AGA0414
Photometry

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Measuring the brightness of the stars

What does it mean?

It means that you want to measure how many photons you get from an object.

How do we measure the brightness of a star?

Normally, you just count how many photons entered a circular aperture centered on your star

How do we measure the brightness of a galaxy?

You count photons but the aperture can have funny shape

How do we get the “full” flux of a star (or a galaxy)?

You never do but you can estimate how much flux you are missing

Aperture Photometry

The easiest way:

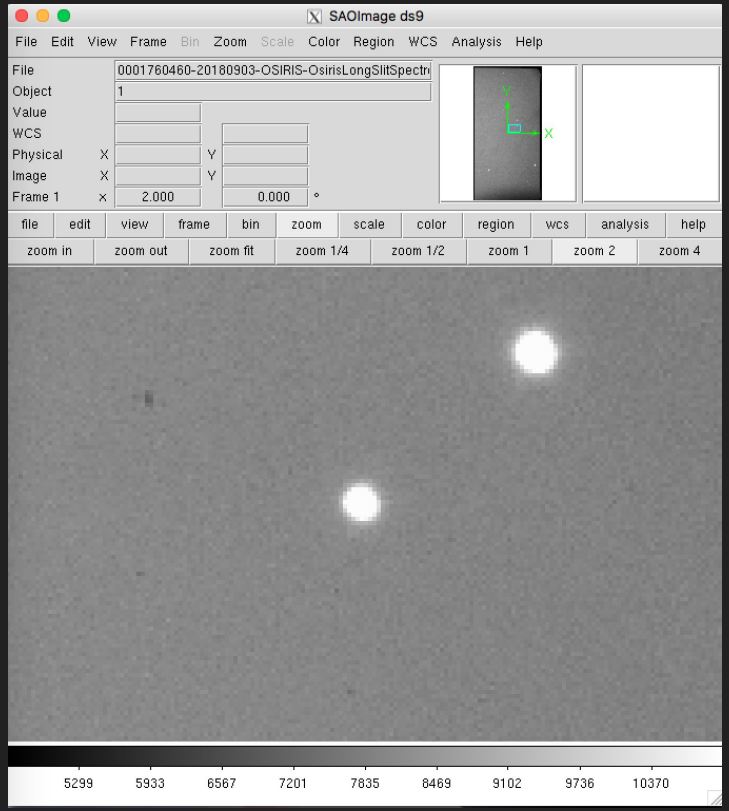
- You draw an aperture and you sum the counts you have in the aperture
- Make sure you subtract the background!

