Orbital motion

PHYS 246 class 4

https://lkwagner.github.io/IntroductionToComputationalPhysics/intro.html

Announcements/notes

```
from google.colab import drive
drive.mount('/content/drive')
!cp /content/drive/MyDrive/Colab\ Notebooks/Dynamics.ipynb ./
!jupyter nbconvert --to HTML "Dynamics.ipynb"
```

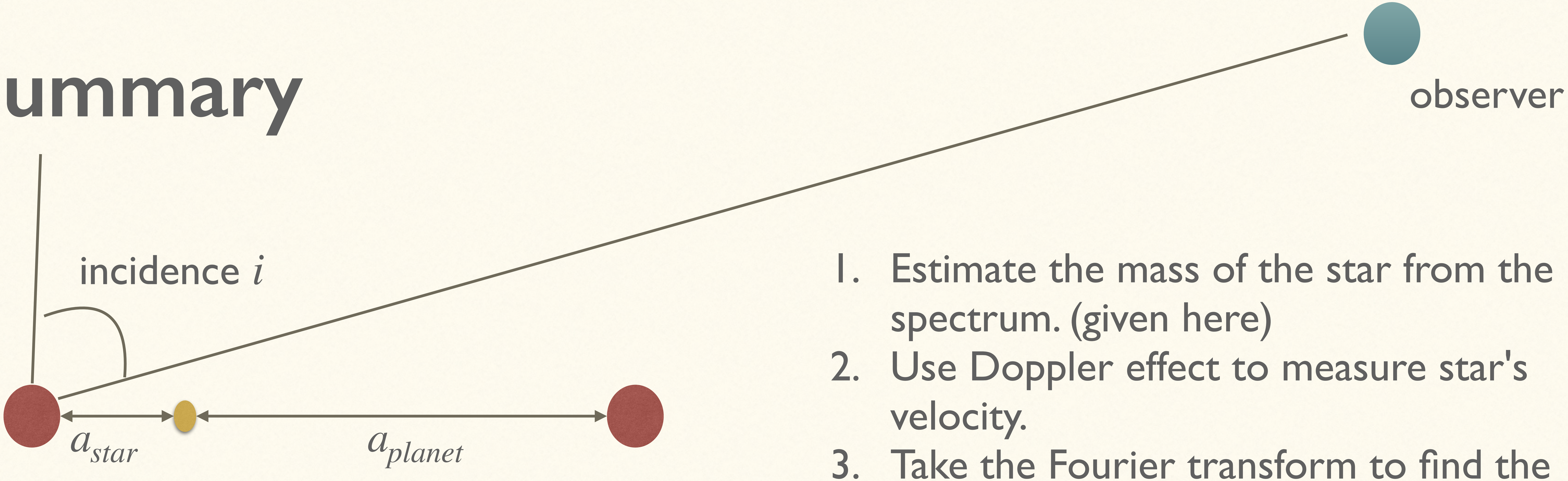
- 'Orbital dynamics' is due tonight on canvas

- PDF uploads are required to be graded. Ungradeable submissions will not get credit (most people did fine!)
- Late homework is accepted only if you contact us beforehand.

- Class is supposed to be mainly for the topic of the day, not to finish your homework. If this becomes a problem, we will adjust the due date.

- For today there is a 'short' and a 'long' version. Both are ok. Long has a LOT of exposition.

