ES431 ASTRONOMY LAB: Session I – CCD Characterization-Data Analysis

Session Plan: Analysing the data obtained to evaluate the CCD.

Note: Show all steps to the faculty present. Submit the report.

1. **Bias Level:** For all the bias frames taken for the CCD do the following (1) Examine each bias frame. Draw boxes of different sizes and determine the mean value. For this you need to avoid cosmic ray hits. The best way to do that is to use the task **'cosmicrays' in noao - imred - crutil**. The default parameter values will suffice. **Make a table listing the bias level in different frames.** (2) If you have taken bias frames at different operating temperatures then include this information in the table. Does the bias level change with temperature.

   Bias frames are used to compensate for the CCD's positive voltage offset that would otherwise result in an artificially high count rate in all images. Since this rate can vary by location on the CCD, we need to correct each pixel independently, rather than using a constant offset value across the CCD. Make an average bias frame (using 'imcombine') and subtract this from all images taken at this particular operating temperature.

2. **Read Noise:** Determine the read noise of the CCD by examining the bias subtracted read noise frames. Determine the average read noise (with rms) in the CCD. Repeat this exercise for the different exposure times used by you. How does the read noise vary with exposure time? **Make a table to show individual measurements.**

3. **Dark Current (a):** Use 'bias-subtracted' dark frames to obtain average signal as a function of time. **Make a table showing the exposure time and the average signal for it. Plot the same and determine the dark current.** Dark frames were obtained using two methods. Is there any difference in the values? Interpret your result.

   Use large statistics box (ncstat and nlstat around 50 or more) in 'imexamine'.

4. **Dark Current (b): Make a table and a plot to show the behaviour of dark current with temperature.**

5. **Gain:** Refer to the 'CCD Characterization' manual and obtain the **gain** of the CCD. **Show the plot.**

6. **Linearity: Make a table and show the plot for linearity.**

7. **Charge Transfer Efficiency:** Refer to the manual and determine the CTE of the CCD.

   The expression for $(\mathrm{DN})_{\mathrm{p}}$ / $(\mathrm{DN})_{\mathrm{p+1}}$ in terms of the CTE can be written as

$$\frac{(DN)_p}{(DN)_{p+1}} = \frac{N\alpha^p}{pN\alpha^{p-1}(1-\alpha)} = \frac{\alpha}{p(1-\alpha)} \tag{1}$$

   Invert the above equation to get an expression for the CTE, α. Use the data from any dark frame that has cosmic ray hits, and measure the signal at the cosmic ray hit pixel and the next adjacent pixel. Use the equation derived above to determine the charge transfer efficiency. Repeat this exercise for several cosmic ray hits. Show your analysis below: