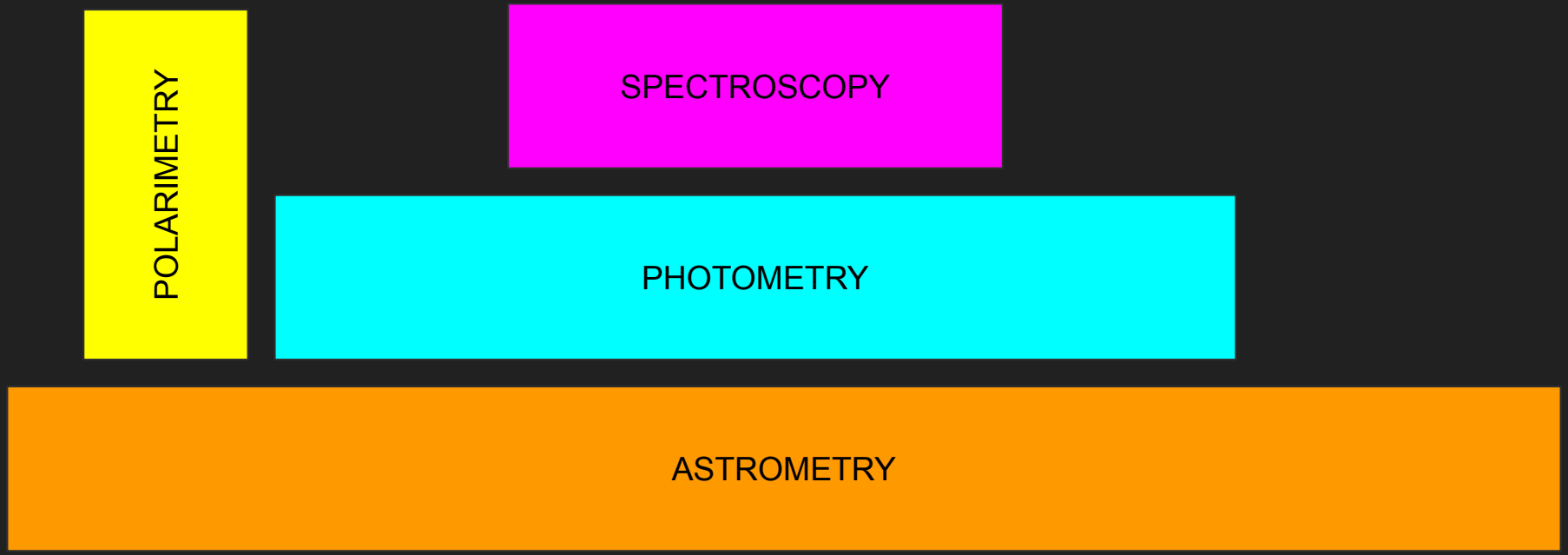
AGA5802
Imagers and Filters

Prof. Alessandro Ederoclite

The astrophysical techniques pyramid

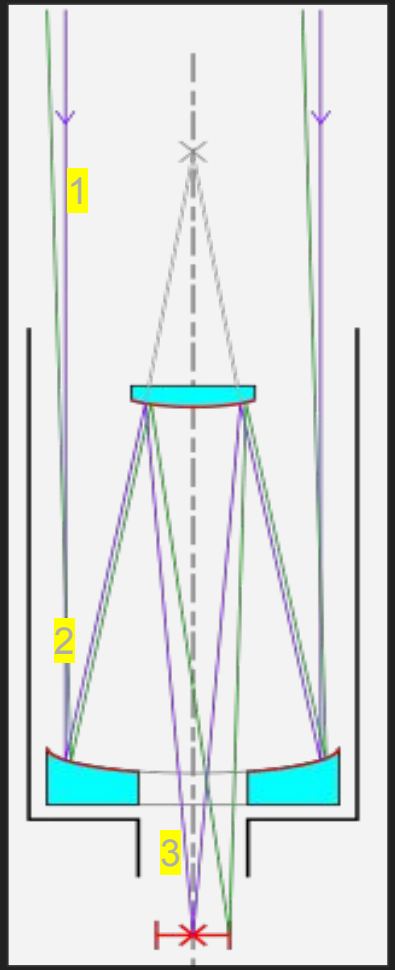


(from AGA5921)

What happens if I put something in front of a telescope?

If I put something on the primary mirror?

If I put something in front of the focal plane?



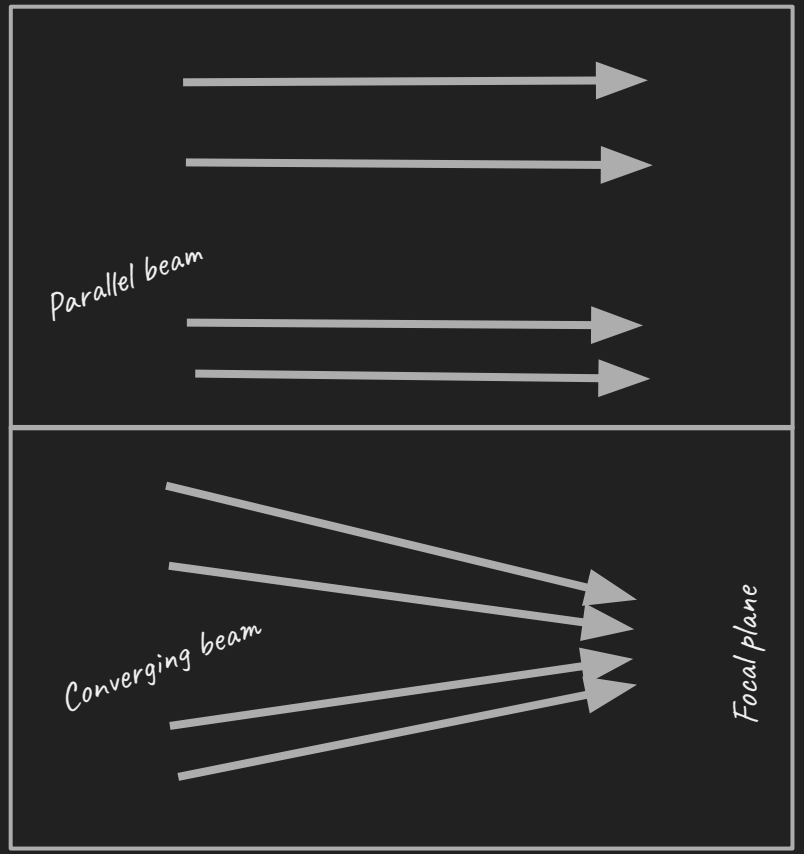
http://www.strw.leidenuniv.nl/dai/top/system/pupils-images/txt.html

