HW4

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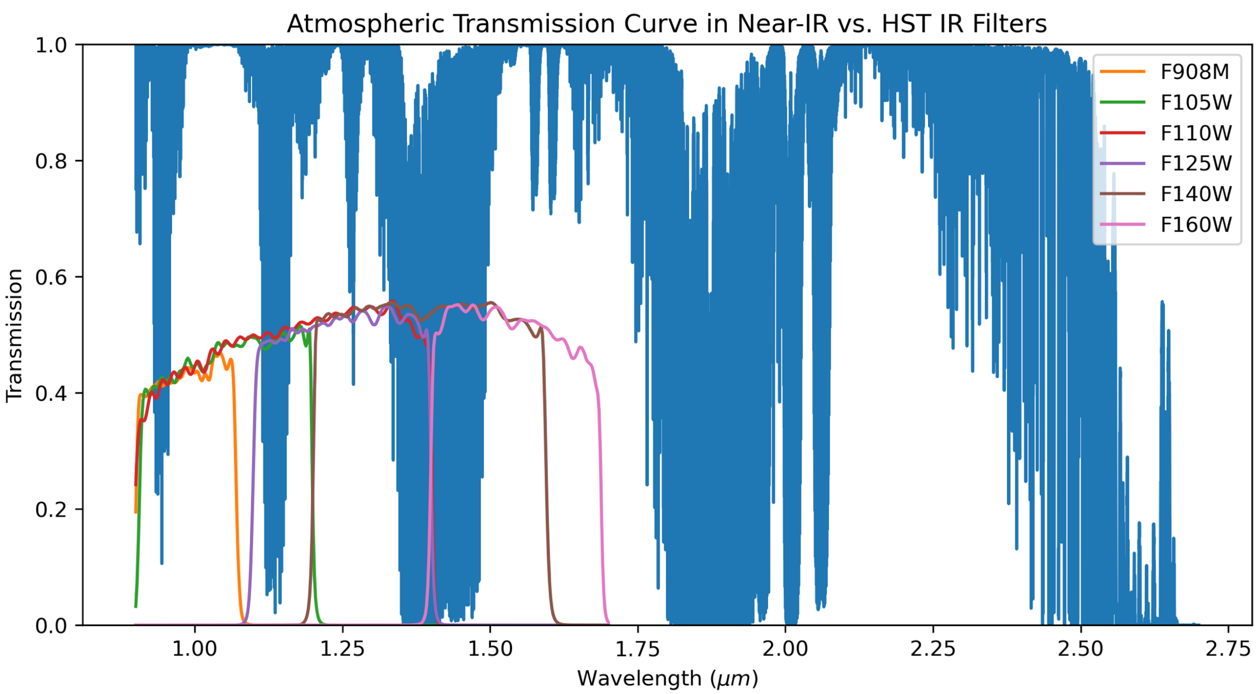
1)

In [ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

In [ ]:
```
nir_transmission = pd.read_csv("mktrans_zm_10_10.dat", sep = ' ',  header =
nir_transmission = nir_transmission.apply(pd.to_numeric)
nir_transmission.columns = ['wavelength', 'transmission']


f98 = pd.read_csv("filters/f098m.IR.tab.txt", sep = ' ',  header = None, ski
f98 = f98.drop(0, axis=1)
f98.columns = ["wavelength", "transmission"]
f98.wavelength /= 1e4

f105 = pd.read_csv("filters/f105w.IR.tab.txt", sep = ' ',  header = None, sk
f105 = f105.drop(0, axis=1)
f105.columns = ["wavelength", "transmission"]
f105.wavelength /= 1e4

f110 = pd.read_csv("filters/f110w.IR.tab.txt", sep = ' ',  header = None, sk
f110 = f110.drop(0, axis=1)
f110.columns = ["wavelength", "transmission"]
f110.wavelength /= 1e4

f125 = pd.read_csv("filters/f125w.IR.tab.txt", sep = ' ',  header = None, sk
f125 = f125.drop(0, axis=1)
f125.columns = ["wavelength", "transmission"]
f125.wavelength /= 1e4

f140 = pd.read_csv("filters/f140w.IR.tab.txt", sep = ' ',  header = None, sk
f140 = f140.drop(0, axis=1)
f140.columns = ["wavelength", "transmission"]
f140.wavelength /= 1e4

f160 = pd.read_csv("filters/f160w.IR.tab.txt", sep = ' ',  header = None, sk
f160 = f160.drop(0, axis=1)
f160.columns = ["wavelength", "transmission"]
f160.wavelength /= 1e4


filters = [f98, f105, f110, f125, f140, f160]
labels = ['F908M', 'F105W', 'F110W', 'F125W', 'F140W', 'F160W']
```

