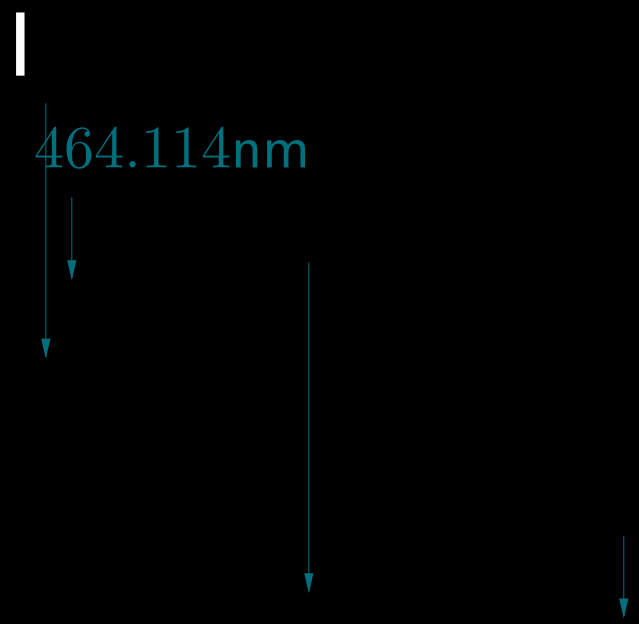




(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))	
	464.355 nm
Reduced Chi-Sqr	0.006044603369693
Adj. R-Square	0.9191519064584
s	4.3907648247226 ± 0.081104349233679
b	1.5180165177701 ± 0.051762252346911

$\beta \approx 1.52$

Peak 2



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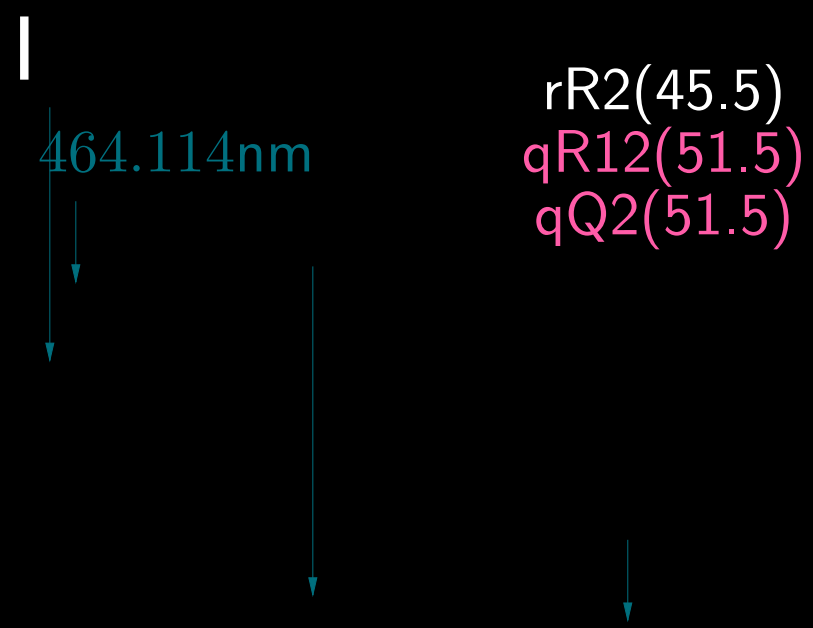
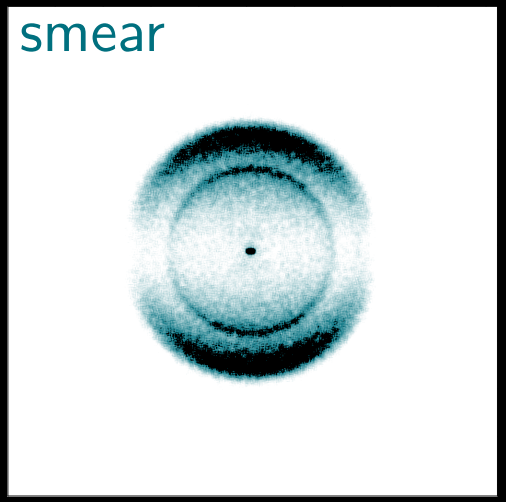
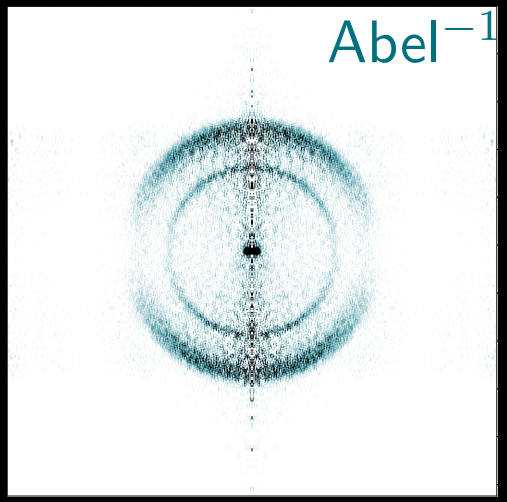
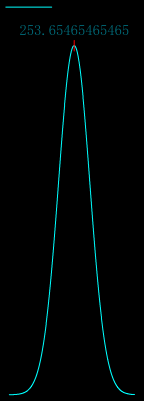


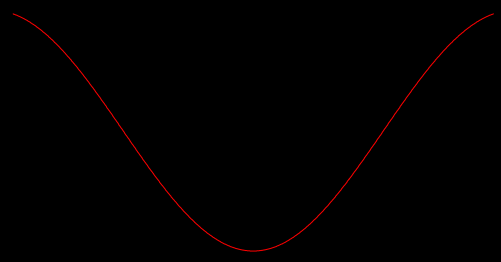
Peak 2





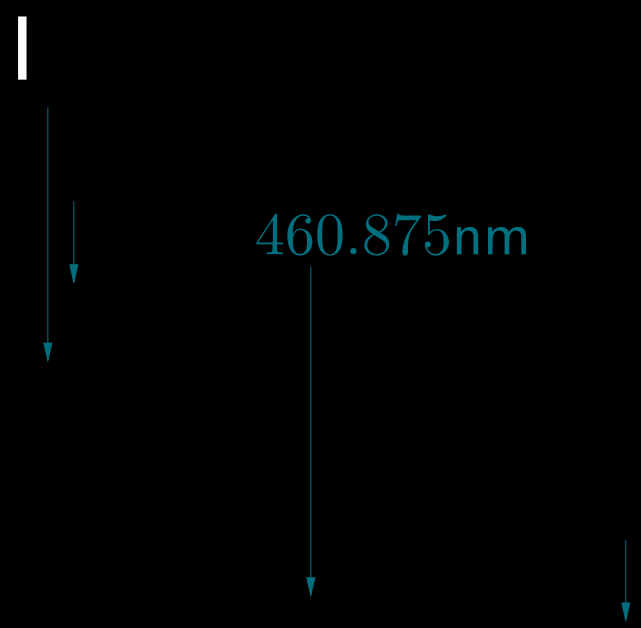


(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))	
	464.484 nm
Reduced Chi-Sq	0.010894933798294
Adj. R-Square	0.789707741391
s	4.1050335631855 ± 0.108550008226
b	1.2193264971086 ± 0.067352522218