The “beam”

2 types of beam:

- Parallel (or “collimated”) beam
  - If I put an obstacle in a collimated beam, I “only” loose light

- Converging beam
  - If I put an obstacle in a converging beam, I get an image of it (normally out of focus)

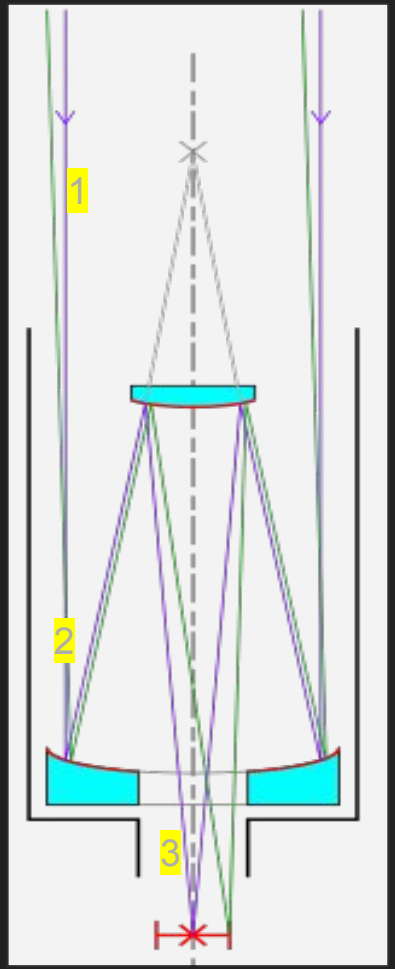


(from AGA5921)

What happens if I put something in front of a telescope? *- nothing*

If I put something on the primary mirror? *- nothing*

If I put something in front of the focal plane? *- I create a shadow*

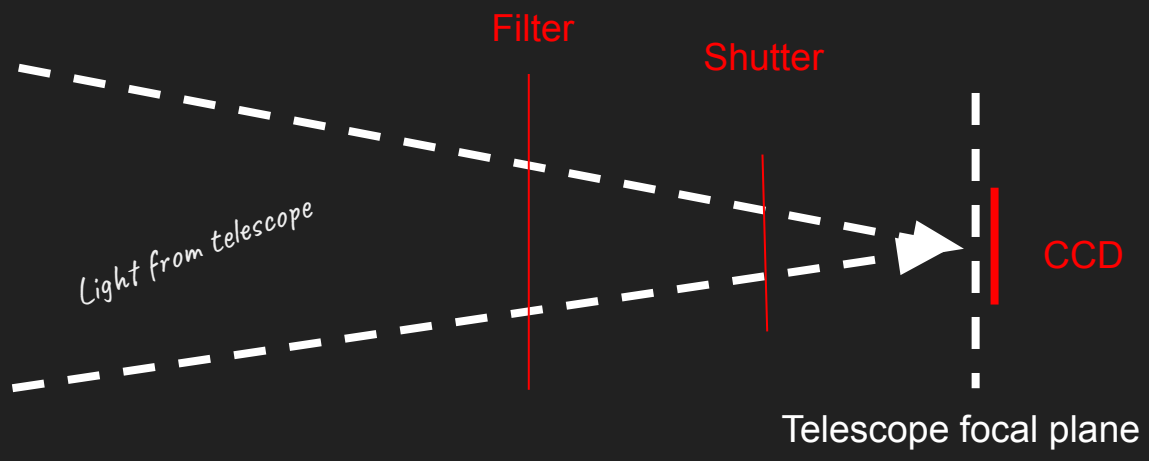


http://www.strw.leidenuniv.nl/dai/top/system/pupils-images/txt.html

Direct Imagers

The simplest optical system you can imagine:

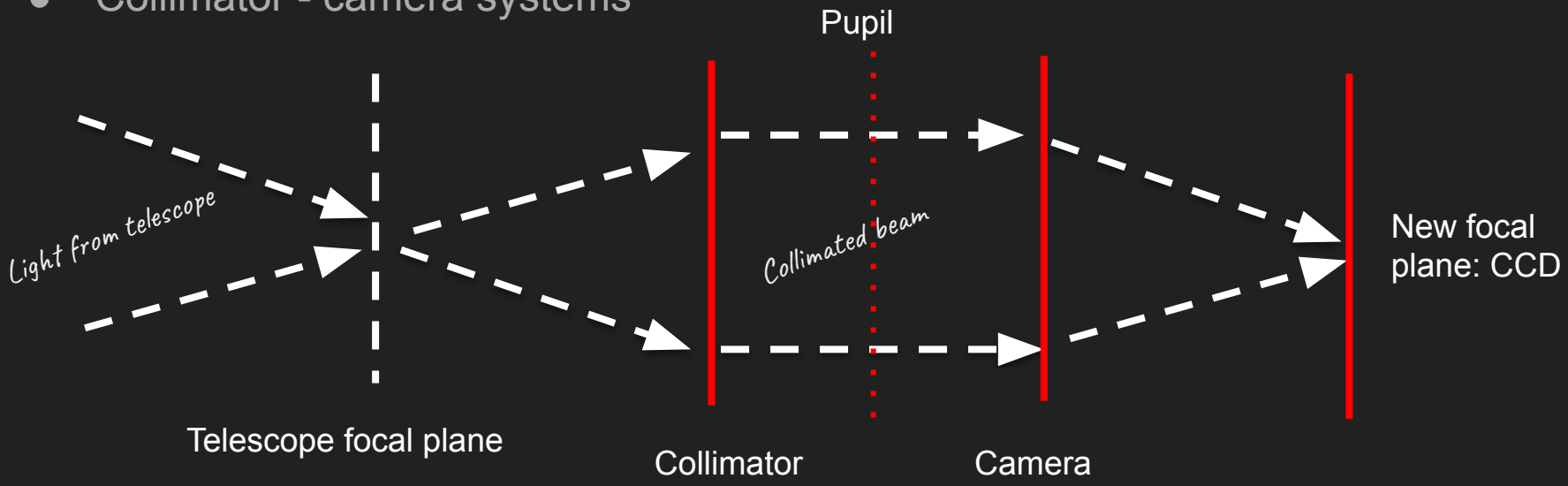
- A filter (possibly on a filter wheel)
- A shutter
- A detector (a CCD)



Focal Reducers

Change focal length -> change plate scale

- Beam accelerators
- Collimator - camera systems



Filters

Stars come in many colours.

