

Detection of Light - Exercises IX  
6 December - due 02 December 2009  
Practical exercises requiring (IDL) image processing

The files are provided on the course website  
[http://www.strw.leidenuniv.nl/~brandl/DOL/Detection\\_of\\_Light.html](http://www.strw.leidenuniv.nl/~brandl/DOL/Detection_of_Light.html)

**Important:** Please provide (via email to [brandl@strw.leidenuniv.nl](mailto:brandl@strw.leidenuniv.nl) with cc. to [martinez@strw.leidenuniv.nl](mailto:martinez@strw.leidenuniv.nl) and [kendrew@strw.leidenuniv.nl](mailto:kendrew@strw.leidenuniv.nl) ):

- the numbers/solutions to the problem
- the (IDL) reduction/analysis procedure you used

Name: \_\_\_\_\_

- 1. Signal-to-noise measurement.** The exposure 'image1.fits' contains four sources, one at the center of each quadrant<sup>1</sup>. The two sources in the upper part of the image are point sources, whereas the lower two sources are slightly extended. Use a square 5×5 pixel aperture to measure the average noise in the image and the fluxes of each source. Note that there is a uniform offset/bias level to the image. What is the signal-to-noise (S/N) for each source? What can be qualitatively said about the comparison between point and extended sources?
- 2. Read noise measurement.** The file 'image2.fits' is a data cube consisting of seven images, taken as a series of exposures and stacked together into one file. Each of the seven planes represents a single short exposure, which is dominated by read noise (as no other significant signal is present). However, note the strong fixed pattern noise, which is present on small (pixel) and large (gradient) scales. Our detector system has an amplifier gain that yields 4.6 electrons per data unit (the latter is what you measure in the images). What is the average read noise in electrons?
- 3. Dark current measurement.** 'image3.fits' is a data cube containing two planes of dark frames. The first plane corresponds to an exposure time of 5 seconds, the second to an exposure time of 30 seconds. Unfortunately, our exposures suffer from cosmic ray hits (the number increasing with time), which are clearly detectable but must be excluded from the statistics. The images show also the read-noise calculated above. For simplicity, the dark current shall not be associated with Poisson noise and is the same for all good pixels. What is the dark current in electrons per second (using again an amplifier gain of 4.6 electrons per data unit)?

---

<sup>1</sup> In IDL the position are at (32,96), (96,96), (32,32), and (96,32). Note the pixel counting convention for IDL starting at zero, while most other programs, such as 'ds9' start at one; hence, the center of the lower left quadrant would be at (33,33).