In [ ]:
```
fig = plt.figure(figsize=(10, 5), dpi= 300)
ax = fig.gca()
mask = np.where((nir_transmission.wavelength < 2.7) & (nir_transmission.wave
x = nir_transmission.wavelength.to_numpy()[mask]
y = nir_transmission.transmission.to_numpy()[mask]
ax.plot(x, y)

for i, filter in enumerate(filters):

    mask = np.where((filter.wavelength <= 2.7) & (filter.wavelength >= .9))
    x = filter.wavelength.to_numpy()[mask]
    y = filter.transmission.to_numpy()[mask]
    ax.plot(x, y, label = labels[i])


ax.set_ylim(0, 1)
ax.set_xlabel("Wavelength ($\mu m$)")
ax.set_ylabel("Transmission")
ax.legend(loc = "upper right")
ax.set_title("Atmospheric Transmission Curve in Near-IR vs. HST IR Filters")
plt.show()
```



6)

$s = \frac{206265}{6} = 3.44 \times 10^4 s \cdot m^{-1} = .0344 s \cdot \mu m^{-1}$

pixel scale = $18\mu m \times .0344 s \cdot \mu m^{-1} = .62s$

Frame width = $1024 * .62 = 634s = 10.6min$

8)

$F = 1 \times 10^{-17} W m^{-2}$

$\delta = 15s$

$\sigma = \frac{4F}{\pi\delta^2}$

$d_p = 25\mu m$

$s_p = \frac{206265 * d_p}{f}$

Albert:

$D_A = .3m$

$f_A = 2.4m$

$F_A = \sigma \frac{\pi D^2}{4}$

$E = 100 s_p^2 F_A = 100(\frac{206265 d_p}{f_A})^2 \frac{4F}{\pi\delta^2} \frac{\pi D_A^2}{4}$

In [ ]:
```
F = 1e-7
delta = 15
D = .3
dp = 25e-6
f = 2.4

sigma = 4*F / (np.pi * delta**2)
Fa = sigma * np.pi * D**2 / 4
s = 206265 * dp / f

print("Pixel energy collected for Albert:", np.round(100 * s**2 *Fa, 11), "J
```

```
Pixel energy collected for Albert: 1.847e-08 J
```

Bertha:

$D_B = 30m$

$f_B = 120m$

$F_B = \sigma \frac{\pi D^2}{4}$

$E = 100 s_p^2 F_B$

In [ ]:
```
F = 1e-7
delta = 15
D = 30
dp = 25e-6
f = 120

sigma = 4*F / (np.pi * delta**2)
Fb = sigma * np.pi * D**2 / 4
s = 206265 * dp / f

print("Pixel energy collected for Bertha:", np.round(100 * s**2 * Fb, 11), "
```

```
Pixel energy collected for Bertha: 7.386e-08 J
```

9)

For 300 nm:

$\theta = \frac{1.22 \cdot 300 \times 10^{-9}}{2.4m}$

In [ ]:
```
diffraction_limit = 1.22 * 300e-9 / 2.4 * 206265
print("The diffraction limit for Hubble at 300 nm is:", np.round(diffractior
```

```
The diffraction limit for Hubble at 300 nm is: 0.031 arc seconds
```

At 2 μm:

$\theta = \frac{1.22 \cdot 2 \times 10^{-6}}{2.4m}$

In [ ]:
```
diffraction_limit = 1.22 * 2e-6 / 2.4 * 206265
print("The diffraction limit for Hubble at 2 micrometers is:", np.round(diff
```

```
The diffraction limit for Hubble at 2 micrometers is: 0.21 arc seconds
```

For an 8m telescope at 2 μm:

$$\theta = \frac{1.22 \cdot 2 \times 10^{-6}}{8m}$$

In [ ]:
```
diffraction_limit = 1.22 * 2e-6 / 8 * 206265
print("The diffraction limit for the 8 meter scope at 2 micrometers is:", np
```

```
The diffraction limit for the 8 meter scope at 2 micrometers is: 0.063 arc
seconds
```