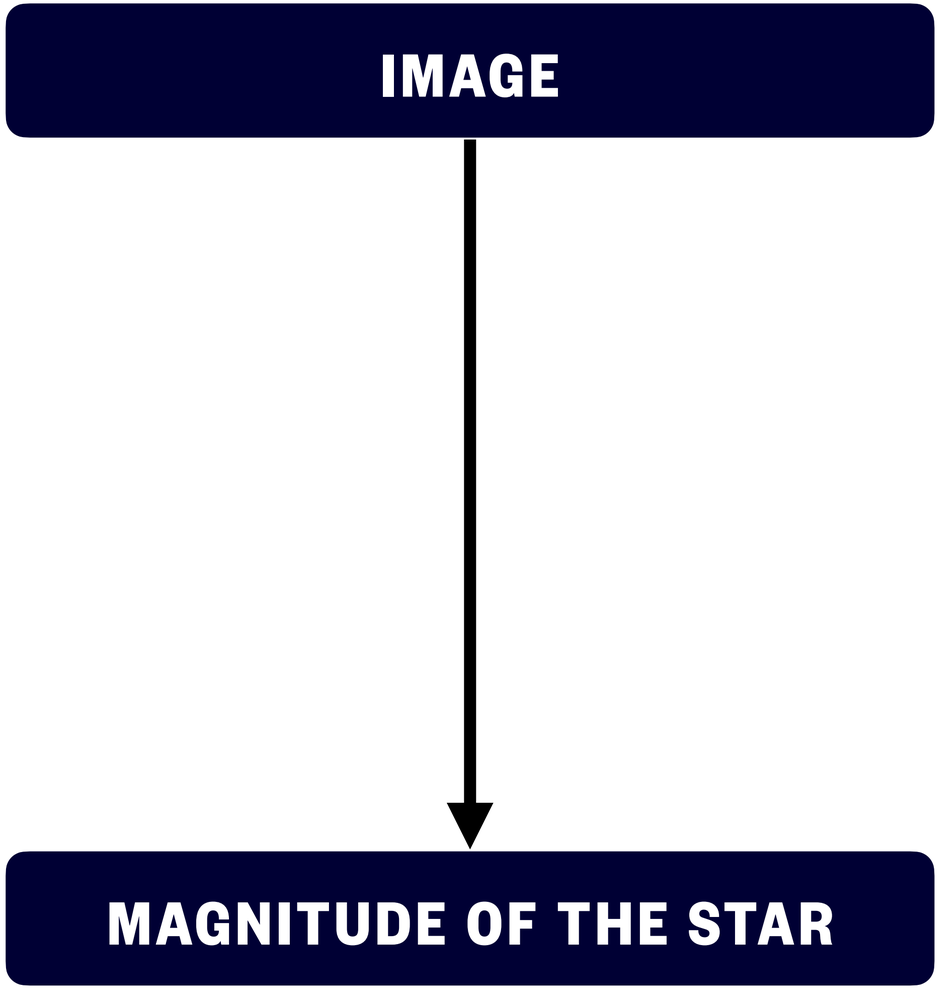
Star Cluster Part I - Aperture Photometry

25.04.08

Image of the Open Star Cluster

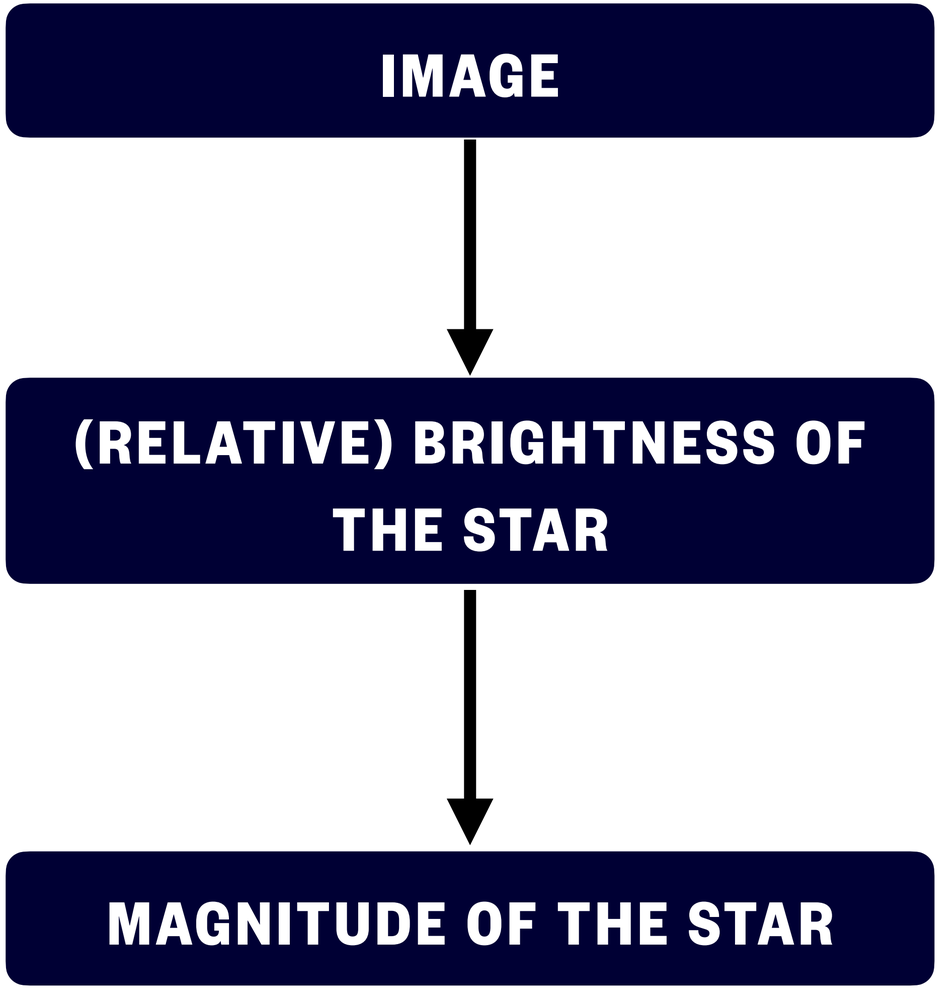
From an image to a magnitude



- Q. What is a magnitude?

  A. a measure of brightness

From an image to magnitudes



- Q. How can we define the brightness of a star?

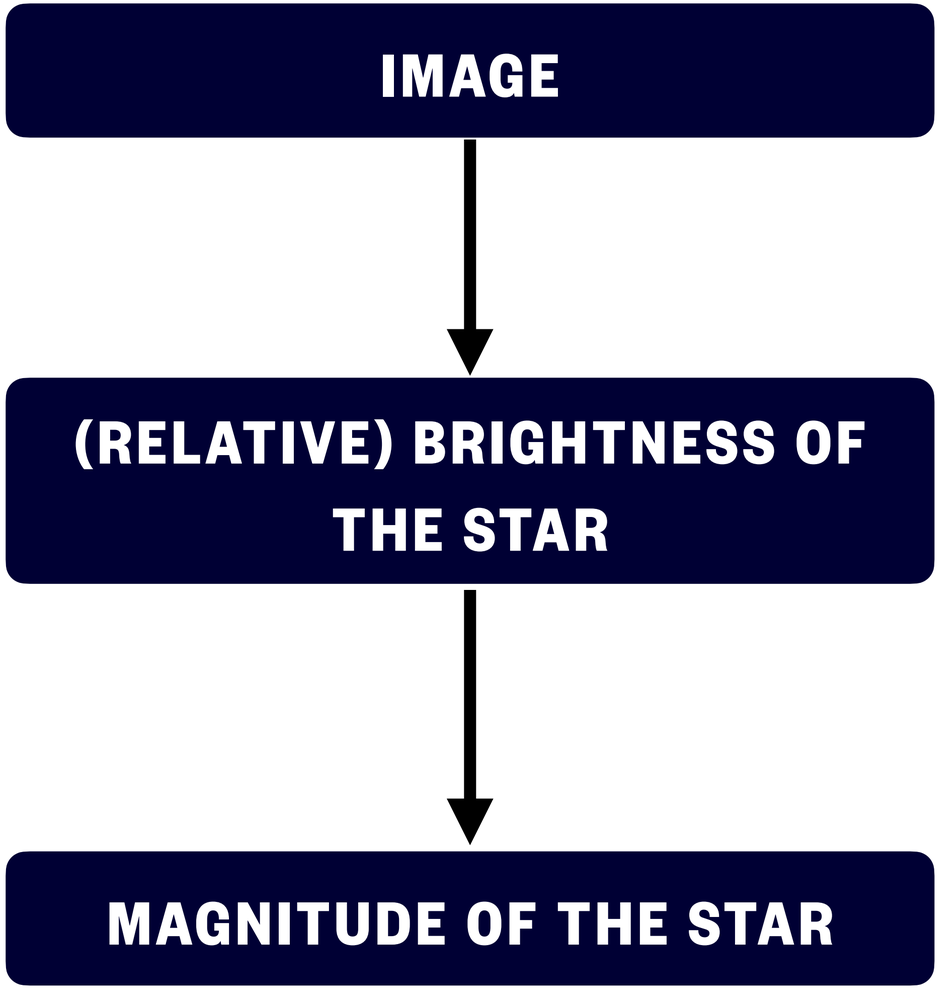
  Hint. pixel value $\propto$ # of photons

- Do CCD pixels detect only photons from the star?

  A. No, there are many sources of photons

  - target star
  - sky background
  - other stars
  - unresolved obejcts

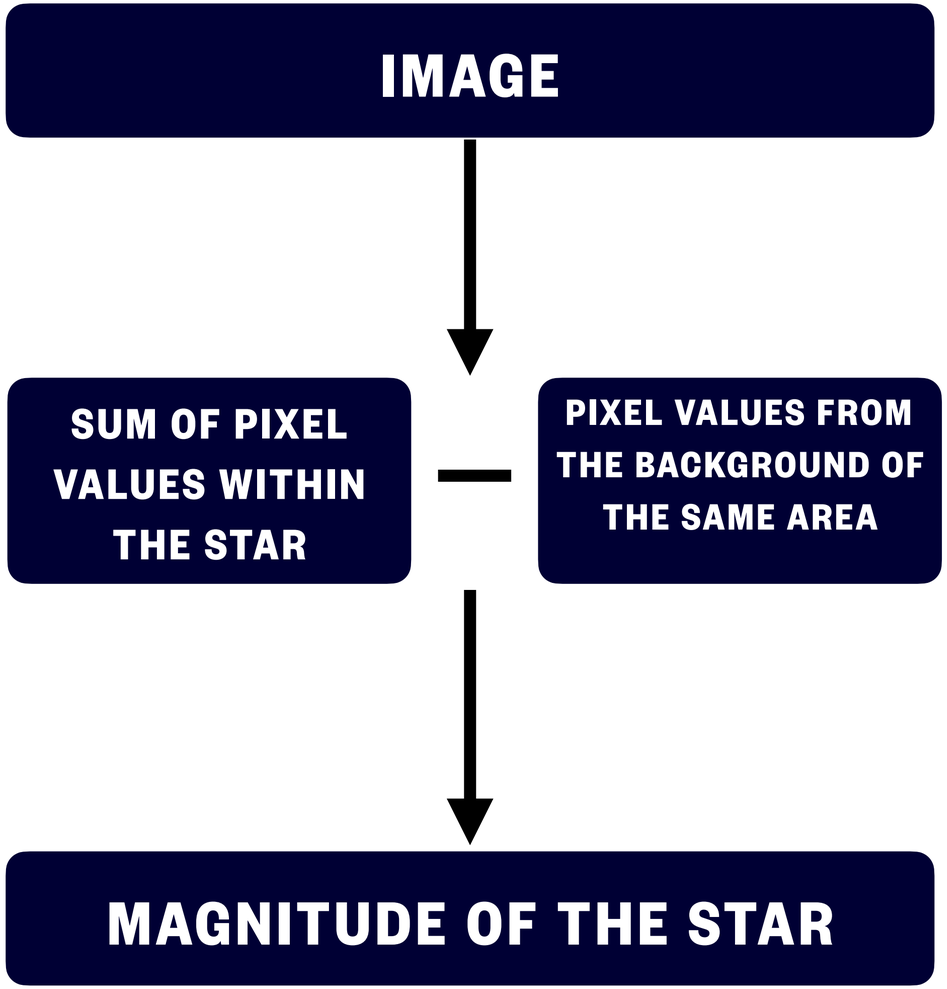
From an image to magnitudes



- Q. How can we count only the photons from the star?

  A. Subtract the photons from the background

From an image to magnitudes



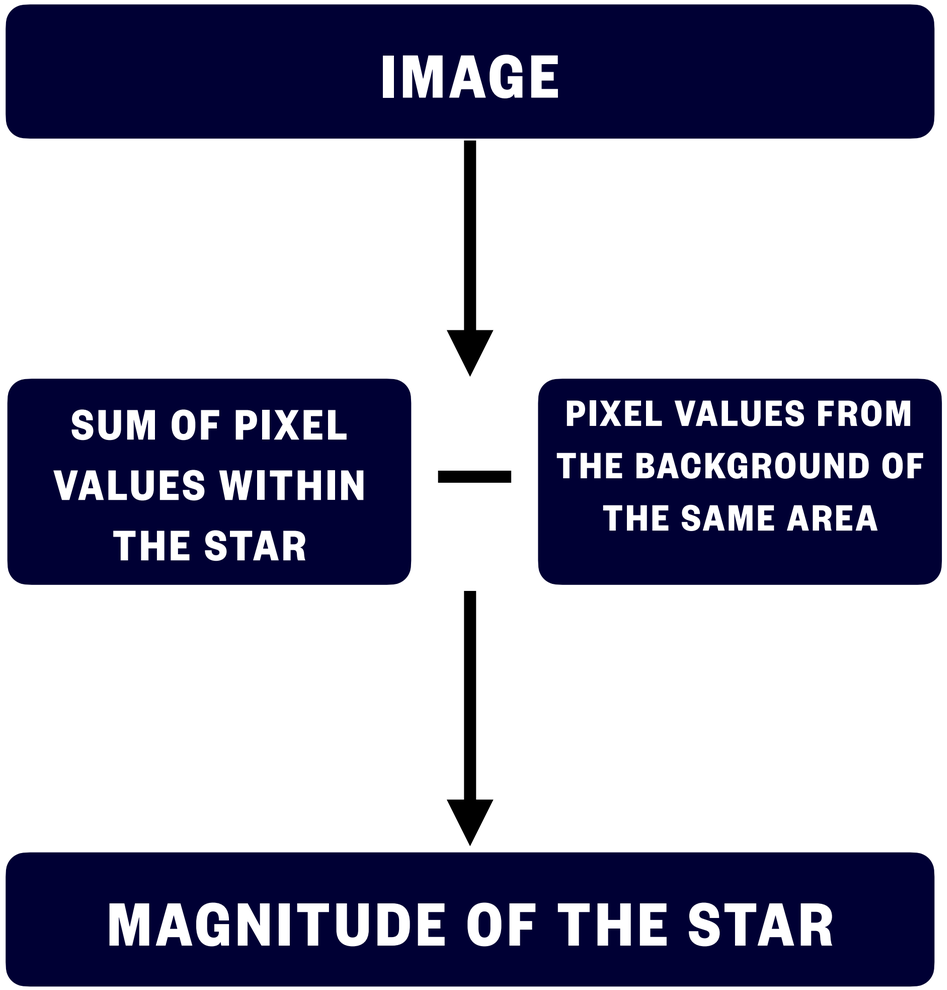
- Q. What is the range of the sum?

  A. are the star occupies, surely.

- Q. How can we define the ‘region’ of the star?

  A. Little vague…

From an image to magnitudes



- Detection of the star?
- Center of the star?
- Boundary of the star?