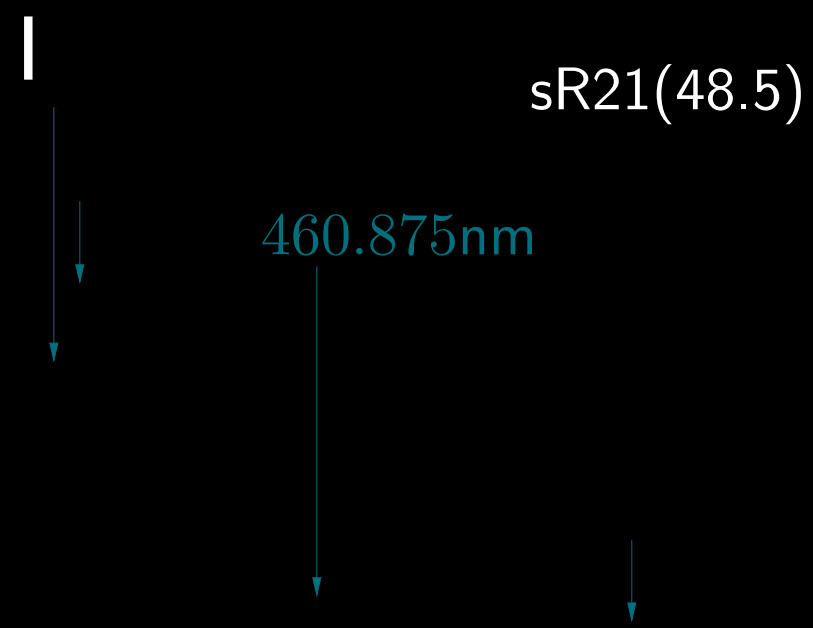


$\beta \approx 1.22$

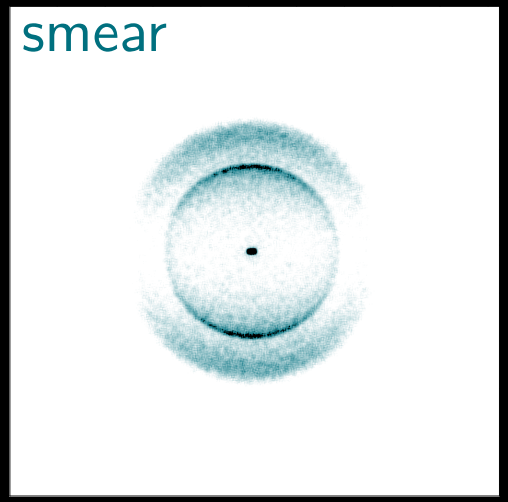
Peak 3

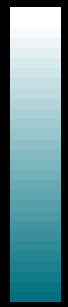


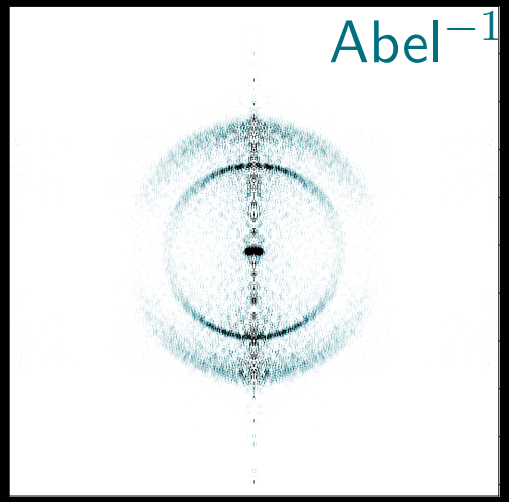
Peak 3

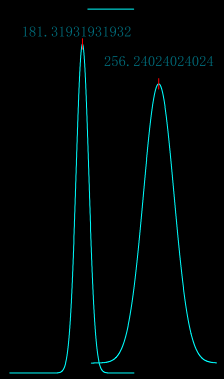


Peak 3

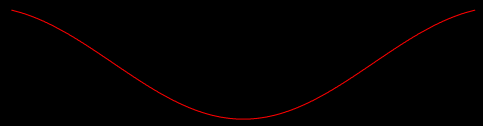






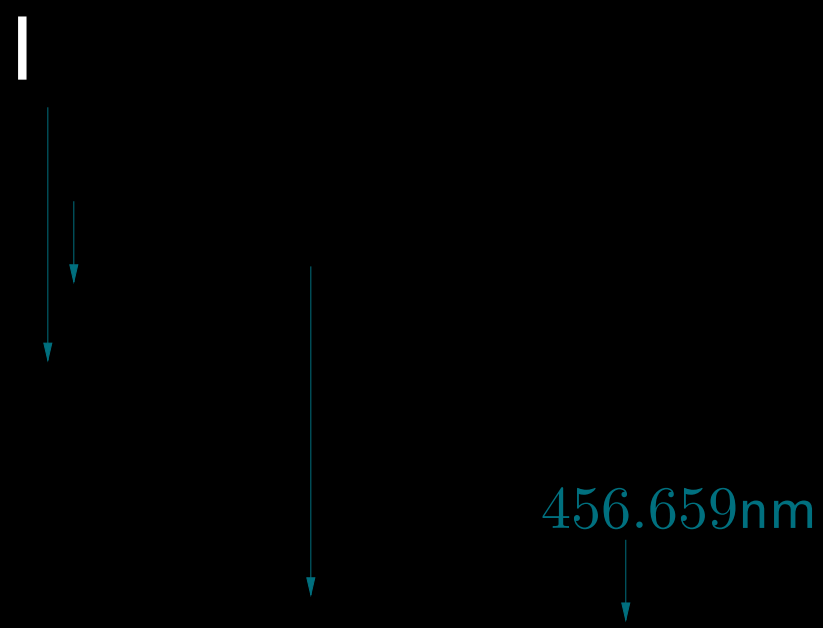


(s/(4*pi))*(1+b*(1.5*cos(x*pi/180)^2-0.5))	
	460.745 nm
Reduced Chi-Sqr	0.009006604812538
Adj. R-Square	0.482229047711
s	2.703678269771 ± 0.09900244758819
b	0.863963760626 ± 0.08589983039179

