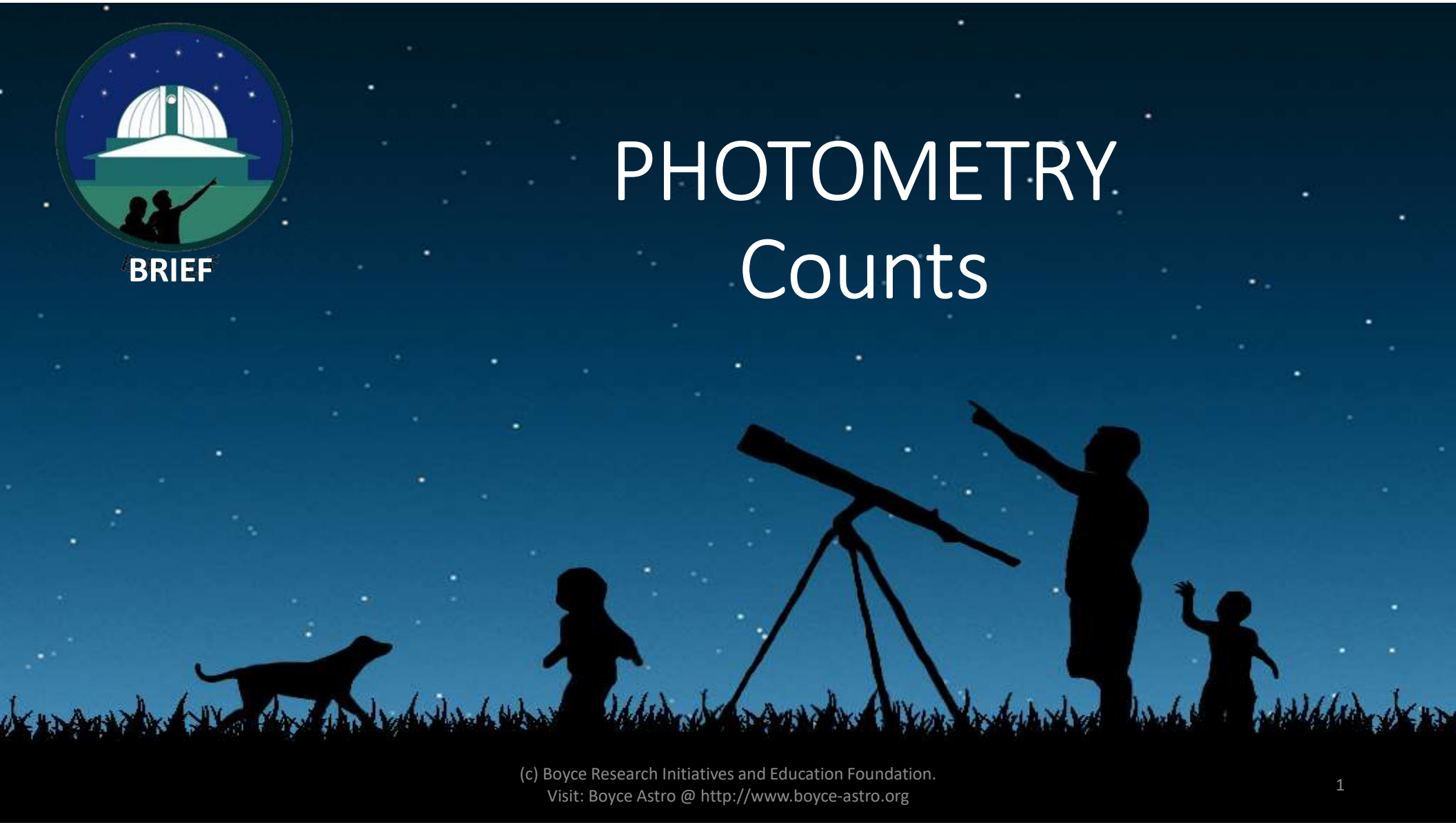
BRIEF

PHOTOMETRY Counts



Overview

The term “counts” is very common in photometry, especially Aperture Photometry.

