Let’s revise my planning.

I have a problem:

- Next week I will be in the US
- End of May, I will be in Spain

Do we manage to squeeze one or two lectures?

Next two thursdays are in the lab (one without me; so you can have fun!)

Ideally there will be more time in the lab.

I would like to use the telescope on campus with you!

Affonso and Matheus are already “captured”.

How do we set up an observing evening?

AGA0414
Photometry 2

Prof. Alessandro Ederoclite

Magnitudes

Need to go from counts to flux!

Magnitude (Vega; the Pogson's equation):

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

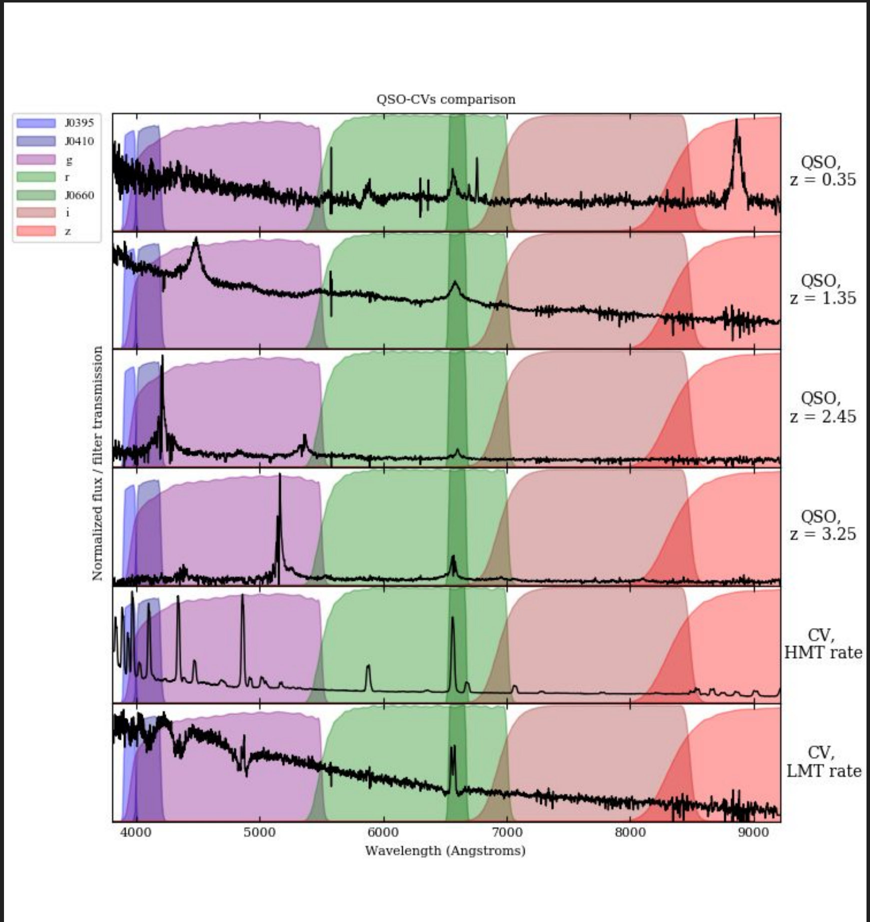
f_v is the "spectral flux density"

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.



(Unfortunate) definition of magnitude

Defined by Ptolemy/Hipparchus: bright stars “first magnitude” and faint stars “sixth magnitude”.

We said that the response of the human eye is logarithmic.