This is Orion. Can you spot Betelgeuse?

If you only had “one filter” (i.e. if you could only see in black and white) you would not be able to tell the various colours.

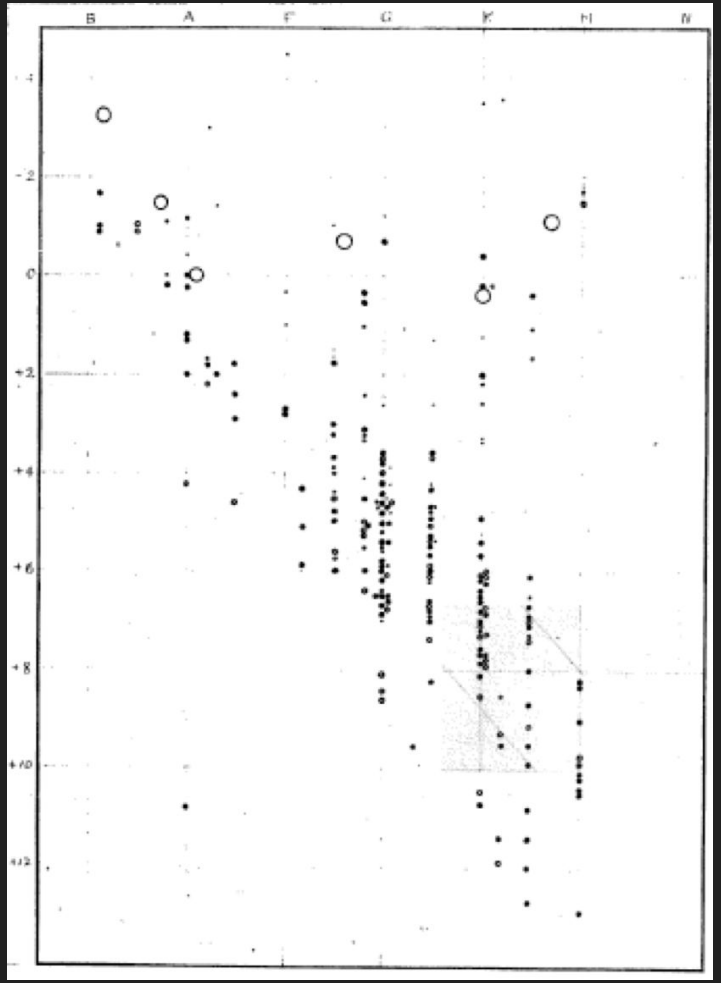
The HR Diagram

The original HR diagram:

One filter in y-axis (absolute magnitude or all stars at the same distance, e.g. in a cluster) and a difference between two filters (a “blue” and a “red”) in x-axis.

Remember that, in astronomy, the difference between two magnitudes is a “colour”.

https://en.wikipedia.org/wiki/Hertzsprung%E2%80%93Russell_diagram



What is a filter

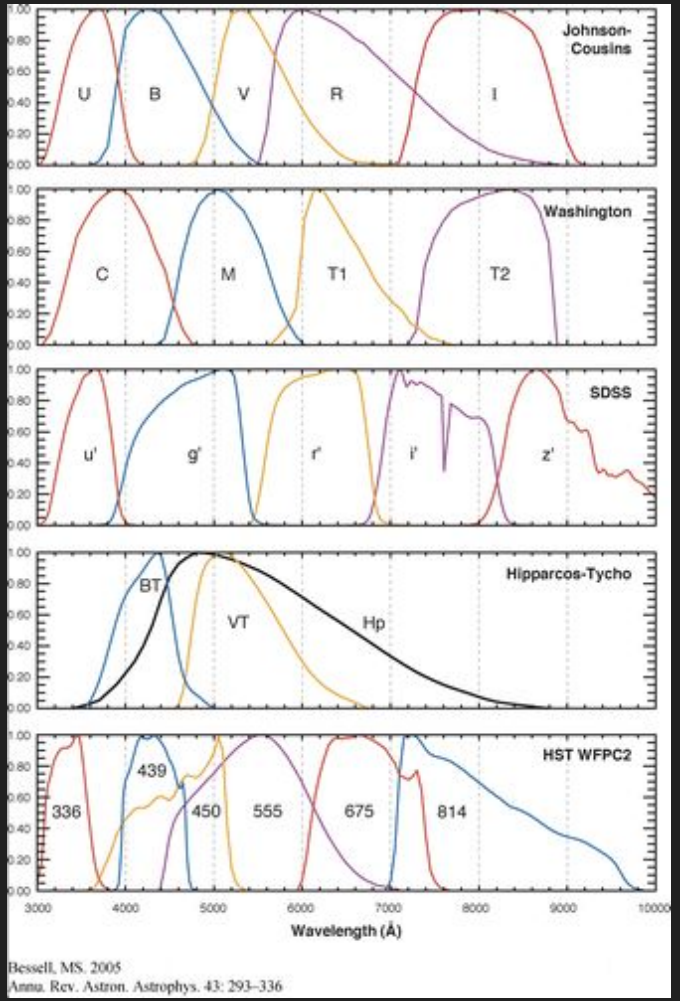
Select an interval of wavelengths/frequencies/energies.