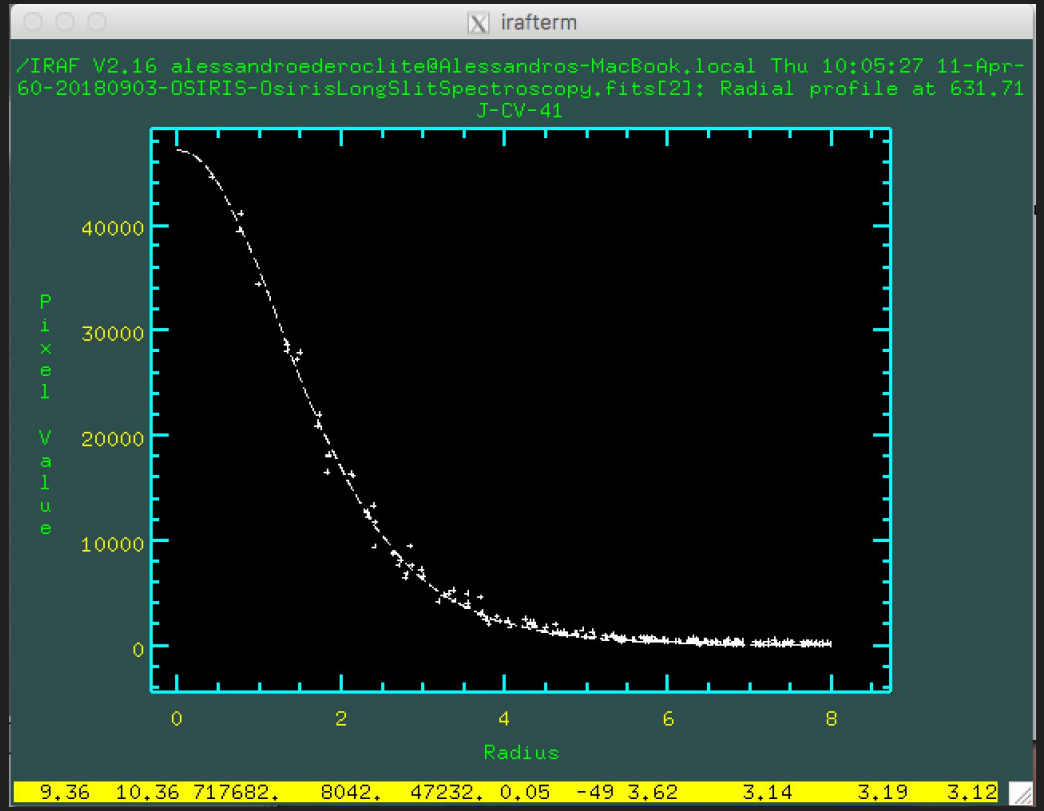
You subtract the background measuring it in an annulus around your object. This background is mostly due to the emission of the sky and, a little, some noise due to the detector (but, remember?, you removed the bias already)

Getting the right size of aperture and background annulus is a form of art.

To begin with, you need to measure the psf of the star.

Aperture photometry





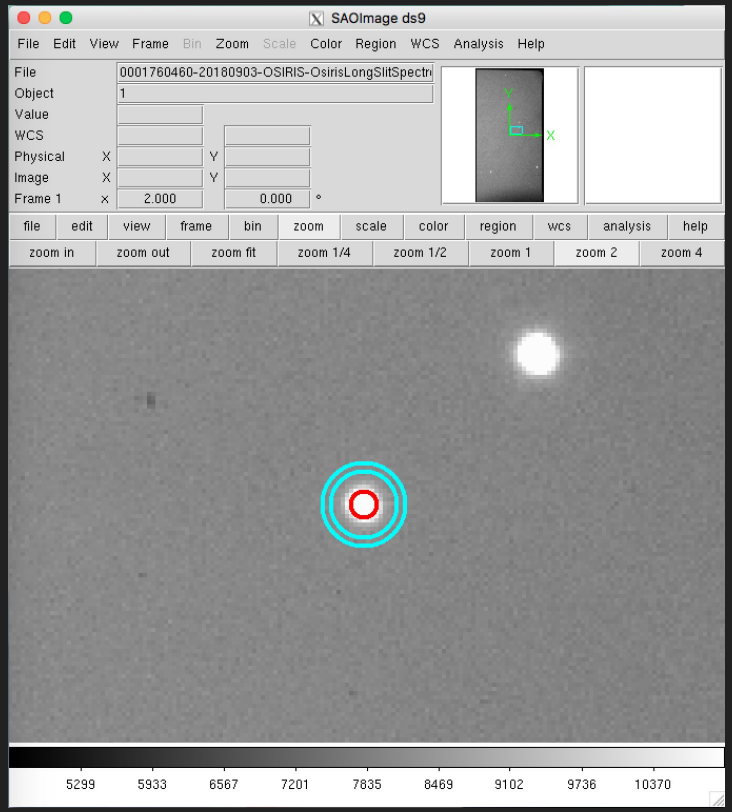
Aperture Photometry

Radius = 3.2 pixels

Annulus:

-) inner radius= 8 pixels

-) inner radius= 10 pixels



psf-photometry

In some cases, you cannot do aperture photometry plane and simple.

You need to model the psf.

Model of isolated stars of different brightness across the field of view.

Why stars?

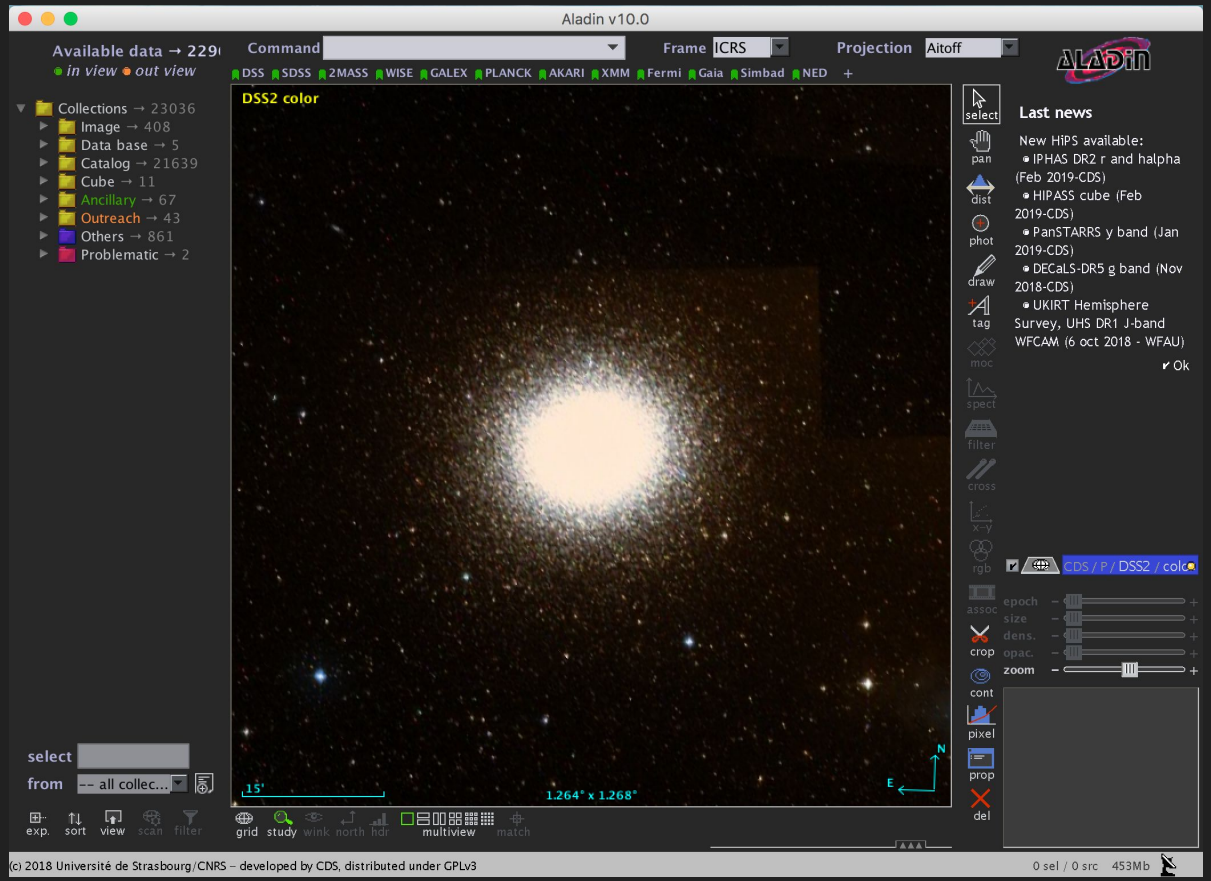
Because a star is the closest to the psf of the telescope!

ω Cen

A globular cluster is the case where people normally need psf-photometry

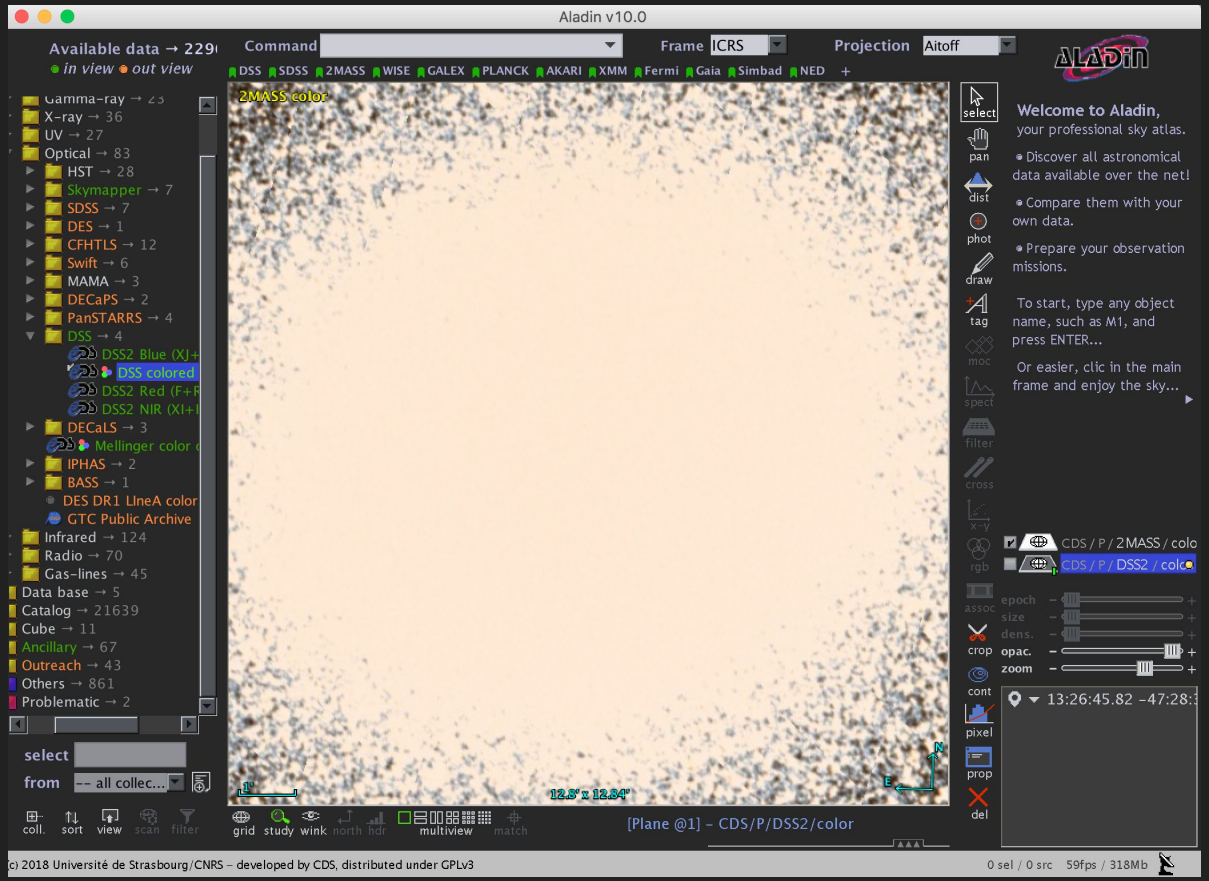
(image from the Digitised Sky Survey)

The most common psf-photometry software is DAOPHOT (but I won't teach you)



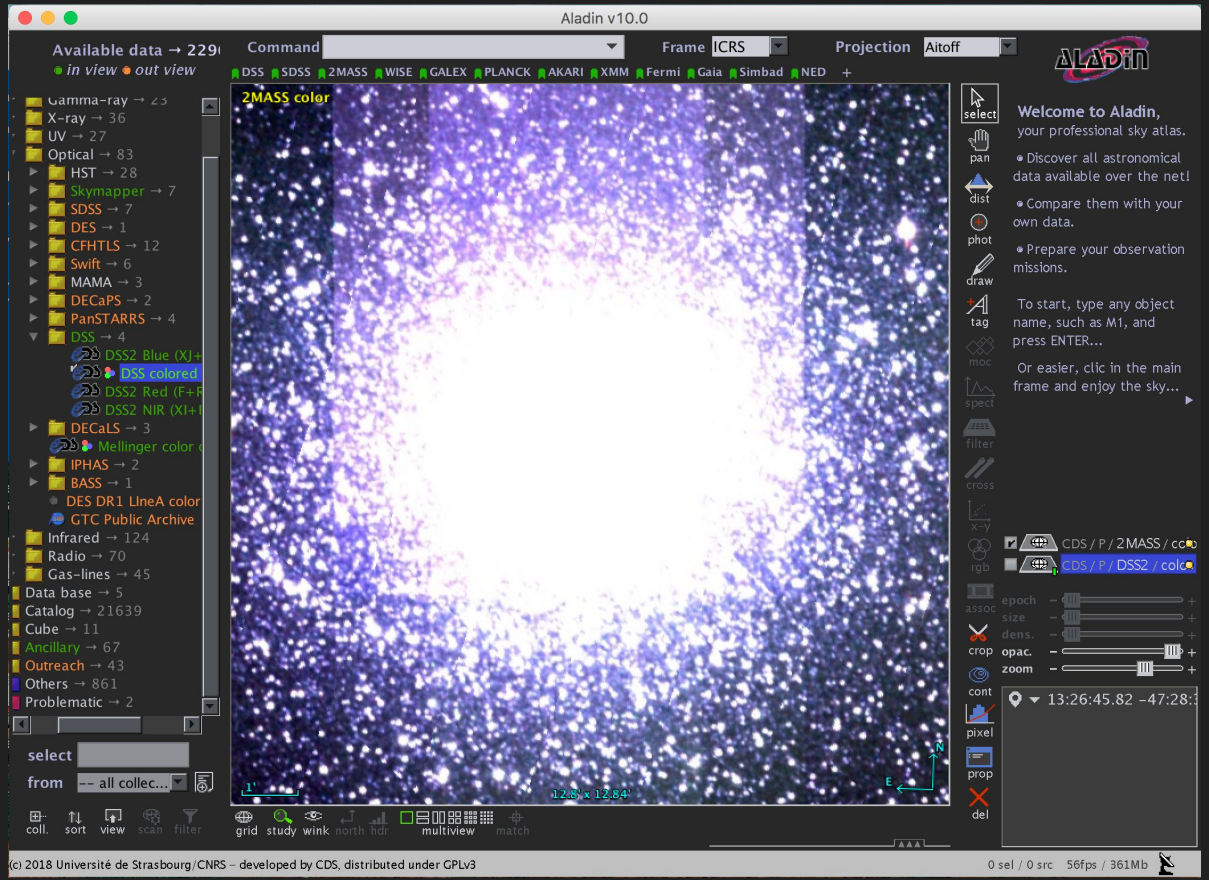
ω Cen

This is a zoom on the centre of the cluster.



ω Cen

In near infrared (this image is from 2MASS), the psf is smaller but still you need to do psf-photometry.

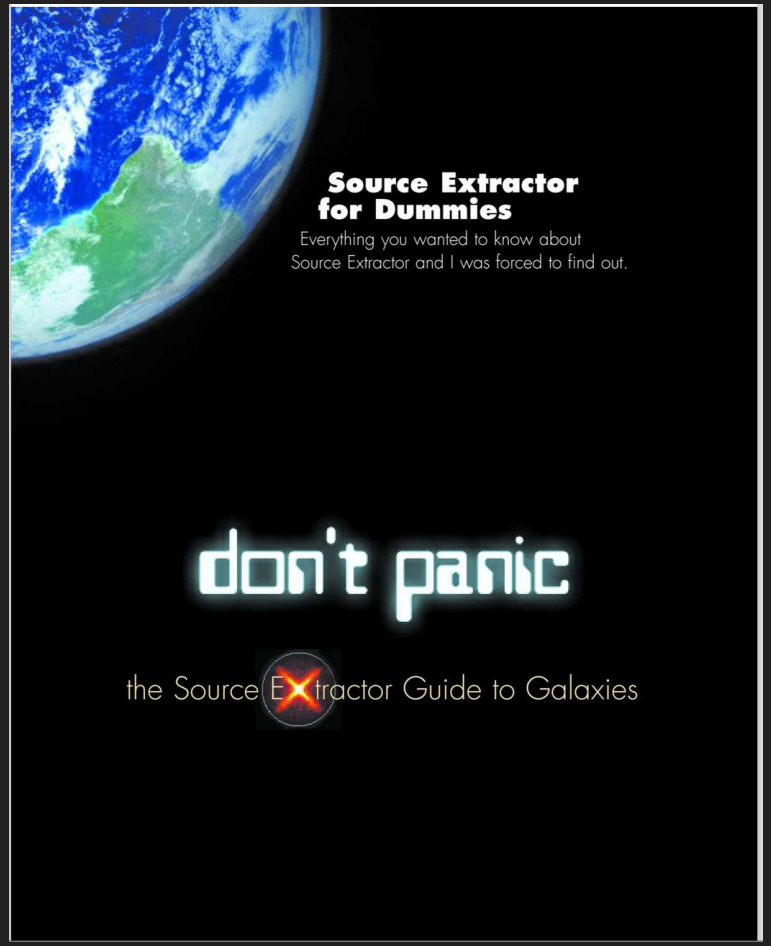


SExtractor

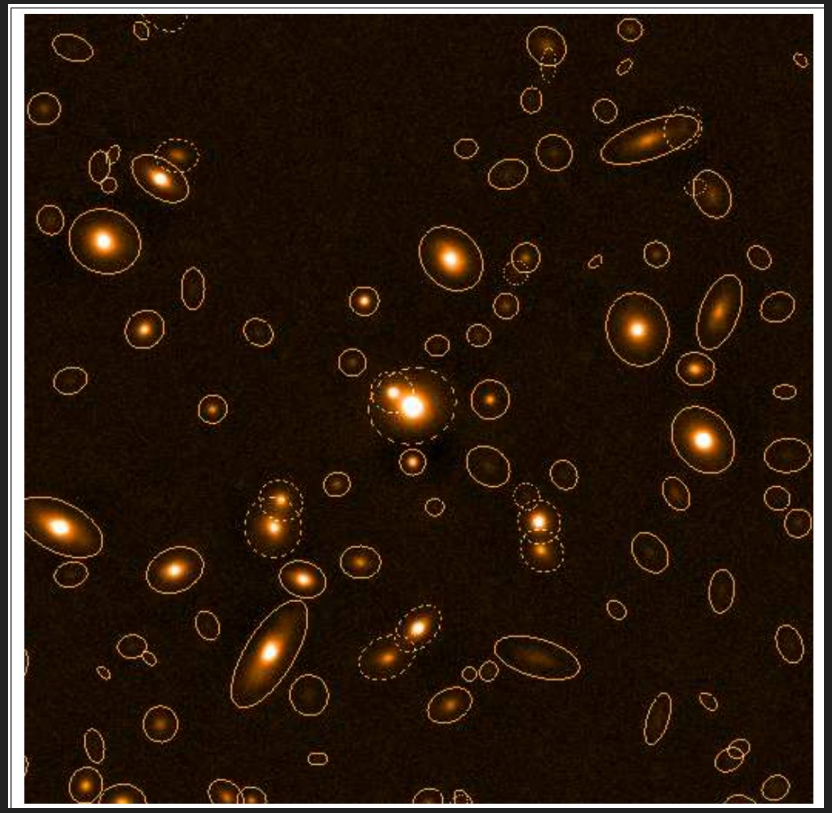
Nothing of what I have explained so far works in the case of galaxies.

