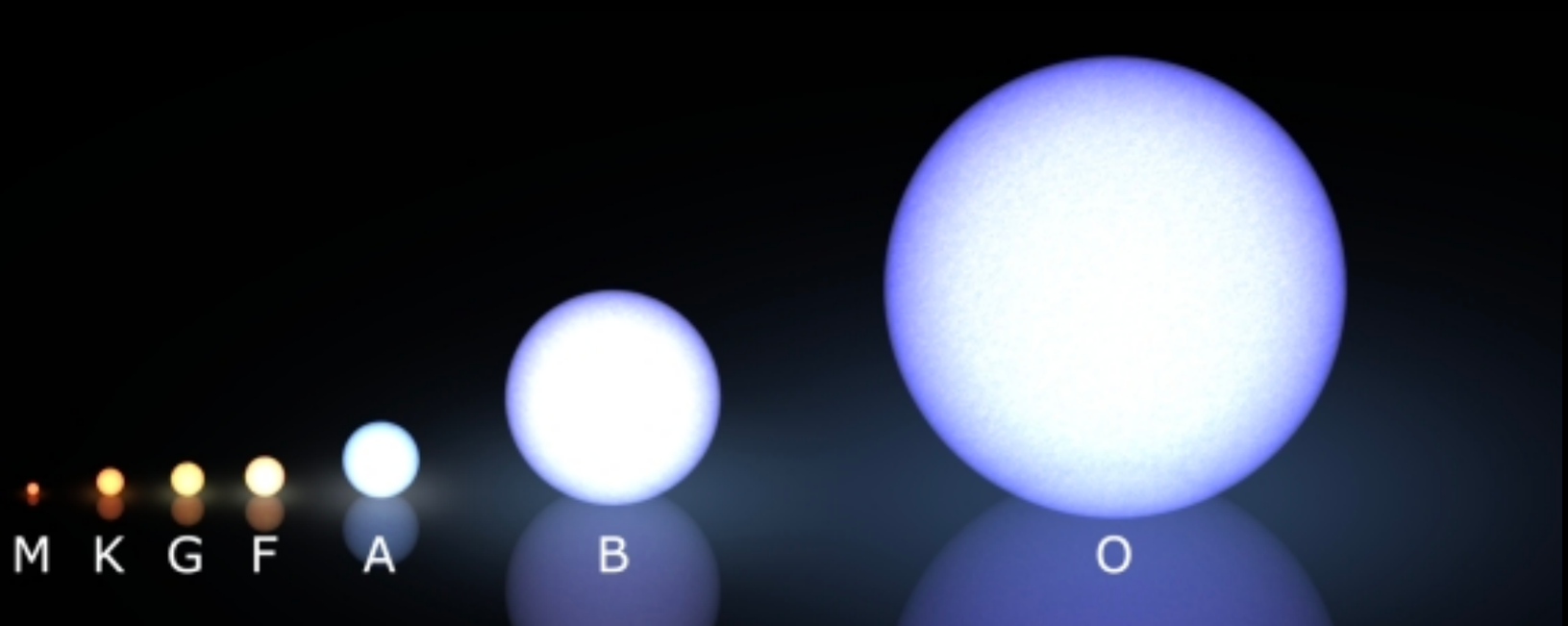
LAB 8

# COLOR-MAGNITUDE DIAGRAMS

# STELLAR PROPERTIES

- Stars come in a range of sizes, colors, temperatures and brightness.
- Low surface temperature stars are smaller, redder, less luminous and have longer life spans (billions of years).
- High surface temperature stars are larger, bluer, more luminous and have shorter life spans (millions of years).
- Stellar classification system: M, K, G, F, A, B, O. The sun is a G-type star!



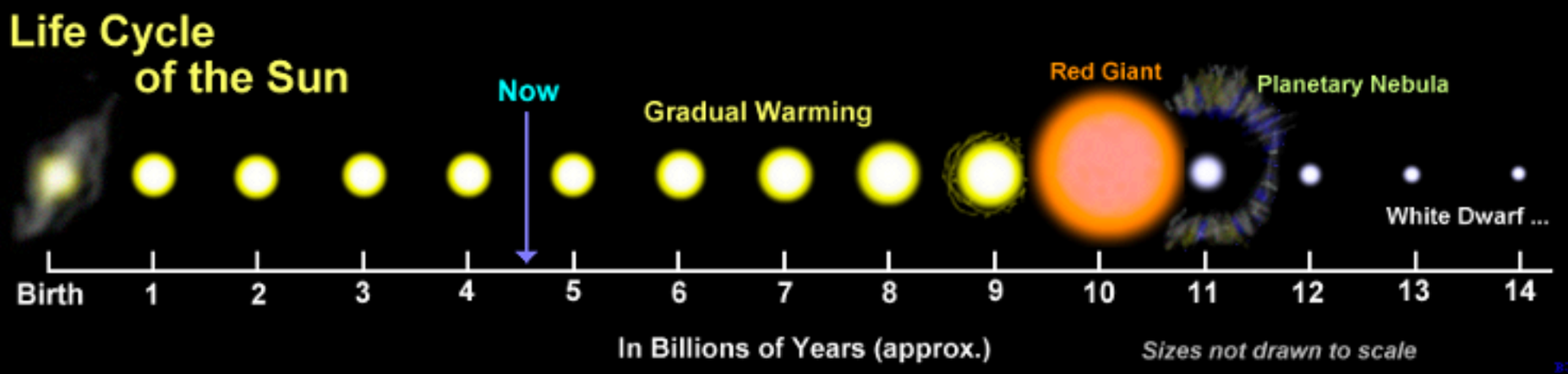
# STELLAR LIFESPANS

- After formation (a few million years), the temperature and luminosity of stars changes drastically. These are called pre-main sequence stars.