Aperture photometry is used in differential photometry and absolute photometry.

Counts focuses on all measured values within an aperture as opposed to focusing on data contained within a single pixel.

The Bucket Analogy – How a CCD Works

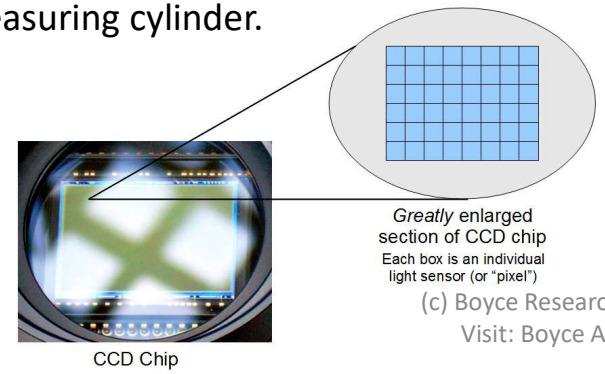
A common analogy for the operation of a CCD is a bucket-carrying conveyor belt.

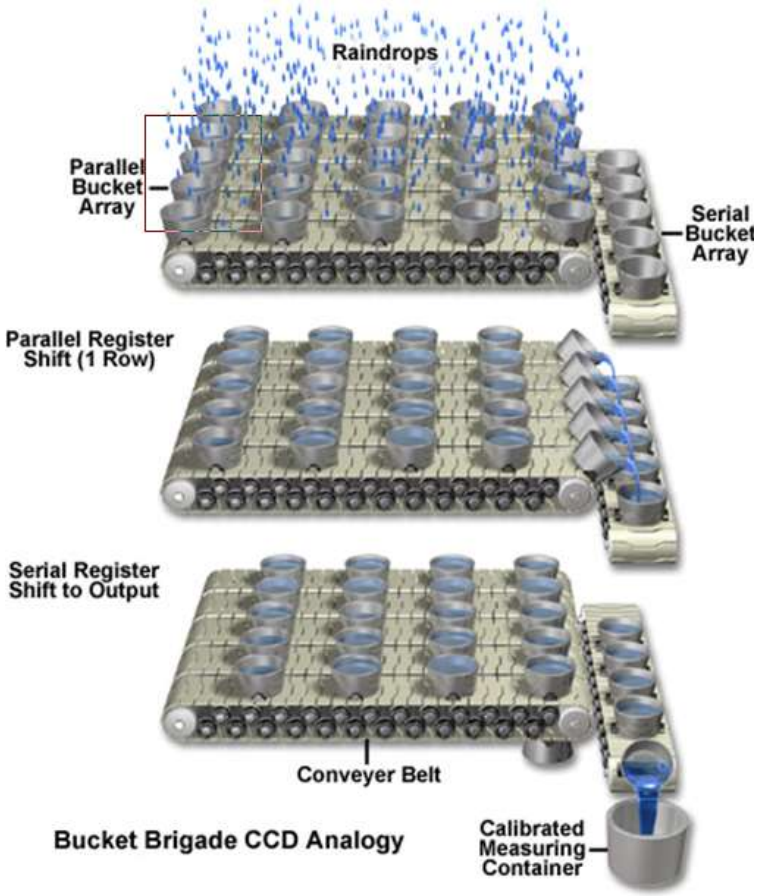
Each bucket is a pixel. Each pixel is distributed across the CCD chip.

The buckets collect rain which are Photons.

The buckets catch all rain that falls on them during the “exposure” time.

