Fotometría absoluta

Absolute vs. Differential Photometry

absolute photometry:

– requires aperture correction

– **requires non-variable photometric standard stars**
  similar time and location on sky as science targets (**same airmass)**
  ideally, with identical color (e.g., B–V) as science targets

– **requires photometric weather conditions**

– best attainable accuracy ~1%

– example applications:
  color-magnitude diagrams
  supernova flux measurements

differential photometry:

– usually, with respect to stars of known brightness in the same field • identical time and airmass

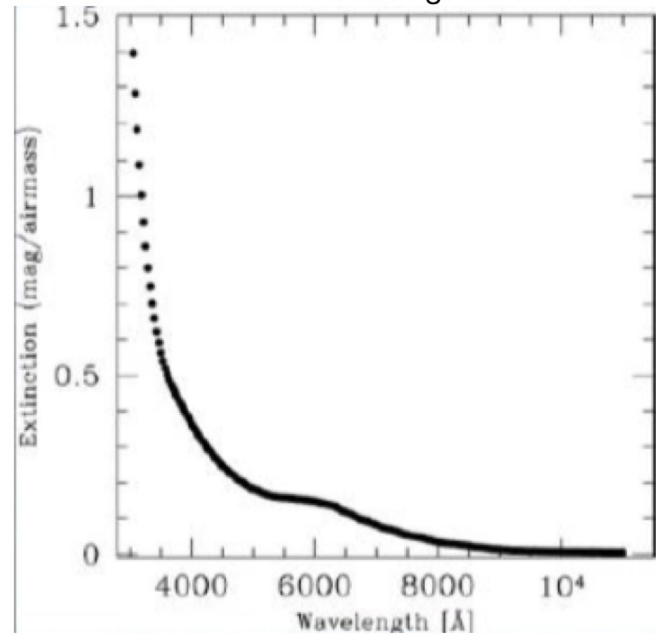
– subject to variability of reference stars

– best attainable accuracy ~0.001% (space), ~0.05% (ground)

– example applications:
  searches for transiting planets

Extinción Atmosférica

Stritzinger et al. 2005



- El efecto total de la dispersión de Rayleigh causa lo que llamamos **extinción**
- La **extinción** A (en un filtro dado) se define como diferencia entre la magnitud observada *m* de una estrella y la magnitud m_o que tendría en ausencia de la atmósfera

$$A = m - m_o$$

- La extinción depende de la **masa de aire X**:

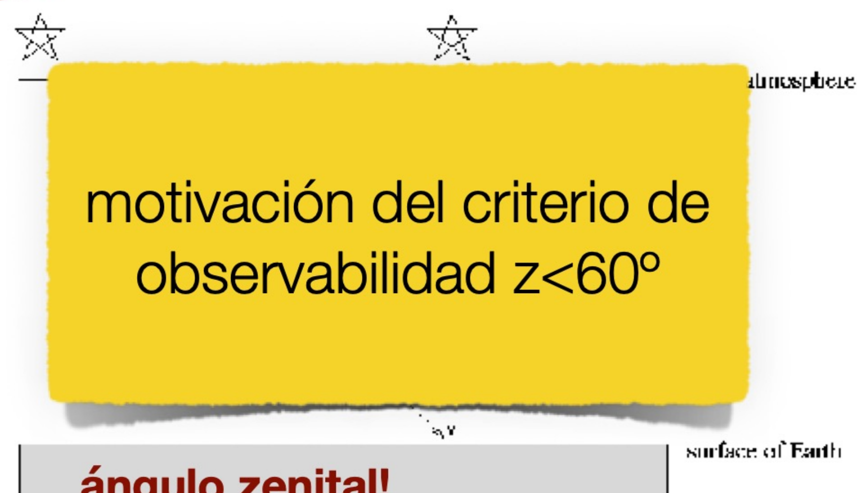
$$m(X) = m_o + k \cdot X$$

coeficiente de extinción

- En la aproximación de una atmósfera (localmente) plano paralela, tenemos:

$$X \approx \frac{1}{\cos z} = \sec z$$

ángulo zenital!