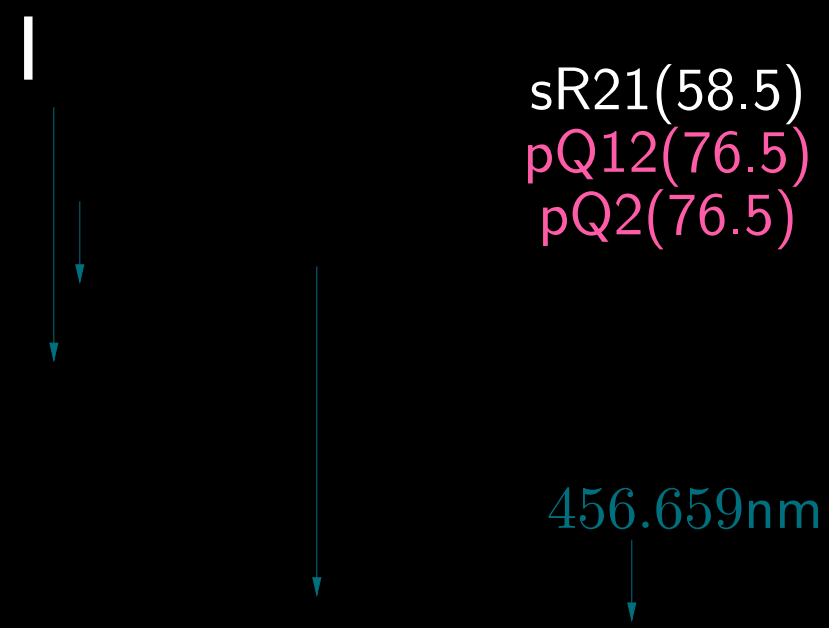


$\beta \approx 0.864$

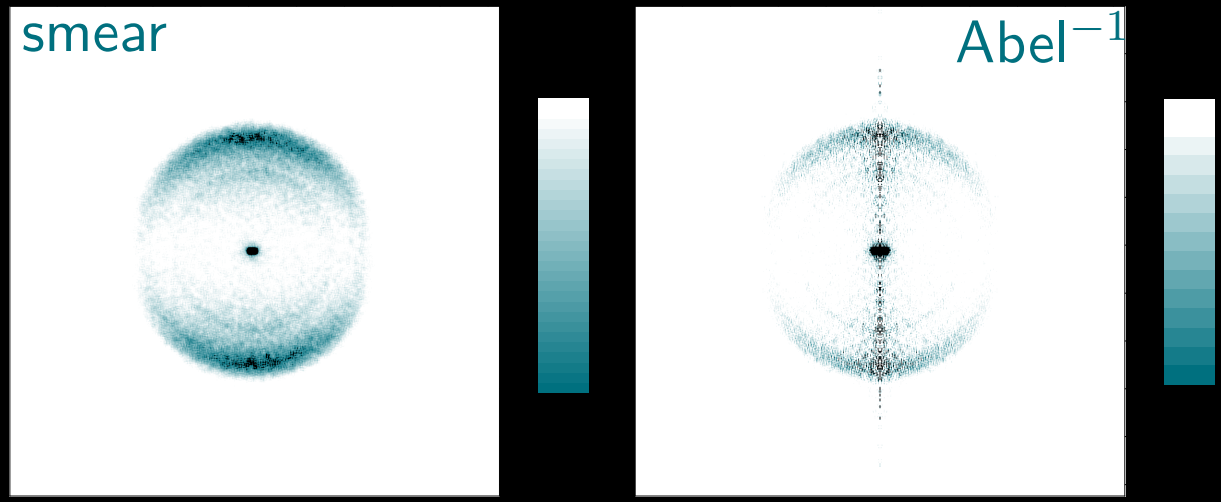
Peak 4

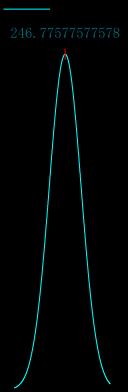


Peak 4



Peak 4





$\beta \approx 0.440$

(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

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 $= 253.162$	px $= 253.655$	px $= 181.319$ & 256.240	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

Trans. energy of NO

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

Trans. energy of NO

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

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

Speed correction

Trans. energy of NO

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

Vib. energy level

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

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

Speed correction

Trans. energy of NO

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

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

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

Speed correction

Trans. energy of NO

	E_{total}	$E_{\text{bond}}(\text{O}-\text{NO})$[3]	$E_{\text{int.}}(\text{NO})$
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}

Rot. energy level

Simulated data generated by PGOPHER[4].

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

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

Speed correction

Trans. energy of NO

$E_{\text{int.}}(\text{O})$ [5]	$E_{\text{trans}}(\text{total}) \approx 2.875464 E_{\text{trans}}(\text{NO})$ $= E_{\text{total}} - E_{\text{bond}}(\text{O}-\text{NO}) - E_{\text{int.}}(\text{O}) - E_{\text{int.}}(\text{NO})$	$E_{\text{trans}}(\text{NO})$ $= \frac{1}{2} m(\text{NO}) v^2(\text{NO})$
${}^3P_2$	11081.356cm^{-1}	4375.588cm^{-1}
	10964.609cm^{-1}	4334.685cm^{-1}
(0cm^{-1})	10794.143cm^{-1}	4344.824cm^{-1}
	9398.766cm^{-1}	3870.489cm^{-1}
${}^3P_1$	10922.731cm^{-1}	4320.423cm^{-1}
	10805.984cm^{-1}	4279.520cm^{-1}
(158.625cm^{-1})	10635.518cm^{-1}	4289.659cm^{-1}
	9240.141cm^{-1}	3815.324cm^{-1}
${}^3P_0$	10854.379cm^{-1}	4296.653cm^{-1}
	10737.632cm^{-1}	4255.749cm^{-1}
(226.977cm^{-1})	10567.166cm^{-1}	4265.888cm^{-1}
	9171.789cm^{-1}	3791.553cm^{-1}