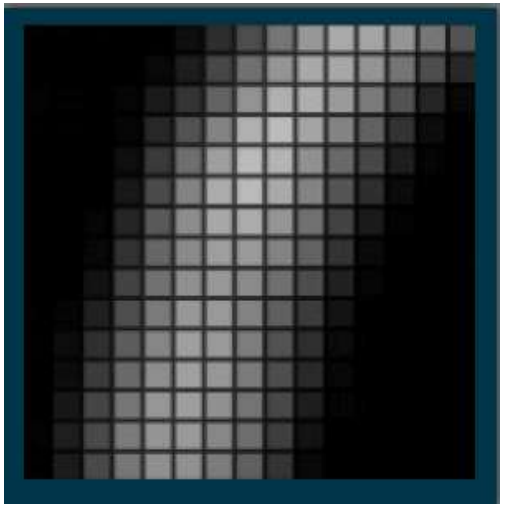
When the exposure is over, the buckets close and transfer the rain, one by one, to a measuring cylinder.





How a CCD Works

- The camera electronics convert this analog signal into a digital number
- The end result is a file containing the position of the pixel on the chip and a digital representation of the amount of charge it held at the end of the exposure.
- Details of the image are accumulated in an image meta file: FITS Header



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3	2	3	3	11	31	72	113	150	170	168	149	118	78	41
5	3	2	7	28	51	100	147	177	175	155	123	82	38	10
3	3	3	8	41	83	132	177	188	165	132	98	52	15	0
2	0	3	16	59	111	160	188	181	145	105	72	31	7	0
0	0	3	26	75	131	172	186	170	132	85	47	13	3	2
0	0	7	38	90	141	168	172	150	113	67	28	5	3	2
2	0	10	51	103	139	159	155	132	98	52	13	3	3	3
2	2	20	67	114	144	152	139	111	78	34	8	2	3	3
3	7	34	78	123	152	154	131	96	60	21	3	0	3	2
3	13	49	93	134	159	154	126	83	47	13	3	0	2	0
0	16	60	106	142	160	152	123	78	43	10	2	2	2	0
2	25	70	118	150	159	145	116	72	31	7	3	0	0	0
5	31	74	123	149	154	136	110	64	21	2	2	0	0	0
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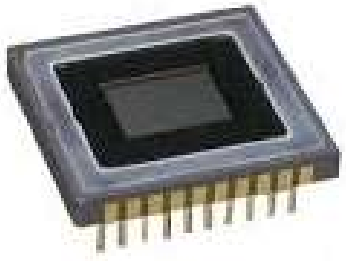
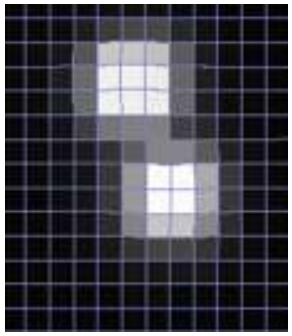




Back to the CCD

Going deeper, pixels do not store the number of photoelectrons but instead an accumulated charge. The output voltage from a given pixel is converted to a digital number and is typically discussed from then on as either counts or ADUs (analog-to-digital units). The analog value for each pixel is converted to a digital number by an analog-to-digital (A/ D) converter.

The amount of voltage needed (the number of collected electrons or received photons) to produce 1 ADU is termed the gain of the device. Gain of a CCD is measured in electrons per A/D unit (e/ A). Example: If the gain is 4 e/A, this means that it takes 4 photoelectrons to generate enough charge to represent 1 ADU, 1 count.

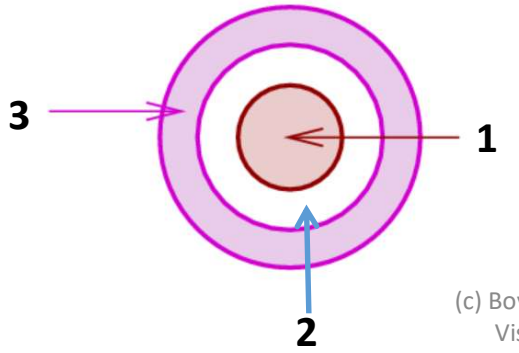
In a CCD, A/D converters have a maximum value that can be assigned to a pixel. Typically this range is, from a 16-bit camera, is from 0 to 65,535.

