Astronomical Observing Techniques 2016: Exercises on Detectors 2 (Due on 18 April 2016 at 11:15)

April 11, 2016

1   Gain Determination

The analog-to-digital converter in CCD cameras converts the electrical signal into digital numbers, so-called Arbitrary Digital Units (ADU). When calibrating a CCD camera, one needs to know the gain G, which relates the ADU A and the number of electrons e via $A = G \cdot e$. Show that $G = \frac{\sigma_A^2}{A}$ where σ_A^2 is the measured variance in ADU due to the Poisson statistics of photon-generated electrons.

2   Silicon Reflectivity

A backside-illuminated CCD has pure silicon on the back surface. Silicon has an index of refraction of 5.6 at 400 nm. Calculate the percentage of light at 400 nm that is reflected at normal incidence using the Fresnel equations.

3   X-ray CCD Camera

An X-ray CCD camera on a satellite observes a constant X-ray source for 30 minutes. Every minute, the camera takes 2 exposures of 25 seconds. The remaining time is used to read out the CCD. During the whole observation, a total of 720 X-ray photons hit the surface of the CCD detector. How many exposures can we expect with less than 3 photons?