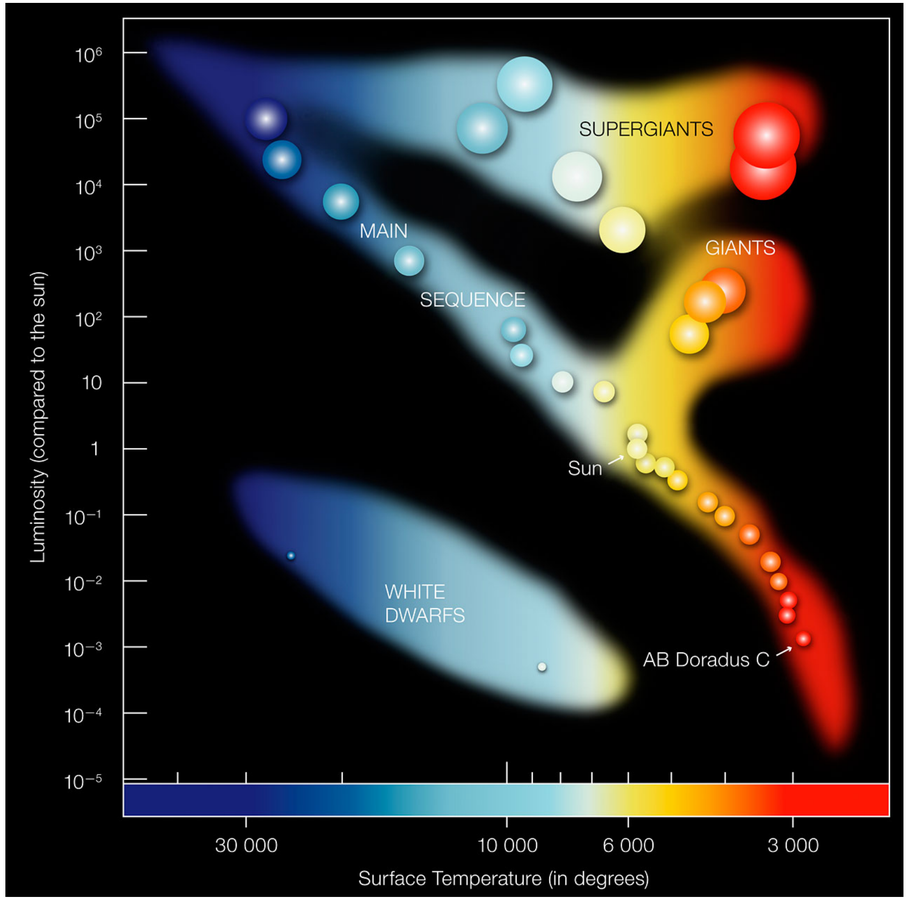
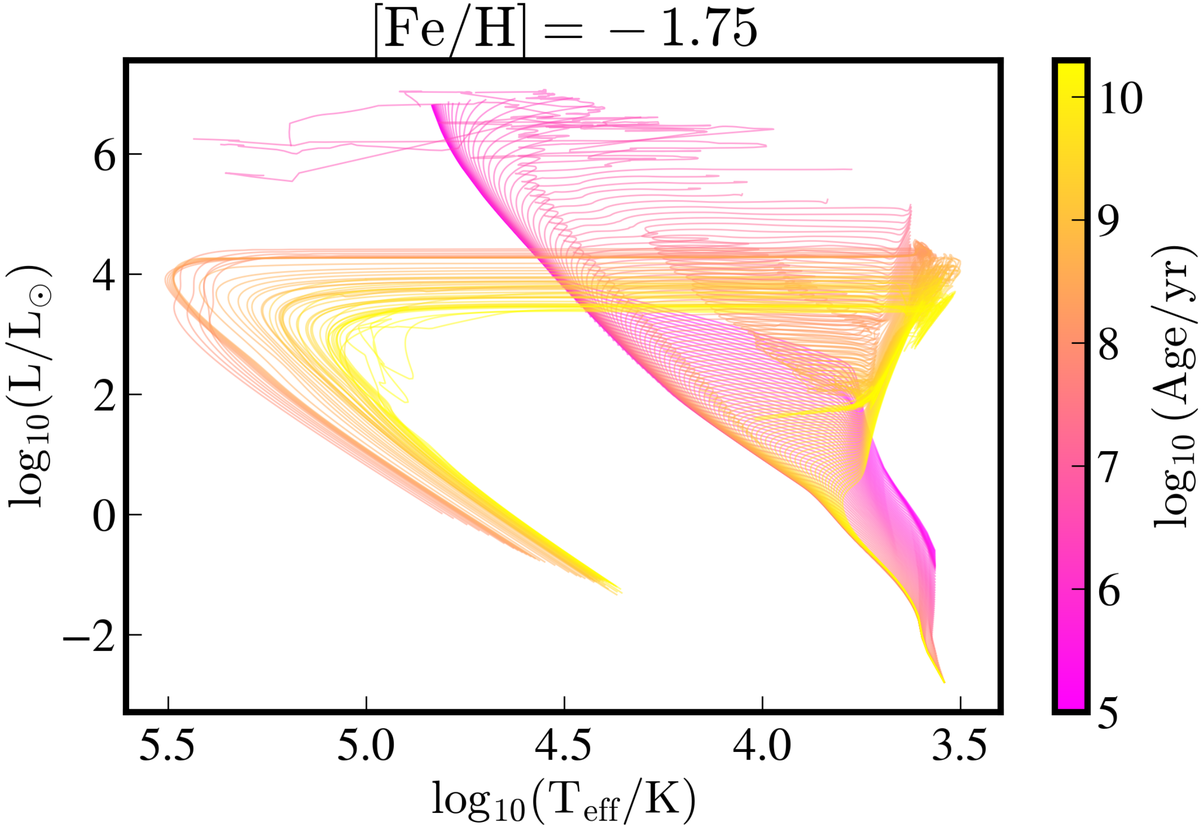
Star Cluster Part II - Isochrone