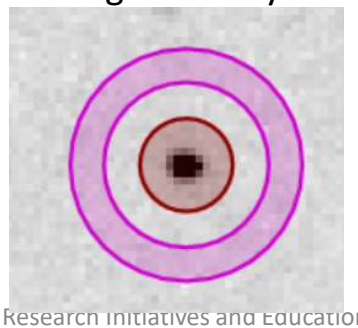
REVIEW - What is an Aperture

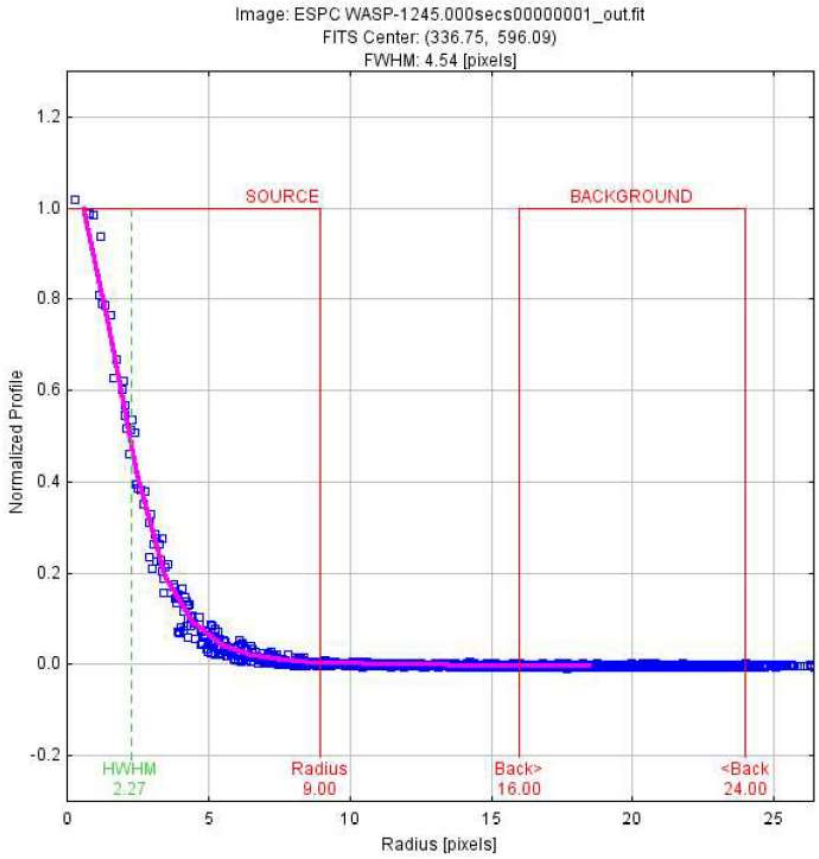
An aperture is nothing more than a circular ring.

Aperture Photometry uses multiple rings for the following:

1. Measuring Aperture (Aperture): Light from the target and the background sky
2. Null/Dead Zone: Light from all pixels within this area are ignored. Prevents double counting of pixel values by creating separation.
3. Sky Annulus (Annulus): Light from the background sky





