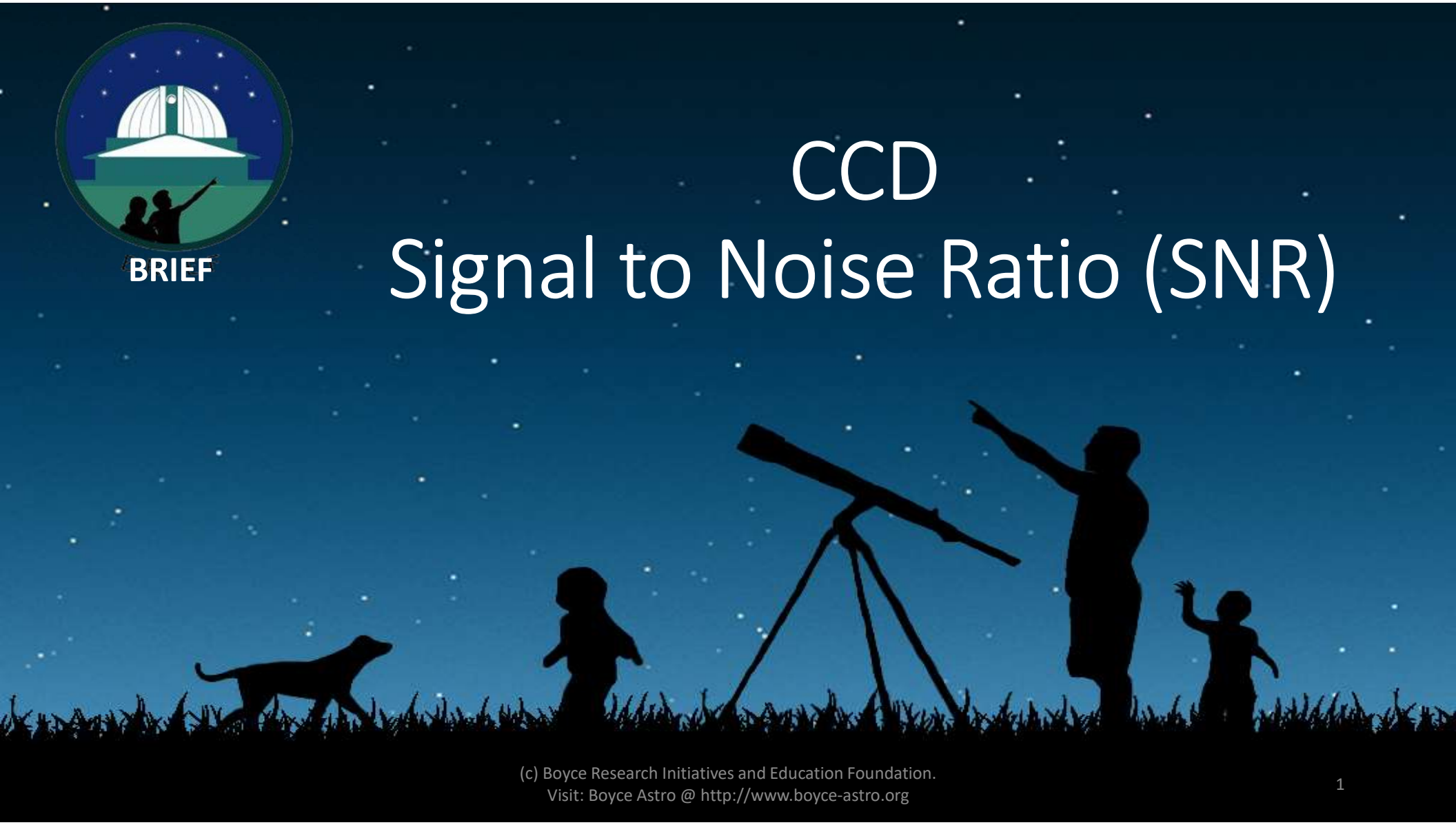
BRIEF

CCD
Signal to Noise Ratio (SNR)



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Overview

For any electronic measuring system, the signal-to-noise ratio (SNR) characterizes the quality of a measurement and determines the ultimate performance of the system.