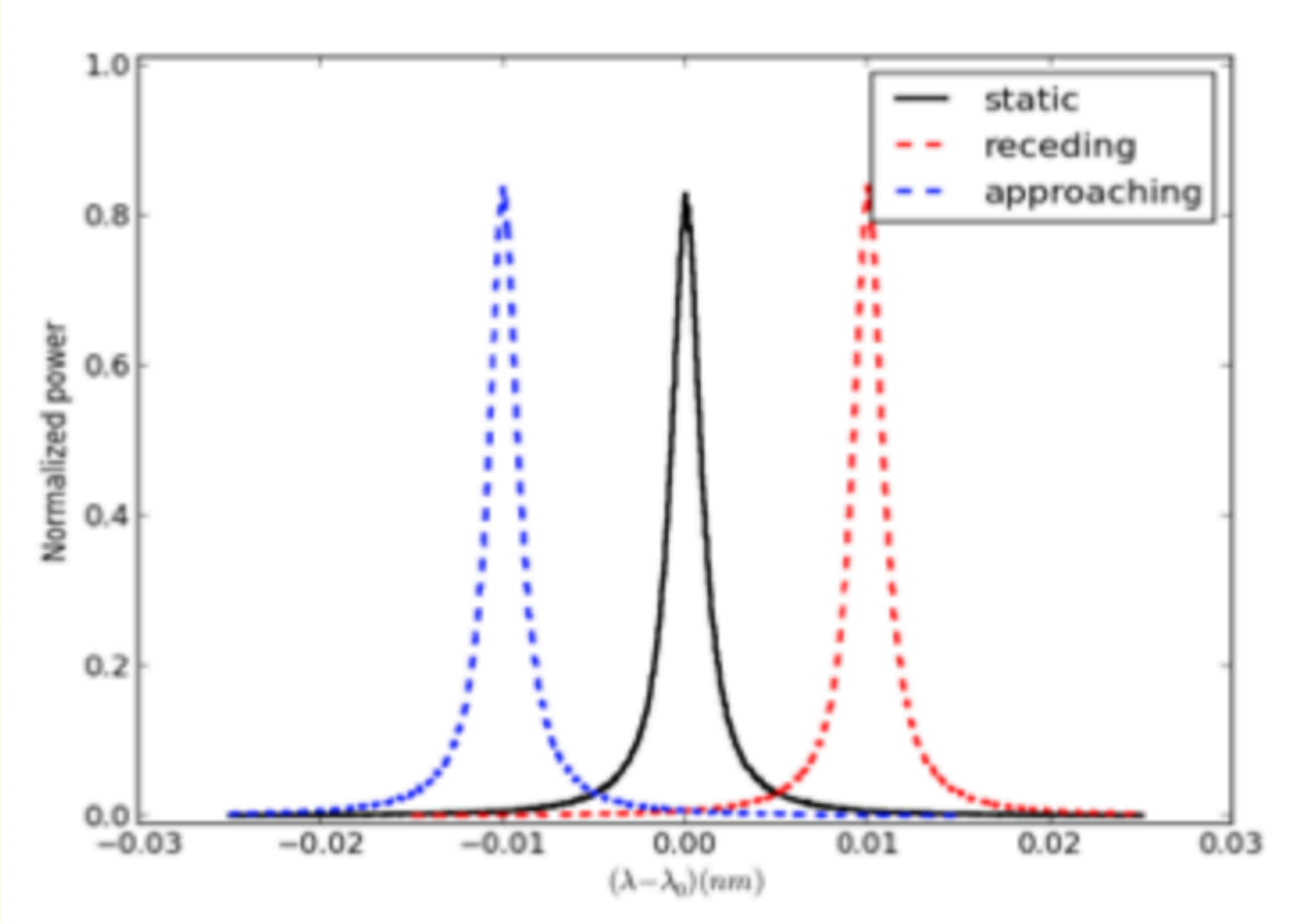
Summary



1. Estimate the mass of the star from the spectrum. (given here)
2. Use Doppler effect to measure star's velocity.
3. Take the Fourier transform to find the period of the star's velocity P
4. Use the max velocity, mass, and period to estimate the planet's mass.

$$m_{\text{projected}} = \left(\frac{m_{\text{star}}^2 P}{2\pi G}\right)^{1/3} v_r$$