Filters were born to tell red stars from blue stars (the “UBV”, Johnson system, Johnson & Morgan 1953)

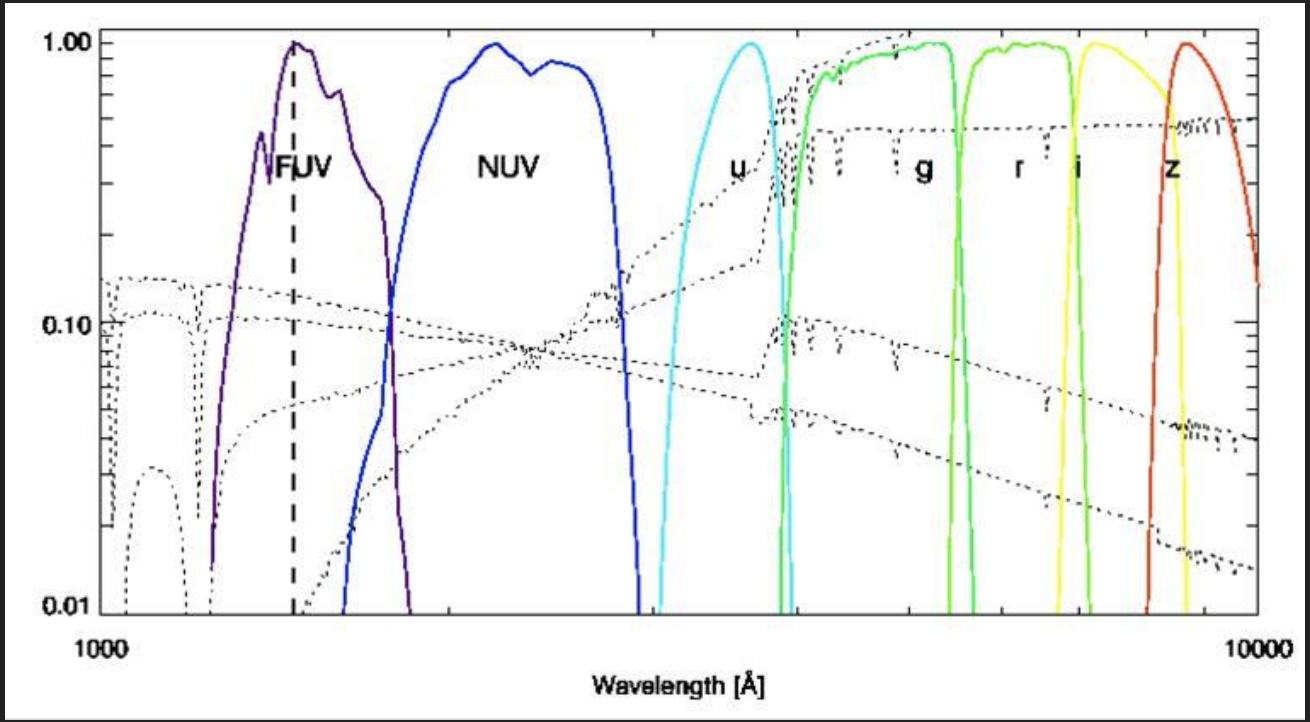
“Poor man spectroscopy”

Now, the SDSS system is a new standard: Fukugita et al. (1996)

https://www.astro.umd.edu/~ssm/ASTR620/mags.html



UV filters



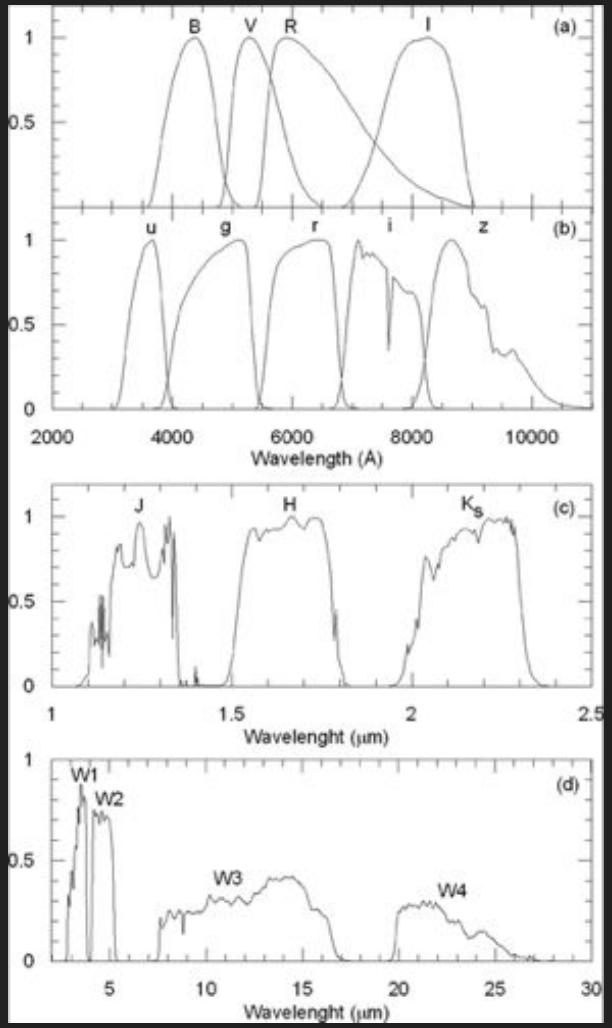
http://www.galex.caltech.edu/DATA/gr1_docs/GR1_Observers_guide_v1.htm