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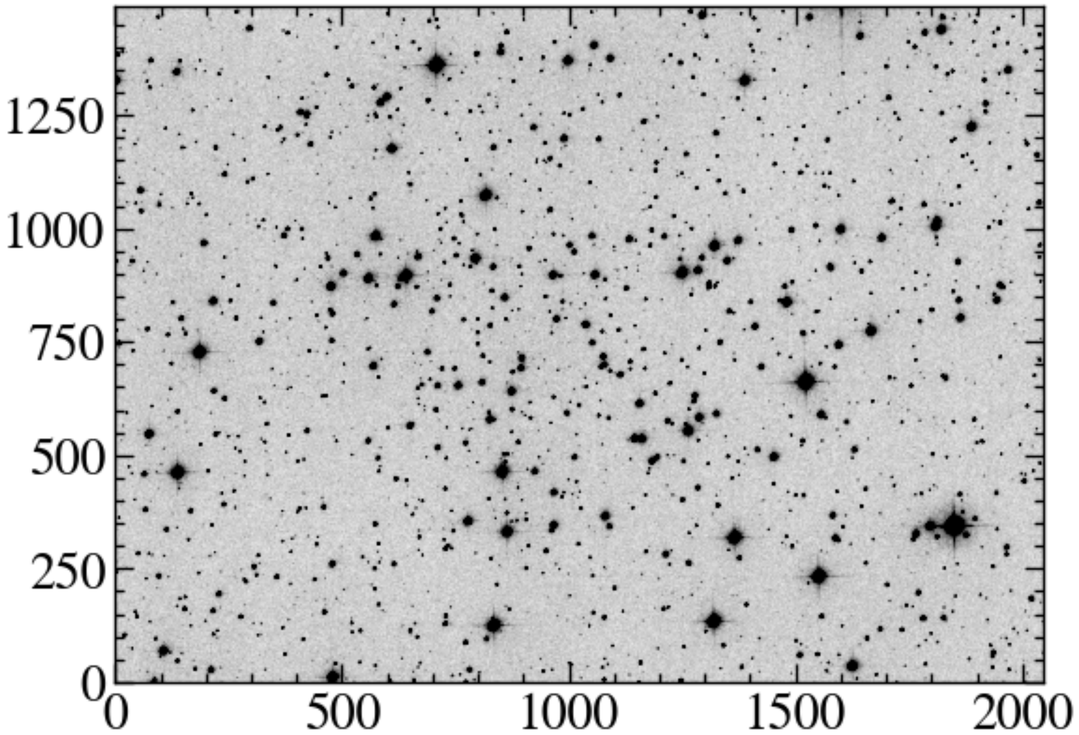

- Detection of the star?
  - Find a local maximum
  - profile width > $(\mathrm{FWHM})_{\mathrm{thres}}$ ~ seeing
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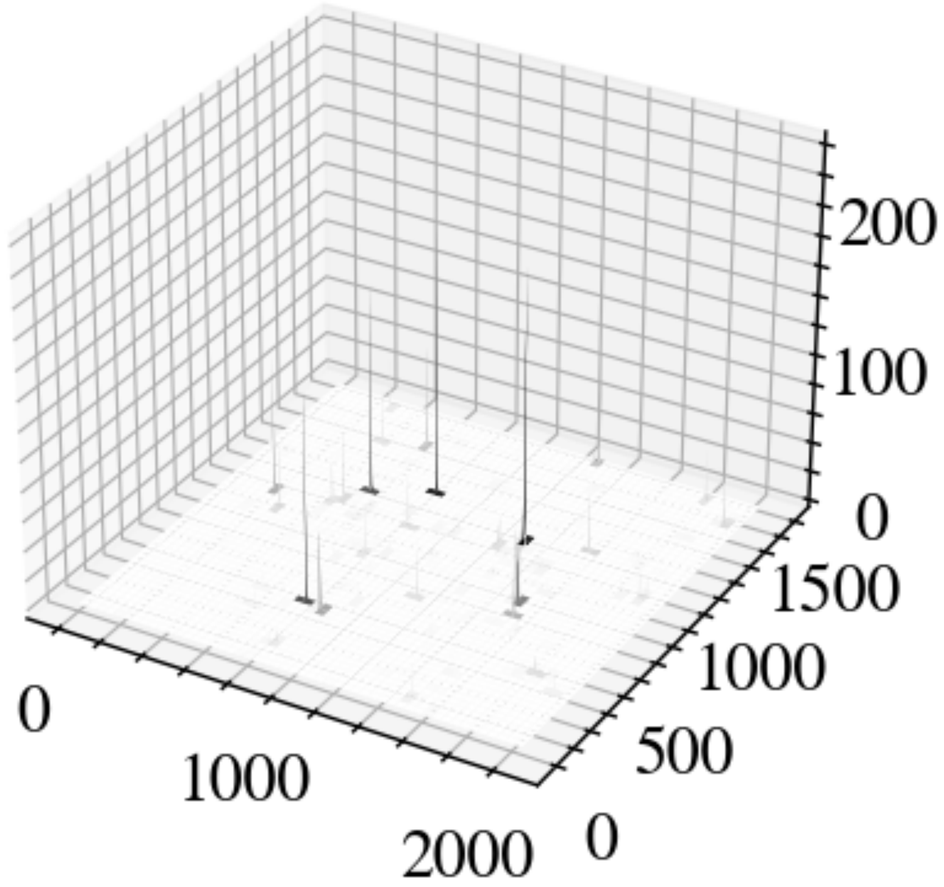
From an image to magnitudes



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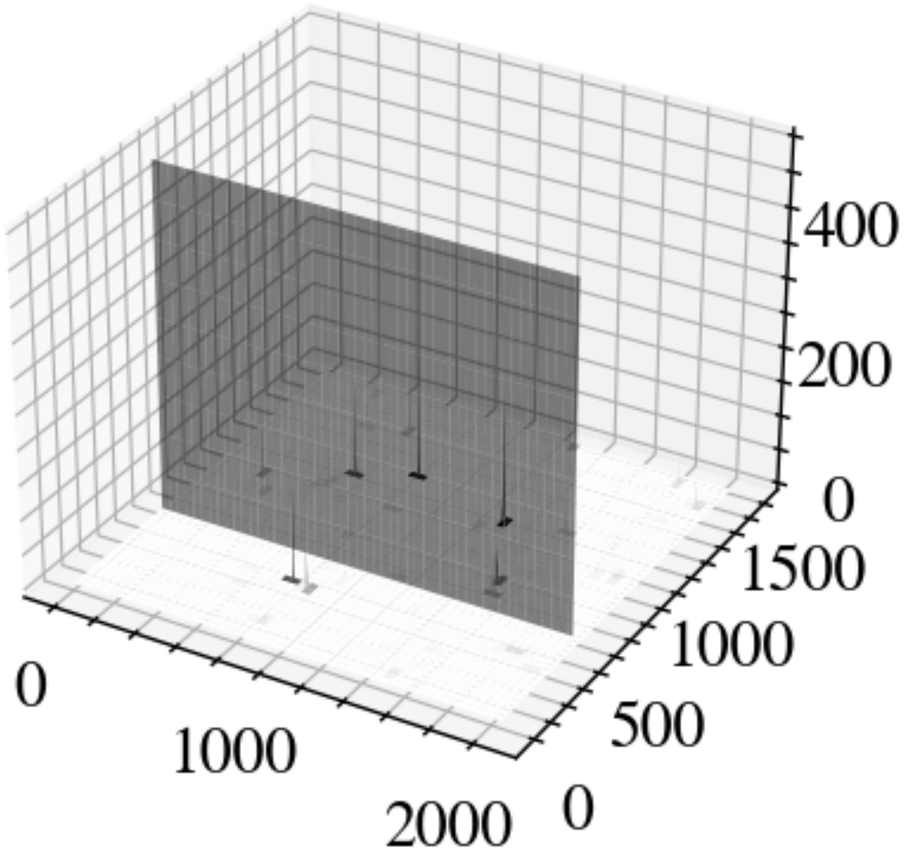