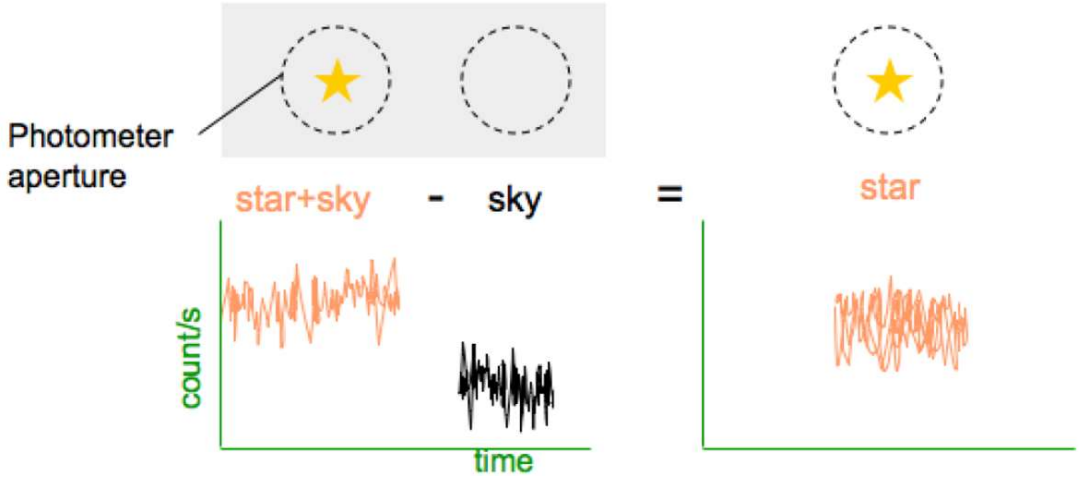


REVIEW - Aperture Photometry Process

A measuring Aperture is most commonly a circular ring of measurement we use to determine photon counts within.

In Aperture photometry, another aperture is used to measure the sky background.

The sky background counts are subtracted from the target aperture counts around the target.



PHOT

Phot is a method of measuring the counts for a particular object.

It uses the aperture photometry process just discussed.

This works well for uncrowded fields. Crowded fields would benefit from Pointspread Function (PSF).

Phot measures the total counts in the measurement aperture (taking proper account of partial pixels along the edge of the circle), then measures (in one of several ways- average, median, or mode of the pixel values in the sky annulus) the sky signal per pixel in the sky annulus.

Counts – Application

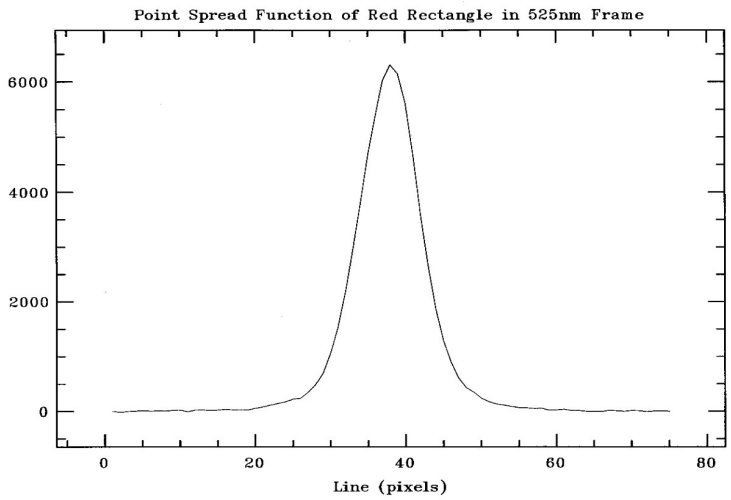
To determine counts, software is used on the star in question.

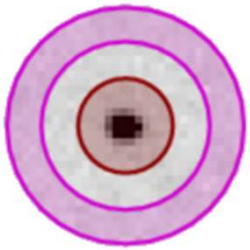
The aperture placed over the star will estimate the center of the star, or Point Spread Function (PSF).

With the center determined, the software inscribes a radius about the center that would cover the entire captured flux of the target. This radius is based on Full Width at Half Maximum (FWHM).

The all the counts for each pixel within the area $A = \pi r^2$ is summed and the estimated background noise is removed. Similar to aperture photometry.

Remembering that pixels are squares, and the aperture is circular, these are incompatible geometric shapes. Therefore, the software will average the pixels that are truncated by the circular aperture.





Summary

Counts are a key term that you will use often in Photometry.

This provides the measure of a target and comp star on a CCD image.

These counts are then measured throughout a time series of images to determine flux changes of the stars being studied.

Questions?