Detection of Light – Problem Set 6

28 October 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

Important: Read the comments in the header of the provided IDL procedure `DOL_template.pro'. You may use this procedure as the basis for developing your reduction and analysis procedure.
Important: Please provide (via email to brandl@strw.leidenuniv.nl with copy to martinez@strw.leidenuniv.nl):

- the relevant numbers (added to this sheet)
- the output FITS files
- the IDL reduction/analysis procedure you used
  Please name the files like `prob3a_myname.fits' and `idlproc_myname.pro'

Name: ______________________________

1. Our first data (image1.fits) have been obtained with 128 x 128 pixel array. Although the photon shot noise and the read out noise may be low enough to detect our z=5 galaxy the exposure suffers from a so-called "jailbar pattern". It is due to a slightly different baseline value of the readout amplifiers. There are four channels, organized in rows, where channel 1 reads columns 1, 5, 9, …, channel 2 reads columns 2, 6, 10, etc. Hence the four-column wide pattern structure. The pre-amp offsets are just additive and need to be removed to get a "cleaner" image.

1a. What are the offset levels (in counts) for each channel?

1b. Subtract the offsets to get a "cleaned" image. Is our z=5 galaxy now visible? If yes, at what pixel location?

2. Our second data (image2.fits) have also been obtained with the same 128 x 128 pixel array (and the channel offsets have now been fixed). Unfortunately, someone had turned on the TV in the control room during the readout, and the image suffers from an awful 50 Hz humming. The array has been read with a rather slow electronics and the readout time ("clocking") per pixel is 500 ns. Let's assume the 50 Hz noise can be represented by a sine wave.

Remove the 50 Hz noise pattern to get a "cleaned" image. Check if there is a faint source in the image. If so, at what pixel location?

3. Our third data set (image3a.fits, image3b.fits, image3c.fits – all three are cubes of 5 exposures) is from a observation with *LUST*, the Leiden University Sky Telescope. We targeted a very faint brown dwarf and used three slightly different telescope pointings. At each pointing we took 5 exposures (which are already combined in the image cubes). The three files originate from the three pointings, where the second one (image3b.fits) was aiming to get the target close to the center of the array, the first one has a relative offset of the target by 30 pixels to the left on the array, and the third one by 30 pixels to the right.

3a. Co-add (sum up) the five exposures taken at the first position and inspect the image. What are the two dominant structures (effects, artifacts) that dominate the image? (Note: we know from the instrument manual that *LUST* has a thermal straylight problem in the telescope beam, often leading to a high and structured background, which is fortunately constant in time.)

3b. Compute and inspect the filtered "sky" image.

3c. Compute the final image of the total observing sequence (cleaned, sky subtracted, and the pointings combined). Use the second set as the nominal position reference. Did we detect the brown dwarf? If yes, at what pixel location?