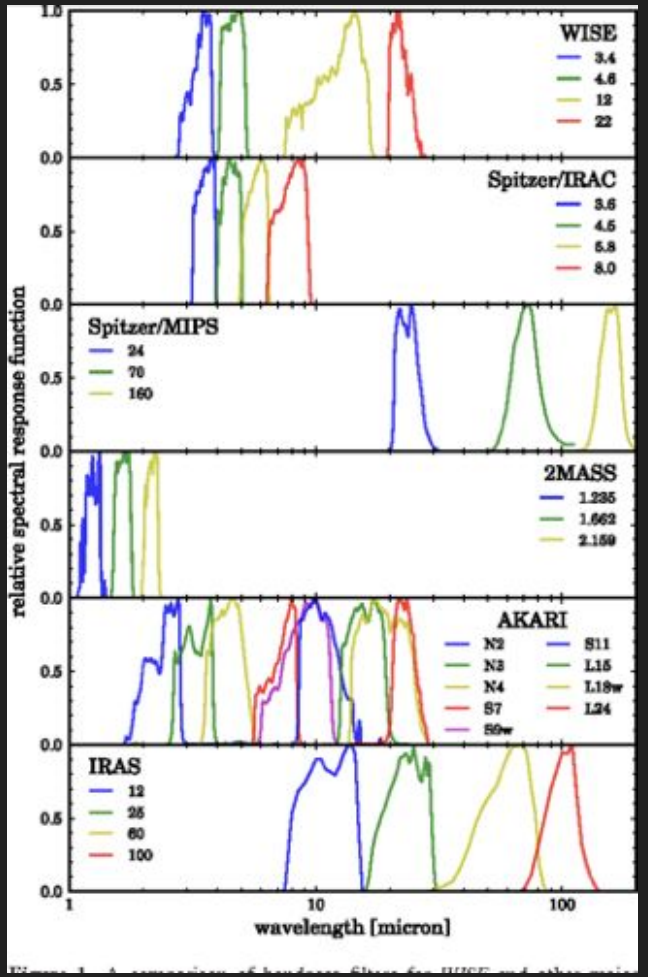
Infrared

<- Bilir et al. (2011)

2MASS
Cohen et al. (2003)

WISE
Wright et al. (2010)





https://www.semanticscholar.org/paper/The-meaning-of-WISE-colours-%E2%80%93-I.-The-Galaxy-and-Nikutta-Hunt-Walker/74719c37d3ed7f26666f6641a343e634c9e131bf

Spectral Energy Distribution

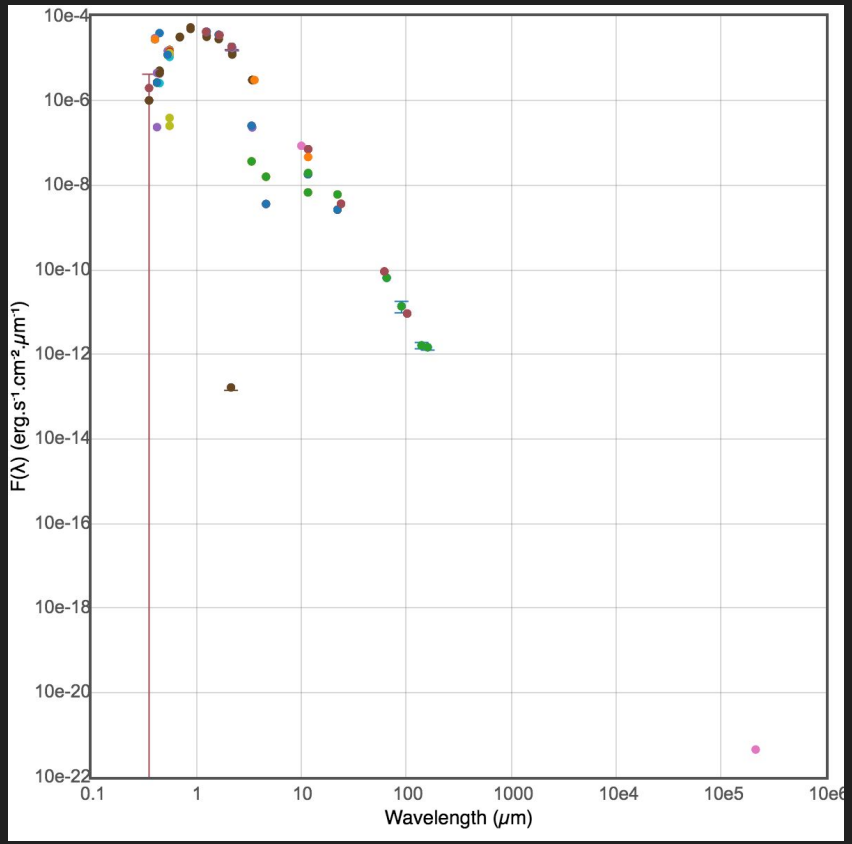
You can make a plot of the energy emitted in a filter vs. the central wavelength of the filter.

This is a Spectral Energy Distribution.

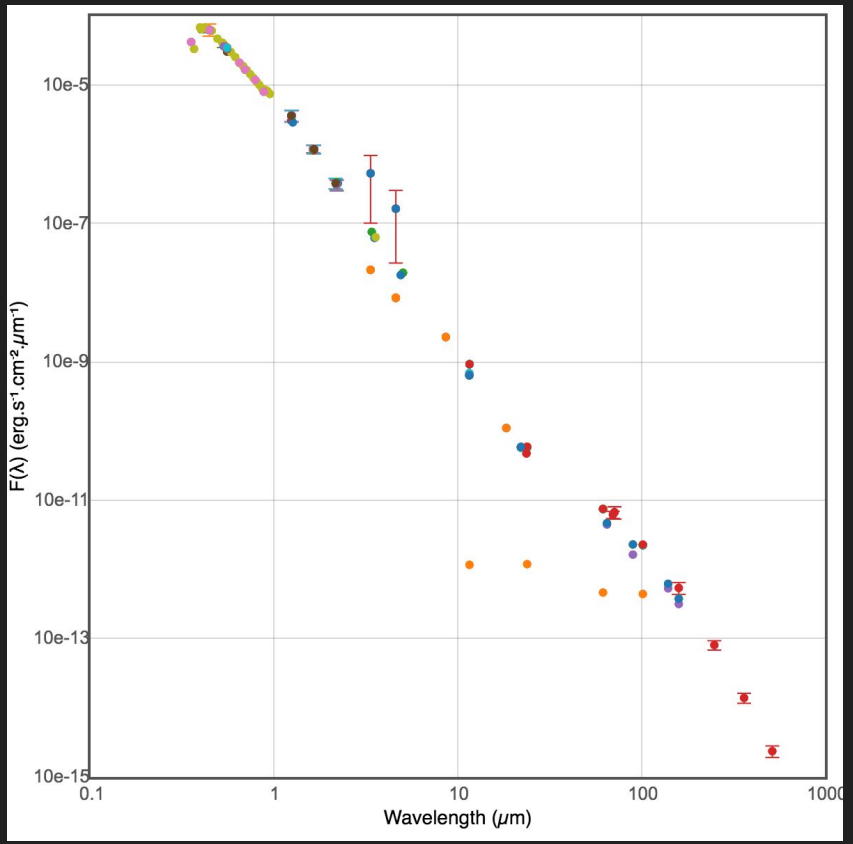
Mind you: this is **not** a spectrum!