motivación del criterio de observabilidad z<60º

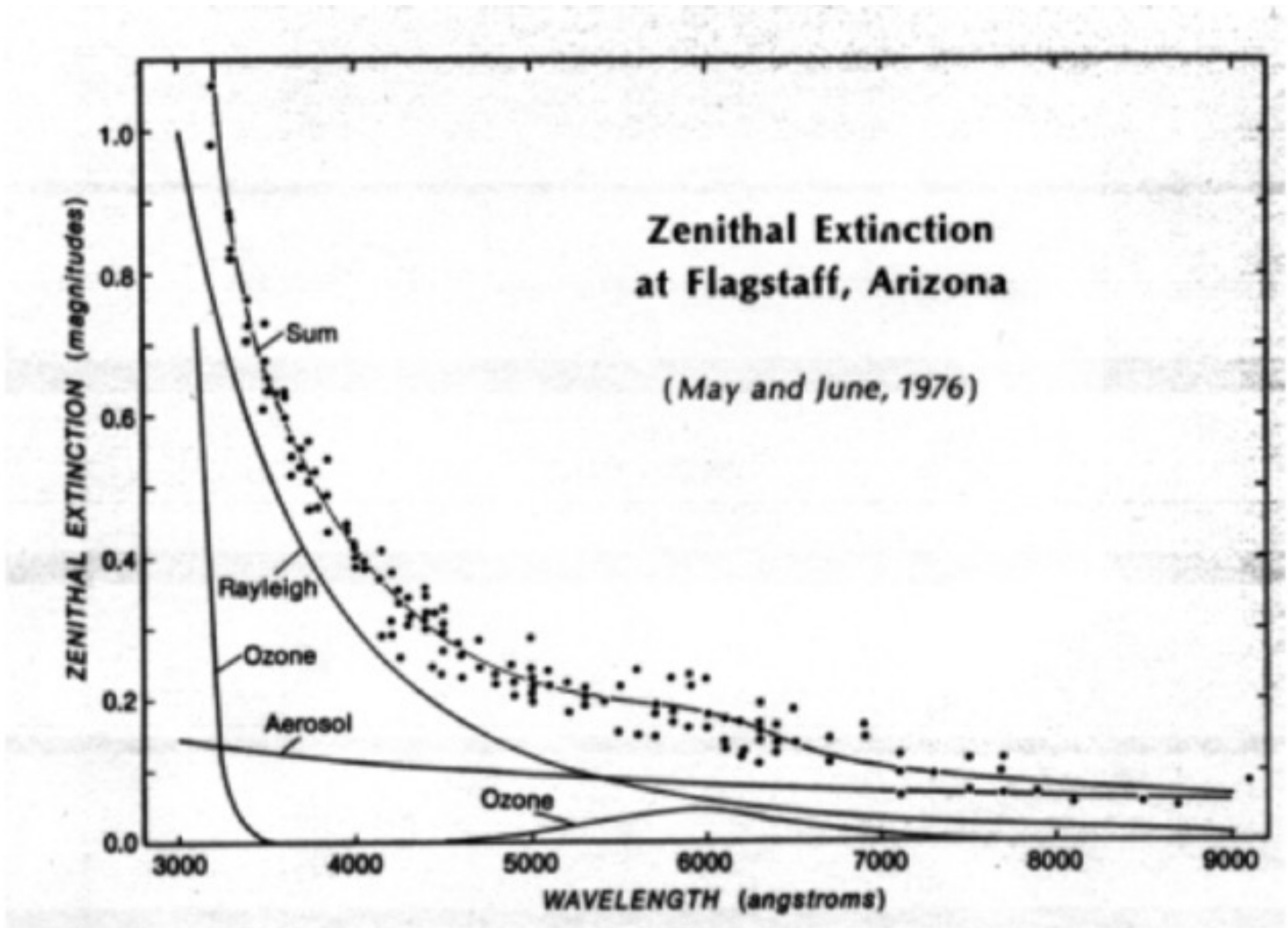


Figure 19.2: Extinction looking "straight up" (towards zenith) from Flagstaff, showing components of extinction. (from "A New Absolute Calibration of Vega" Sky and Telescope Oct 1978)