Pogson (1856)

$$mag_1 - mag_2 = -2.5 \log(f_1/f_2)$$

$$\Delta mag = 5 \rightarrow f_1/f_2 = 100$$

First, it was Vega

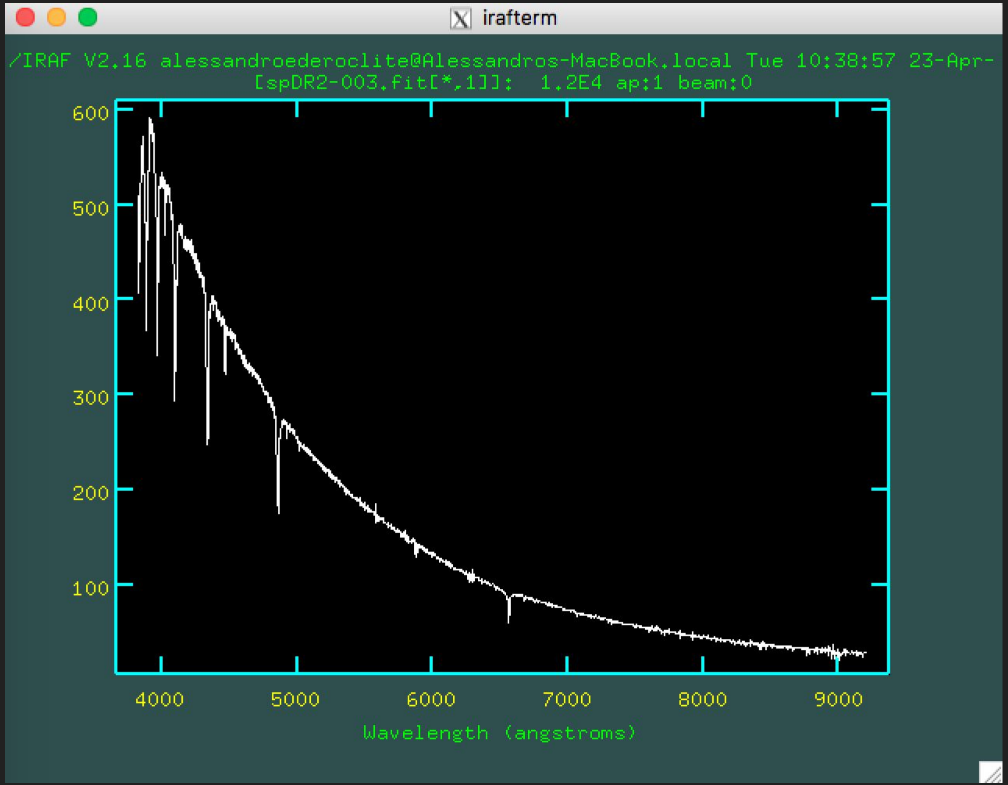
By definition:

- U-B = 0
- B-V = 0

By the way, Vega, by definition, had V=0.0

For any A0 star.

Turns out, that Vega has V=0.03



Then we started using flux

Optical astronomers use f_λ [ergs cm^{-1} $Å^{-1}$ s^{-1}]

Radio astronomers use f_v [ergs cm^{-1} Hz^{-1} s^{-1}]

Luckily: $f_v = (\lambda^2 / c) f_\lambda$

Oke (1974) and Oke & Gunn (1983) defined

$$mag_{AB} = -2.5 \, Log \, f_v - 48.6$$

Useful because it relates to a physical quantity. Hard because f_v strictly relates to its source and its filter.

Caveat! SDSS

The magnitudes in the SDSS catalogue are inverse hyperbolic sine magnitudes!

https://www.sdss.org/dr12/algorithms/magnitudes/#asinh

$m = -2.5/\ln(10) * [\mathrm{asinh}((f/f_0)/(2b)) + \ln(b)]$

Asinh Softening Parameters

Filter	b	Zero-flux Magnitude [$m(f/f_0 = 0)$]	$m(f/f_0 = 10b)$
u	1.4×10^{-10}	24.63	22.12
g	0.9×10^{-10}	25.11	22.60
r	1.2×10^{-10}	24.80	22.29
i	1.8×10^{-10}	24.36	21.85
z	7.4×10^{-10}	22.83	20.32

Excercise:

Show how asinh magnitudes differ from AB magnitudes in a range between 18 and 24.

… but we measure counts on a CCD!

γ -> e^- -> counts

All this relations are linear!

$mag_1 - mag_2 = -2.5 \log (counts_1 / counts_2)$

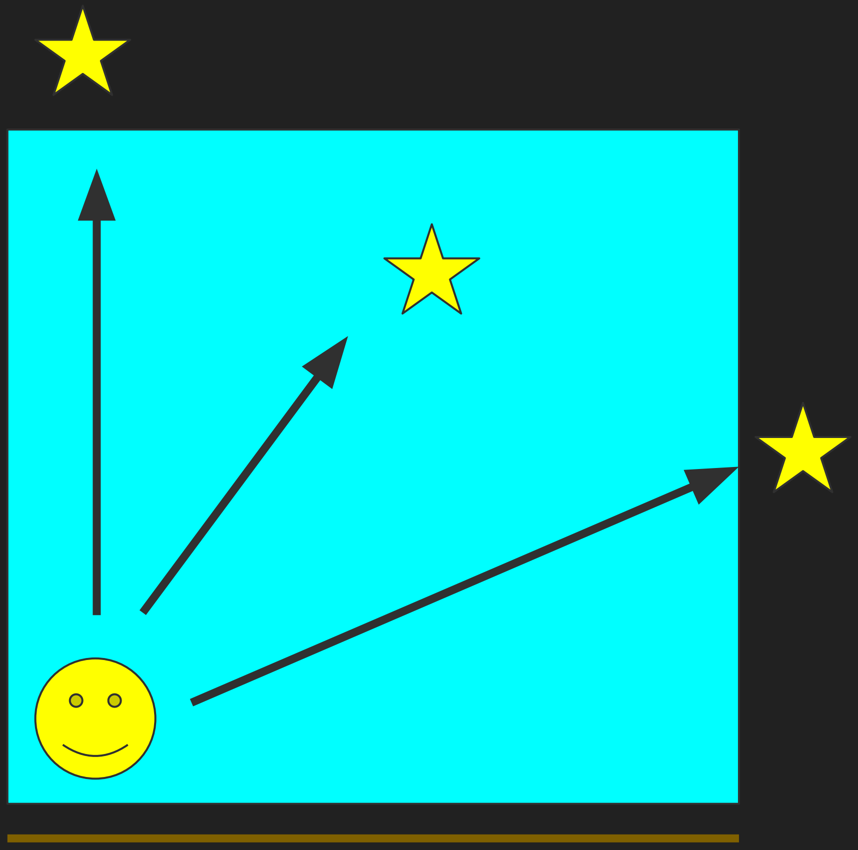
(note that it should be $counts_i$ / exposure time but it cancels out)

The role of the atmosphere

The further from zenith, the more atmosphere is between the observer and the star.

Airmass Z = sec

k is the "extinction coefficient" of the atmosphere. It measures the exctinction (in units of magnitudes) per unit of airmass.



Bouguer's Law

I measure a star of known brightness at different airmass:

$mag_0 = mag_z + k * \sec Z$

THIS DEPENDS ON FILTER!

How does this affect different wavelengths?

