

# 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:

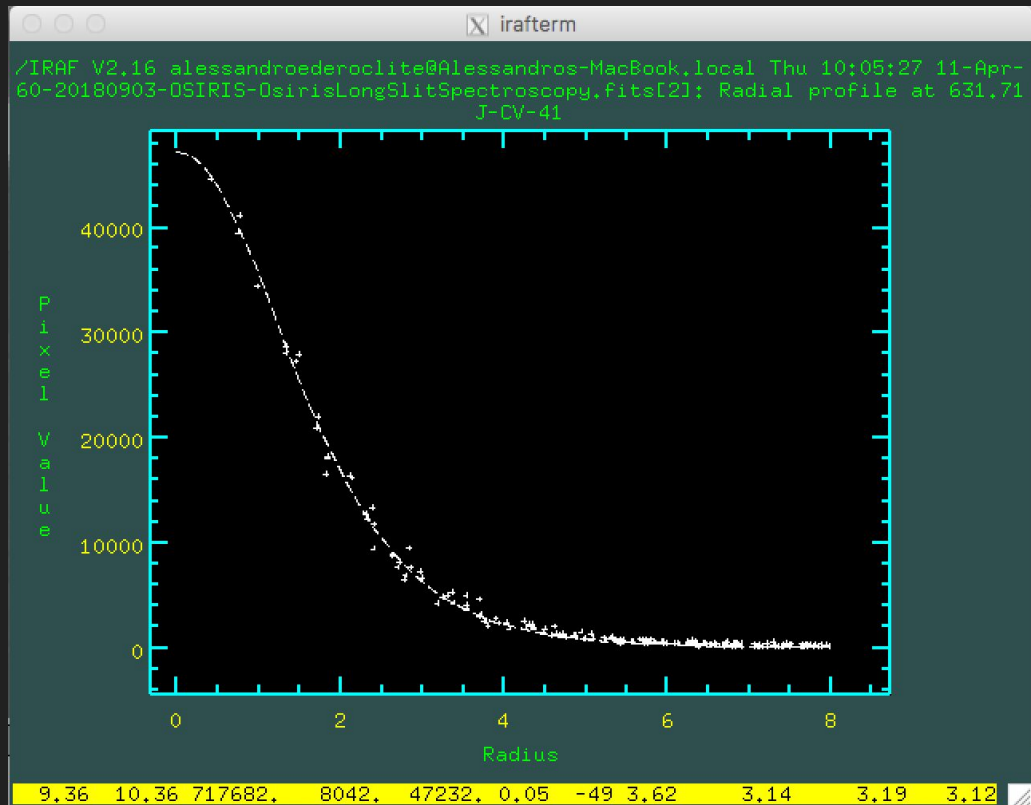
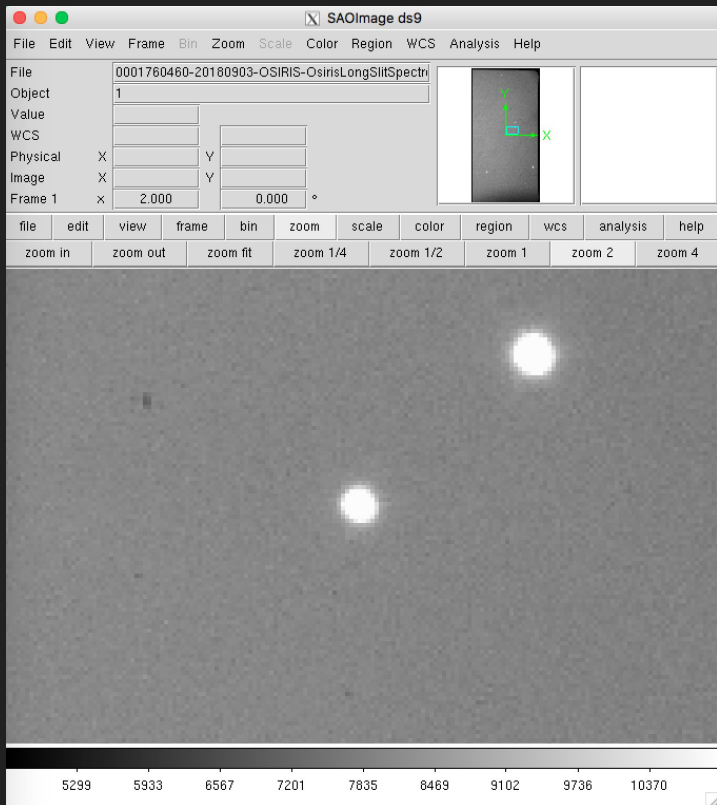
- You draw an aperture and you sum the counts you have in the aperture
- Make sure you subtract the background!

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



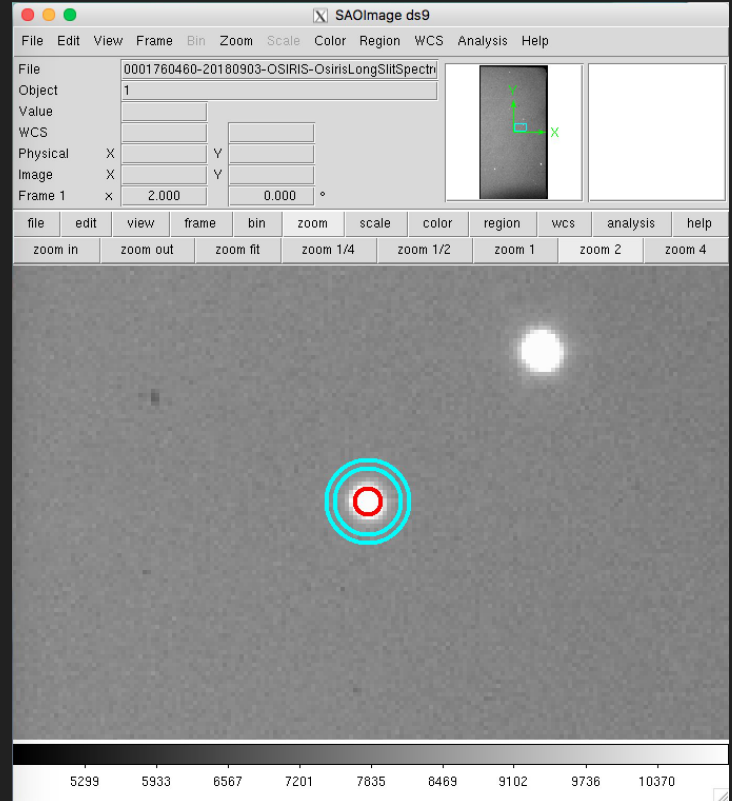
# Aperture Photometry

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!*

# $\omega$ 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)

Aladin v10.0

Available data → 229  
in view out view

Command Frame ICRS Projection Aitoff

DSS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED +

Collections → 23036  
Image → 408  
Data base → 5  
Catalog → 21639  
Cube → 11  
Ancillary → 67  
Outreach → 43  
Others → 861  
Problematic → 2

DSS2 color

15'

1.264" x 1.268"

Last news

New HIPs available:

- IPHAS DR2 r and halpha (Feb 2019-CDS)
- HIPASS cube (Feb 2019-CDS)
- PanSTARRS y band (Jan 2019-CDS)
- DECaLS-DR5 g band (Nov 2018-CDS)
- UKIRT Hemisphere Survey, UHS DR1 J-band WFCAM (6 oct 2018 - WFAU) ✓ Ok

epoch - +  
size - +  
dens. - +  
crop - +  
zoom - +

0 sel / 0 src 453Mb

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# $\omega$ Cen

This is a zoom on the centre of the cluster.

Aladin v10.0

Available data → 2291  
● in view ● out view

Command [ ] Frame ICRS Projection Aitoff

DSS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED +

2MASS color

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epoch - +  
assoc size - +  
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crop opac. - +  
zoom - +  
cont  
pixel  
prop  
del

Welcome to Aladin,  
your professional sky atlas.

- Discover all astronomical data available over the net!
- Compare them with your own data.
- Prepare your observation missions.

To start, type any object name, such as M1, and press ENTER...

Or easier, clic in the main frame and enjoy the sky...

CDS / P / 2MASS / color  
CDS / P / DSS2 / color

12.5" x 12.5"

[Plane @1] - CDS/P/DSS2/color

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0 sel / 0 src 59fps / 318Mb



# $\omega$ Cen

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

The screenshot displays the Aladin v10.0 software interface. The main window shows a 2MASS color image of the star cluster  $\omega$  Cen, with a central bright region and a surrounding field of stars. The interface includes a data catalog on the left, a central image window, and a control panel on the right. The control panel features various tools for image manipulation and data analysis, such as select, pan, dist, phot, draw, tag, moc, spect, filter, cross, xxy, rgb, epoch, size, dens, opac, zoom, cont, pixel, prop, and del. The status bar at the bottom indicates the current coordinates (13:26:45.82 -47:28:3) and the image dimensions (12.8' x 12.84').

Available data → 229  
in view out view

Command Frame ICRS Projection Aitoff

DSS SDSS 2MASS WISE GALEX PLANCK AKARI XMM Fermi Gaia Simbad NED +

2MASS color

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select  
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zoom  
cont  
pixel  
prop  
del

CDS / P / 2MASS / col  
CDS / P / DSS2 / col

13:26:45.82 -47:28:3

1' 12.8' x 12.84'

coll. ↑ sort view scan filter grid study wink north hdr multiview match

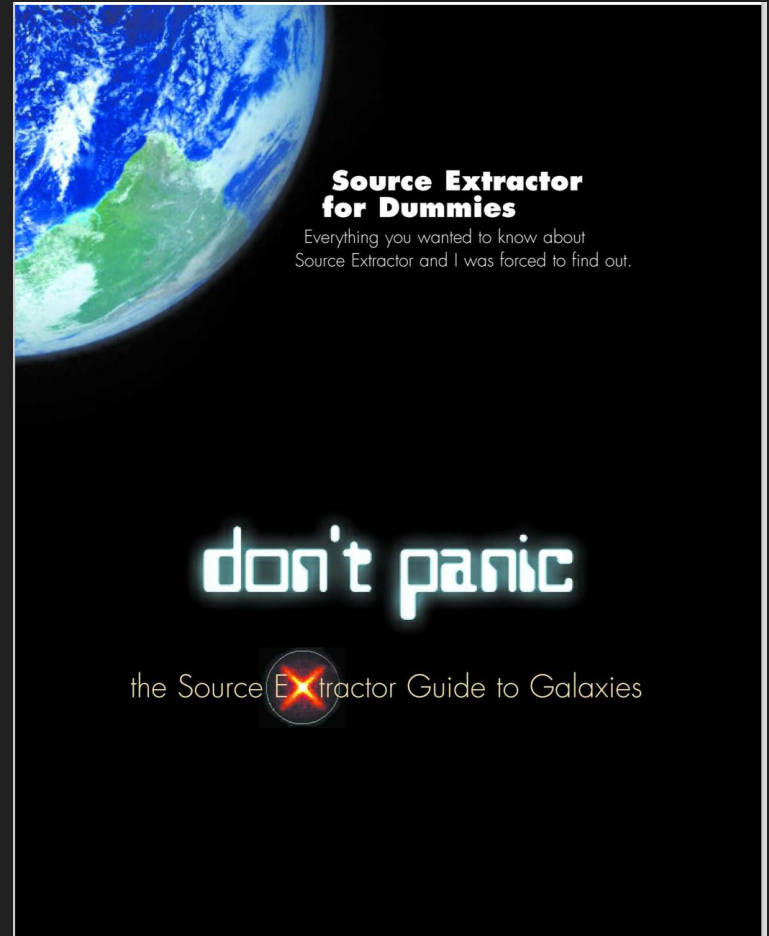
© 2018 Université de Strasbourg/CNRS – developed by CDS, distributed under GPLv3 0 sel / 0 src 56fps / 361Mb