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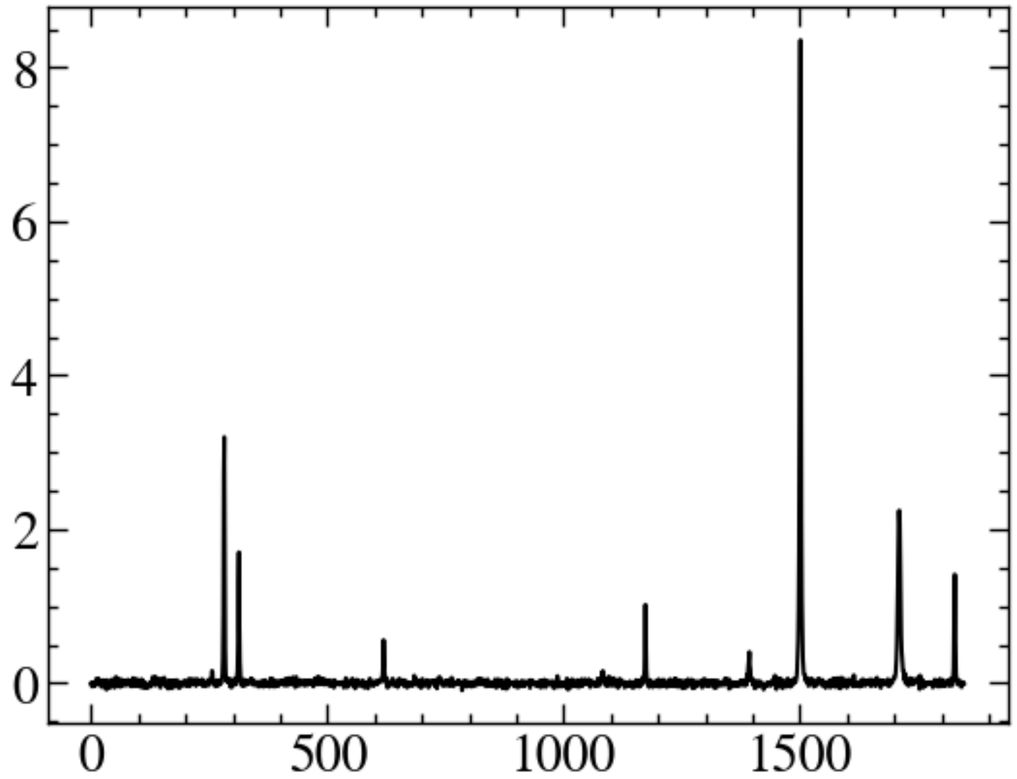

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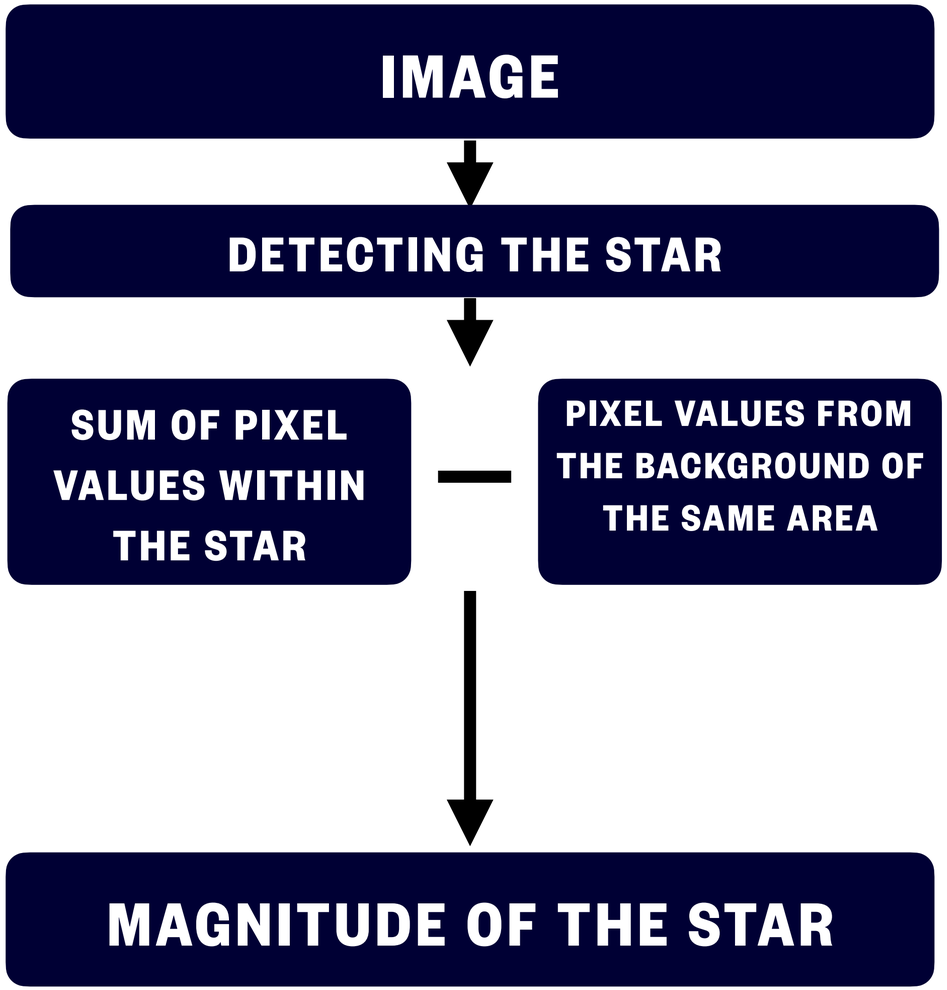

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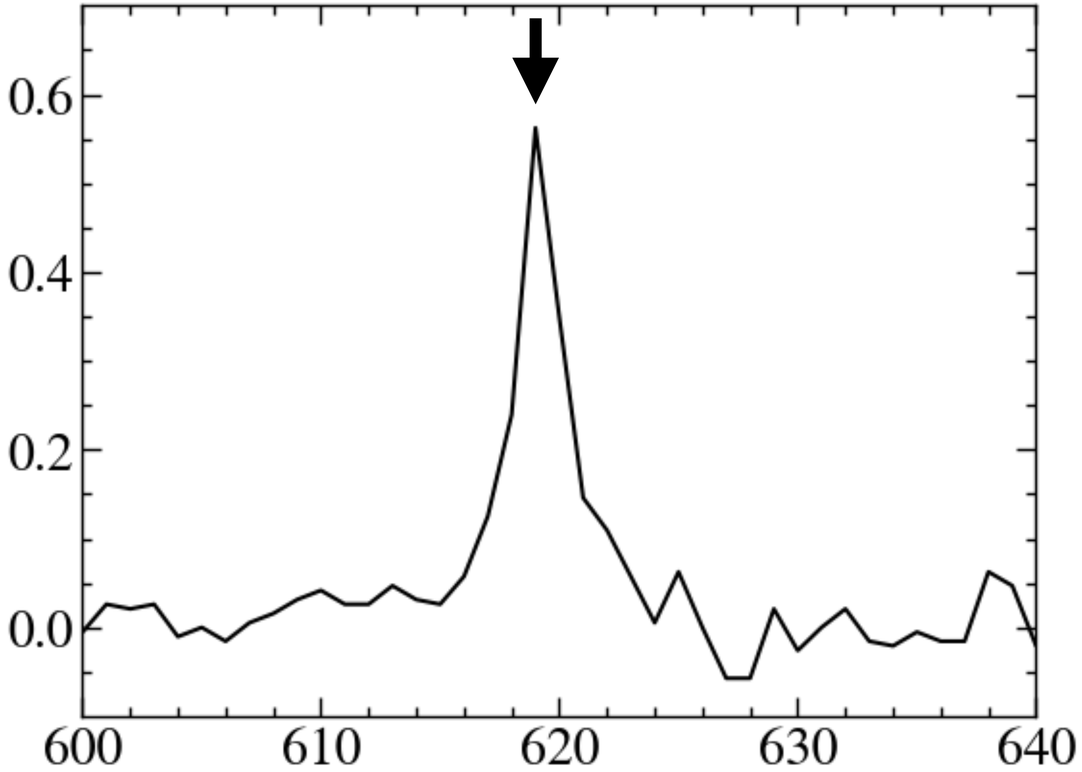

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  - center of mass/Gaussian fitting
- Boundary of the star?