Stars get "redder" with increasing airmass

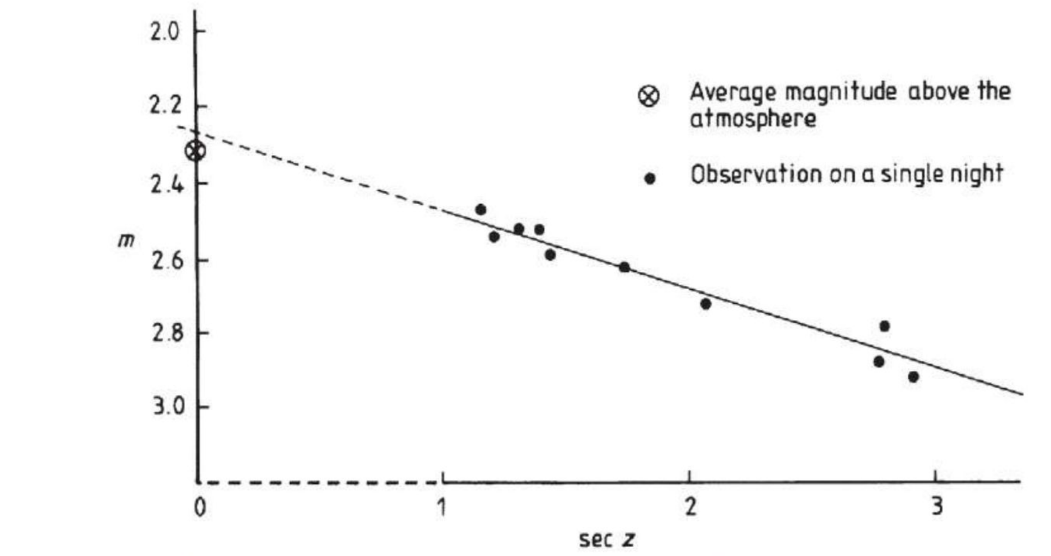
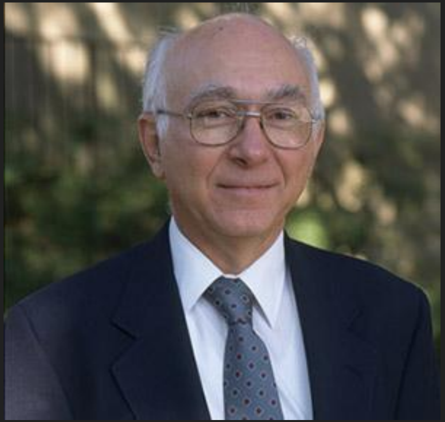


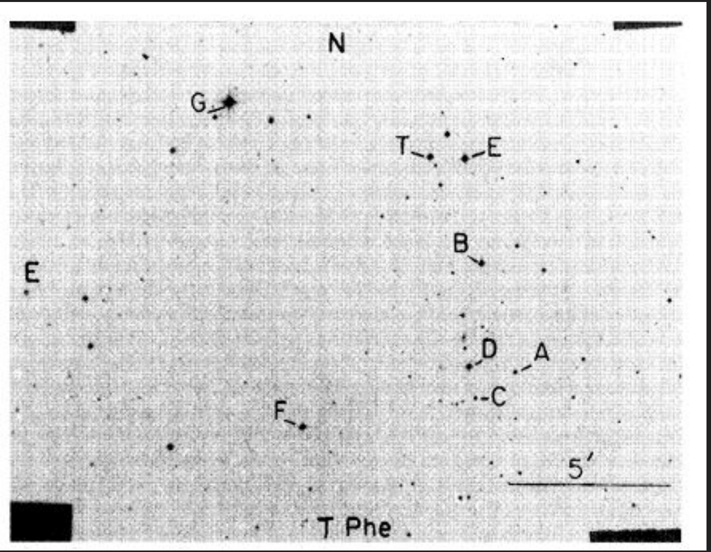
Figure 3.2.5. Schematic variation in magnitude of a standard star with zenith distance

Landolt's Fields

In fact, usually we measure a whole field of stars. The main standard fields have been identified by Arlo Landolt https://en.wikipedia.org/wiki/Arlo_U._Landolt

An astronomer is really famous once his papers are not cited but taken for granted as basic astronomical knowledge.





Colour terms

The Bouger's Law gives you the zeropoint and the extinction coefficient for your filter.

Yet, you still have to get the colour-terms:

$$(U\ B\ V\ R\ I)_{calibrated} = C\ (U\ B\ V\ R\ I)_{instrumental} + \text{Zeropoints}$$

Where "C" is a matrix

- Normally you do not have to take care of all the elements

Absolute Magnitude vs. Apparent Magnitude

The magnitudes we observe are “apparent” ones.

An apparently faint star may just be a very far away bright star (or…? ;-))

We define “absolute magnitude” the magnitude of a star as if it was at a standard distnance of 10 parsecs.