25.04.22

Stellar Isochrone curve





Stellar Isochrone curve

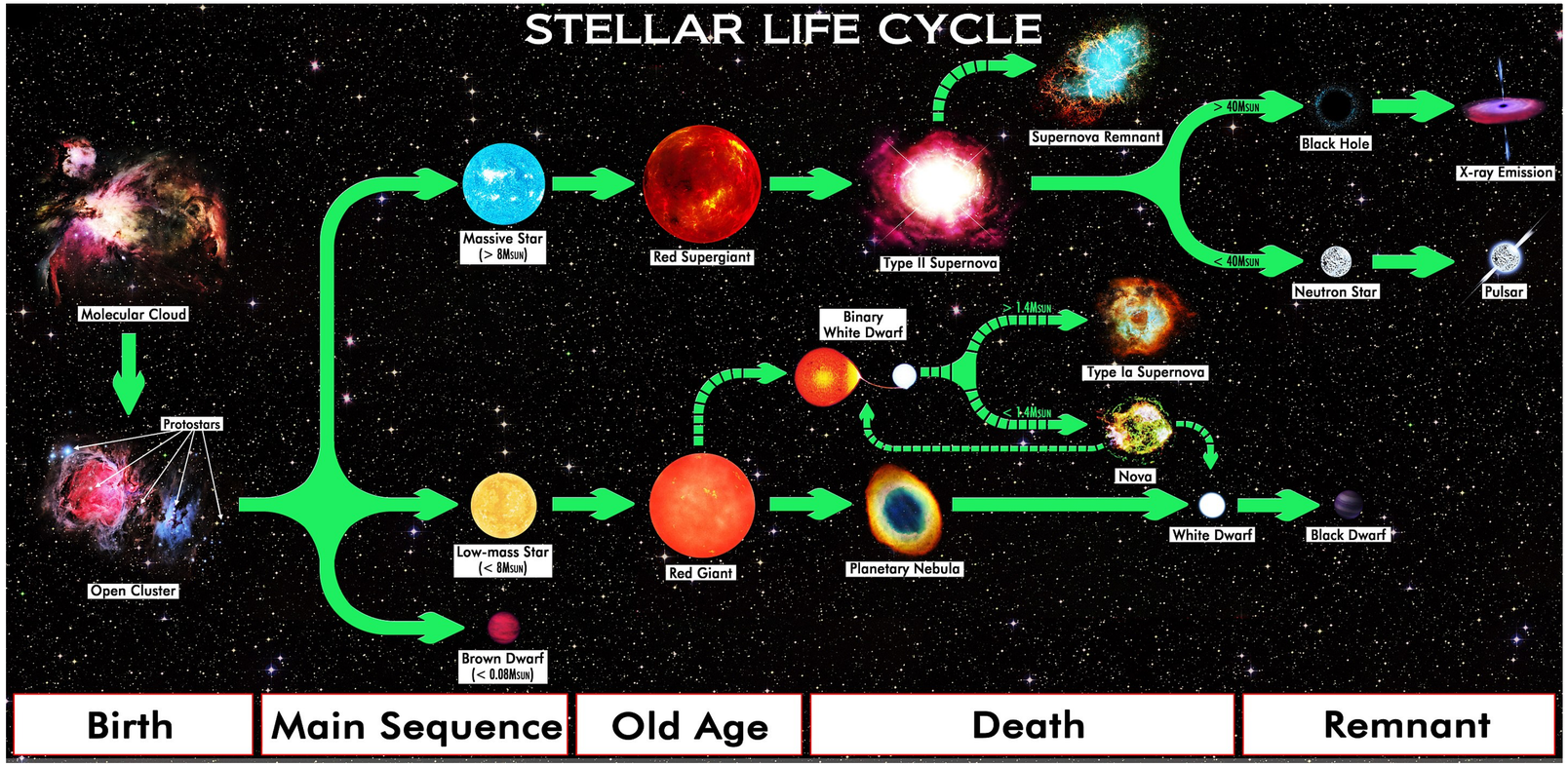
- The meaning of isochrone: Iso(Same) + Chrone(Time)