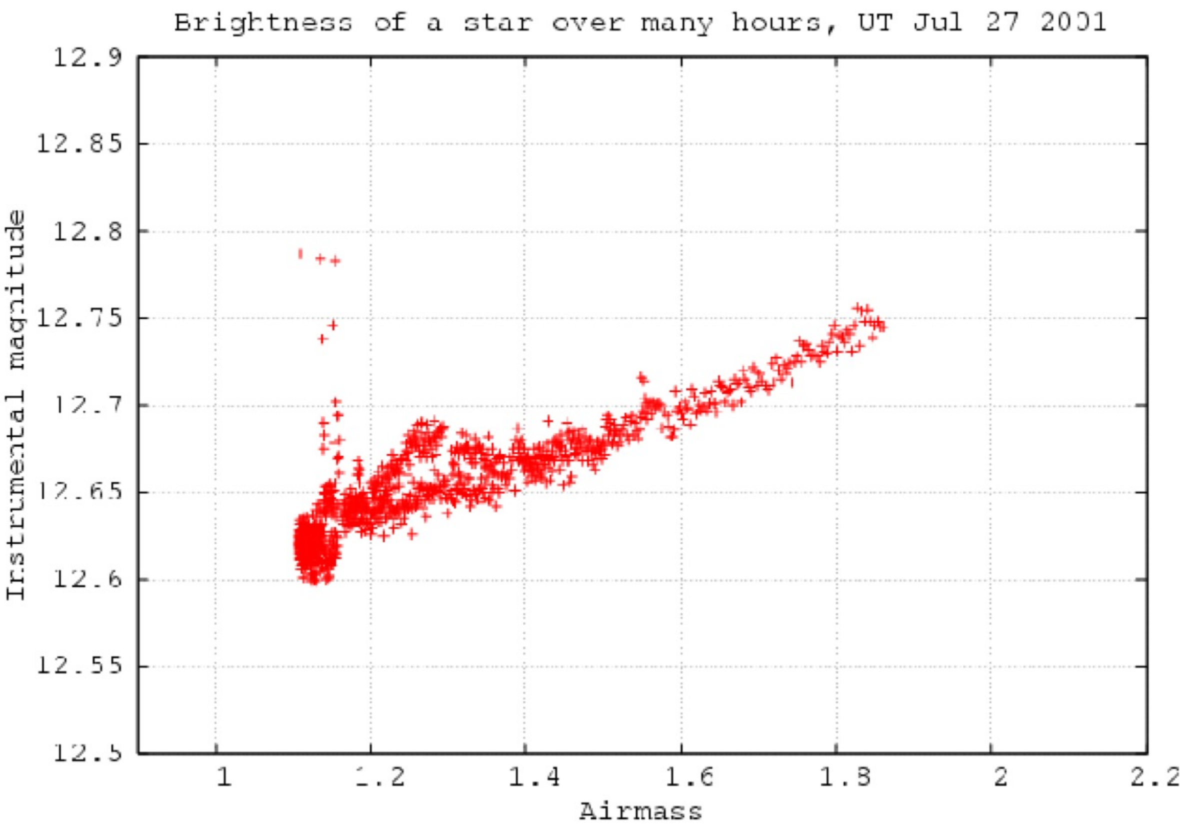
Extinción Atmosférica

- El coeficiente de extinción ***k*** depende de la longitud de onda / filtro, del lugar, de las condiciones climáticas de la noche de observación…