$M = m + 5 \log d[pc] + 5$

<u>This is an incomplete version of an absolute magnitude!</u>

Distance modulus: $M - m = 5 \log (d/10pc)$

Parallax

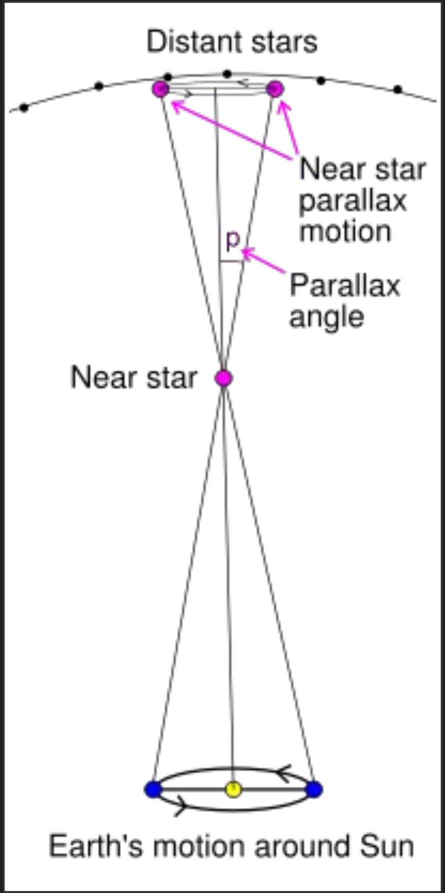
π = 1arcsec

corresponds to

206265 astronomical units

1 parsec

d[pc] = 1 / π(arcsec)



Interstellar extinction

The universe is full of gas and dust.

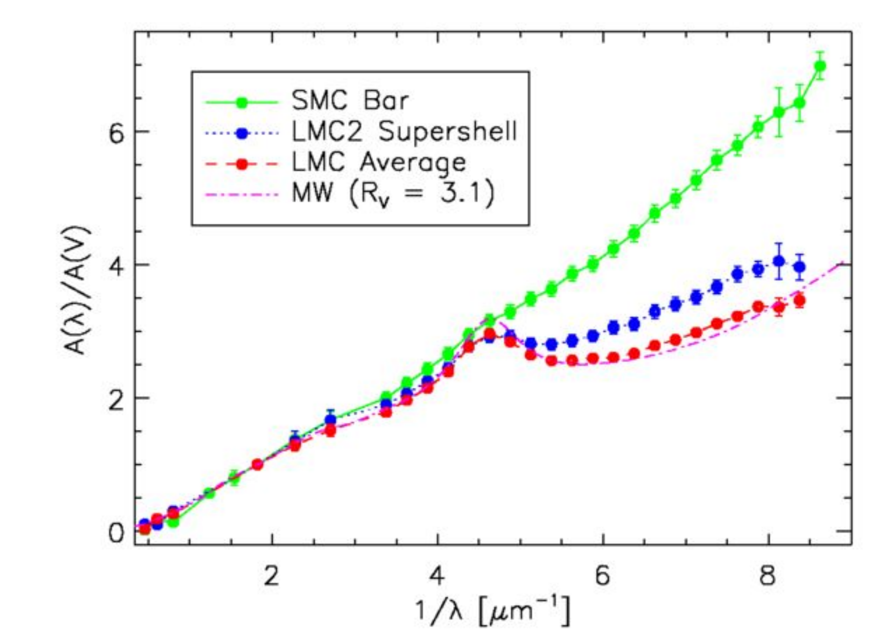
How does this gas and dust affect starlight?

Light gets absorbed and reddened!

$R_V = A_V / E_{B-V}$

The complete expression of "absolute magnitude" is:

$M = m + 5 \log d[pc] + 5 + A_V$



https://en.wikipedia.org/wiki/Extinction_(astronomy)

See you on Thursday in the IT lab