



Stellar Parallax  
Freshman Seminar 131

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2025

## Data from Days Gone By using MaximDL

Date	$t$ (years)	$x$ (pixels)	$y$ (pixels)
2012-06-21	-0.494	681.56	639.56
2013-06-06	0.461	680.42	657.00
2013-09-05	0.715	678.68	661.21
2014-04-10	1.307	679.42	671.82
2014-07-05	1.547	677.87	676.72
2014-10-27	1.844	676.81	681.75

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- $t$  is time in years
- Unknowns:  $x_0$ ,  $v_x$ ,  $a$ ,  $y_0$ ,  $v_y$ , and  $b$
- 1 pixel = 0.575 arcseconds
- $a$  = parallax
- $\sqrt{v_x^2 + v_y^2}$  = proper motion
- $\tan^{-1}(b/a)$  = orbital inclination

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$$\text{distance} = 1/\text{parallax} = 1.83 \text{ parsec}$$

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$$x(t) = x_0 + v_x t + a \sin(2\pi t)$$

$$y(t) = y_0 + v_y t + b \cos(2\pi t)$$

- $t$  is time in years
- Unknowns:  $x_0$ ,  $v_x$ ,  $a$ ,  $y_0$ ,  $v_y$ , and  $b$
- 1 pixel = 0.575 arcseconds
- $a$  = parallax
- $\sqrt{v_x^2 + v_y^2}$  = proper motion
- $\tan^{-1}(b/a)$  = orbital inclination

$$\text{distance} = 1/\text{parallax} = 1.83 \text{ parsec}$$

$$\text{proper motion} = 10.6 \text{ arcsec/yr}$$

## Data from Two Years Ago using MaximDL

Date	$t$ (years)	$x$ (pixels)	$y$ (pixels)
2012-06-21	-0.494	681.48	639.48
2013-06-06	0.461	680.33	657.00
2013-09-05	0.715	678.54	661.18
2014-04-10	1.307	679.39	672.09
2014-07-05	1.547	677.76	676.81
2014-10-27	1.844	676.66	681.51

$$x(t) = x_0 + v_x t + a \sin(2\pi t)$$

$$y(t) = y_0 + v_y t + b \cos(2\pi t)$$

- $t$  is time in years
- Unknowns:  $x_0$ ,  $v_x$ ,  $a$ ,  $y_0$ ,  $v_y$ , and  $b$
- 1 pixel = 0.575 arcseconds
- $a$  = parallax
- $\sqrt{v_x^2 + v_y^2}$  = proper motion
- $\tan^{-1}(b/a)$  = orbital inclination

$$\text{distance} = 1/\text{parallax} = 1.71 \text{ parsec}$$

$$\text{proper motion} = 10.6 \text{ arcsec/yr}$$

## Data from One Year Ago using StackImages.py

Date	$t$ (years)	$x$ (pixels)	$y$ (pixels)
2012-06-21	-0.494	758.95	649.41
2013-06-06	0.461	758.24	665.87
2013-09-05	0.715	756.69	669.24
2014-04-10	1.307	758.11	679.03
2014-07-05	1.547	756.82	684.50
2014-10-27	1.844	756.31	690.32

$$x(t) = x_0 + v_x t + a \sin(2\pi t)$$

$$y(t) = y_0 + v_y t + b \cos(2\pi t)$$

- $t$  is time in years
- Unknowns:  $x_0$ ,  $v_x$ ,  $a$ ,  $y_0$ ,  $v_y$ , and  $b$
- 1 pixel = 0.575 arcseconds
- $a$  = parallax
- $\sqrt{v_x^2 + v_y^2}$  = proper motion
- $\tan^{-1}(b/a)$  = orbital inclination

$$\text{distance} = 1/\text{parallax} = 1.90 \text{ parsec}$$

$$\text{proper motion} = 9.9 \text{ arcsec/yr}$$

## Data from Today using StackImages.py

Date	$t$ (years)	$x$ (pixels)	$y$ (pixels)
2012-06-21	-0.494	741.95	649.41
2013-06-06	0.461	741.47	666.47
2013-09-05	0.715	739.60	670.57
2014-04-10	1.307	741.10	680.18
2014-07-05	1.547	739.84	685.55
2014-10-27	1.844	738.82	690.55

$$x(t) = x_0 + v_x t + a \sin(2\pi t)$$

$$y(t) = y_0 + v_y t + b \cos(2\pi t)$$

- $t$  is time in years
- Unknowns:  $x_0$ ,  $v_x$ ,  $a$ ,  $y_0$ ,  $v_y$ , and  $b$
- 1 pixel = 0.575 arcseconds
- $a$  = parallax
- $\sqrt{v_x^2 + v_y^2}$  = proper motion
- $\tan^{-1}(b/a)$  = orbital inclination

$$\text{distance} = 1/\text{parallax} = 1.61 \text{ parsec}$$

$$\text{proper motion} = 10.1 \text{ arcsec/yr}$$



RA: 17h59m14.53s DE:+04°45'48.3"  
 Az:+199°30'45.1° Alt:+89°19'28.6"

RA: 17h58m59.70s DE:+04°45'48.3" Star: BD+04 3561a Visual magnitude: 9.539 Colour index B-V: 1.57  
 Rise:10h05m43s Az:85°10' Culmination: 16h08m50s Set: 22h11m58s Az:274°50' LHA: 0h01m

## Python Code

```
from numpy import *

t = array([ -0.494,  0.461,  0.715,  1.307,  1.547,  1.844 ])
x = array([ 741.95 , 741.47 , 739.60 , 741.10 , 739.84 , 738.82  ])
y = array([ 649.41 , 666.47 , 670.57 , 680.18 , 685.55 , 690.55  ])

o = ones(6)
A = vstack([o, t, sin(2*pi*t)]).T
(x0, vx, a) = linalg.lstsq(A,x,rcond=None)[0]
A = vstack([o, t, cos(2*pi*t)]).T
(y0, vy, b) = linalg.lstsq(A,y,rcond=None)[0]

pixres = 0.575

print('x0 = ',x0, 'y0 = ',y0)
print('vx = ',vx, 'vy = ',vy)
print(' a = ',a, ' b = ',b)
print('orbital inclination = ', arctan(b/a)*180/pi, ' degrees')
print('parallax = ', a*pixres, ' arcseconds')
print('Distance to Barnards star = ', 1/(a*pixres), ' parsec')
print('Proper motion = ', sqrt(vx**2 + vy**2)*pixres, 'arcsec/yr')
```