- (We assume that) the cluster’s stars were born at the same time
- (We assume that) the stars have same metallicity

- Even though we assumed that, the **‘mass’ of stars is distinctive!**

Stellar Evolution History

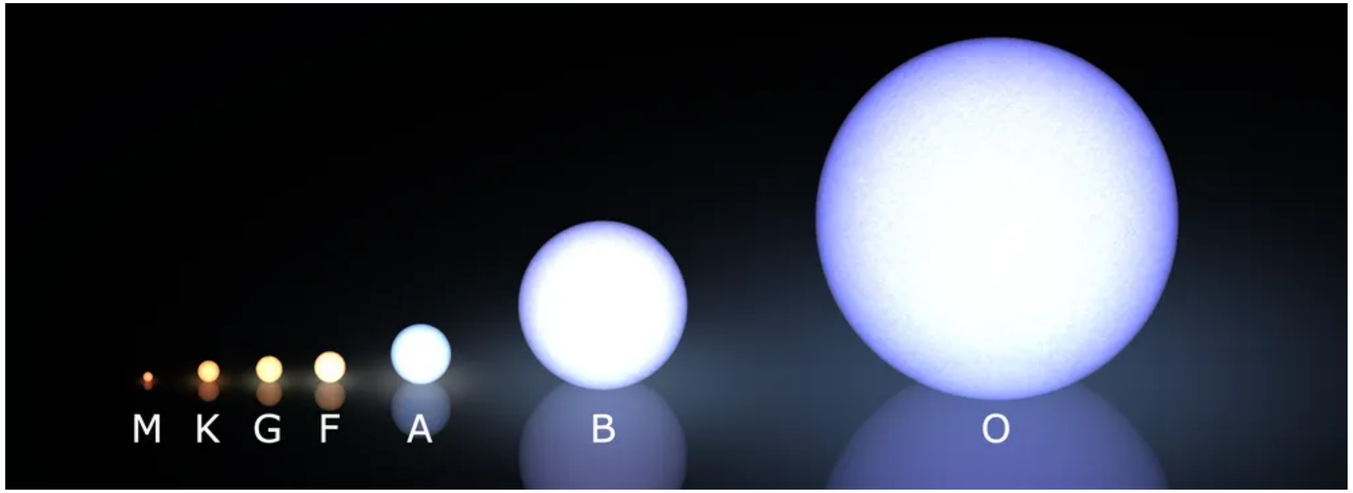
- The mass of star determines everything

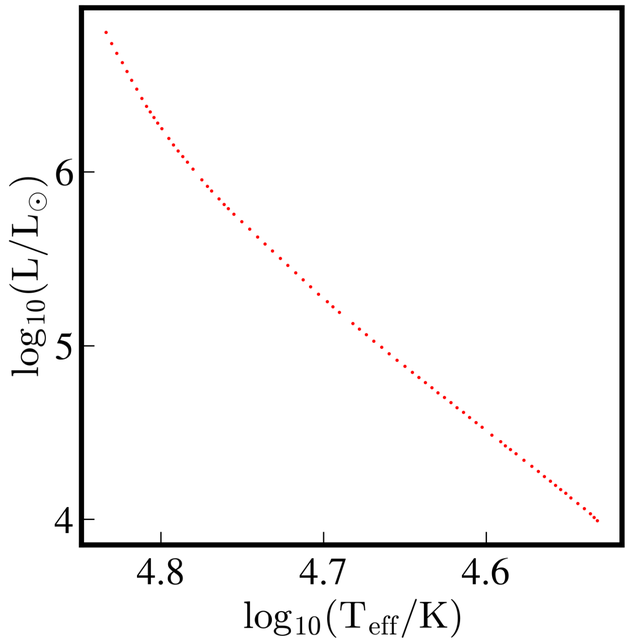


Main Sequence

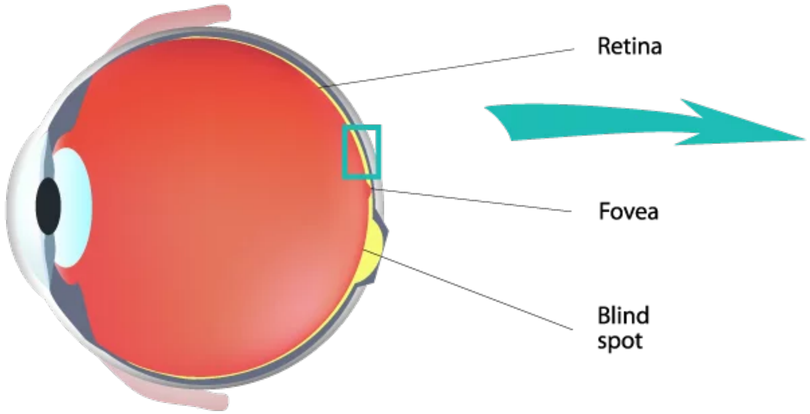
- The mass of star determines the surface temperature of main sequence star!