With a CCD (charge-coupled device) image sensor, the SNR value specifically represents the ratio of the measured light signal to the combined noise, which consists of undesirable signal components arising in the electronic system, and inherent natural variation of the incident photon flux.

The three primary sources of noise in a CCD imaging system are photon noise, dark noise, and read noise, all of which must be considered in the SNR calculation.

A large signal-to-noise ratio is important in the acquisition of high-quality digital images, and is particularly critical in applications requiring precise light measurements.

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SNR – What is it?

Signal = (Photons striking the CCD chip) x (Time)

Noise:

- CCD noise
- Sky background
- CCD Readout
- Dark Current

SNR = Signal/Noise

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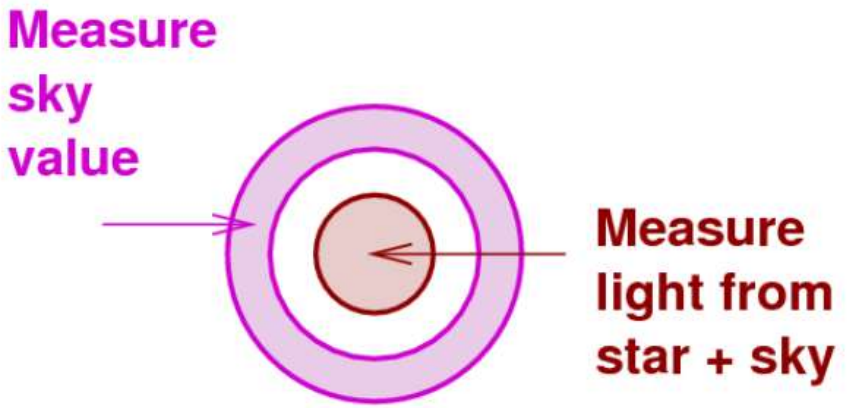
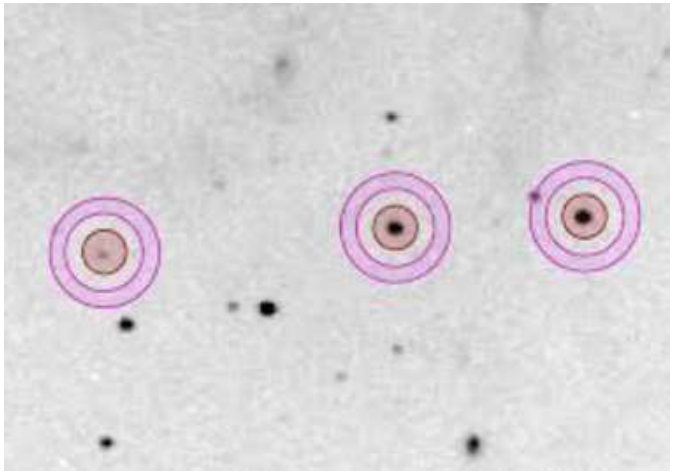
Noise – Sky Background

Sky background is light in the atmosphere, dust, light pollution, and anything detracting from a dark sky

Sky background is present in every single pixel in the image whether that pixel is receiving photons from the astronomical source or not.

Aperture Photometry will further address this Sky Background noise removal.