Let’s see examples.

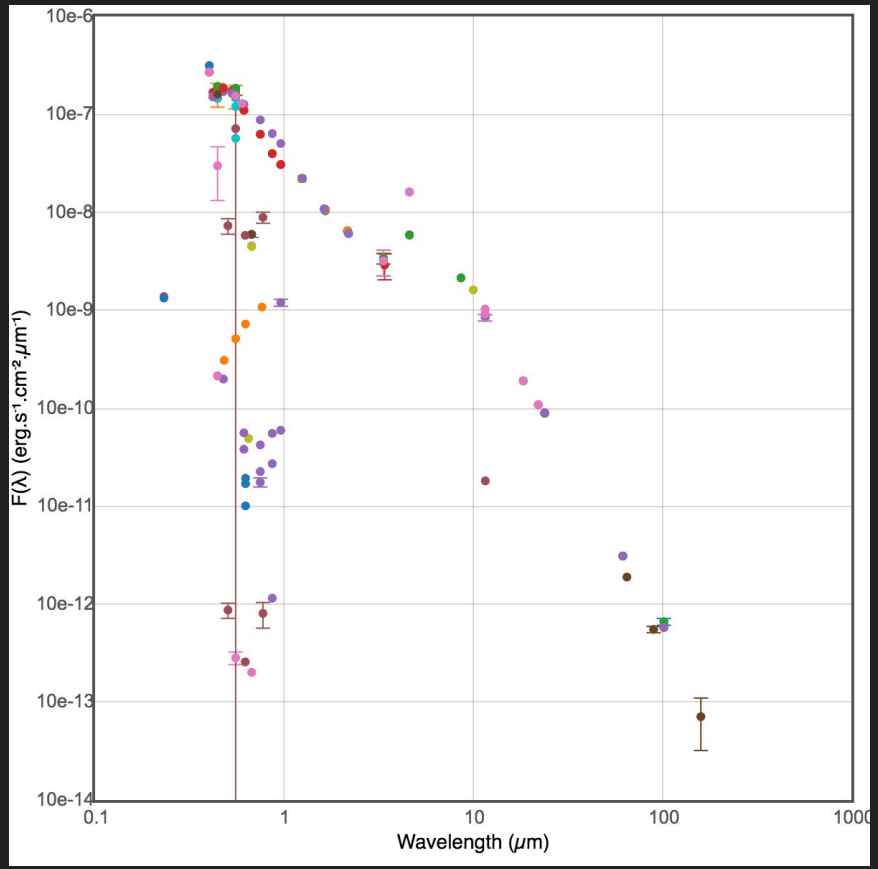
Antares (red star)



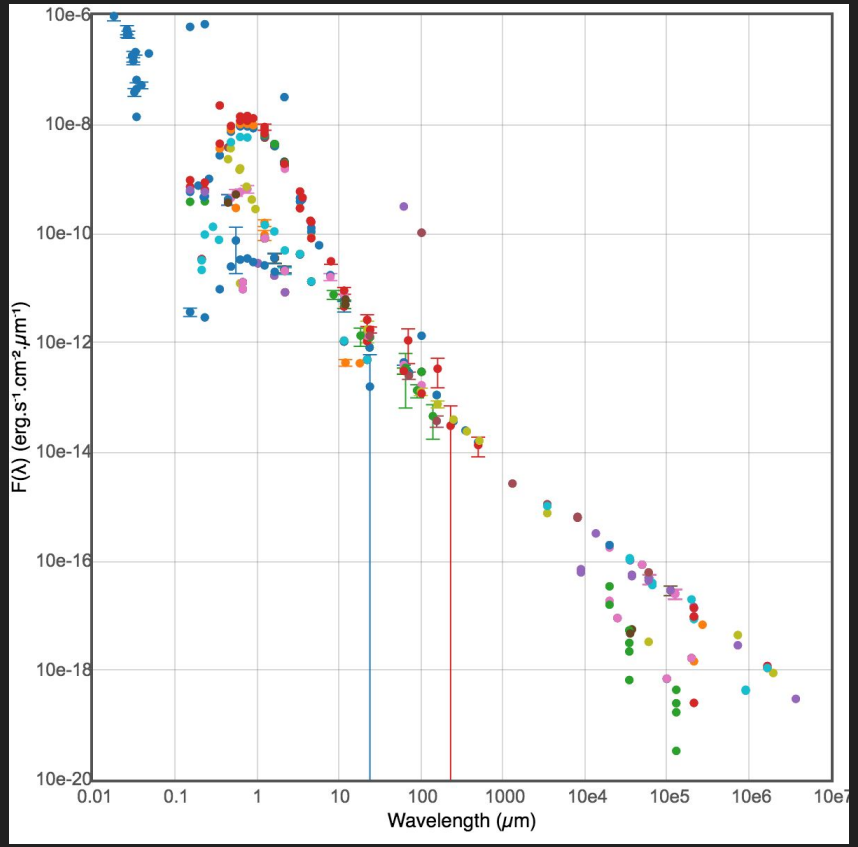
Vega (hot star)