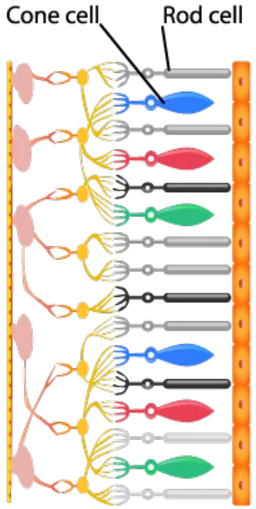
- The hotter, the larger, the brighter, the bluer

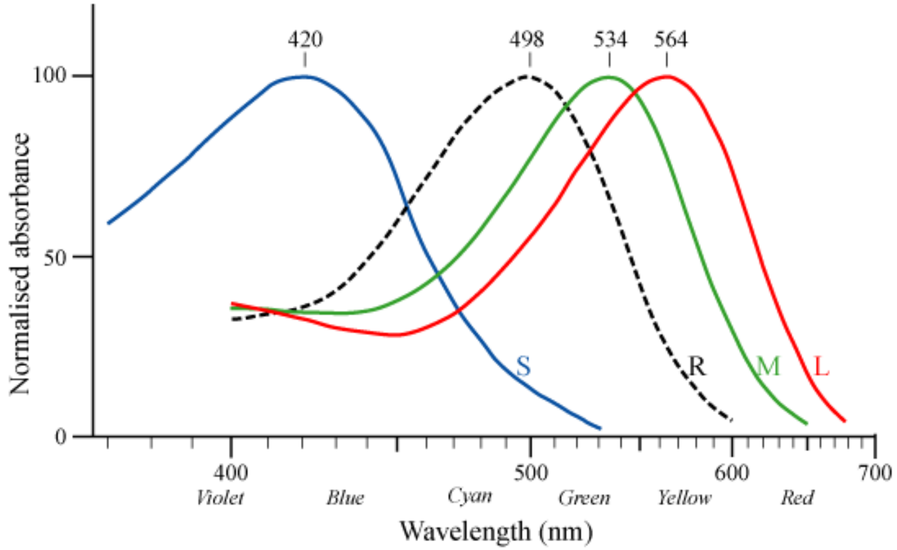




What is Band?