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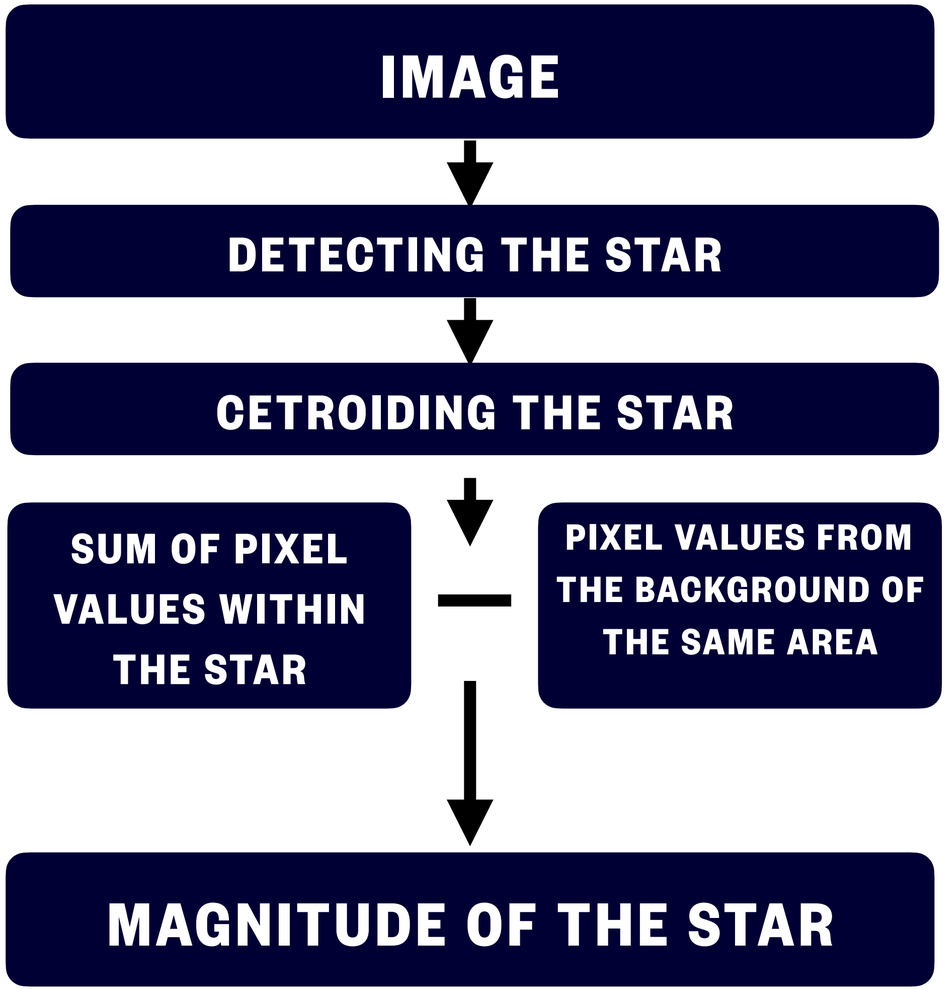

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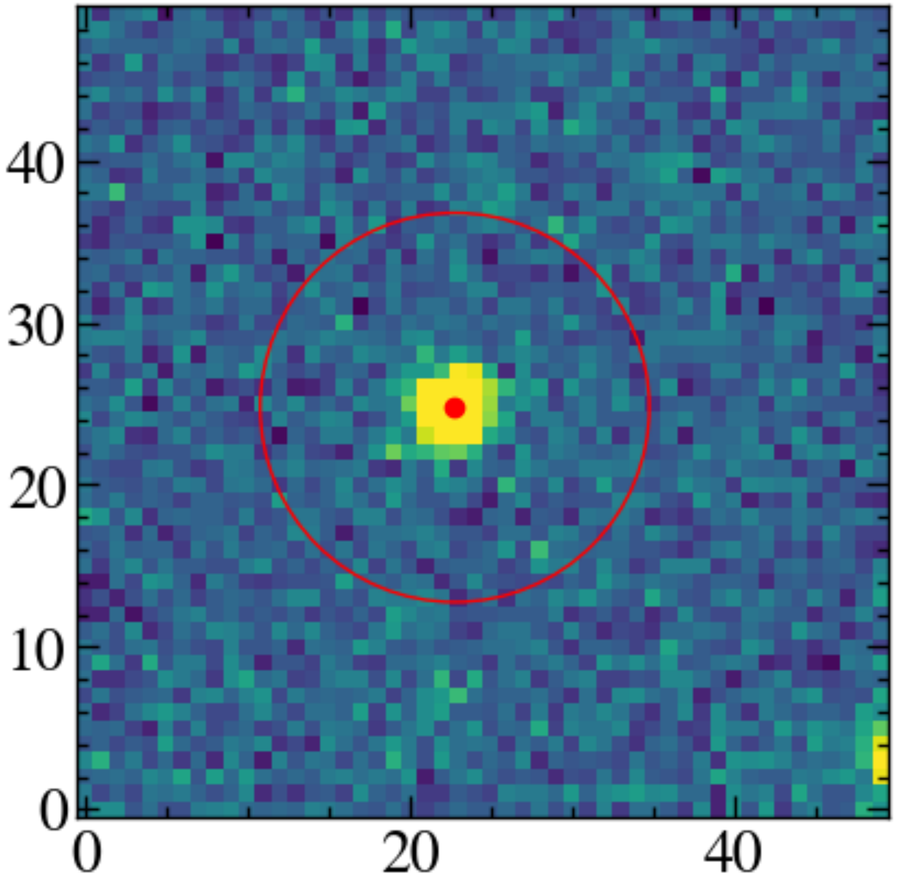

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- Center of the star?
- Boundary of the star?
  - In principle, the star extends infinitely
  - In practice,
    - ✓ small enough not to contaminated from other sources
    - ✓ large enough to include the ‘most’ of the sar

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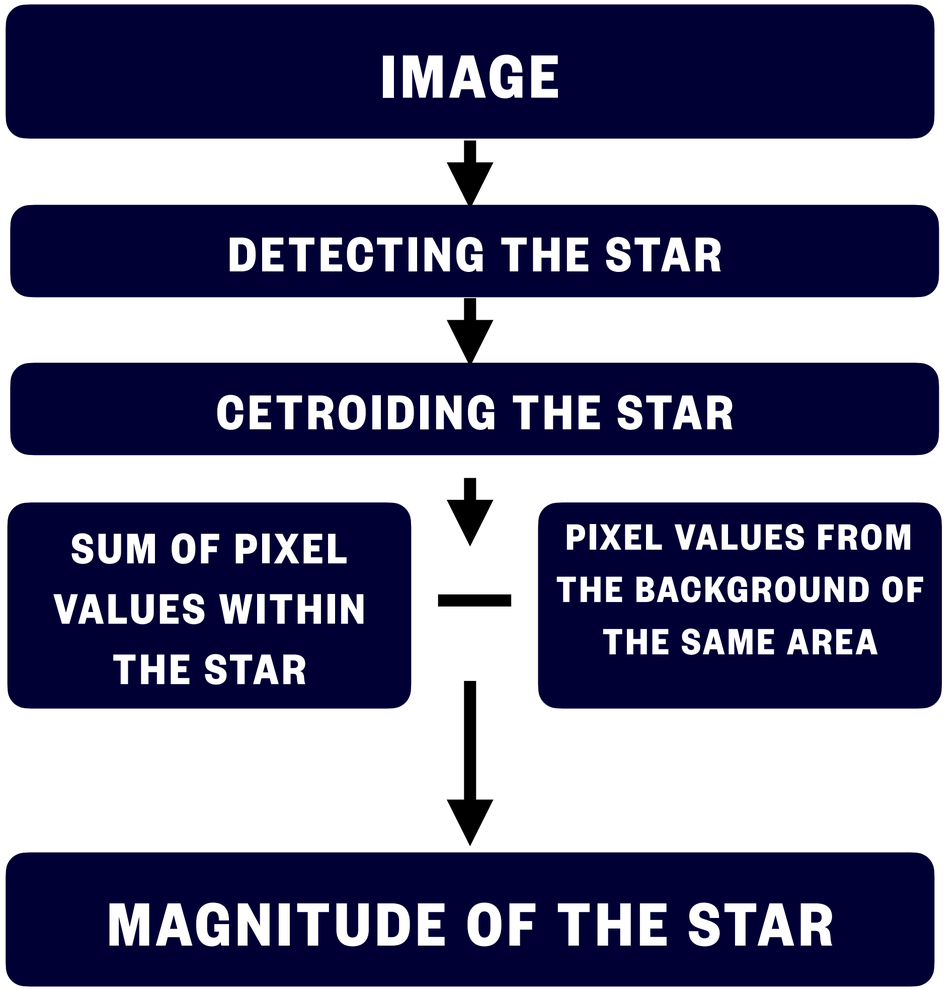

