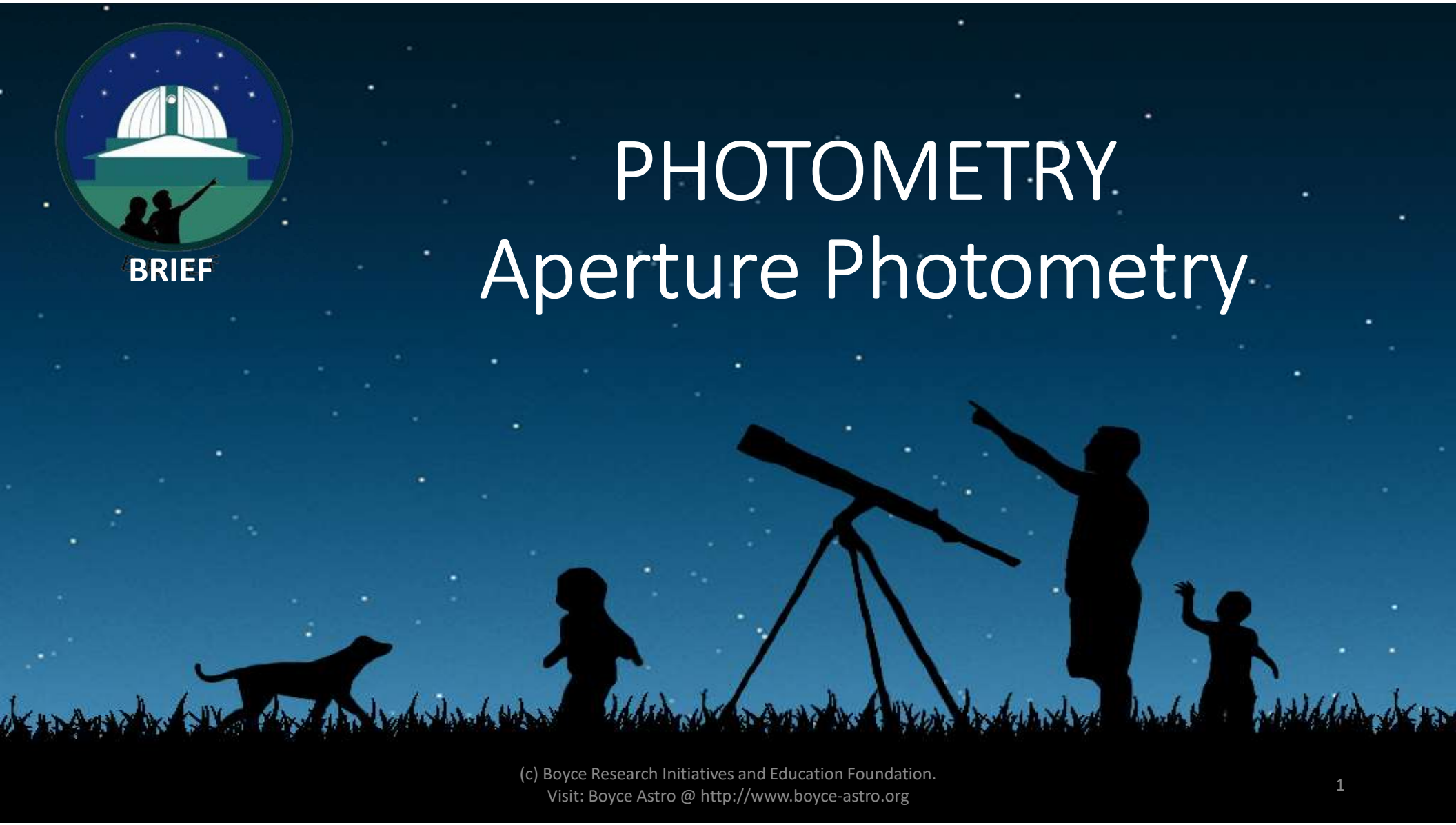
BRIEF

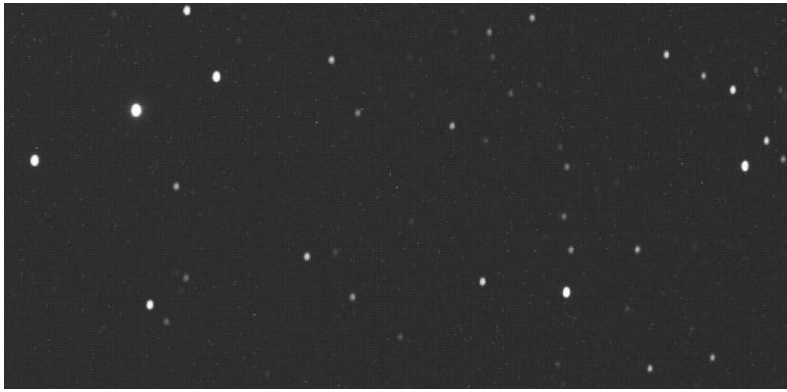
PHOTOMETRY
Aperture Photometry



Overview

When measuring the Flux (light) output of a star, there are a few methods to accomplish this. Two most common are: Aperture Photometry and Point Spread Function (PSF).