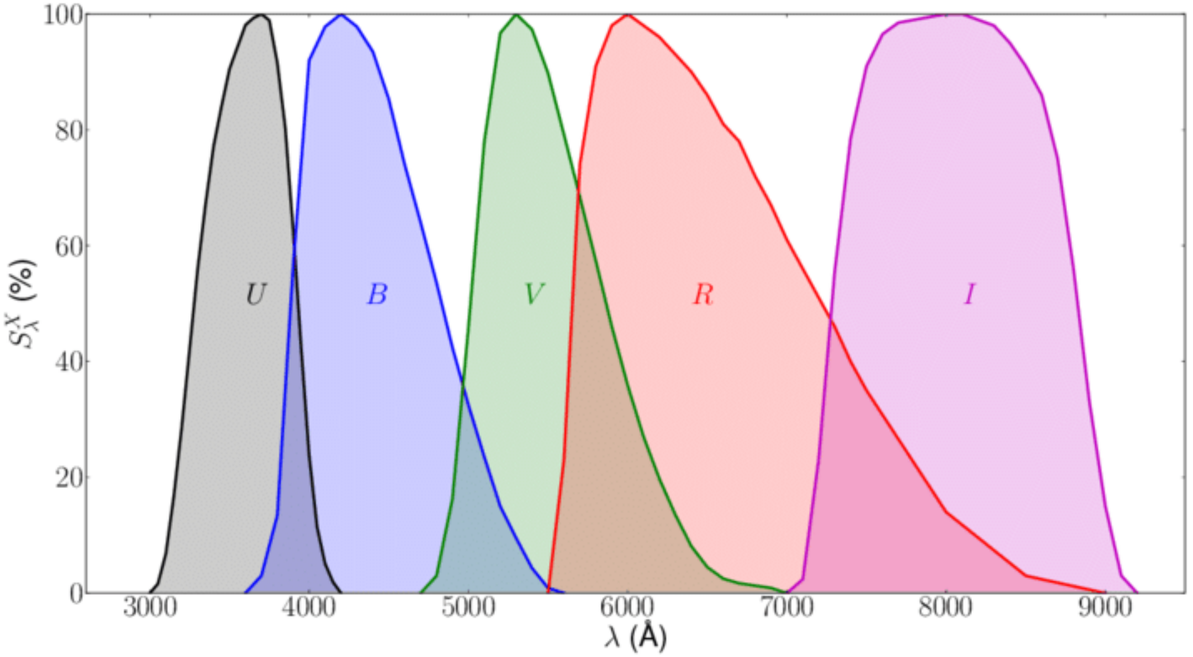


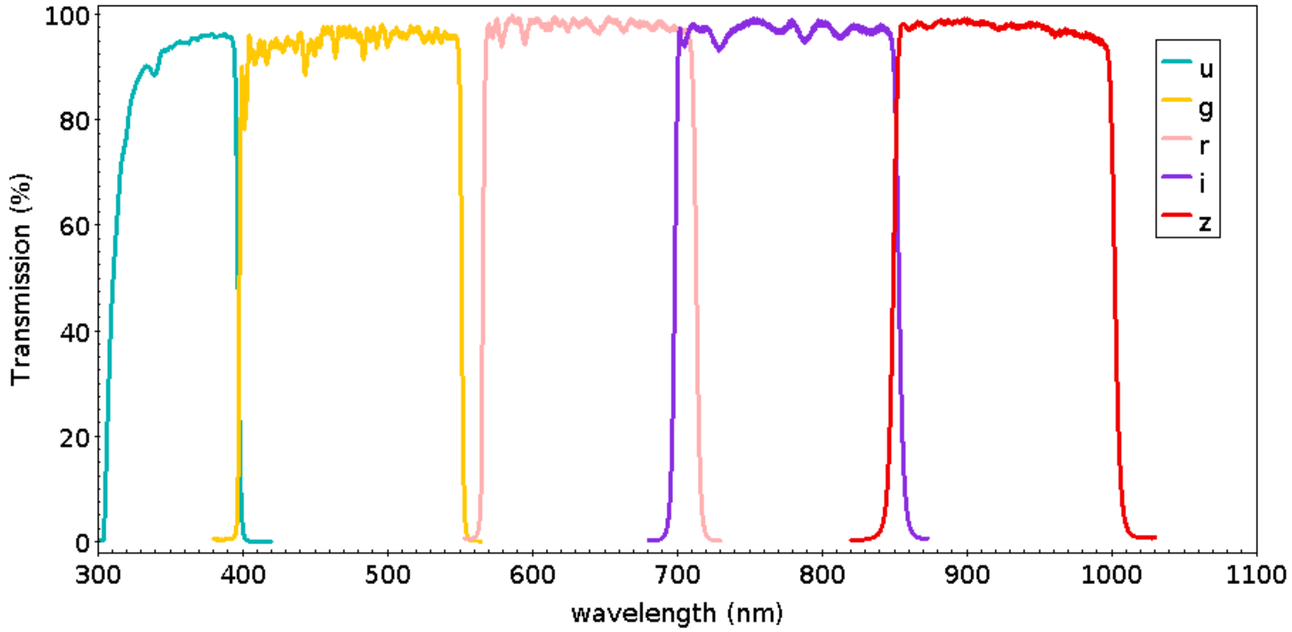




- Our eyes detect the light color with RGB cone cells, each cell has overlapped wavelength area, but reacts for different range. Our brain reproduces color with these three cone cell reactions.
- The observation also, but with more various cone cells, we call them as **‘bands’**

Example of bands





- X-axis means wavelength ($1\ \mathring{\text{A}} = 10^{-1}\ \text{nm} = 10^{-10}\ \text{m}$), Y-axis briefly means reactivity
- There are various bands, from radio to γ-ray. These examples cover Near UV ~ Near IR
- We can choose band systems according to scientific goal.

Magnitude

- Hipparchus ranked the magnitudes of stars on a numerical scale from 1 to 6.
- Today, we define that **magnitude 1 star is 100 times brighter than magnitude 6 star.**

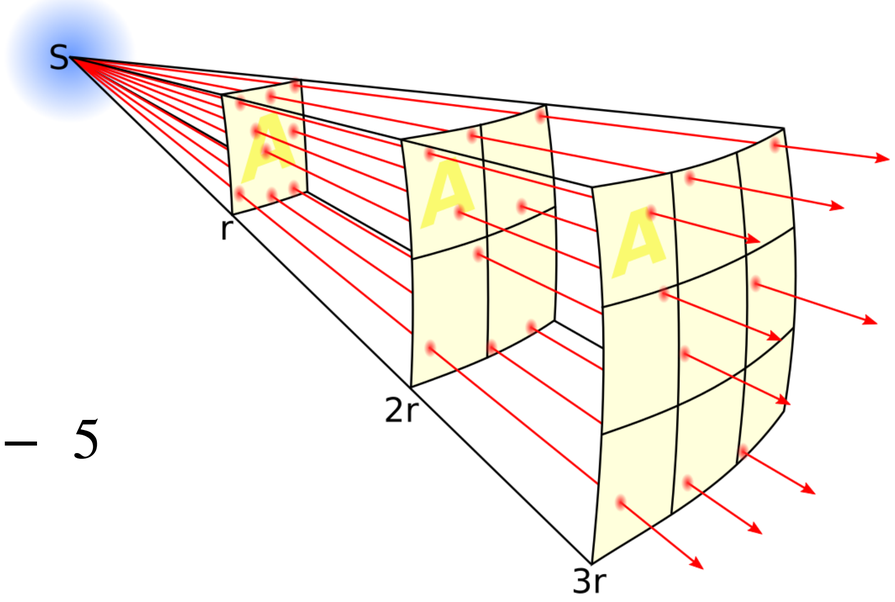
LUMINOSITY, FLUX ↑ ⟷ ↓ **MAGNITUDE**

- Magnitude - Luminosity Formula: $M_1 - M_2 = -2.5 \log \left(L_1 / L_2 \right)$