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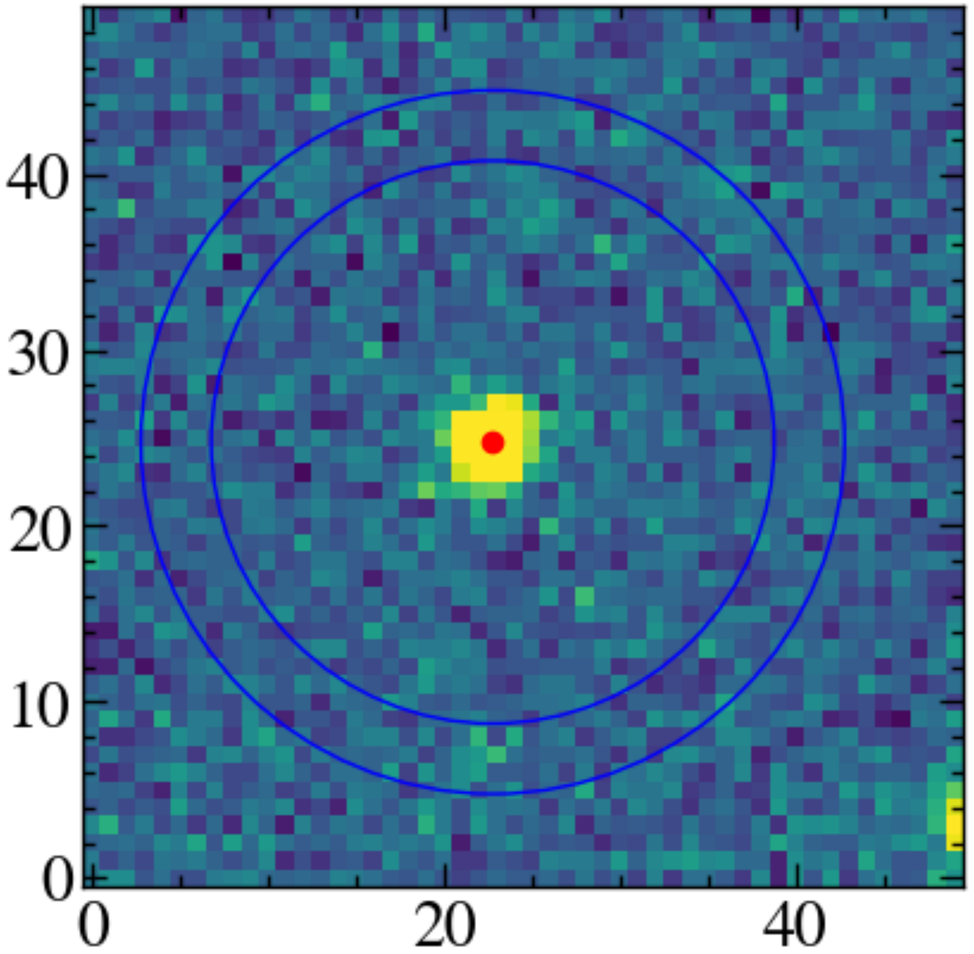
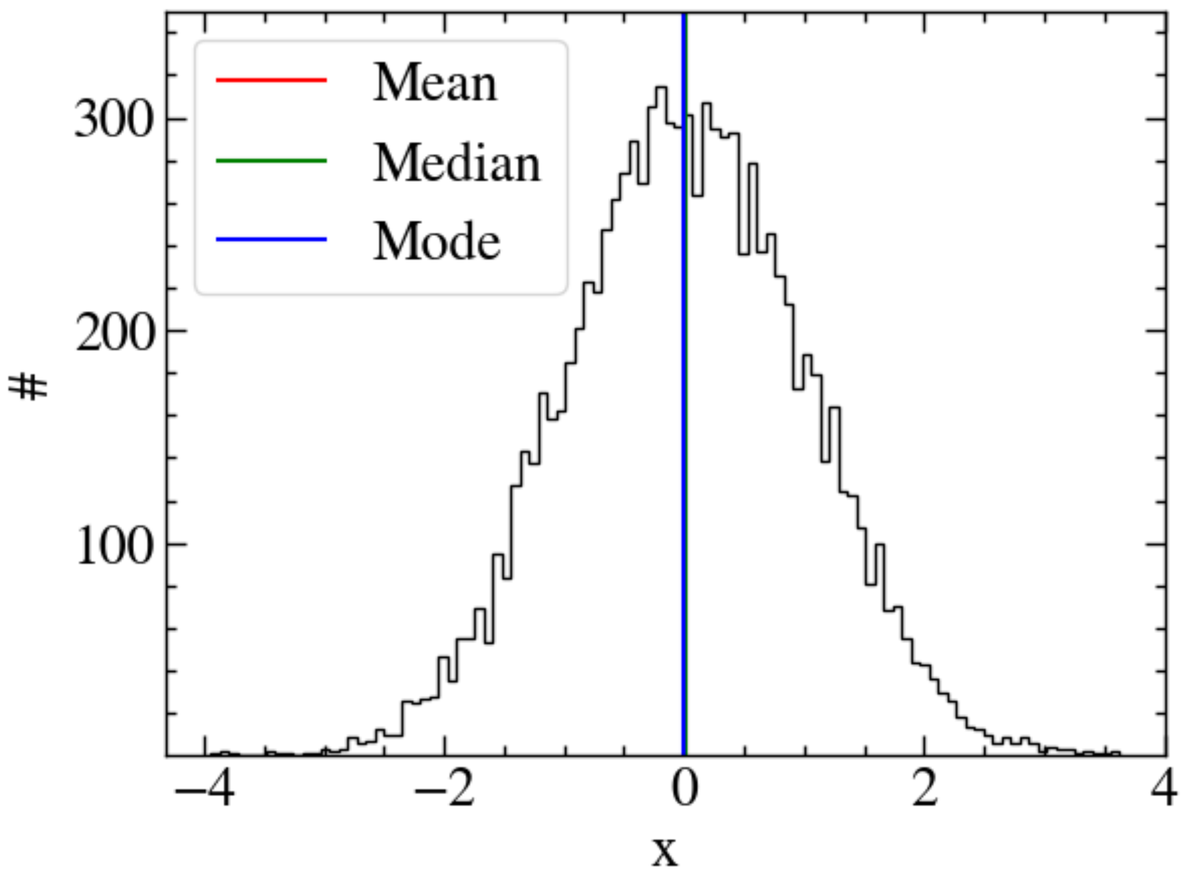
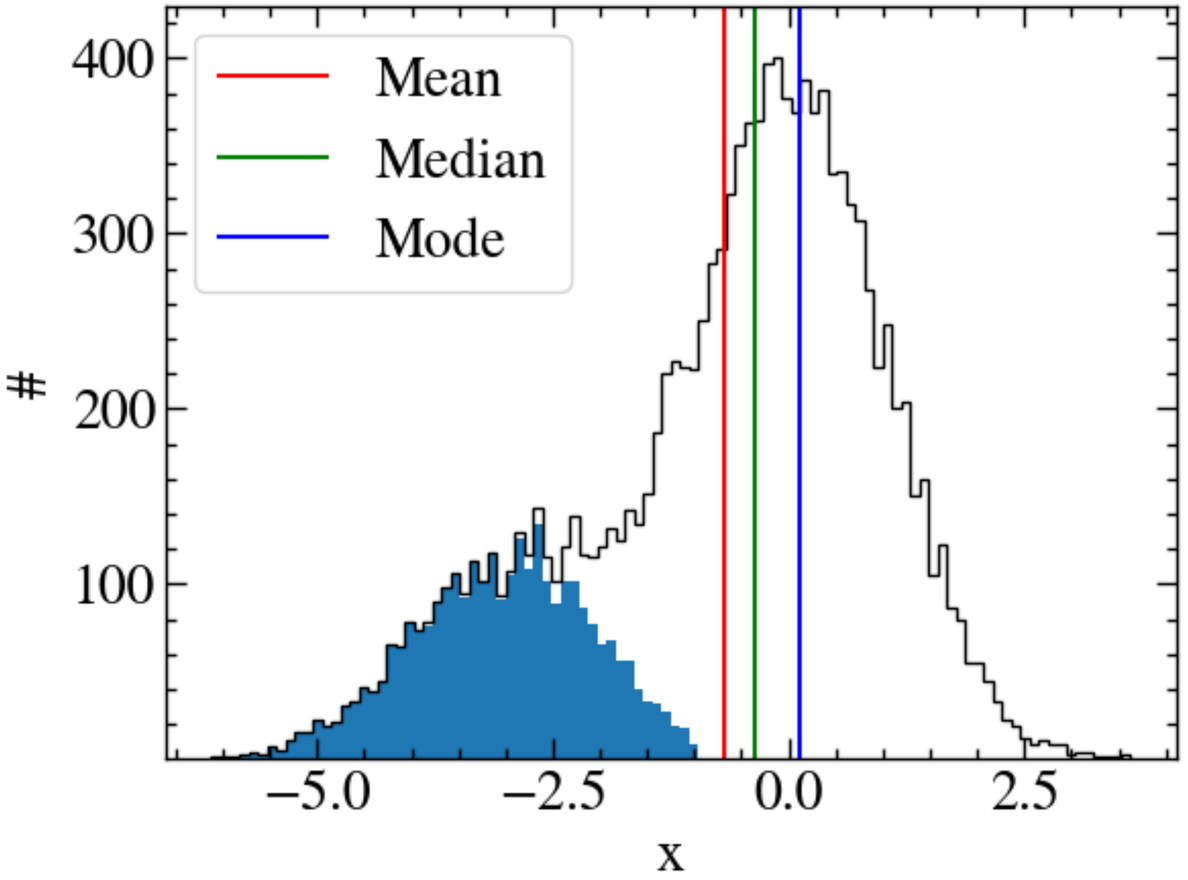
- Which background?
  - ~~The star area~~
    - The most exact. But we can’t.
  - ~~Mean of all background in the image~~
    - the background varies over the image.
  - Nearby area
    - approximately correct. Actually, in general, correct enough.