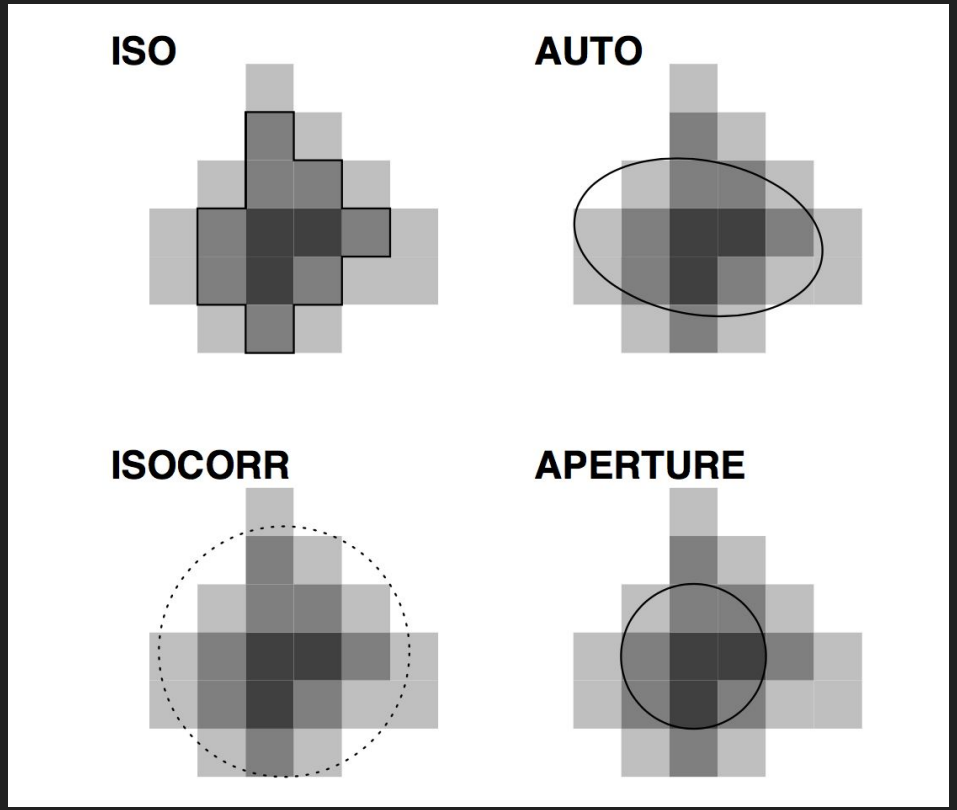
For galaxies, it is better to use other programs. One which is widely used is SExtractor.

In the following, an example of how SExtractor finds sources and the apertures it uses (this is what we are going to use).



SExtractor





Differential photometry

Compare a star with a neighbouring star.

You normally use three stars:

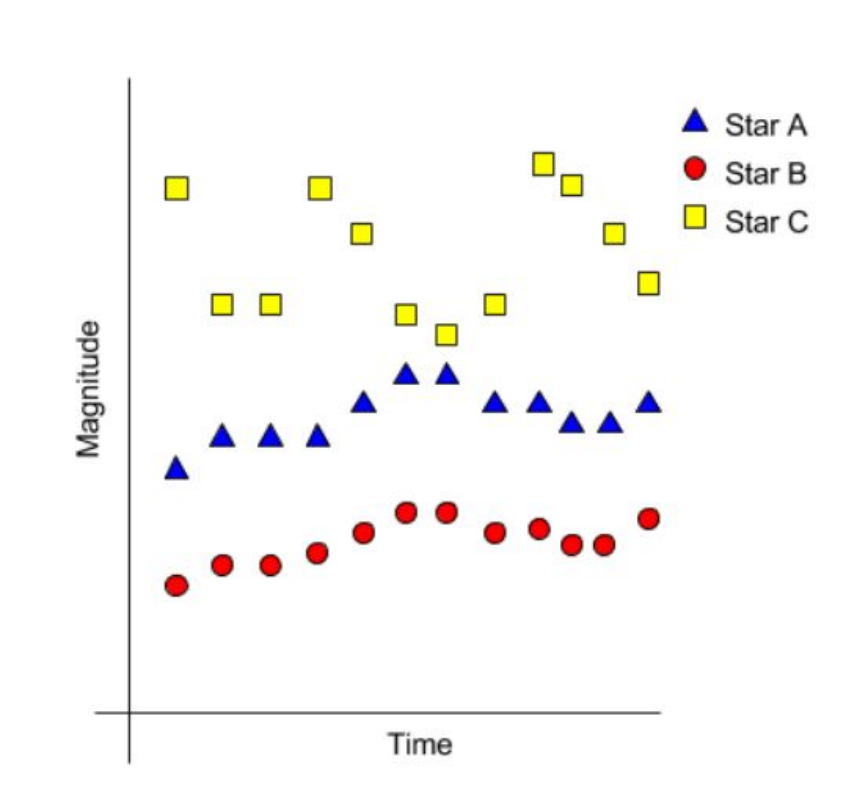
- The science star
- The comparison star
- The “check star”