Doppler effect: measuring relative velocities

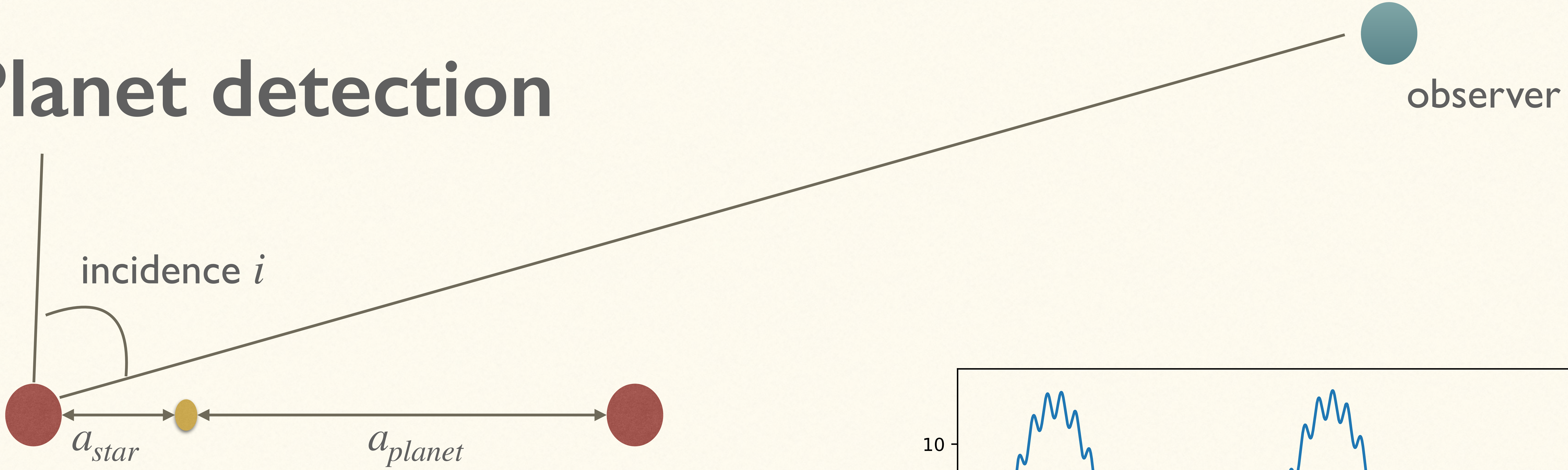


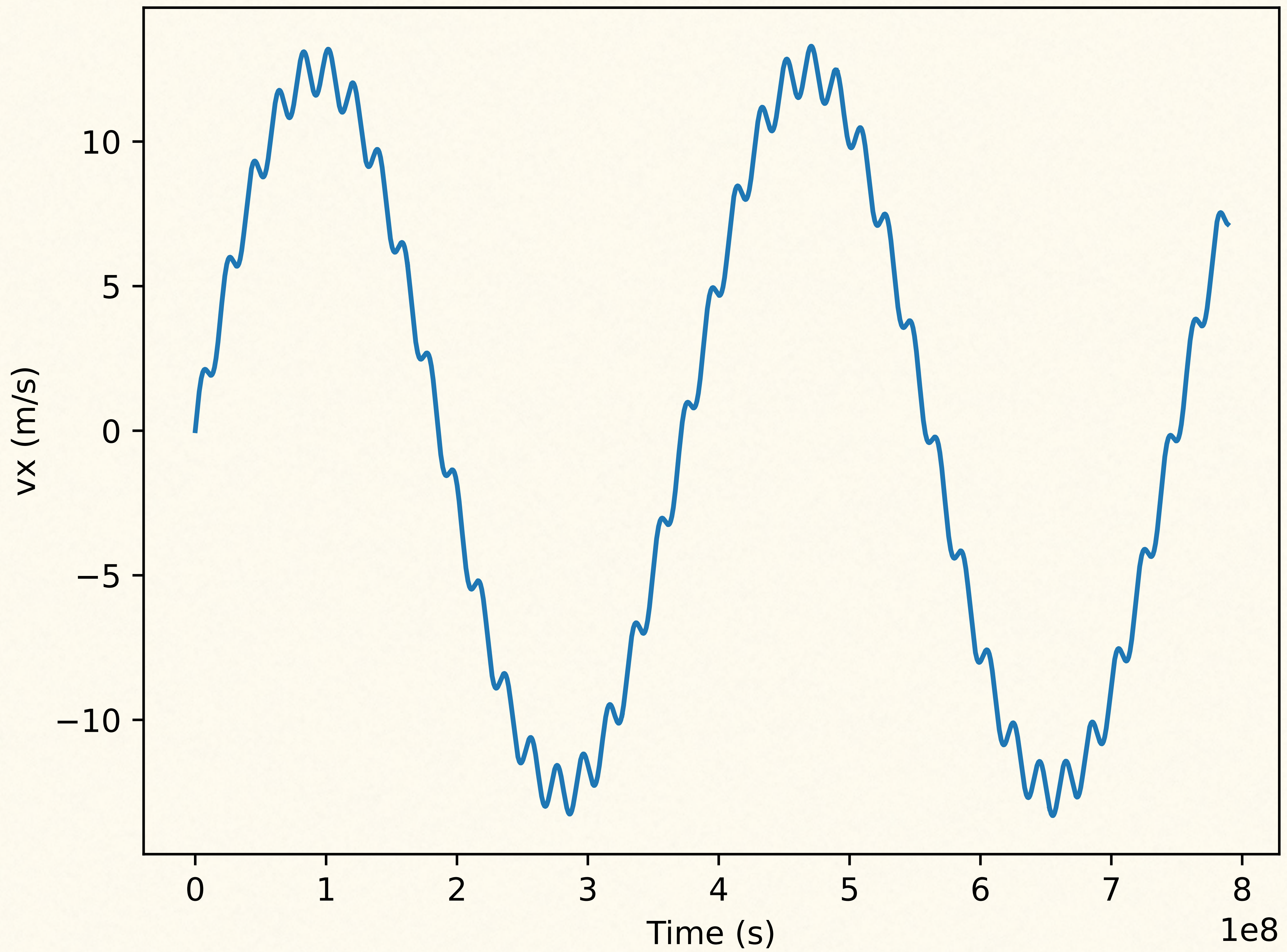
$$\frac{\lambda_{\text{observed}} - \lambda_{\text{source}}}{\lambda_{\text{source}}} = \frac{v_r}{c}$$

"Redshift" vs "blueshift"

This is also how we know the universe is expanding!

