Homework Assignment
Data Analysis III: Optical/Infrared
Due: 3:30 PM, Friday, November 19

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. **The shaded regions in tables should include values with appropriate numbers of significant digits.**

Download the data for this homework assignment, and save in the "data" subdirectory of your home directory. For this assignment, you will use the JHK images of B59.

1. Similar to the procedure you followed for Lab 8 and its associated homework assignment using images of B59-CONTROL, determine the noise characteristics of the JHK images of B59, and then detect objects (using an intensity threshold of 50 × *n)* in those images. Record the relevant information in the table below.

	J Image	**H Image**	**K Image**
Noise1 [ADU]			
Noise2 [ADU]			
Noise3 [ADU]			
Mean Noise, n [ADU]			
Std. Dev. of Noise, σ_n [ADU]			
Error in Mean Noise, Δn [ADU]			
Adopted Noise, $n \pm \Delta n$			
Intensity Threshold [ADU]			
FWHM estimate [pix]			
Number of Objects Detected			
Number of Objects Rejected by Inspection			
Number of Real Objects			

2. Similar to the procedure you followed in Lab 8 and its associated homework assignment, proceed to obtain aperture photometry at JHK for the objects detected in Question 1. Save the aperture photometry tables as PhotVis data (PV_DAT) files with names B59_J.pvd, B59_H.pvd, and B59_K.pvd in the "data" subdirectory. (To be safe, you may also want to save your IDL sessions as B59_J.idl, B59_H.idl, and B59_K.idl, in case you need to quickly retrieve your sessions without needing to start from the beginning.) As you did in Lab 8, use the *wcs_pvd* procedure to transform the coordinates in the PV_DAT files from (x, y) pixel positions to WCS coordinates (RA, Dec). Save the WCS PV_DAT files as B59_J_wcs.pvd, B59_H_wcs.pvd, and B59_K_wcs.pvd in the "data" subdirectory.

Use the star known as 2MASS 17114624-2724118 as the standard star to derive the zero point offsets for the JHK images of B59. This standard star has the following coordinates:

RA(standard star) = 17h 11m 46.24s = 257.94268
Dec (standard star) = -27° 24′ 11.8″ = -27.40328

This standard star should be detected in your images and included in WCS PVD_DAT files. If it is not, there *may be* a problem (but not necessarily) with the intensity threshold or FWHM estimate, and you may want to revisit these estimates. Either way, however, if the standard star was not automatically detected by the PhotVis source extraction procedure, you should add it manually and re-derive the aperture photometry. Record the relevant information about this standard star in the table below, and derive the zero point offsets. **Note that you should find *mindist* ≤ 1 arcsec; otherwise, the standard star was not included in the WCS PVD_DAT file.**

For the purposes of this assignment, assume that the observed coordinates are known to within 0.00001 deg and the instrumental magnitudes are known to within 0.01 mag. While the 2MASS magnitude errors typically include several non-zero digits, each magnitude error should be considered to have only one significant digit. In turn, the position of this significant digit determines which digits in the 2MASS magnitude are significant.

	J Image	**H Image**	**K Image**
Observed RA			
Observed Dec.			
mindist **[arcsec]**			
Instrumental Magnitude			
2MASS Magnitude			
2MASS Magnitude Error			
Zero Point Offset			

3. With the same considerations for the color-color diagram created in Lab 10, make a color-color diagram of the sources detected with legitimate photometry in all three JHK images of B59. For the purpose of this assignment, use the instrumental colors. **Print the diagram in portrait orientation, and attach it to this assignment.**

4. Make a color-color diagram that includes the *transformed* (J-H) and (H-K) colors for B59-CONTROL and B59 sources detected with legitimate photometry in all three JHK images. Plot the B59 sources as asterisks (psym=2) and the B59-CONTROL sources as filled circles. Again, be sure to plot (J-H) on the y-axis and (H-K) on the x-axis, label the axes appropriately, and force the axes to plot the same ranges without excluding any of the data. For reference, overlay a thick green curve and thick red curve representing the intrinsic colors of main-sequence stars and giants, respectively, on this diagram, using the instructions that follow.

The intrinsic (J-K) and (H-K) colors of main-sequence stars (**Spectral Types O6 through M8 only**) from the 1983 paper by J. Koornneef (Columns 3 and 4 of Table 3) may be saved in arrays as follows:

```
IDL>  jk_ms = [-0.21, -0.19, -0.18, -0.17, …, 0.90]
IDL>  hk_ms = [-0.05, -0.05, -0.05, -0.05, …, 0.33]
```

Then, create an array of the (J-H) colors of these main-sequence stars:

```
IDL>  jh_ms = jk_ms – hk_ms
```

Similarly, create arrays of the (J-K), (H-K), and (J-H) colors of giant stars (**Spectral Types G3 through M6 only**), named jk_giants, hk_giants, and jh_giants.

Finally, the thick green curve (main-sequence stars) and thick red curve (giants) may be overplotted on your color-color diagram by adding the following statements:

```
IDL>  tek_color
IDL>  oplot, hk_ms, jh_ms, color=3, thick=7
IDL>  oplot, hk_giants, jh_giants, color=2, thick=4
```

Save this diagram as a PostScript file, using portrait orientation, and email it to the instructors.