DIFFERENCE OF MAGNITUDE ⟷ **RATIO OF LUMINOSITY, FLUX**

Apparent and Absolute magnitude

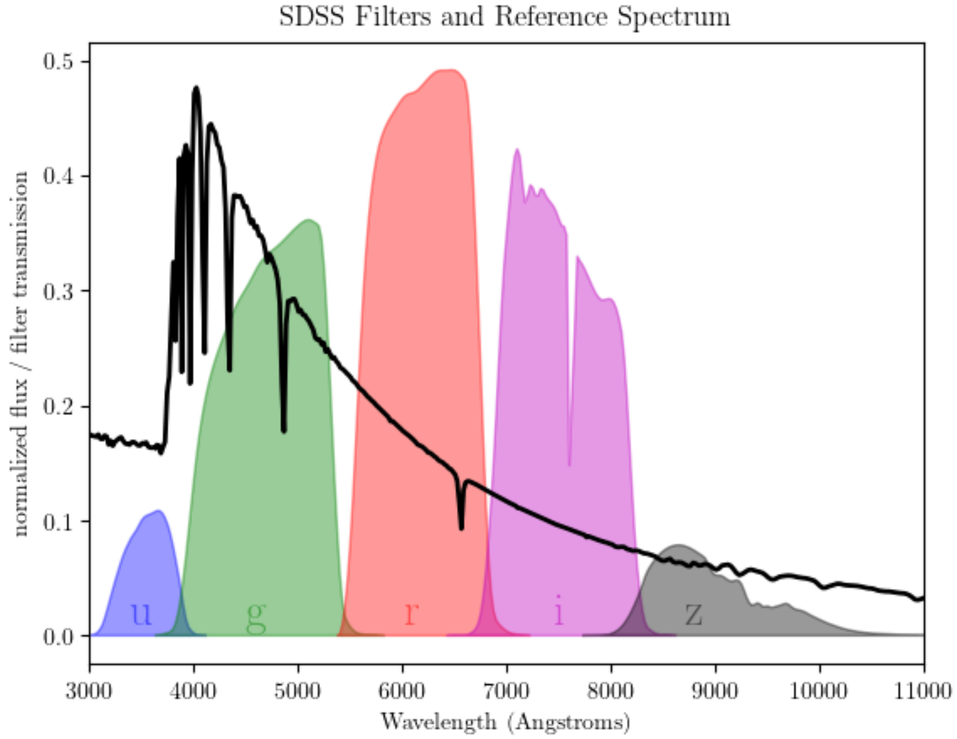
- Apparent magnitude(m): Magnitude of target what telescope observed
- Absolute magnitude(M): apparent magnitude that the object would have **if it were viewed from a distance of exactly 10 pc**



- The flux is reduced as $1/d^2$
- Formula: $m - M = -2.5 \log\left((10pc)^2/(d)^2\right) = 5 \log d - 5$