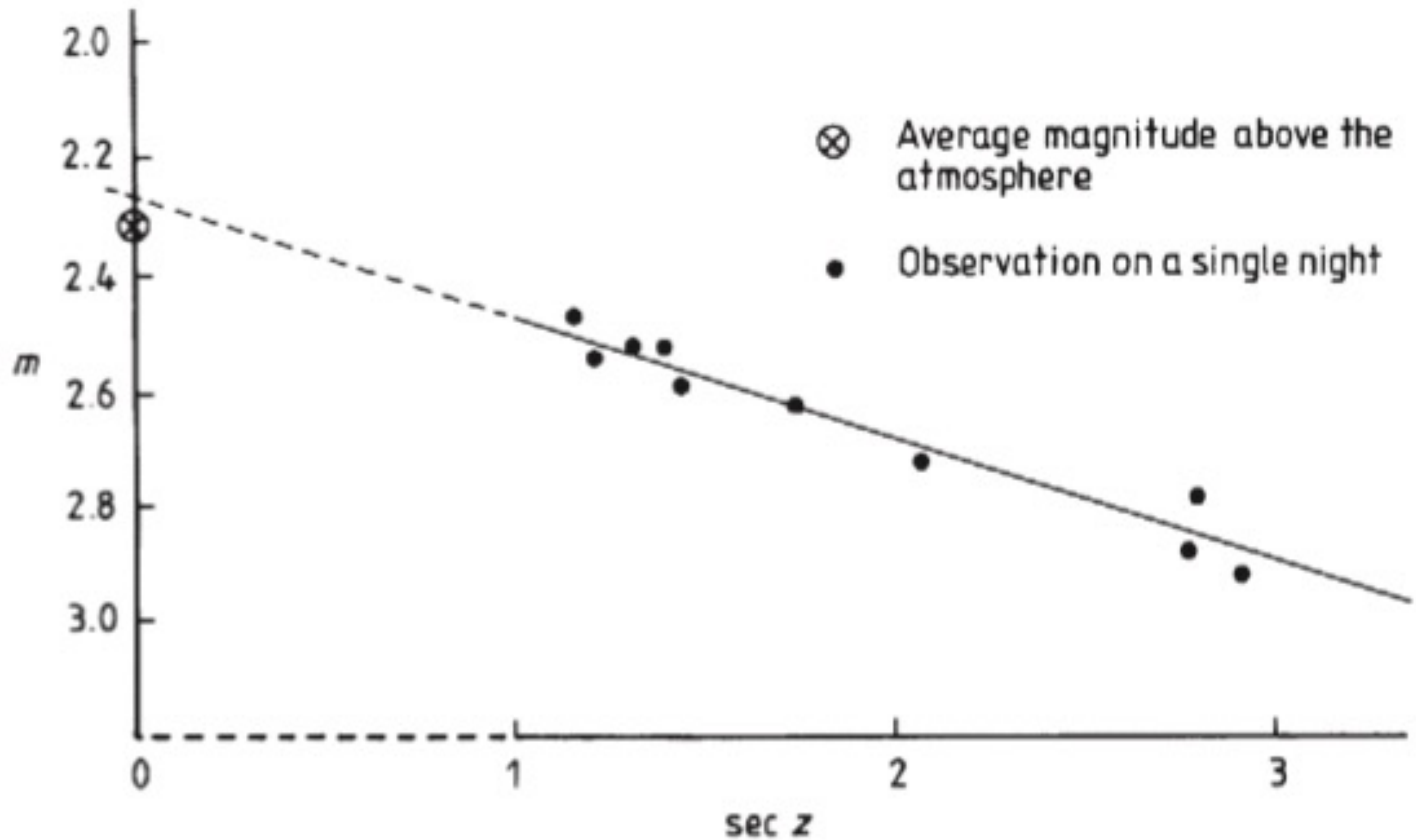
$$m(X) = m_o + k \cdot X$$

- El efecto se puede corregir observando un conjunto de estrellas, en la misma noche, para varias masas de aire

- El punto de corte de la recta m(X) es la magnitud que se observaría sin efecto de la extinción atmosférica



Extinción Atmosférica



Transformación a un sistema standard

Extinción

$$V_0 = v - X[\kappa_v' + \kappa_v''(b - v)]$$

Transformación a sistema fotométrico

$$V_s = V_0 + \epsilon(B - V)_s + C_v$$

- V_0 - mag. exoatmosférica
- v - mag. Instrumental
- b - mag. Instrumental
- X - masa de aire $X = \sec Z$
- κ_v' y κ_v'' - coef. de extinción de 1^er^ y 2^do^ orden
- V_s - mag. corregida
- C_v - const. (punto cero)

