

Exercise 4: Signal to Noise vs. Time

Due: 24 March 2009

Suppose you are conducting a scientific project that requires a high precision measurement of the shape of the light curves for RR Lyrae variable stars. In particular, your goal is to acquire brightness measurements of these stars with a signal-to-noise ratio $S/N = 100$.

You first take some observations of a test star and find the following for your telescope and CCD:

Apparent brightness of test star	$m_V = V = 10$ mag
Integration time	$t = 1$ sec
S/N reached	100

- 1) What is the percent error in the brightness measurements if $S/N=100$?
- 2) What must the signal S in “counts” (=ADU=DN) be for that $V=10$ test star, assuming Poisson statistics?

You have selected 3 globular clusters with RR Lyrae variable stars that you would like to observe. Suppose you know the distance modulus of the clusters and the absolute magnitude of RR Lyrae stars, so that you can estimate how bright the RR Lyrae stars will appear at V in each cluster:

Cluster	V mag of RR Lyrae stars	$f_V/f_{V=10}$	$S(t=1sec)$	$S/N = \sqrt{S}(t=1sec)$	$t(S/N=100)$
A	11				
B	12.5				
C	16.5				

Use the given information to predict the following, filling in the table above, always assuming Poisson statistics. Show your reasoning!

- 3) The ratio $f_V/f_{V=10}$ of the flux from your cluster star to the flux of the $V=10$ test star
- 4) The S/N ratio expected in each cluster in a 1 sec exposure
- 5) The integration time required in each cluster to achieve $S/N = 100$