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

Speed correction

Trans. speed of NO

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

Speed correction

Trans. speed of NO

$^3P_2$

$12.28\,\mathrm{m\,s^{-1}\,px^{-1}}$

Intercept $\approx -1265\,\mathrm{m\,s^{-1}}$

$^3P_1$

$12.37\,\mathrm{m\,s^{-1}\,px^{-1}}$

Intercept $\approx -1298\,\mathrm{m\,s^{-1}}$

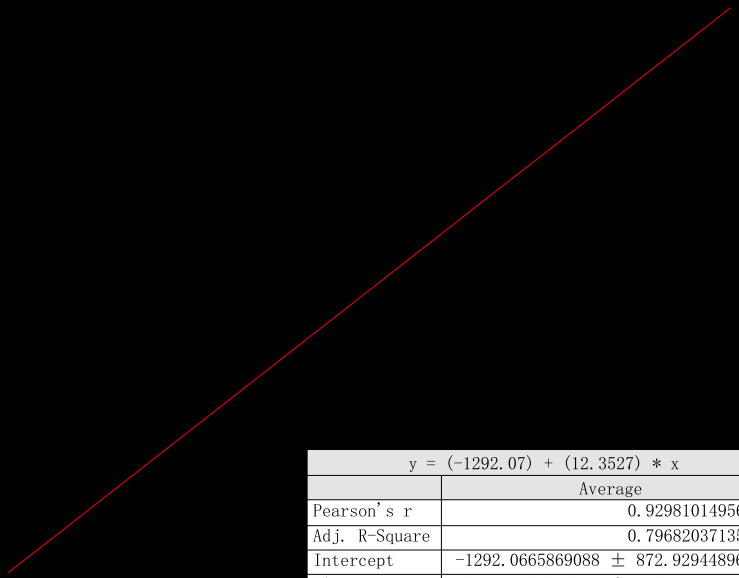
$^3P_0$

$12.40\,\mathrm{m\,s^{-1}\,px^{-1}}$

Intercept $\approx -1313\,\mathrm{m\,s^{-1}}$

Speed correction

Trans. speed of NO



y = (-1292.07) + (12.3527) * x	
	Average
Pearson's r	0.92981014956771
Adj. R-Square	0.79682037135719
Intercept	-1292.0665869088 ± 872.92944896065
Slope	12.352746174772 ± 3.4573925259599

Average

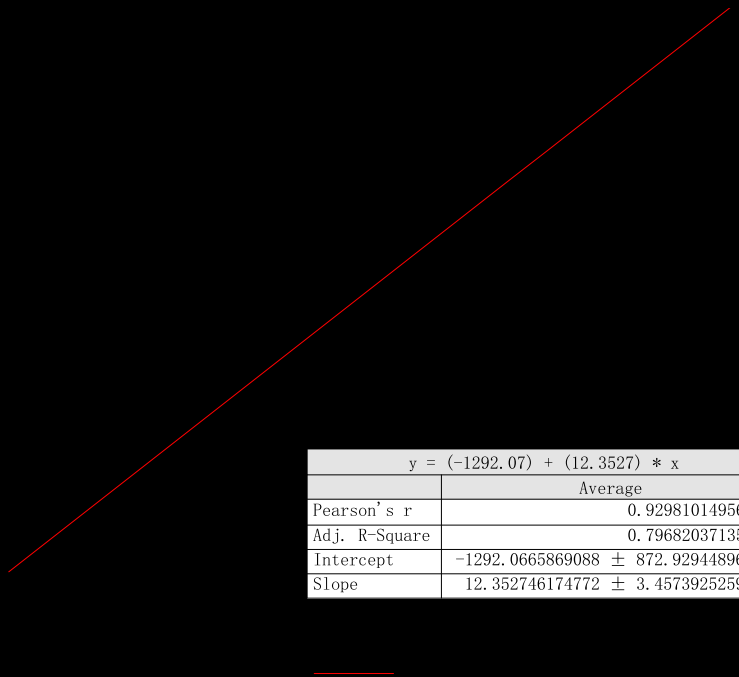
$12.35\,\mathrm{m\,s^{-1}\,px^{-1}}$

Intercept $\approx -1292\,\mathrm{m\,s^{-1}}$

Contents

Contents

Error



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Average

$12.35\,\mathrm{m\,s^{-1}\,px^{-1}}$

Intercept ≈ -1292

Error

[a] Maybe a $\pm 5\,\mathrm{m\,s^{-1}}$-level intercept noise are permitted.

Error

Average
$12.35\,\mathrm{m\,s^{-1}\,px^{-1}}$
Intercept $\approx -1292\,\mathrm{m\,s^{-1}}$

[a] Maybe a $\pm 5\,\mathrm{m\,s^{-1}}$-level intercept noise are permitted.

Error

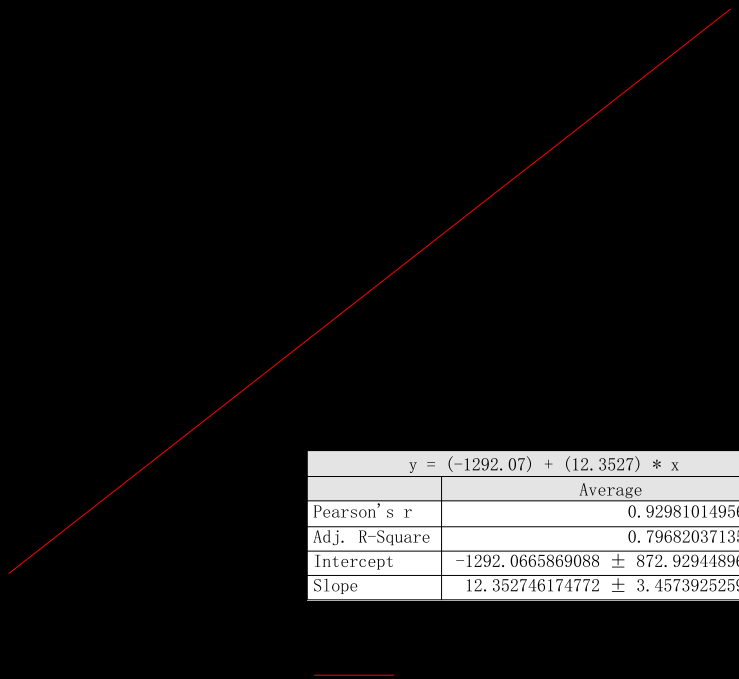
Average
$12.35\mathrm{m\,s^{-1}\,px^{-1}}$
Intercept $\approx -1292\mathrm{m\,s^{-1}}$

Notice

What we are calculating here are actually $|\mathbf{v}_{\mathrm{NO}}|$, which are not supposed to be minus [a].

[a] Maybe a $\pm 5\mathrm{m\,s^{-1}}$-level intercept noise are permitted.