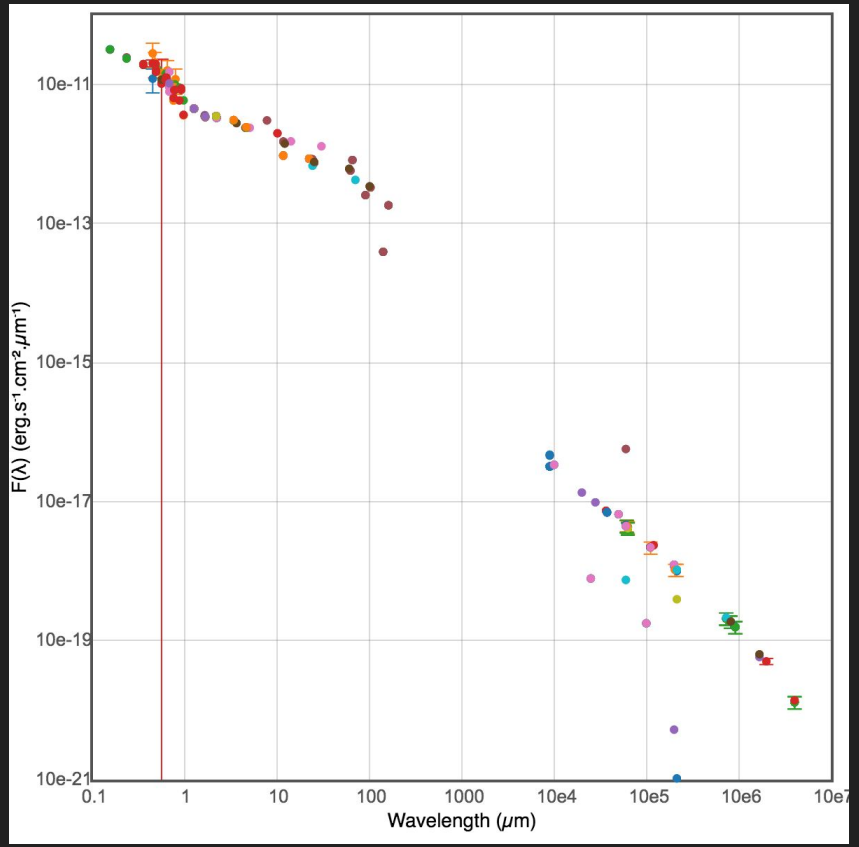
R CrB - variable star with dust (see in infrared)



M87 (giant elliptical galaxy)



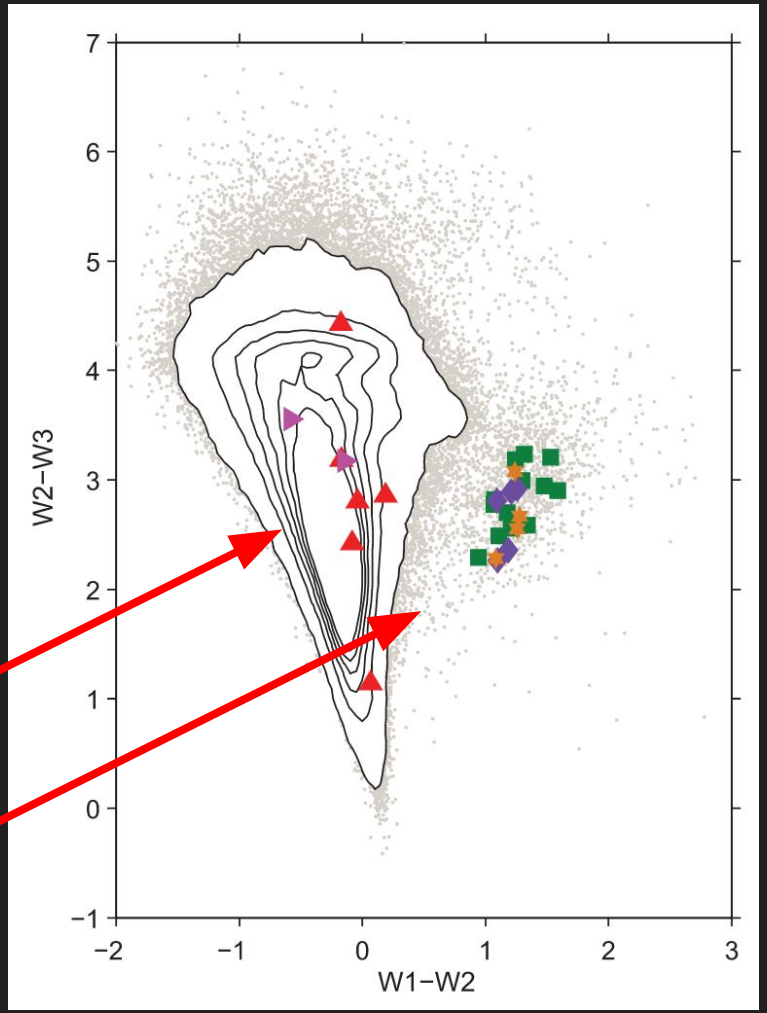
3C 48 (quasar)



Other uses

You can use colours to identify objects (e.g. Scaringi et al. 2013).

In this case, this is a colour-colour diagram using the first three filters of WISE.



Narrow band filters

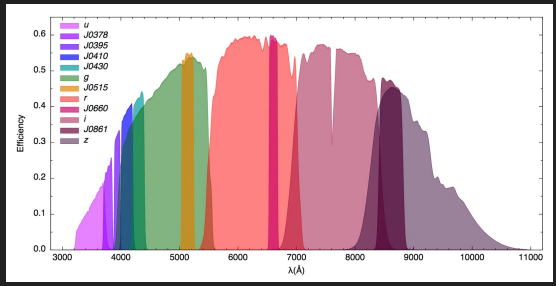
Select a narrow range of wavelengths.

Usually selects a specific line (e.g. Hα; 6563 Å)

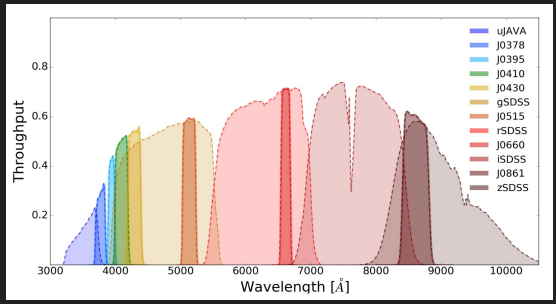
E. g.