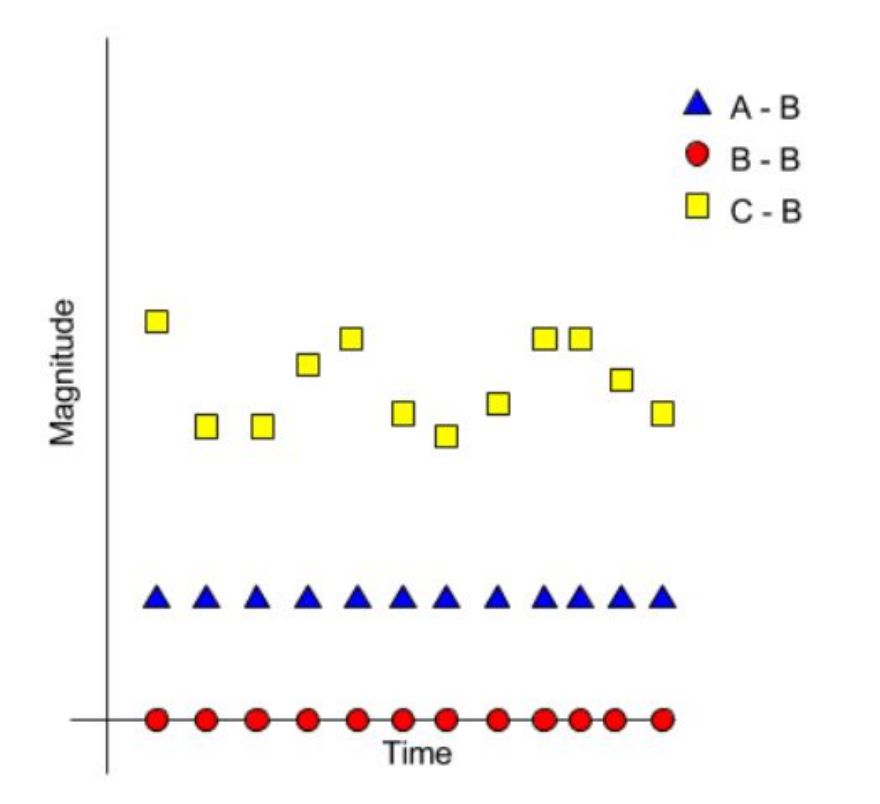
Comparison and check star are **supposed to be** non-variables.

Science star is a variable.

This method “absorbs” extinction variations (really cool!)

Differential photometry





Absolute photometry

What you measure is called “instrumental magnitudes”.

You give a value of the brightness of your object in an absolute sense.

This is tricky.

Even trickier, since we measure things in magnitudes…

Magnitudes

Need to go from counts to flux!

Magnitude (Vega; the Pogson's equation):

$$mag_2 - mag_1 = -2.5 \text{ Log } f_2 / f_1$$

f_v is the "spectral flux density"

Magnitude (AB):

$$Mag = -2.5 \text{ Log } f_v - 48.6$$

What’s in a magnitude...

Convolution of the filter of an object with a filter.