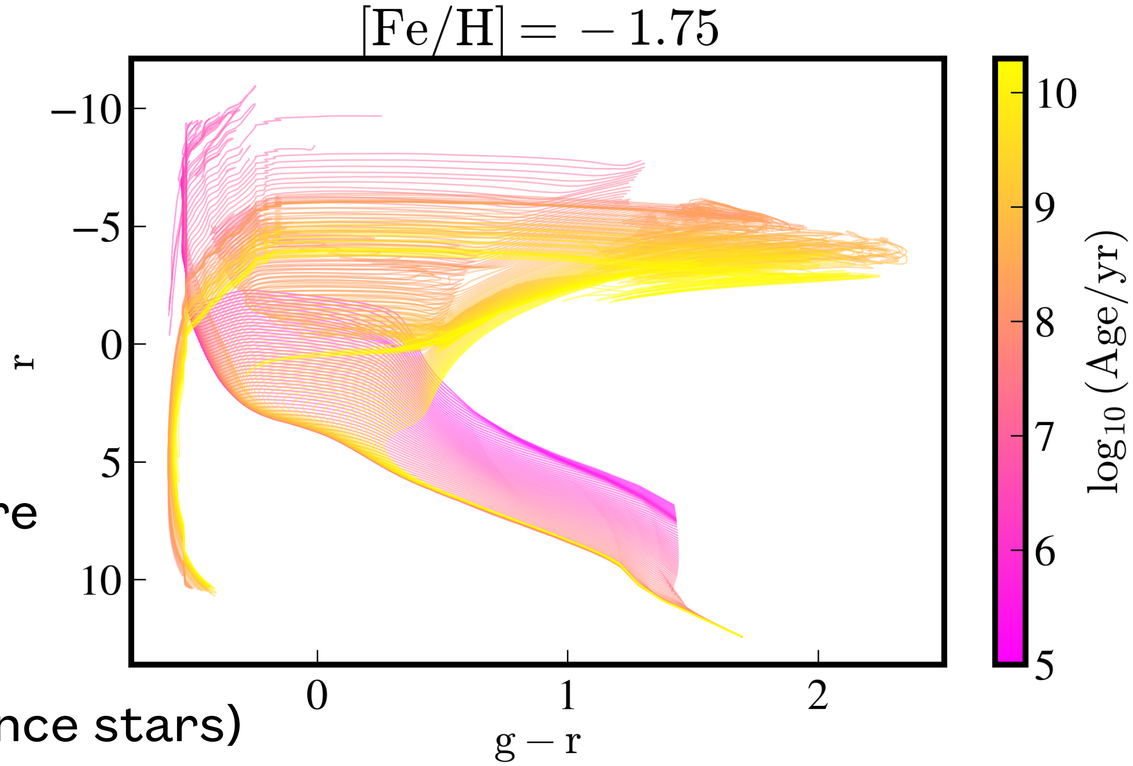
Color index

- In photometric observation, each band returns different magnitude for same object
- Define color index as difference of magnitude of two bands
- Formula: $C = m_{band,\,1} - m_{band,\,2}$
- The color index is '**distance independent' -> Why?**
  - (If an interstellar extinction isn't considered)