Error



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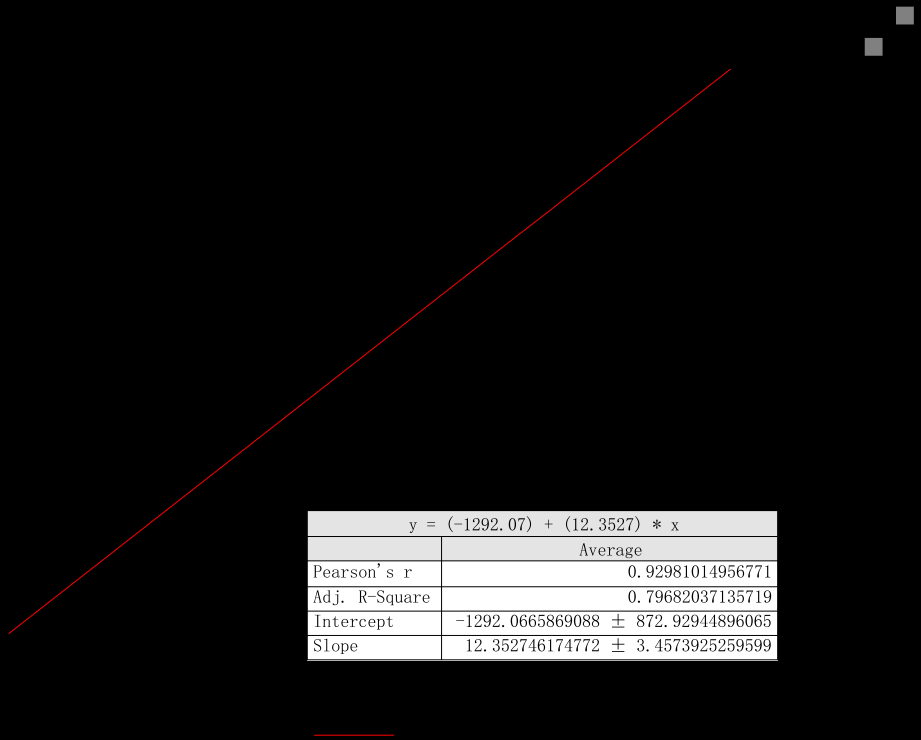

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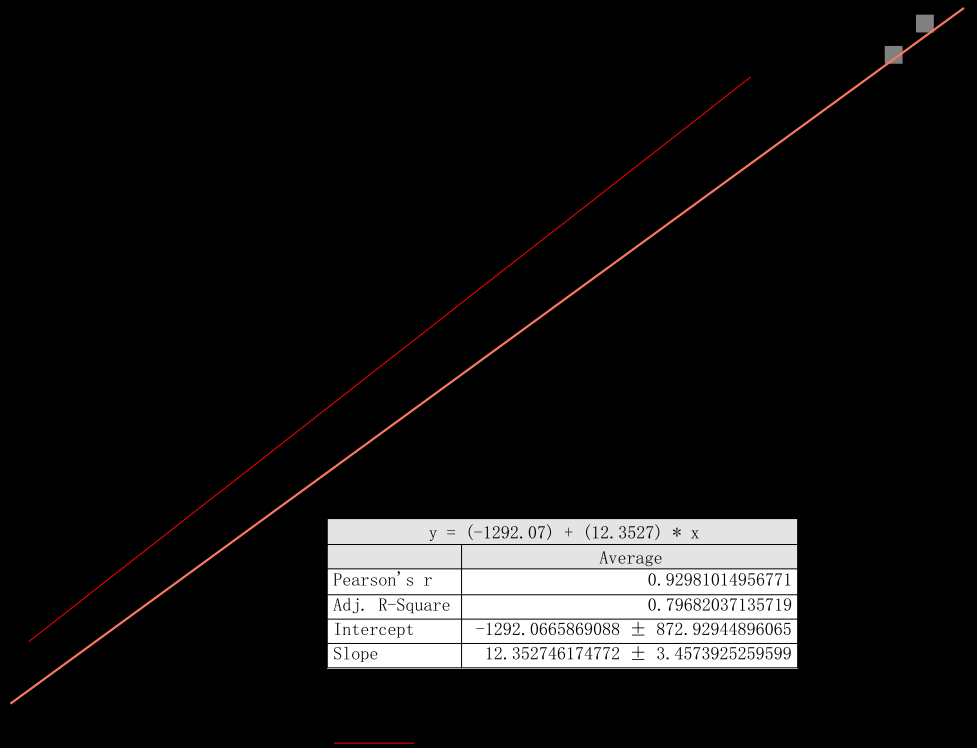
Error



y = (-1292.07) + (12.3527) * x	
	Average
Pearson's r	0.92981014956771
Adj. R-Square	0.79682037135719
Intercept	-1292.0665869088 ± 872.92944896065
Slope	12.352746174772 ± 3.4573925259599

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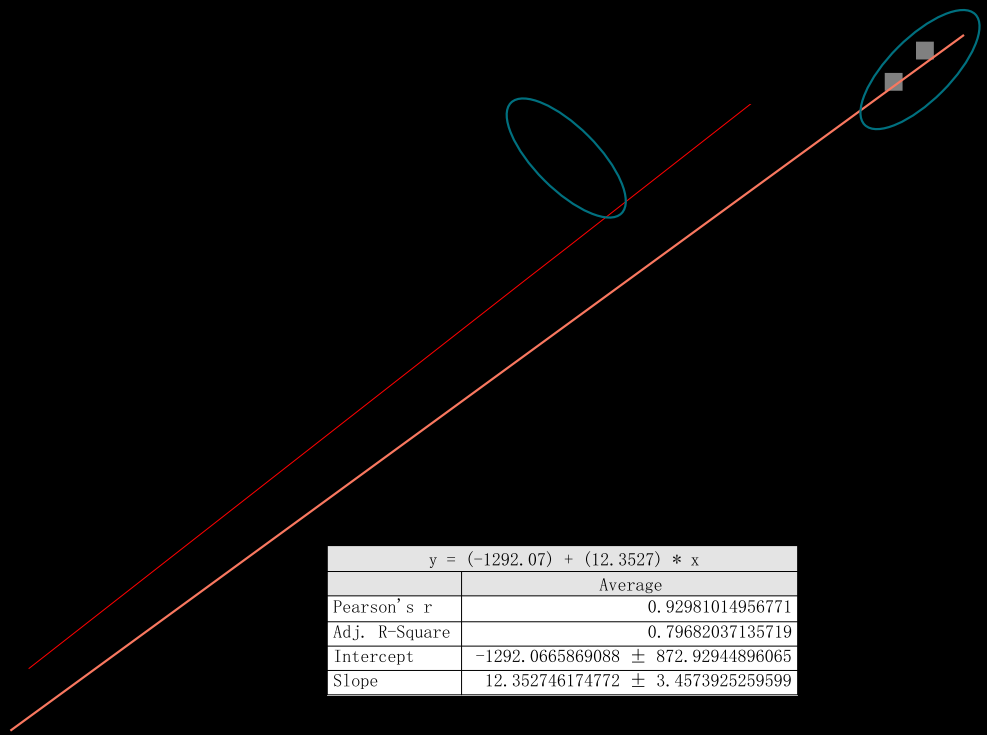