# SExtractor

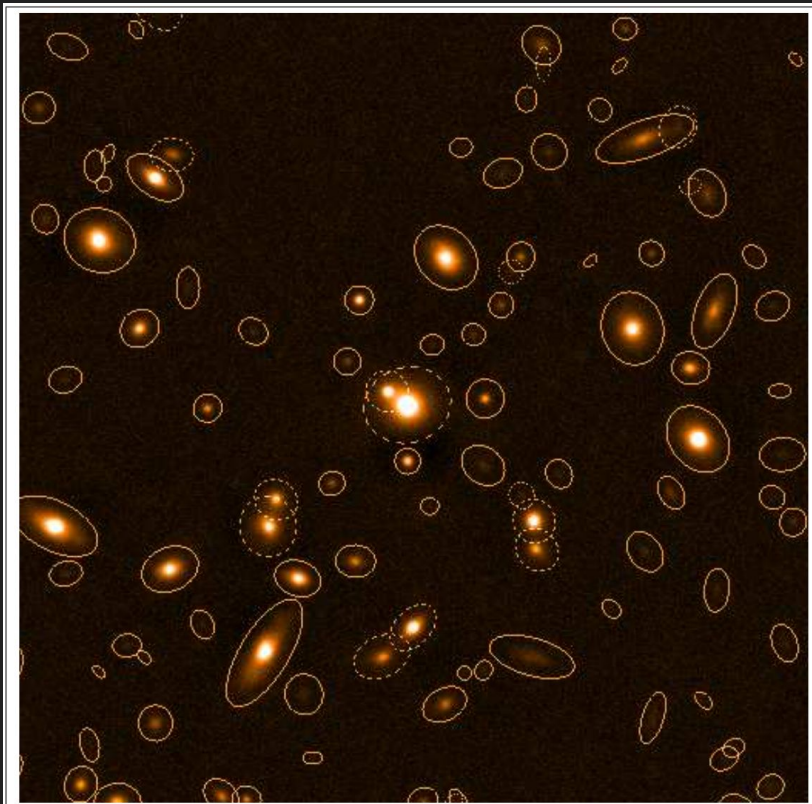
Nothing of what I have explained so far works in the case of galaxies.

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

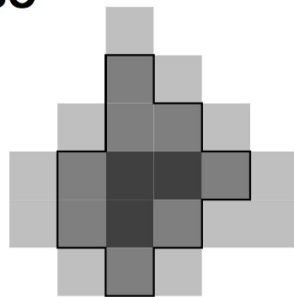
In the following, an example of how SExtractor finds sources and the apertures it uses (this is what we are going to use).



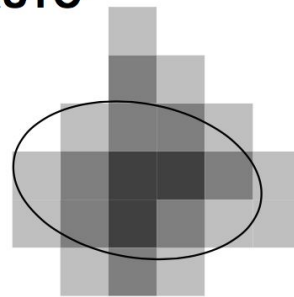
# SExtractor



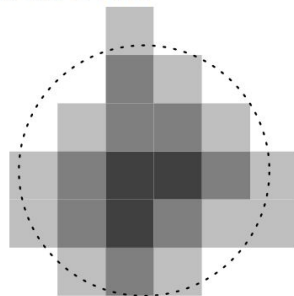
**ISO**



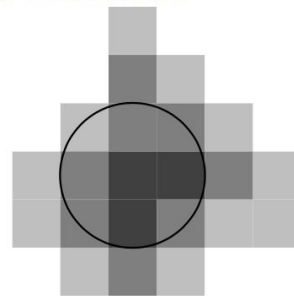
**AUTO**



**ISOCORR**



**APERTURE**



# Differential photometry

Compare a star with a neighbouring star.