Transformación conjunta

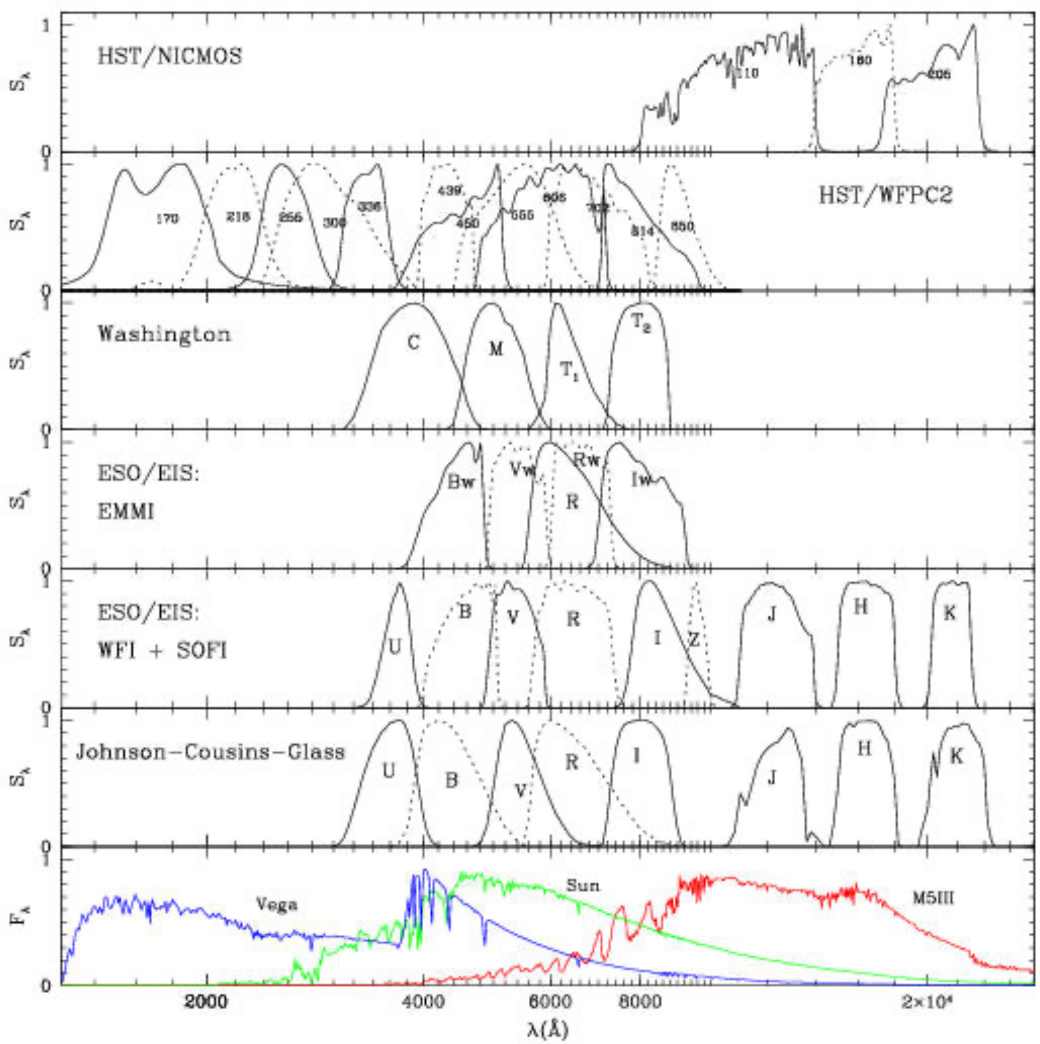
$$V_s = v + a_0 + a_1(B - V)_s + a_2X + a_3X(B - V)_s$$

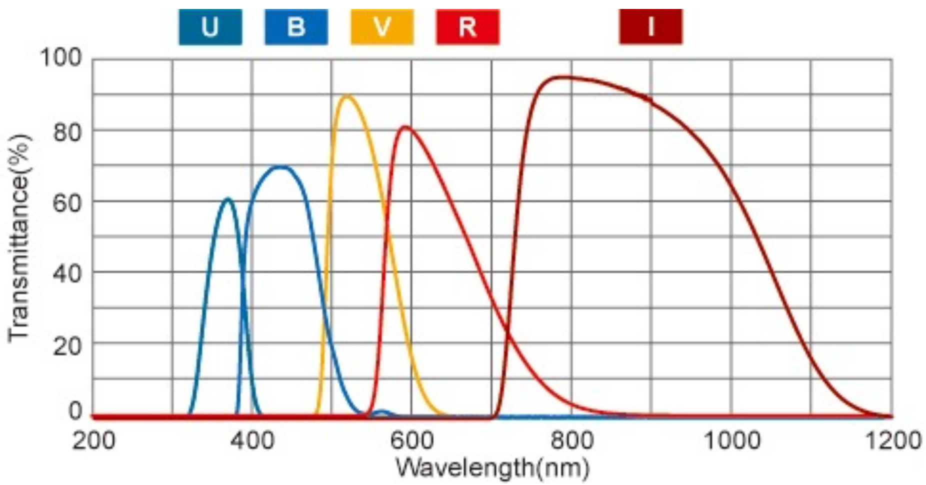
$$B_s = b + d_0 + d_1(B - V)_s + d_2X + d_3X(B - V)_s$$