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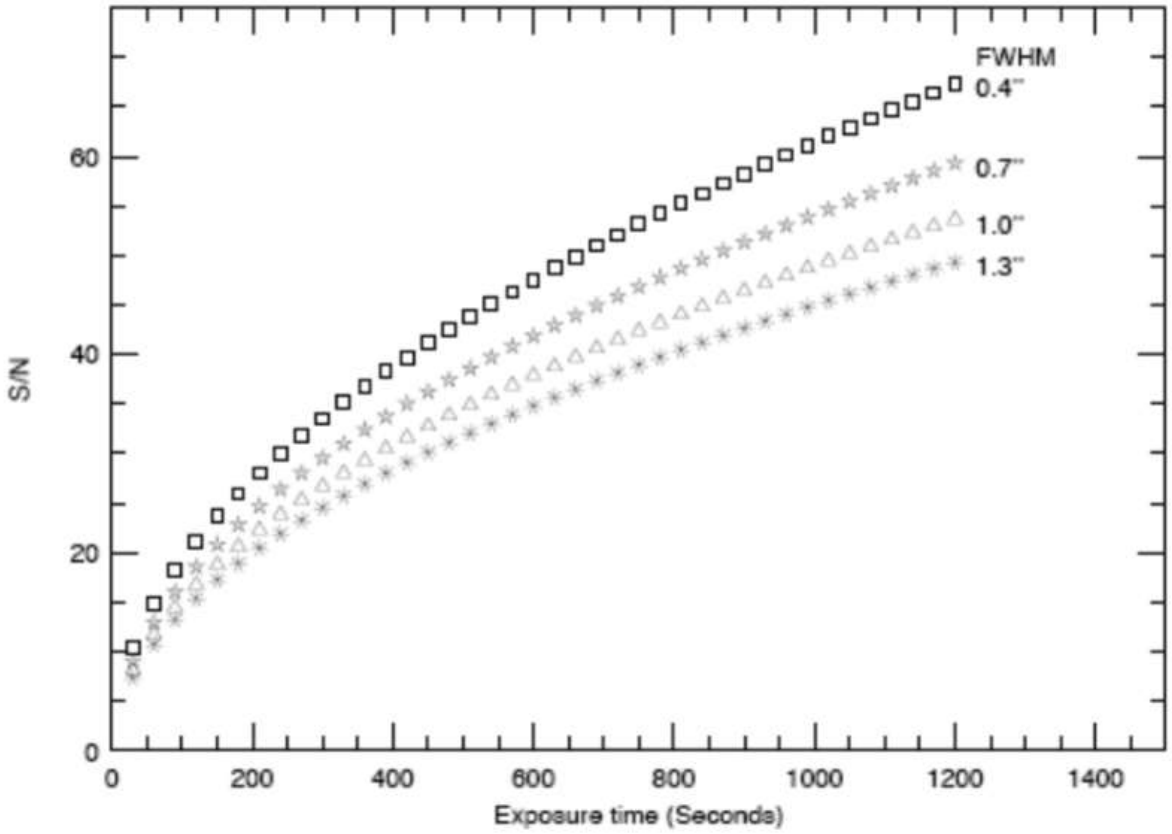
Effect of Exposure Time on SNR

As exposure time increases, the signal, noted by the increase in FWHM, increases and the ratio o SNR decreases.



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Signal to Noise Ratio (SNR)

How to improve SNR

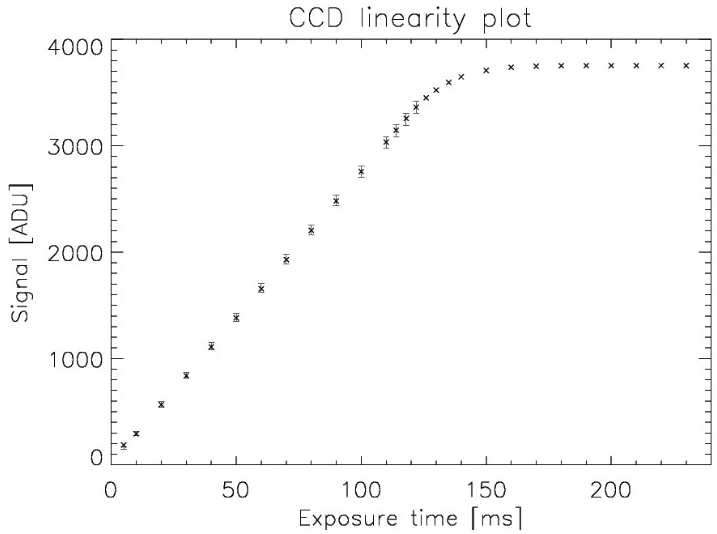
Increase the Exposure Time

Increasing the time, increases the number of photons hitting the chip.

CAUTION:

Longer exposures can reach non-linearity

Blooming may occur



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Summary

Achieving a good SNR is vital in scientific images.

Many different factors affect the noise: Light pollution, electronics, exposure time, etc

Aperture Photometry will provide a means to remove sky glow (light pollution) from images. Other image reduction processes will also reduce electronic noise. This is less essential in Double Star Astrometry.

The signal can be increased through two primary methods: Increased exposure time and binning. Both of these have their limitations and should be used with these in mind.

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Questions?

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