You normally use three stars:

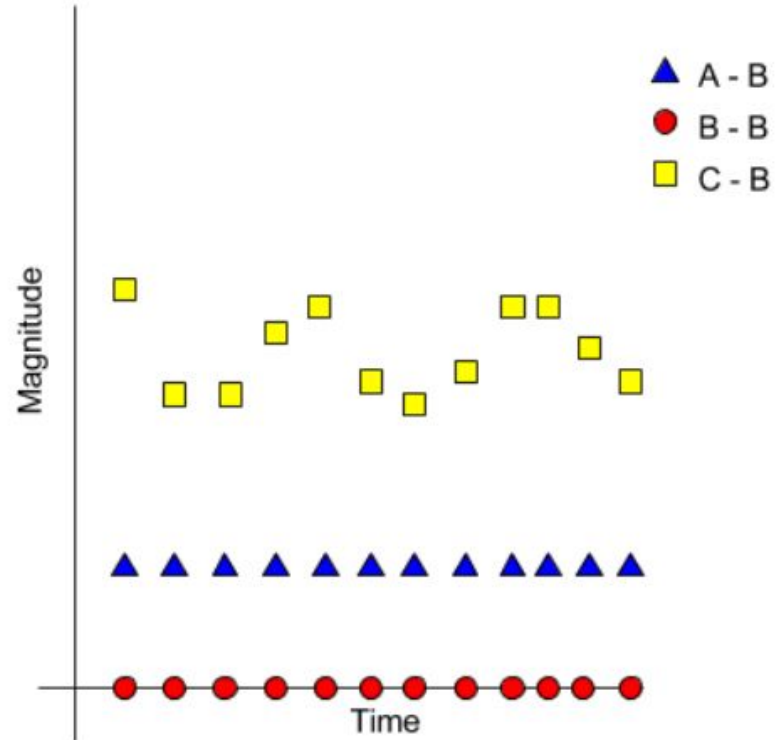
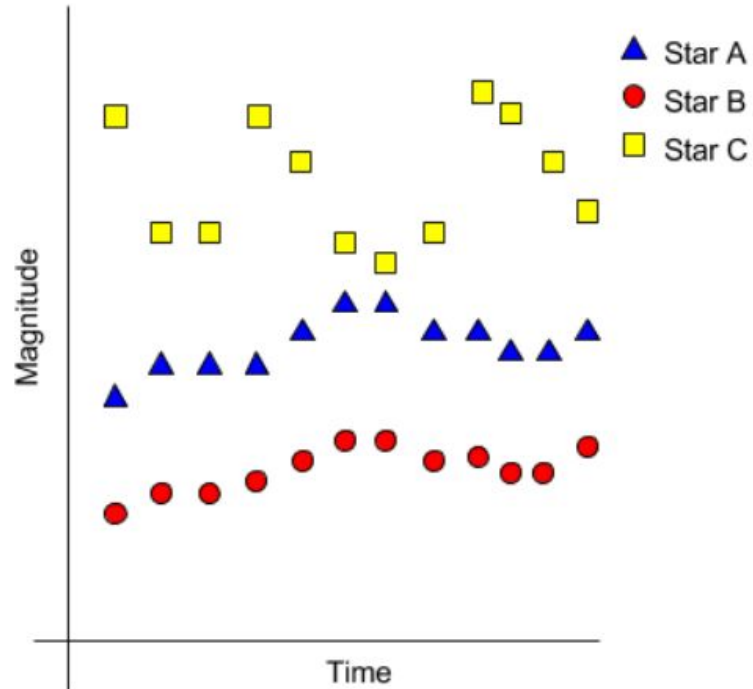
- The science star
- The comparison star
- The “check star”

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):

$$\text{mag}_2 - \text{mag}_1 = -2.5 \text{ Log } f_2 / f_1$$

$f_v$  is the “spectral flux density”

Magnitude (AB):

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

# What's in a magnitude...

Convolution of the filter of an object with a filter.