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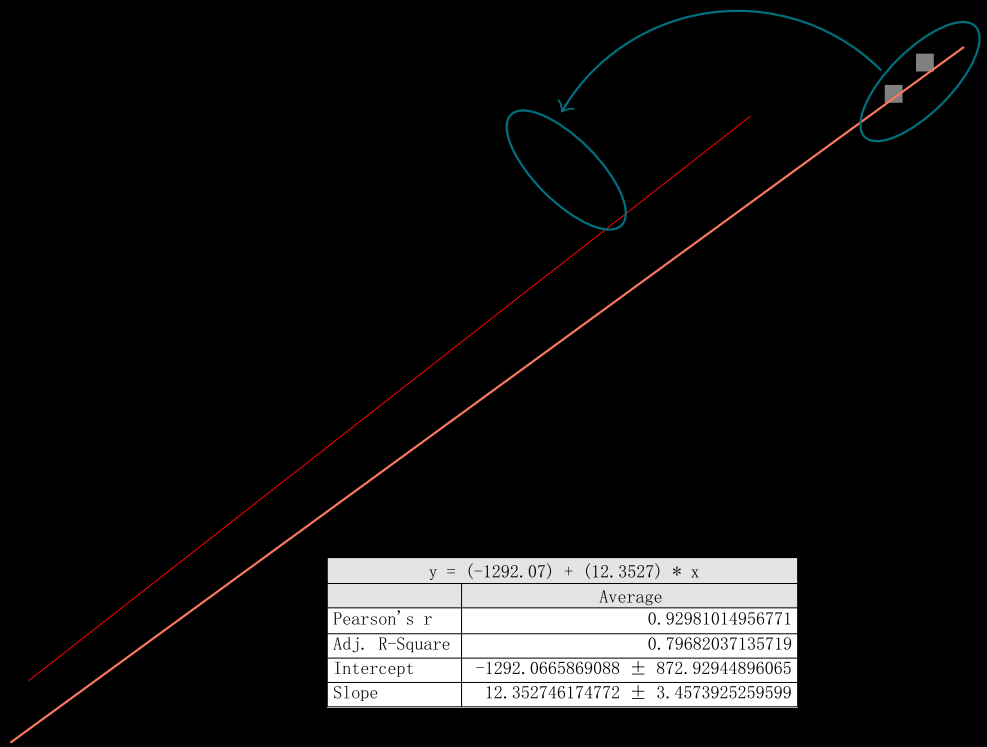

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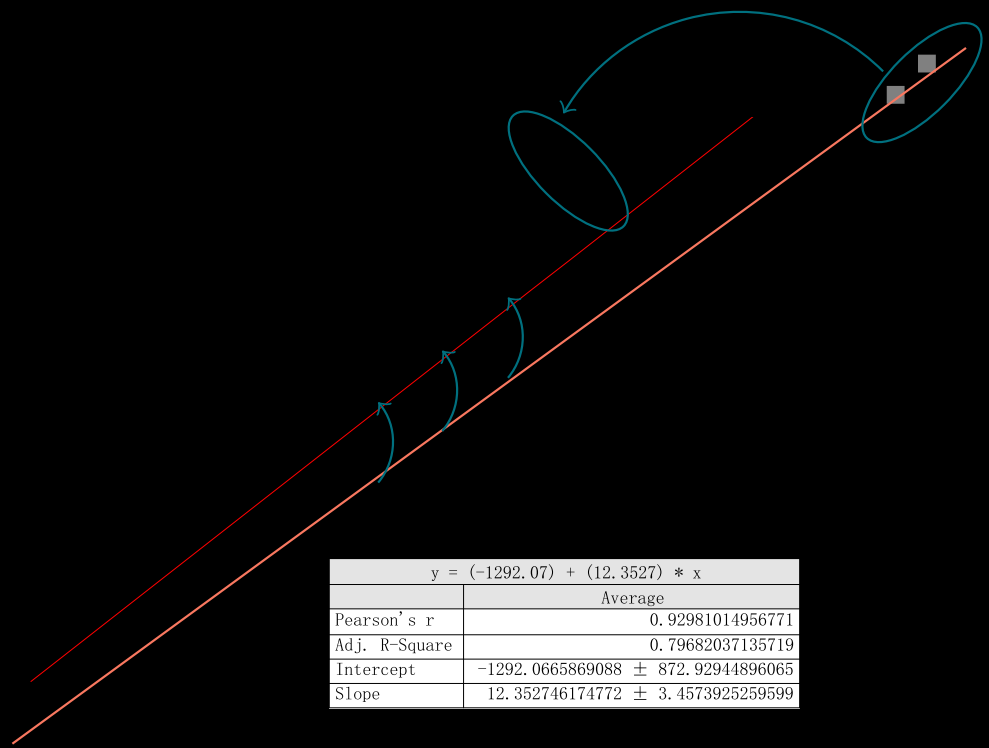

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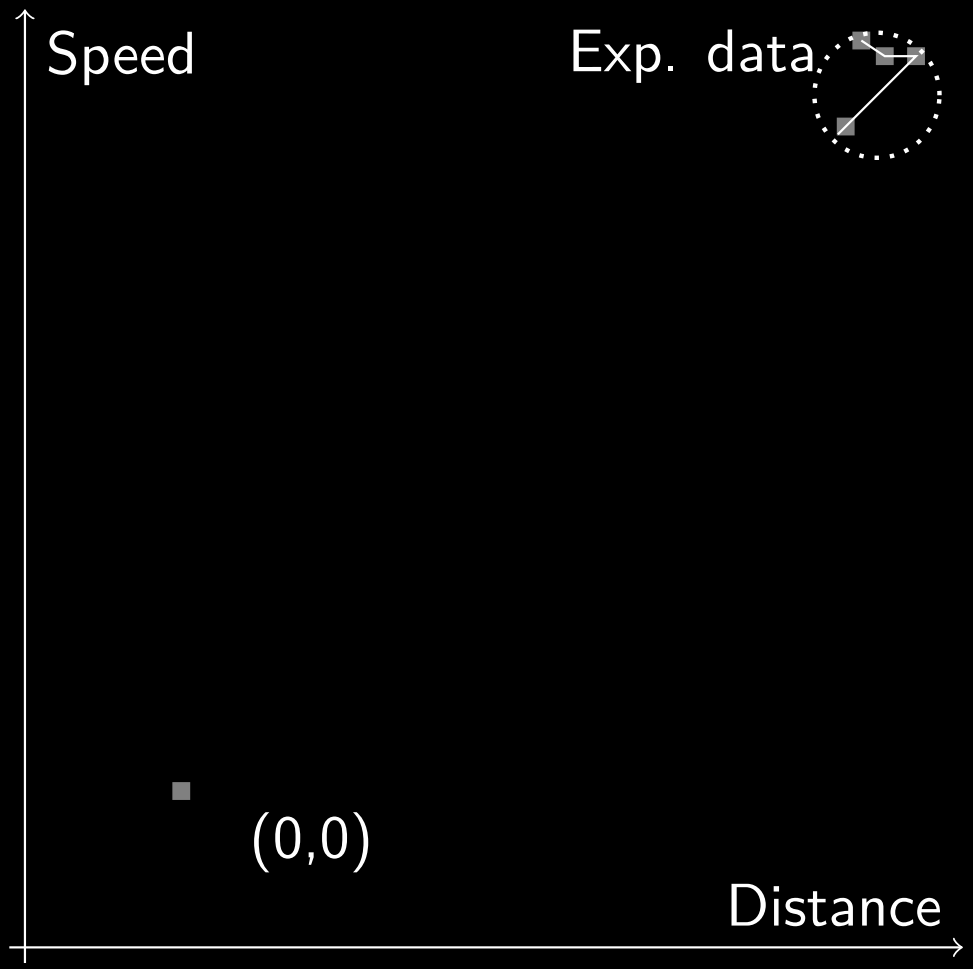

