Homework Assignment
Signal Transmission, Resolution, Detectors
Due: 3:30 PM, Monday, October 25

For any of the questions involving calculations, you should show the details of these calculations. You will be graded not only on the answers that you provide, but on demonstration of the steps and reasoning involved in deriving those answers.

1. In Lab 6, you determined the best-fit FWHM for a source in an IRAC1 image. Repeat this process for two other moderately bright (non-saturated), isolated sources in the IRAC1 image.

	Source #1	**Source #2**	**Source #3**
x(ds9)			
y(ds9)			
RA			
Dec			
Peak estimate			
Background estimate			
FWHM estimate (pix)			
coeffs(0)			
coeffs(1)			
coeffs(2)			
coeffs(3)			
Fitted FWHM (pix)			
Pixel scale (arcsec/pix)			
Fitted FWHM (arcsec)			

Adopted FWHM [arcsec] = ______________________

2. Identify three moderately bright (non-saturated), isolated sources in the MIPS1 image, and follow the procedure outlined in the lab to derive a best-fit FWHM to adopt for these observations.

	Source #1	Source #2	Source #3
x(ds9)			
y(ds9)			
RA			
Dec			
Peak estimate			
Background estimate			
FWHM estimate (pix)			
coeffs(0)			
coeffs(1)			
coeffs(2)			
coeffs(3)			
Fitted FWHM (pix)			
Pixel scale (arcsec/pix)			
Fitted FWHM (arcsec)			

Adopted FWHM [arcsec] = ________________________

3. In Lecture 4, you saw that a Gaussian distribution may be represented by:

$$N = N_{peak}\ e^{-\frac{1}{2}\left[\frac{x - x_0}{\sigma}\right]^2}$$

where N_{peak} is the peak of the distribution, x_0 is the center (or mode) of the distribution, and σ is the standard deviation (or dispersion). You also learned that σ is related to FWHM by:

$$\sigma = \frac{FWHM}{2\sqrt{2 \ln 2}}$$

For Questions 1 and 2, you used the IDL *gaussfit* procedure (with *nterms* = 4) to fit Gaussian distributions to the intensity profiles of sources in the IRAC1 and MIPS1 images. According to the IDL Help pages, the fitted Gaussian is expressed as:

$$f(x) = A_0\ e^{-\frac{1}{2}\left[\frac{x - A_1}{A_2}\right]^2}$$

If you followed the IDL statement, as given in Lab 6, then f(x) was saved as array *result*, and the best-fit values of the parameters were returned in the array *coeffs* = [*A0 , A1 , A2, A3*]. Compute the fitted FWHM, in pixels, for each of the IRAC1 and MIPS1 sources listed in the tables in Questions 1 and 2. Then, convert these FWHM from pixels to arcseconds. Complete the tables in Questions 1 and 2. Use the mean FWHM of IRAC1 sources as the adopted FWHM for sources in IRAC1 image. Similarly, use the mean FWHM of MIPS1 sources as the adopted FWHM for sources in the MIPS1 image.

Given that the primary mirror of the Spitzer Space Telescope has a diameter of 0.85 meters, what is the expected angular resolution in the IRAC1 (3.6 μm) image? in the MIPS1 (24 μm) image?

Expected Angular Resolution in IRAC1 image [arcsec] = ________________________

Expected Angular Resolution in MIPS1 image [arcsec] = ________________________

How do these expected angular resolutions compare to the adopted FWHM from Questions 1 and 2? Now, compute the ratio (MIPS1/IRAC1) of these expected angular resolutions.

Ratio (MIPS1/IRAC1) of Expected Angular Resolutions = ________________________

How does this ratio compare to the ratio (MIPS1/IRAC1) of adopted FWHM from Questions 1 and 2?

4. Assuming the distance to L673-7 is 300 pc, what is the expected physical resolution, in AU, in the IRAC1 image? in the MIPS1 image?

Expected Physical Resolution in IRAC1 image [AU] = ________________________

Expected Physical Resolution in MIPS1 image [AU] = ________________________

5. Given the Hubble Space Telescope has a primary mirror with diameter of 2.4 meters, what are the expected angular resolutions, in arcseconds, of its WFC3 instrument operating at J and H bands?

Expected Angular Resolution in WFC3/J image [arcsec] = ________________________

Expected Angular Resolution in WFC3/H image [arcsec] = ________________________

Expected Physical Resolution in WFC3/J image [AU] = ________________________

Expected Physical Resolution in WFC3/H image [AU] = ________________________

6. Located at a distance of 3.22 pc from Earth, Epsilon Eridani is the nearest star with a known planet. What is the minimum diameter of a space telescope's primary mirror needed to image and resolve (at V band) this star and a potential Earth-like planet orbiting 1 AU from the star?