Planet detection





Fourier transform

Would like to write a general function as

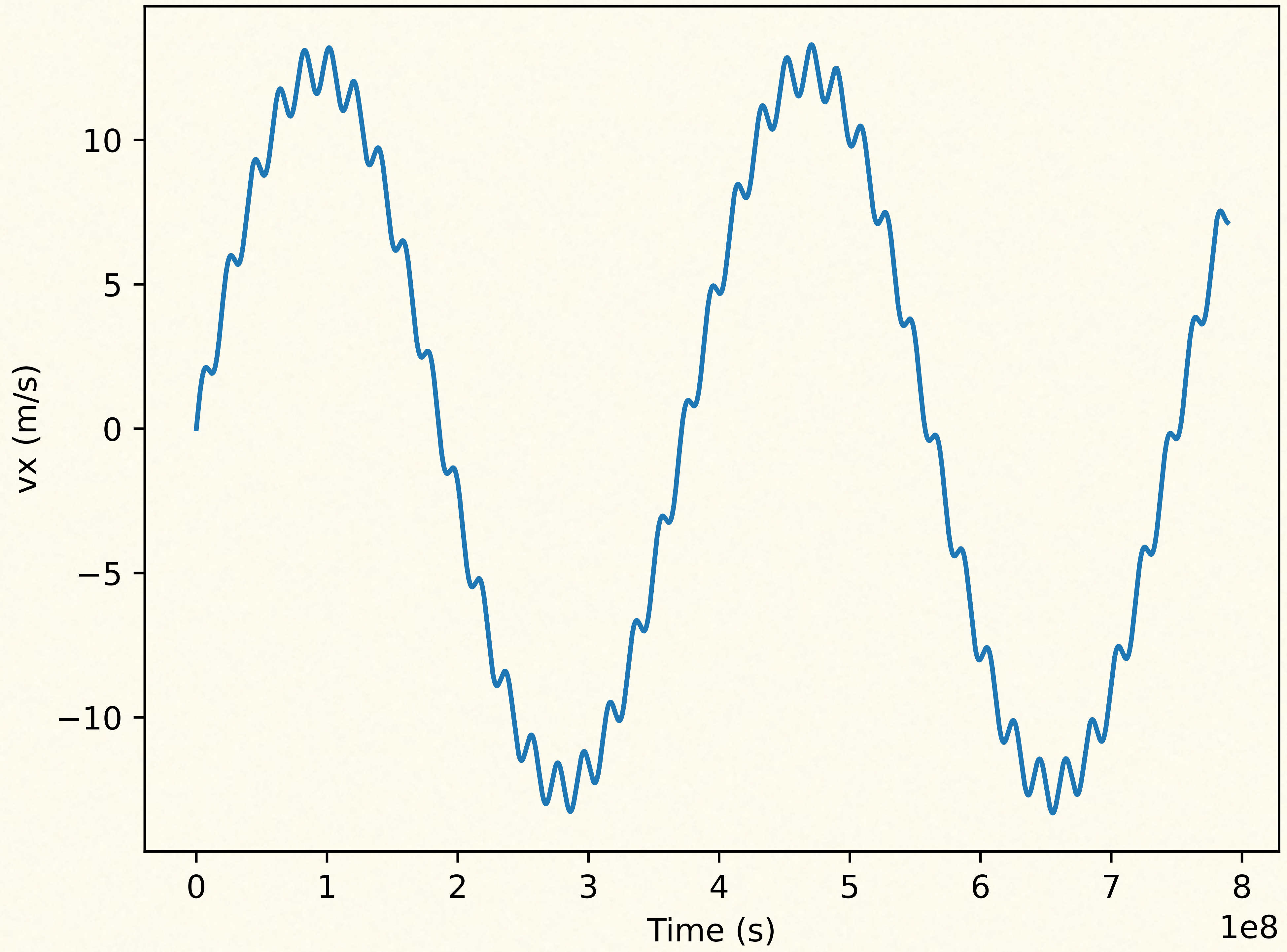
$$f(x) = \sum_k c_k e^{ikx}$$

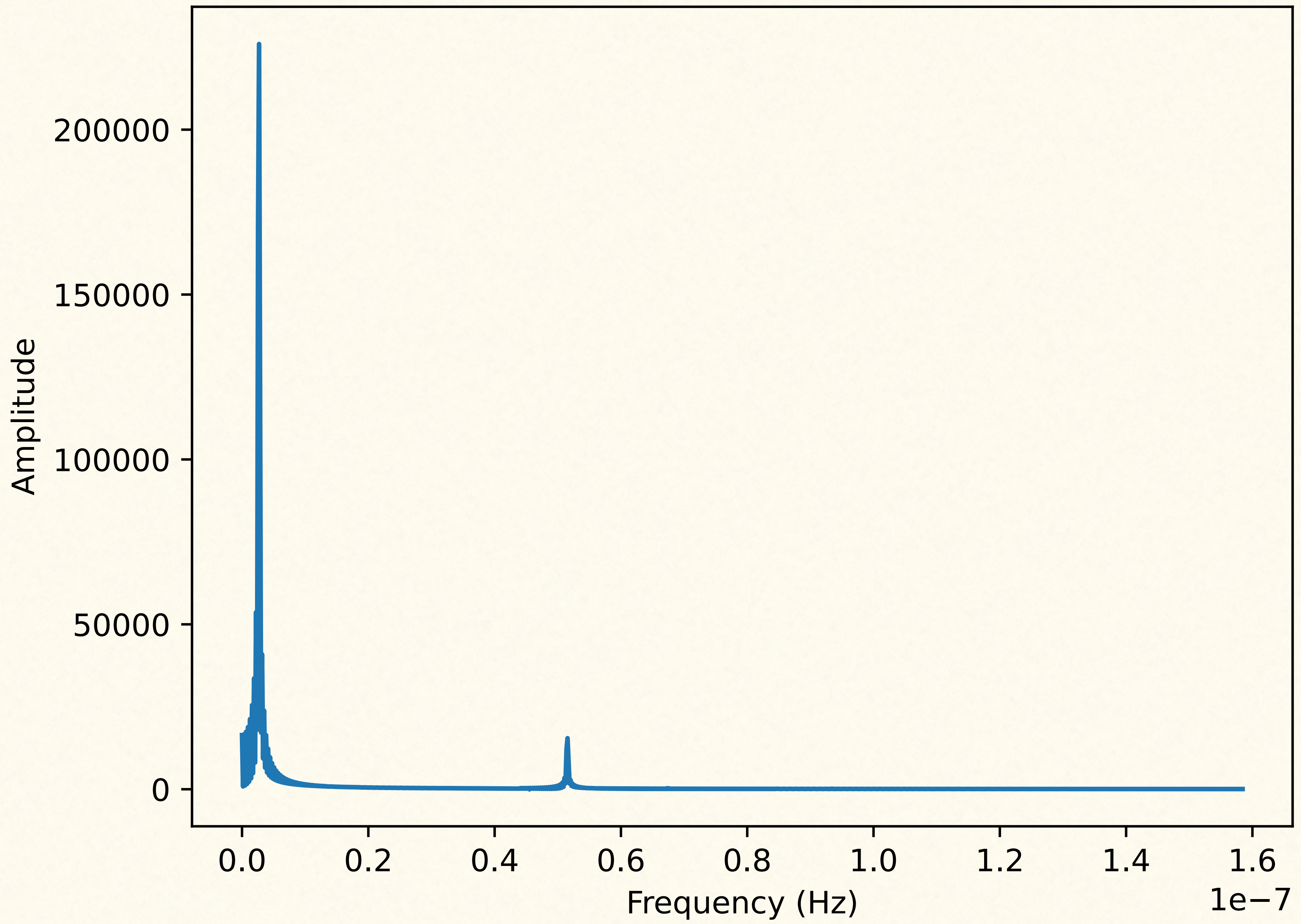
Note that

$$\int e^{-ikx} e^{ik'x} dx = \delta(k - k')$$

So

$$c_k = \int e^{-ikx} f(x) dx$$





Useful things

```
>>> x= np.arange(0,3)
>>> x
array([0, 1, 2])
>>> y = np.arange(5,9)
>>> y
array([5, 6, 7, 8])
>>> x[:,np.newaxis] + y[np.newaxis,:]
array([[ 5,  6,  7,  8],
       [ 6,  7,  8,  9],
       [ 7,  8,  9, 10]])
>>>
```

np.newaxis
np.linspace

Be careful about time units.