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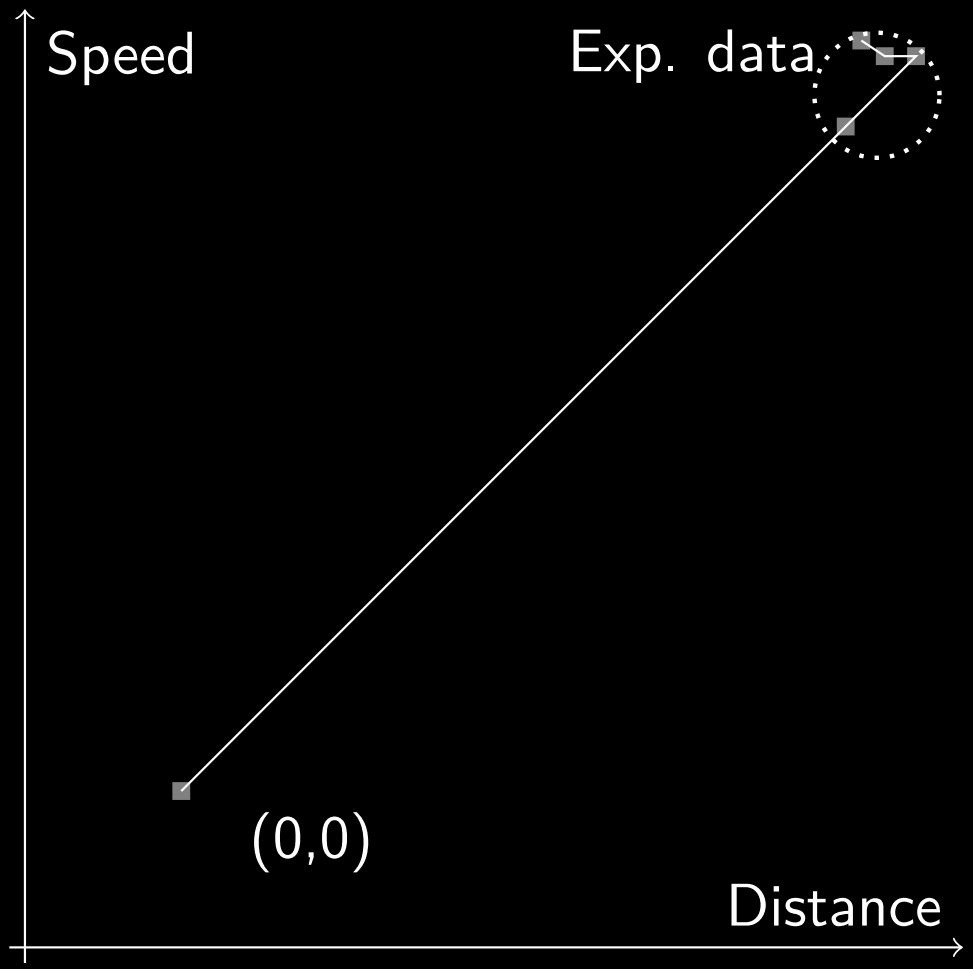

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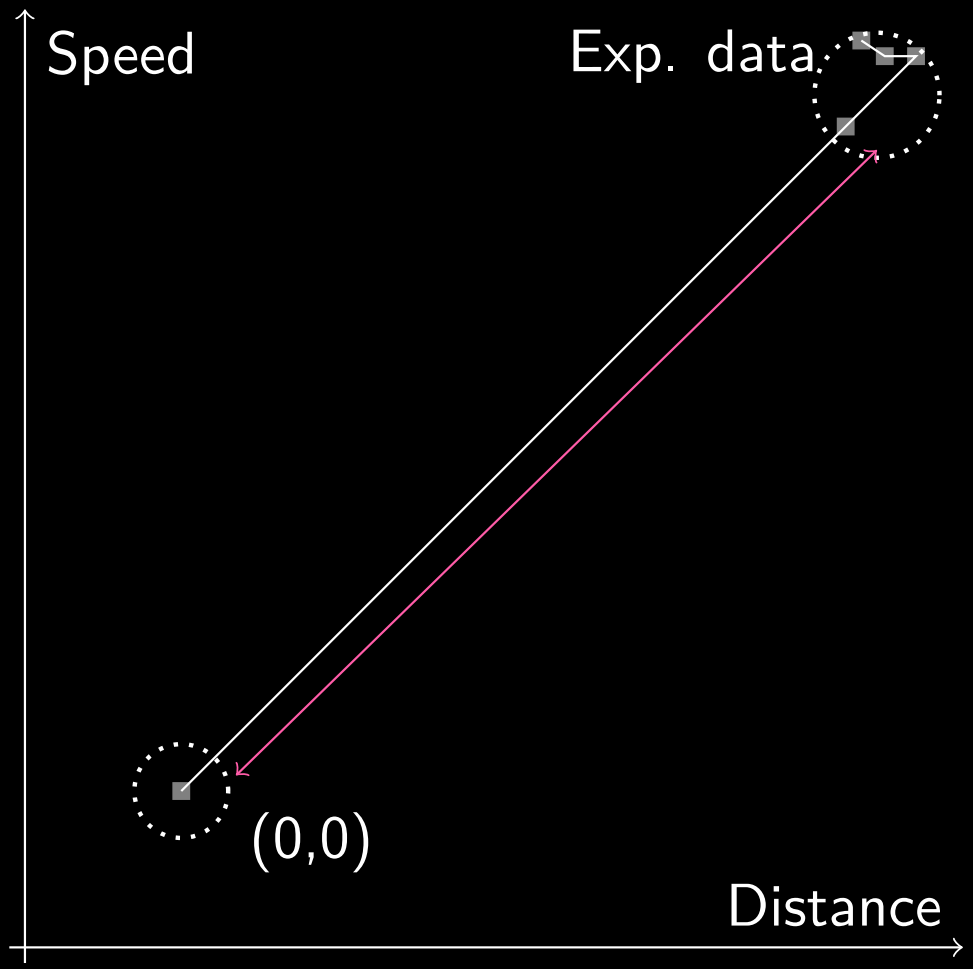