This will focus on Aperture Photometry as it is the most accurate flux measurement, for non-crowded images.



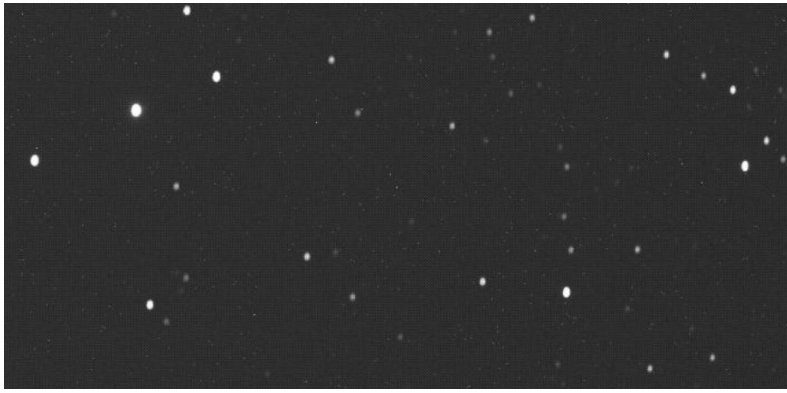
Aperture Photometry

A star is a point source, but due to the atmosphere, the light on a CCD is spread over a number of pixels, and extends to a considerably greater distance on the CCD that it first appears.

To extract the brightness of a star from the image, we must first sum the star's contribution over all pixels illuminated by it, and determine and subtract the contribution from the sky background.

The standard technique for this is called *aperture photometry*.

Aperture photometry is the measurement of light which falls inside a particular aperture; usually a circular aperture of some fixed size and compares it to the background source.

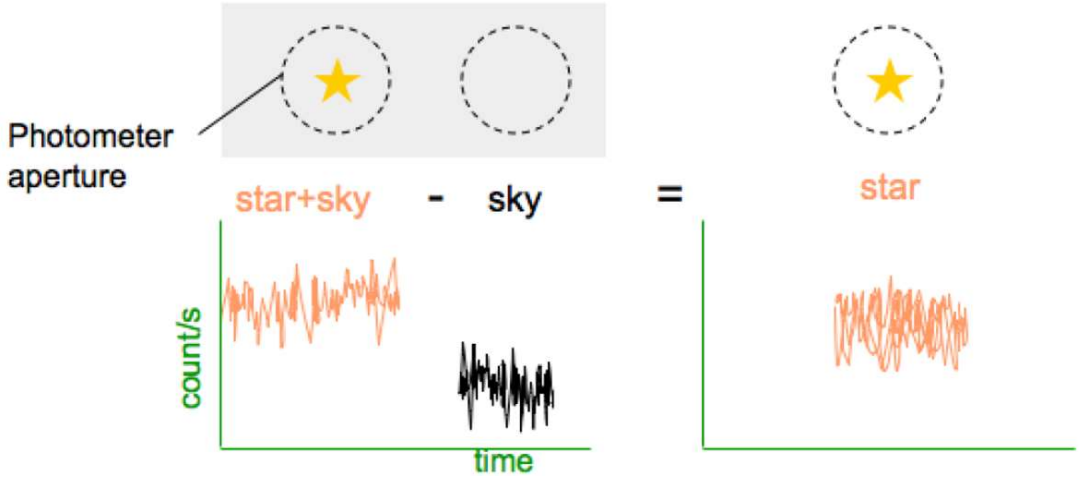


Aperture Photometry Process

Uses, most commonly, a circular ring of measurement, Aperture, to determine photon counts within.

Then, another aperture is used to measure the sky background.