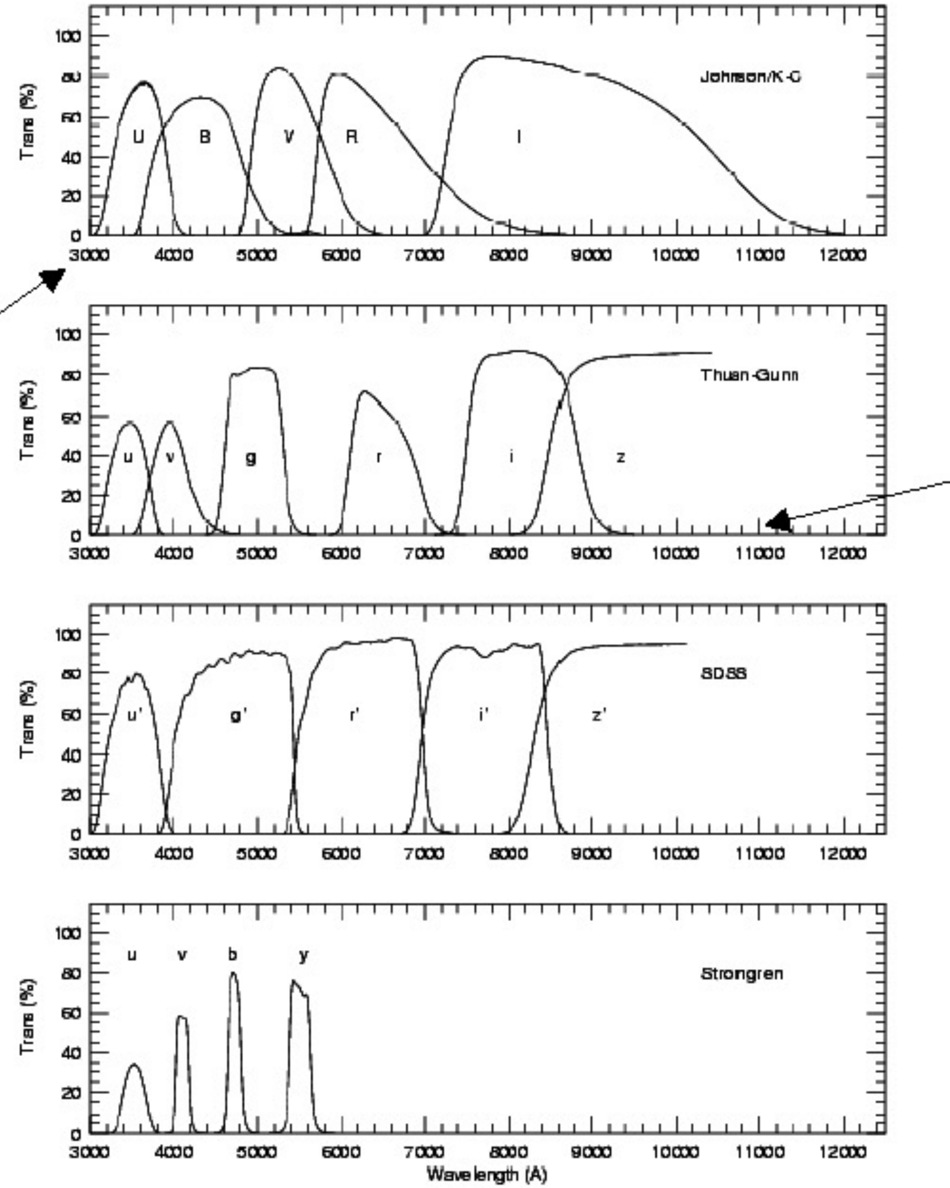
$$R_s = r + c_0 + c_1(V - R)_s + c_2X + c_3X(V - R)_s$$