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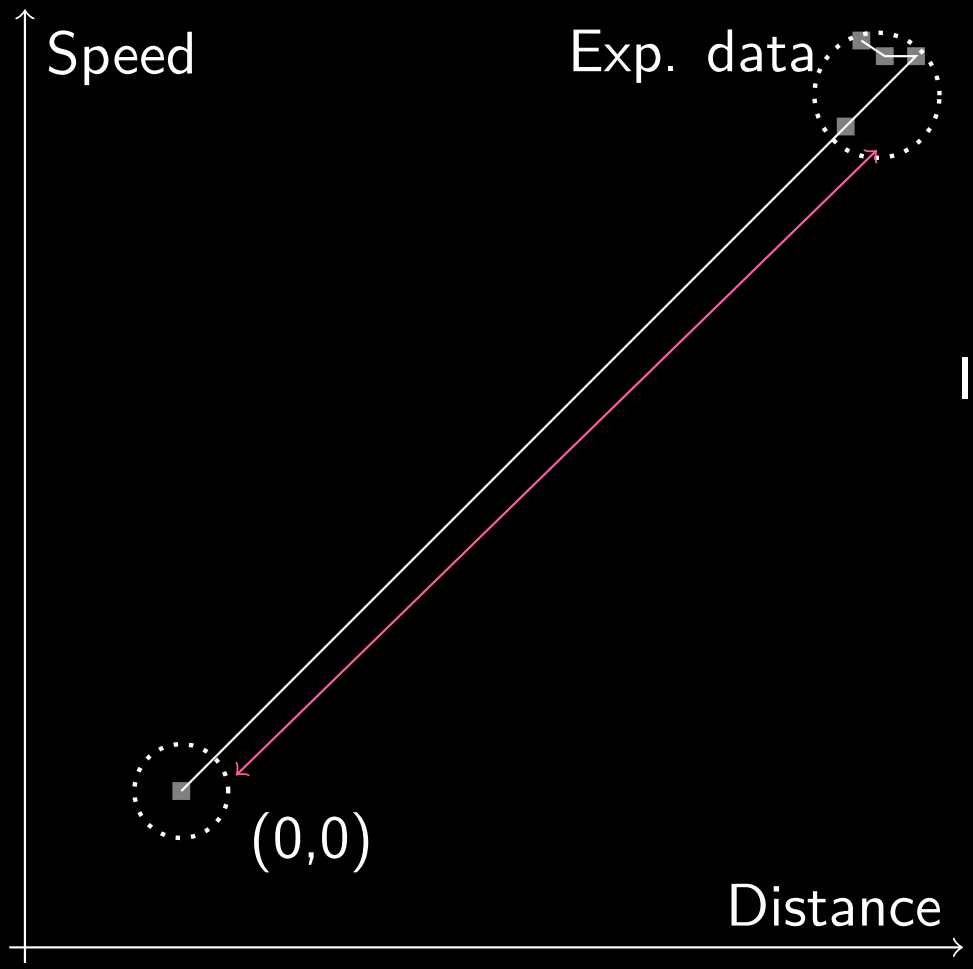
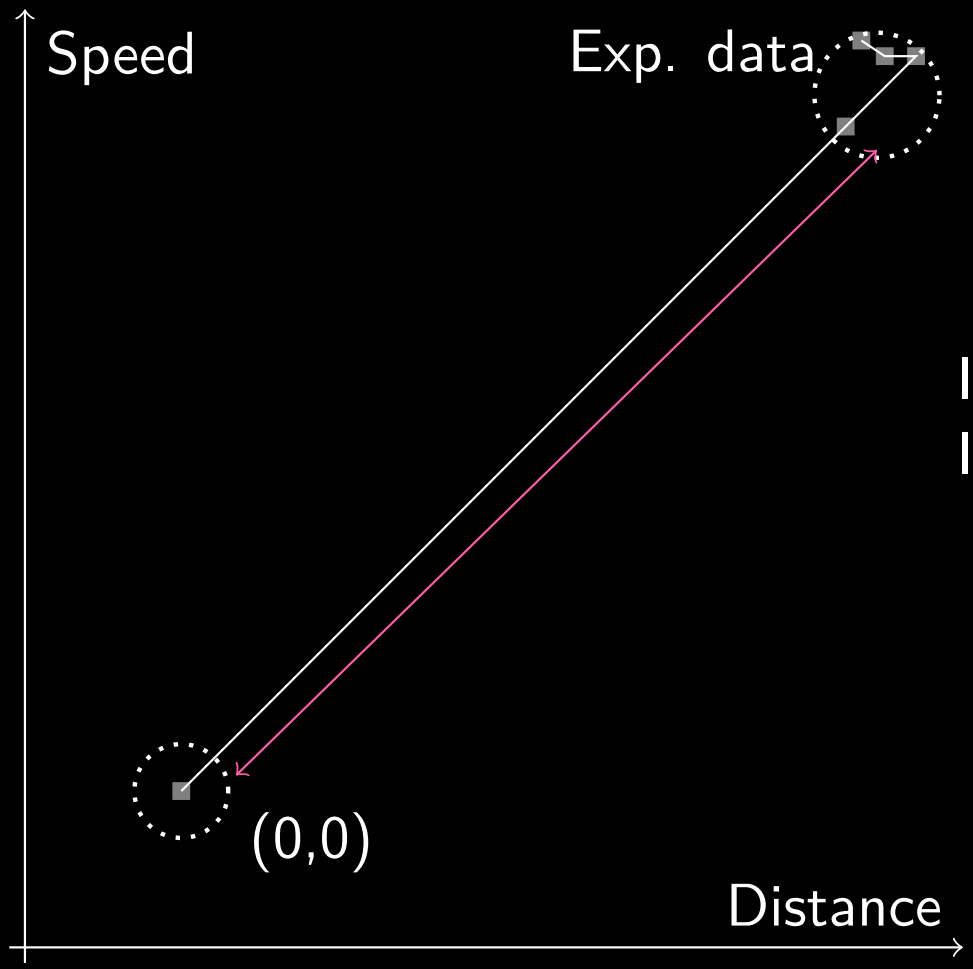


If we assume a zero point:

Error



If we assume a zero point:
It obtains a huge weight!

Reference

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

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

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