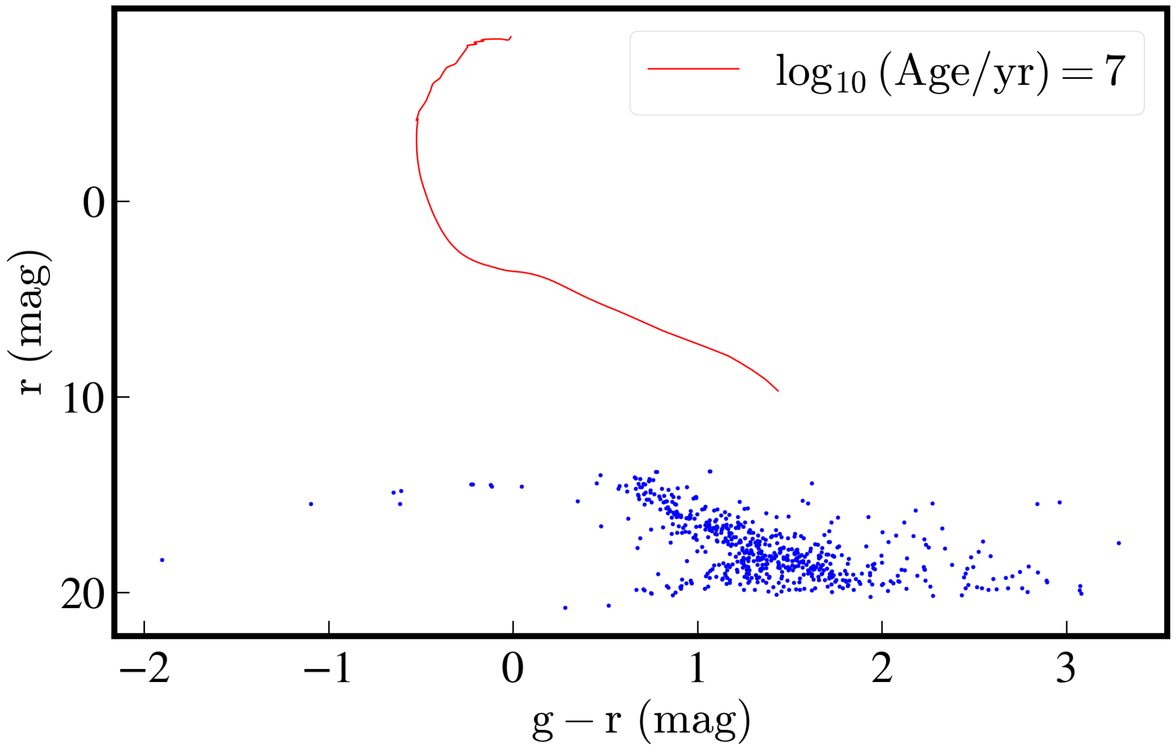
Color index

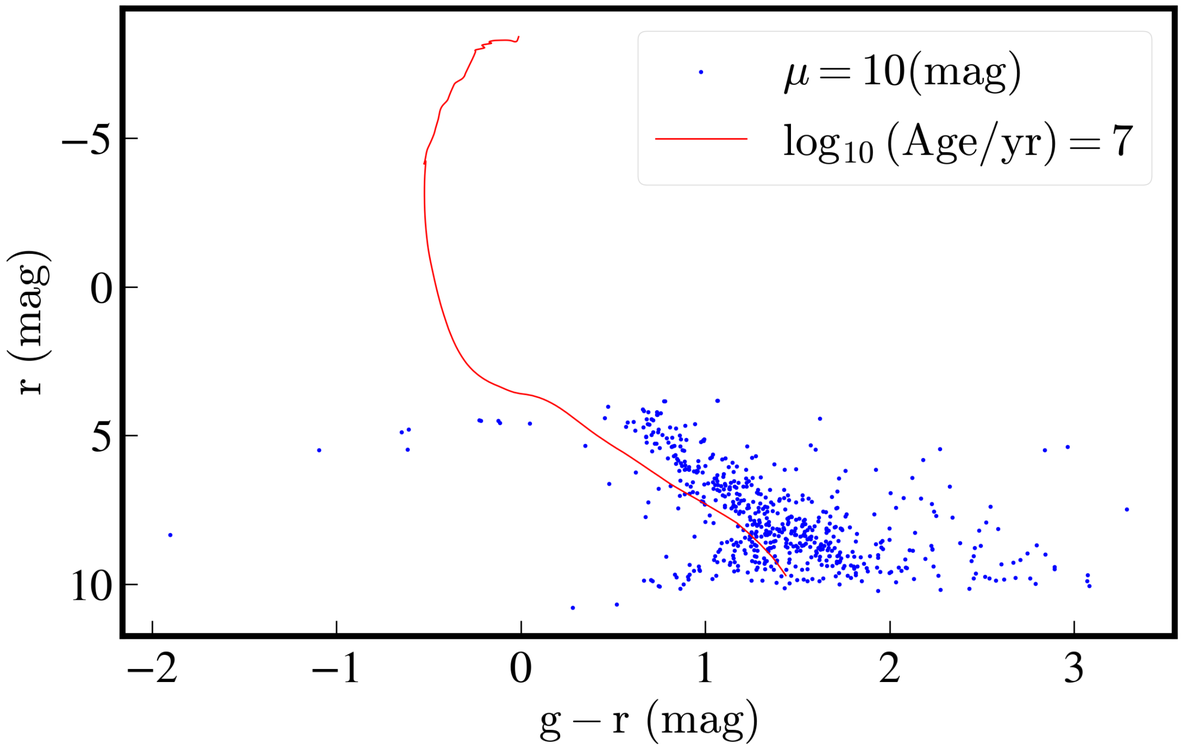
- Color index -> (Distance independent) Color
- (Distance independent) Color -> Surface Temperature
- Surface Temperature -> Stellar Mass (of main sequence stars)



Distance modulus

- $\mu = m - M = 5 \log d - 5$



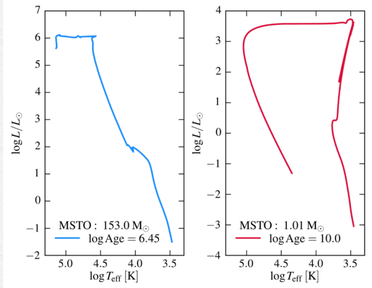


MIST Data

MIST

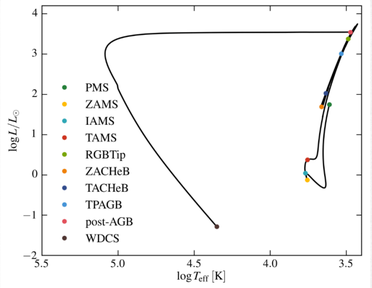
Home | Packaged Model Grids | Web Interpolator | Resources | References

MESA Isochrones & Stellar Tracks



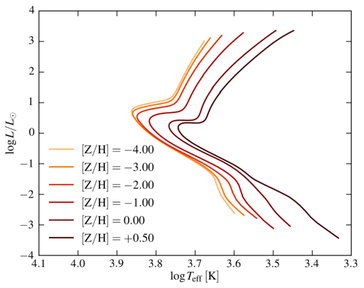
Extensive mass and age coverage

The current release consists of masses ranging from 0.1 to 300 solar masses and log(Age) ranging from 5 to 10.3. We're currently working on extending the models down to the brown dwarf regime.



Pre-main sequence to advanced evolutionary phases

Stars are evolved continuously to central hydrogen depletion, white dwarf cooling sequence, or central carbon depletion depending on the stellar mass.



Wide range in metallicities

The current version of models adopt solar-scaled abundances from Asplund et al. (2009), with metallicities ranging from [Fe/H] = -4 to 0.5. We're currently working on creating models with non-solar-scaled abundances

HW

- Apply **aperture photometry** to at least one **open cluster** of your choice.

- Apply **isochrone fitting** to derive **the distance and age of the cluster**.

Reference

- http://waps.cfa.harvard.edu/MIST/index.html
- https://arxiv.org/pdf/1109.5774
- https://www.tandfonline.com/doi/full/10.1016/j.nrjag.2018.07.006#d1e110