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

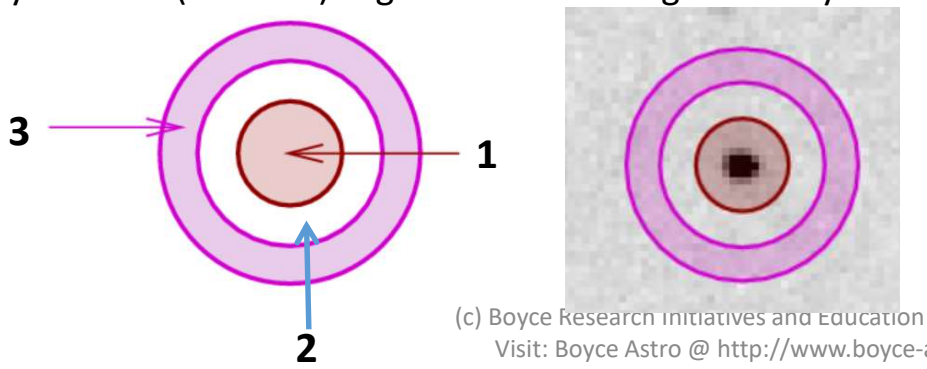


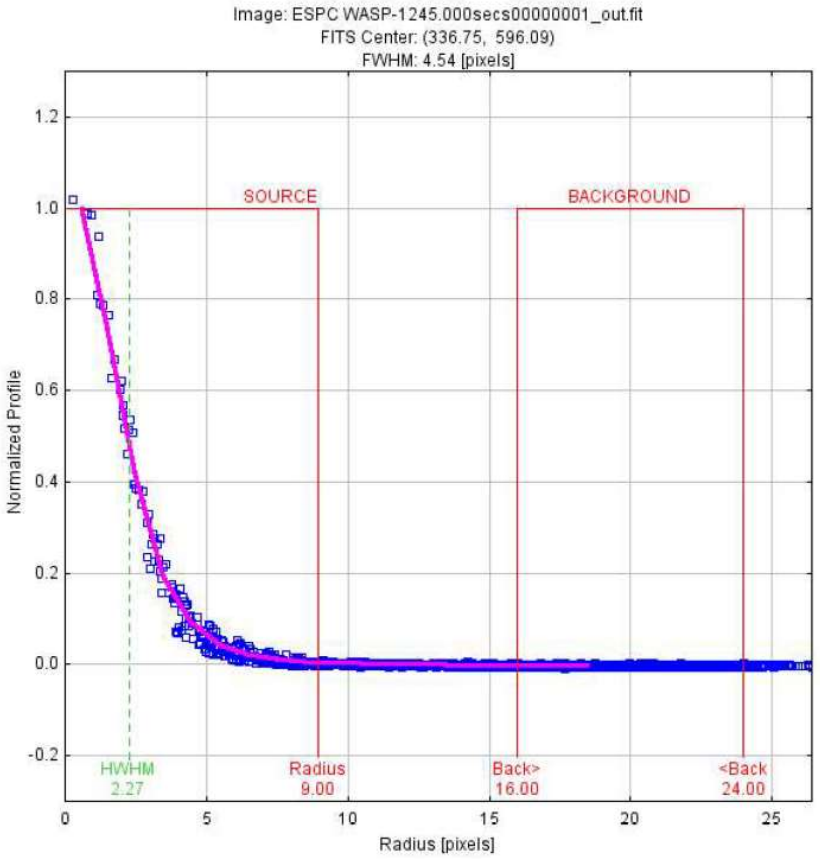
What is an Aperture

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

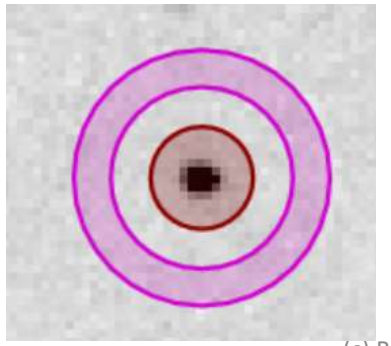


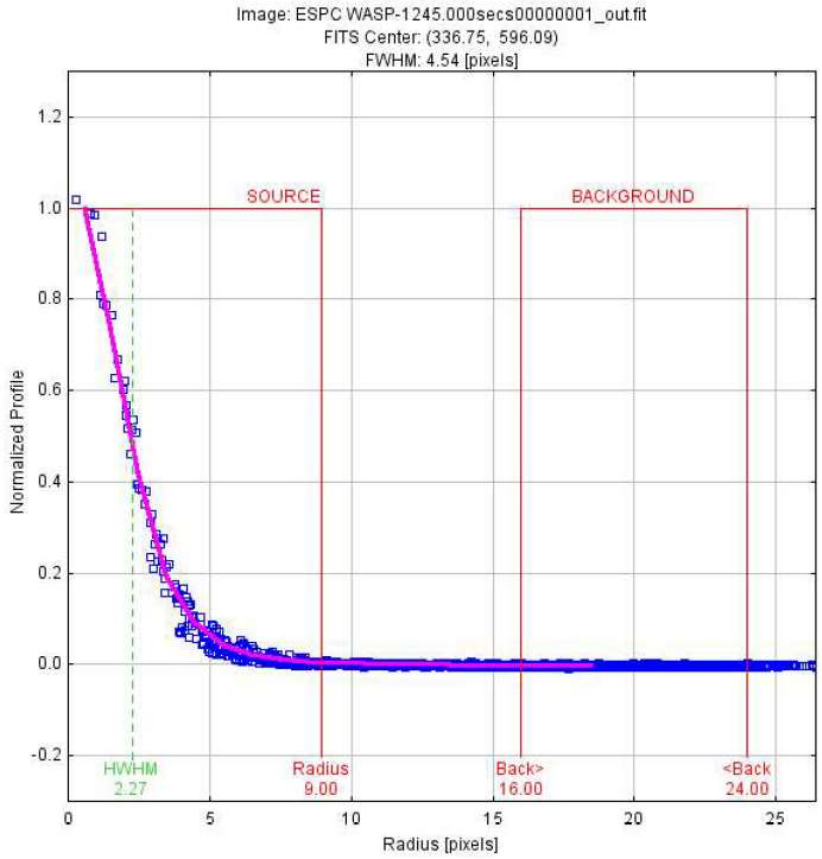


What is an Aperture

With the Aperture defined, the process is as follows:

- The pixels within the measuring aperture are summed to calculate the total signal of the target. IMPORTANT: This includes the sky *AND* the target.
- The pixels within the sky annulus are summed.
- The sky annulus is subtracted from the values in the aperture.





Selecting Aperture Size

Measuring the starlight requires you to make an aperture large enough to include all of the light from the star, but keep the aperture small enough that uncertainties in measuring the sky background are relatively small.

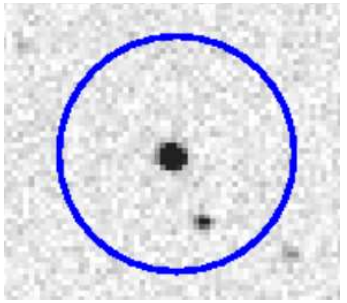
The size of the aperture is key to success: too big and you capture other objects, too small and you'll not receive all counts for a particular target.

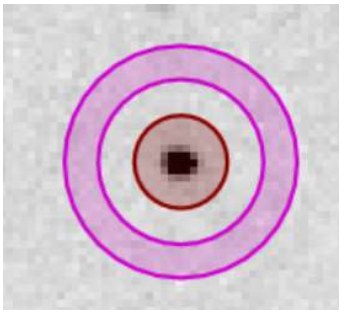
In the first image, the annulus is too large as it encapsulates another star.

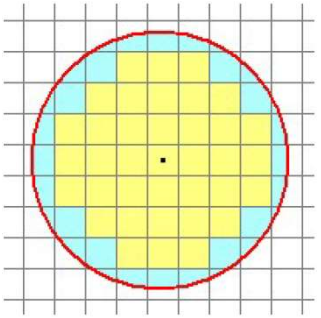
In the second image, the annulus is larger than the star and also captures some background. This background will be subtracted later.

The goal is to pick an aperture which will include

- Most of the light from the star, with
- Little extra light (and noise) from the background sky
- A good compromise is an aperture which is a little bigger than the visible extent of faint stars.







Summary

Understanding Aperture and Aperture Photometry is key to all studies in Photometry.

This process allows the measurement of a target's flux through the removal of all other sources of light.

From this, you have isolated the target and now can study it individually as a single target, or against multiple objects such as in Differential Photometry.

Questions?

Selecting Aperture Size

The inner, object measuring aperture can be adjusted to any radius but, generally, it should not extend all the way to the point where the star appears to merge into the sky noise.

Use the following guidelines to size the object aperture:

- The fraction of the object's total light being measured does not vary over the region of the image(s) being measured.
  - NOTE: The object aperture can cut onto the star profile so long as it does the same for all star profiles.
  - It is ok by making the object aperture large enough to contain "all the light", but this adds more sky noise, which lowers the precision of the measurement and makes the magnitude errors larger.
  - On the other hand, if the star profile varies over the region being measured, you might use an object aperture large enough to hold all the light for bright objects, or as the only option for measuring the field of view.
- The same size aperture is used for measuring every object. Most software automatically handles this.