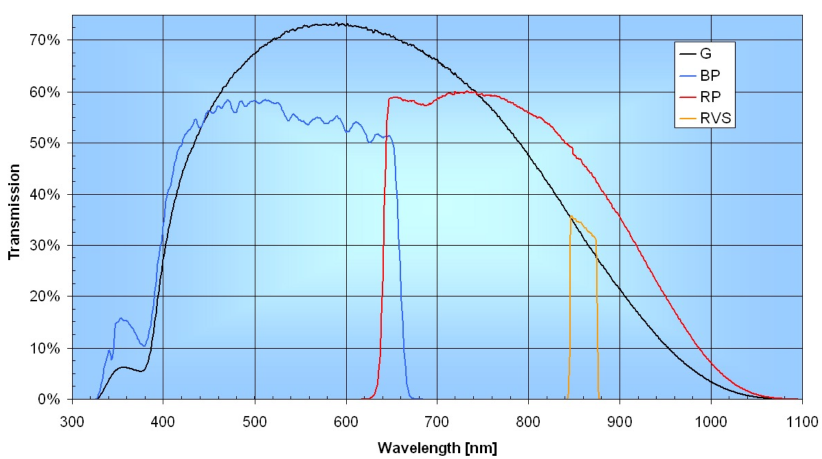
a_0 - punto cero
a_1 - término de color
a_2 - coef. de extinción de 1er orden
a_3 - coef. de extinción de 2do orden

Sistemas fotométricos




U
B
V
R
I
Transmittance(%)
100
80
60
40
20
0
200
400
600
800
1000
1200
Wavelength(nm)


Johnson/K-C
U
B
V
R
I
Thuan-Gunn
u
v
g
r
i
z
SDSS
u'
g'
r'
i'
z'
Strongren
u
v
b
y
Trans (%)
100
80
60
40
20
0
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
Wave length (A)


G
BP
RP
RVS
Transmission
70%
60%
50%
40%
30%
20%
10%
0%
300
400
500
600
700
800
900
1000
1100
Wavelength [nm]

Estrellas standard

En el Sistema UBVRI de Johnson-Cousins

- UBVRI photometric standard stars in the magnitude range 11.5-16.0 around the celestial equator - Landolt, A. U. – The Astronomical Journal, vol. 104, p. 340-371, 436-491 - 1992
- UBVRI photometric standard stars around the sky at -50 declination – Landolt, A. U. - The Astronomical Journal, 133:2502-2523, 2007
- UBVRI Photometric Standard Stars around the Sky at +50 deg Declination – Landolt, A. U. - The Astronomical Journal, 146, article id. 131, 41 pp., 2013
- Faint UBVRI Standard Star Fields, Clem, J. L. ; Landolt, A. U. The Astronomical Journal, 146, article id. 88, 19 pp. (2013).

Bibliografía

- The CCD Photometric Calibration Cookbook - Palmer & Davenhall (2001, Starlink Project) http://star-www.rl.ac.uk/docs/sc6.htx/sc6.html

- Gallaway, An Introduction To Observational Astrophysics

- Bessel 2005, Annual Review in Astronomy and Astrophysics

Paquetes de software para reducción de imágenes y fotometría

Paquetes

- IRAF - Image Reduction and Analysis Facility: “is a collection of software written at the National Optical Astronomy Observatory (NOAO) geared towards the reduction of astronomical images in pixel array form. This is primarily data taken from imaging array detectors such as CCDs.” – Descontinuado con mantenimiento básico

  https://iraf-community.github.io/

- PyRAF: “based on the Python scripting language, is a command language for IRAF that can be used in place of the existing IRAF CL.” – Descontinuado con mantenimiento básico

  https://iraf-community.github.io/pyraf.html

- MIDAS: Developed by ESO (European Southern Observatory). The ESO-MIDAS system provides general tools for image processing and data reduction. It contains applications packages for stellar and surface photometry, image sharpening and decomposition, statistics and various others.

  https://www.eso.org/sci/software/esomidas/

- Astropy: The Astropy Project is a community effort to develop a core package for astronomy using the Python programming language and improve usability, interoperability, and collaboration between astronomy Python packages.

  https://www.astropy.org/index.html

- Photutils: is an affiliated package of Astropy that primarily provides tools for detecting and performing photometry of astronomical sources.

  https://photutils.readthedocs.io/