- Annulus

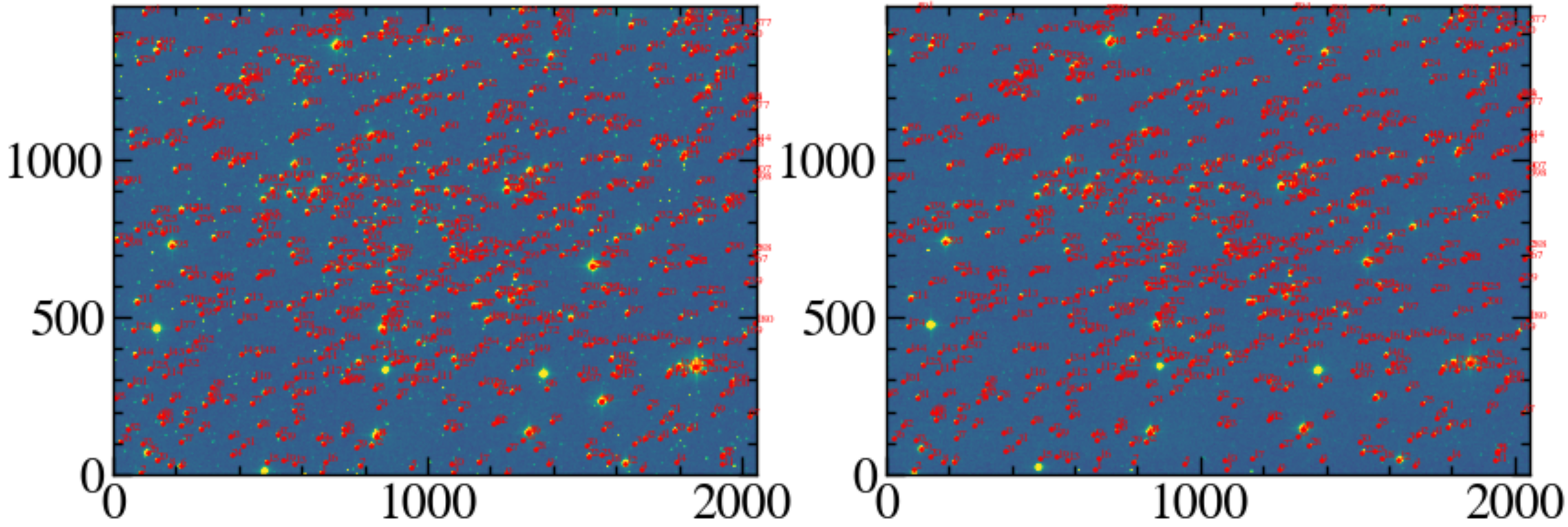


- Mean vs Median vs Mode

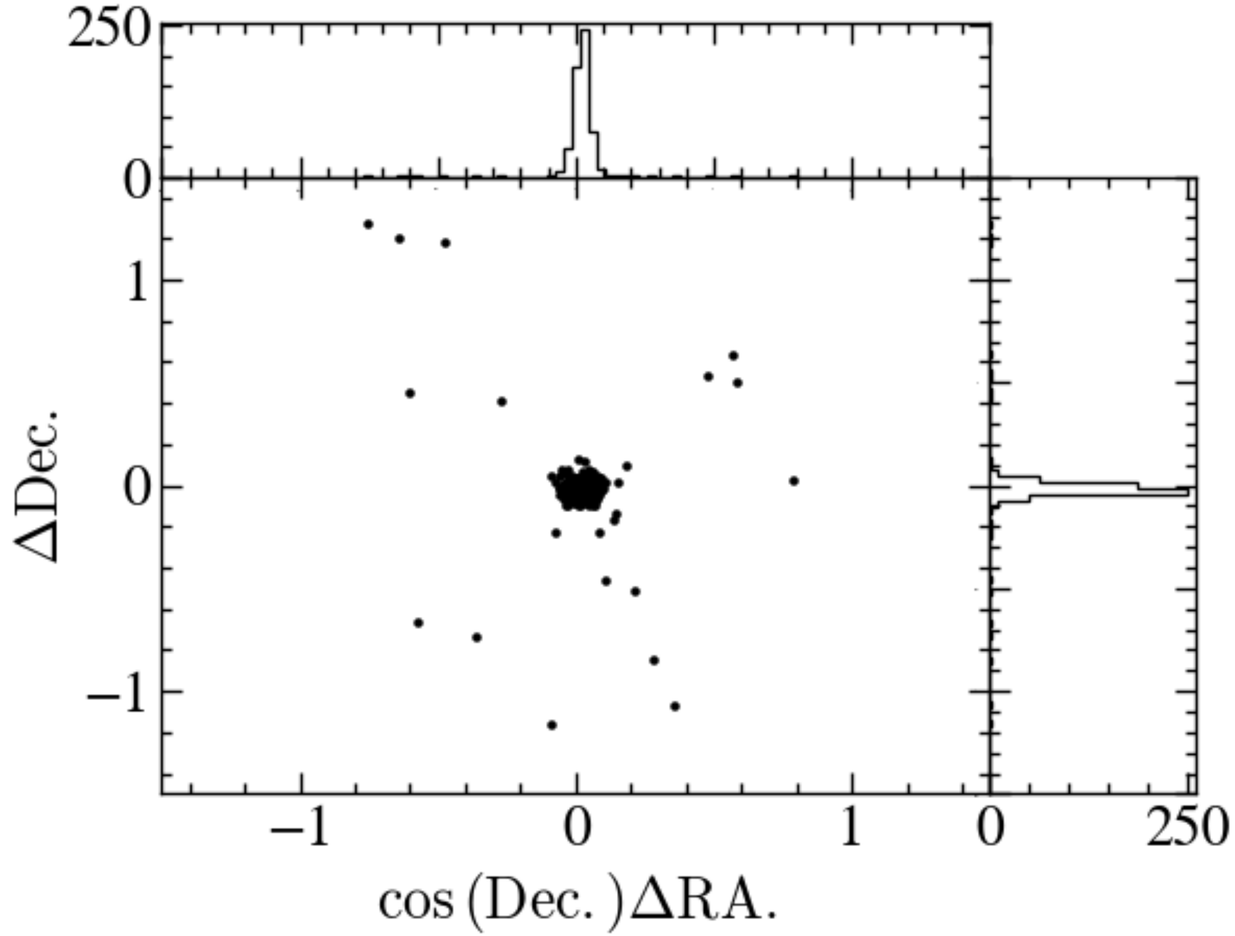




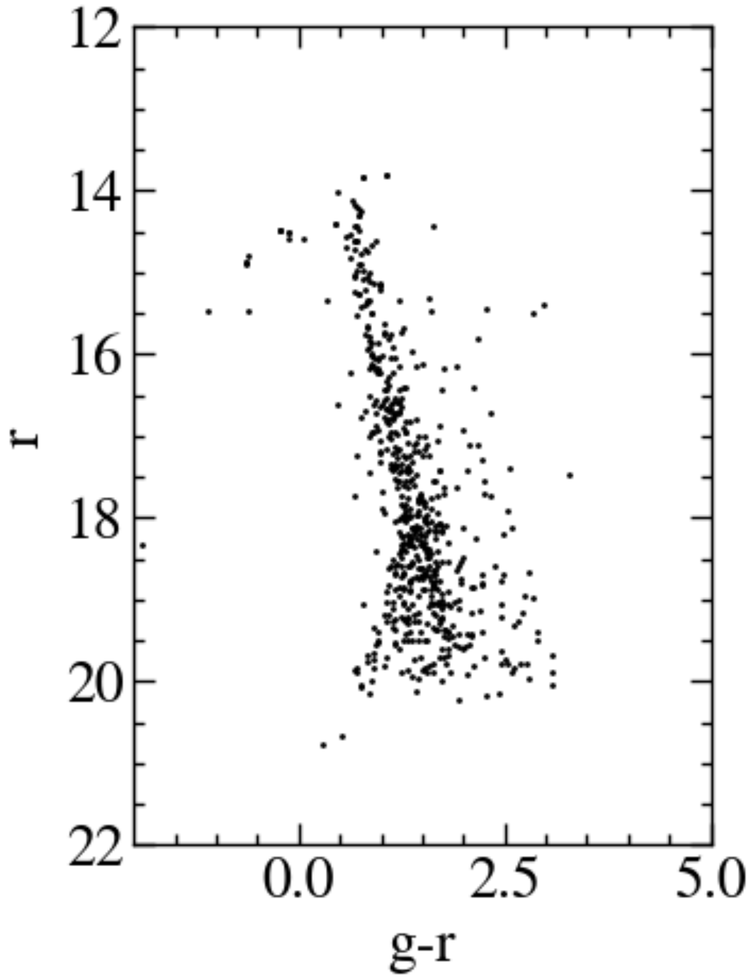
Matching



Matching



Color Magnitude Diagram (CMD)

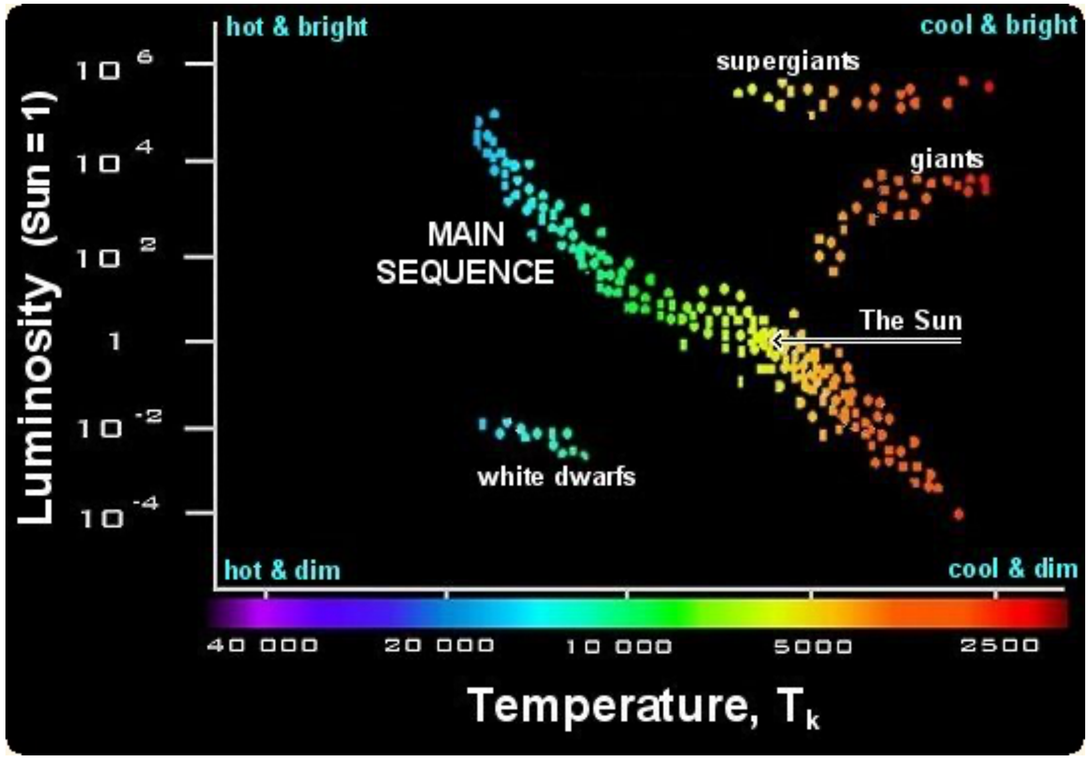


Saturation

- Is this Pleiades cluster picture good to plot CMD?
  - The ‘beautiful twinkles’ are bad sample!
  - We **should** exclude saturated stars from CMD
    - Why?

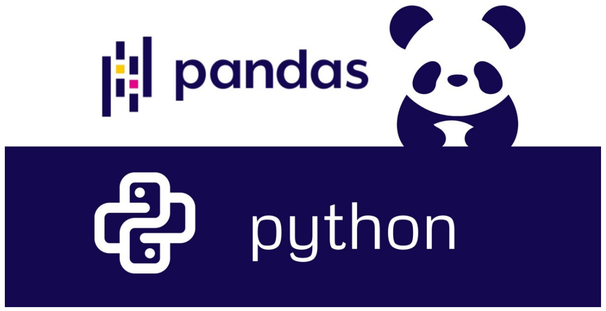
From the CMD, we know

- Compare with a Hertzsprung-Russel diagram.
  - Investigate the distance
  - Estimate the various physical properties
  - **For the next class…**



Necessary Packages

- numpy
- copy
- pandas
- matplotlib
- astropy
- photutils
- astroquery..? (Only who want)



Reference

- Setson 1987 section 3: https://ui.adsabs.harvard.edu/abs/1987PASP...99..191S/abstract
- Da Costa 1992 section 2: https://ui.adsabs.harvard.edu/abs/1992ASPC...23...90D/abstract
- Romanishin 2002 section 17.2: https://www1.phys.vt.edu/~jhs/phys3154/CCDPhotometryBook.pdf
- Photuils doc.: https://photutils.readthedocs.io/en/stable/aperture.html
- AO class material by YS.Bach: https://ysbach.github.io/SNU_AOpython/chaps/03-aperture.html

Tentative HW

- Choose the one or more open clusters to analyze (Whether provided or found by yourself)
- Apply aperture photometry and match the stars from the different bands
- Plot the CMD
- **Next class, we will learn how to analyze the CMD with ‘isochrone fitting’**