- J-PLUS (Cenarro et al. 2019)
- S-PLUS (Mendez de Oliveira et al. 2019)

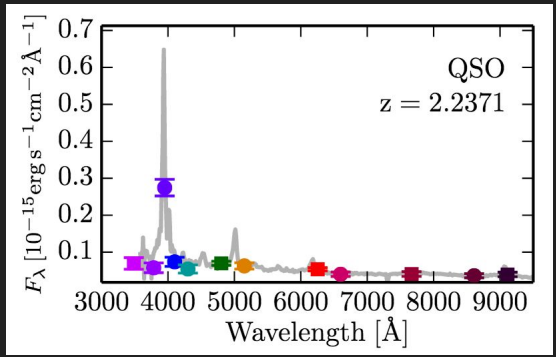
J-PLUS filters

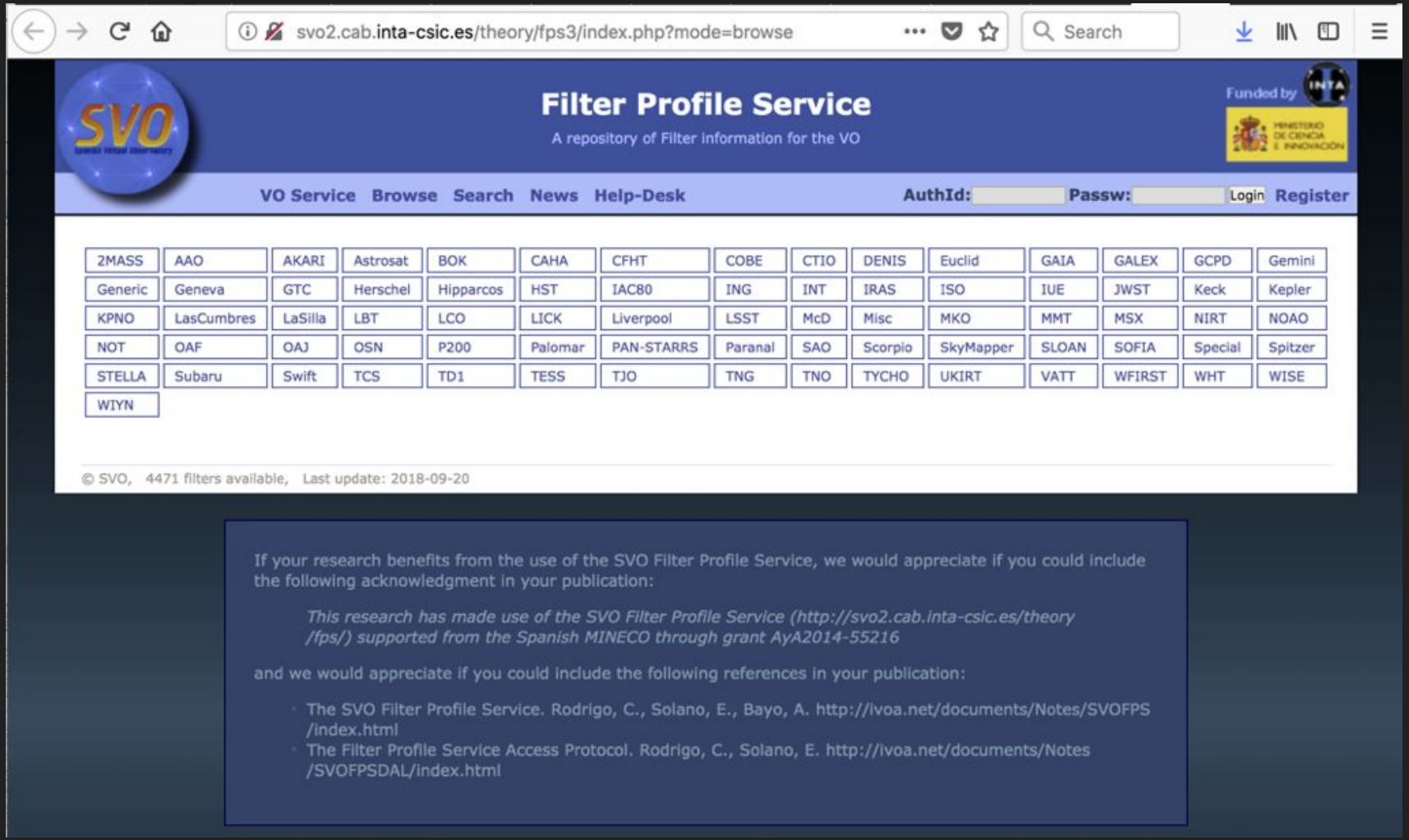


S-PLUS filters



Quasar in J-PLUS (Cenarro et al. 2019)




svo2.cab.inta-csic.es/theory/fps3/index.php?mode=browse
Search
Filter Profile Service
A repository of Filter information for the VO
Funded by
VO Service Browse Search News Help-Desk
AuthId: Passw: Login Register
2MASS AAO AKARI Astrosat BOK CAHA CFHT COBE CTIO DENIS Euclid GAIA GALEX GCPD Gemini
Generic Geneva GTC Herschel Hipparcos HST IAC80 ING INT IRAS ISO IUE JWST Keck Kepler
KPNO LasCumbres LaSilla LBT LCO LICK Liverpool LSST McD Misc MKO MMT MSX NIRT NOAO
NOT OAF OAJ OSN P200 Palomar PAN-STARRS Paranal SAO Scorpio SkyMapper SLOAN SOFIA Special Spitzer
STELLA Subaru Swift TCS TD1 TESS TJO TNG TNO TYCHO UKIRT VATT WFIRST WHT WISE
WIYN
© SVO, 4471 filters available, Last update: 2018-09-20
If your research benefits from the use of the SVO Filter Profile Service, we would appreciate if you could include the following acknowledgment in your publication:
This research has made use of the SVO Filter Profile Service (http://svo2.cab.inta-csic.es/theory/fps/) supported from the Spanish MINECO through grant AyA2014-55216
and we would appreciate if you could include the following references in your publication:
The SVO Filter Profile Service. Rodrigo, C., Solano, E., Bayo, A. http://ivoa.net/documents/Notes/SVOFPS/index.html
The Filter Profile Service Access Protocol. Rodrigo, C., Solano, E. http://ivoa.net/documents/Notes/SVOFPSDAL/index.html