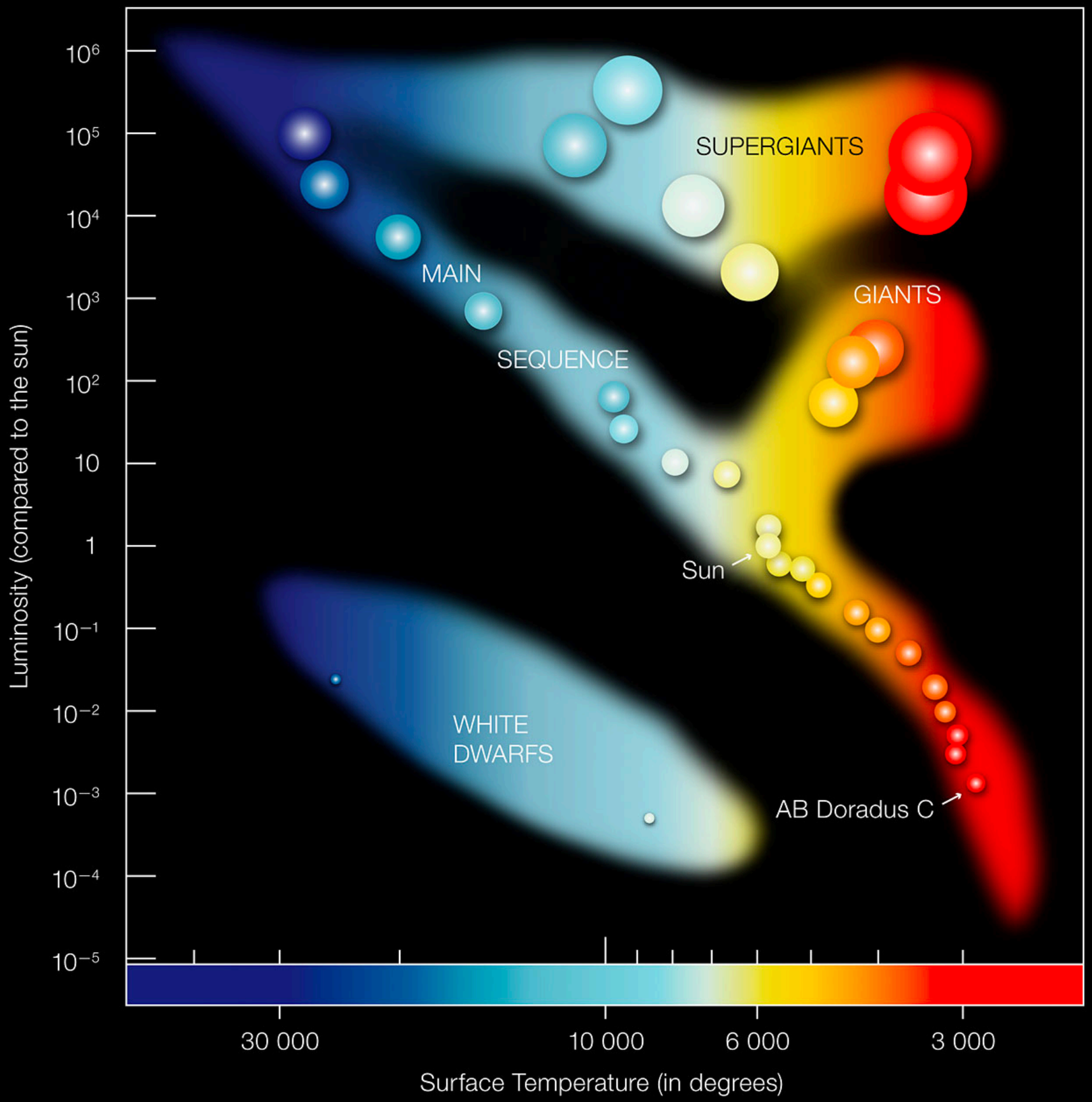
- Eventually, stars will settle at a temperature/luminosity where they will remain for the majority of their lives. These are called main sequence stars.

- Towards the end of their lives, once out of hydrogen to fuse, stars begin to puff up and become redder. These are called giant to super giant stars.

- When stars begin to fuse Iron, they will begin to die, becoming white dwarfs (medium to low mass stars), neutron stars (large stars), or black holes (the largest stars).



# HERTZSPRUNG-RUSSELL DIAGRAM



# OPEN & GLOBULAR CLUSTERS

- Studying clusters of stars in our galaxy gives us a better sense of stellar evolution.

- This is because the stars in these clusters were formed in the same molecular cloud around the same time. This gives them roughly the same age, composition and distance.

Open Cluster

Globular Cluster

# COLOR AND MAGNITUDE

- By looking at the the difference in flux between the B and V filter, we can determine the color of the star. Higher flux in B filter means star is more blue and vice versa.

- Instead of flux, we use the magnitude system. Smaller magnitude means a brighter object and vice versa. Therefore, lower (B-V) = bluer star, while higher (B-V) = Redder star.

- Uses a logarithmic scale. Ex: Magnitude=2 is 100 times brighter than magnitude=7.

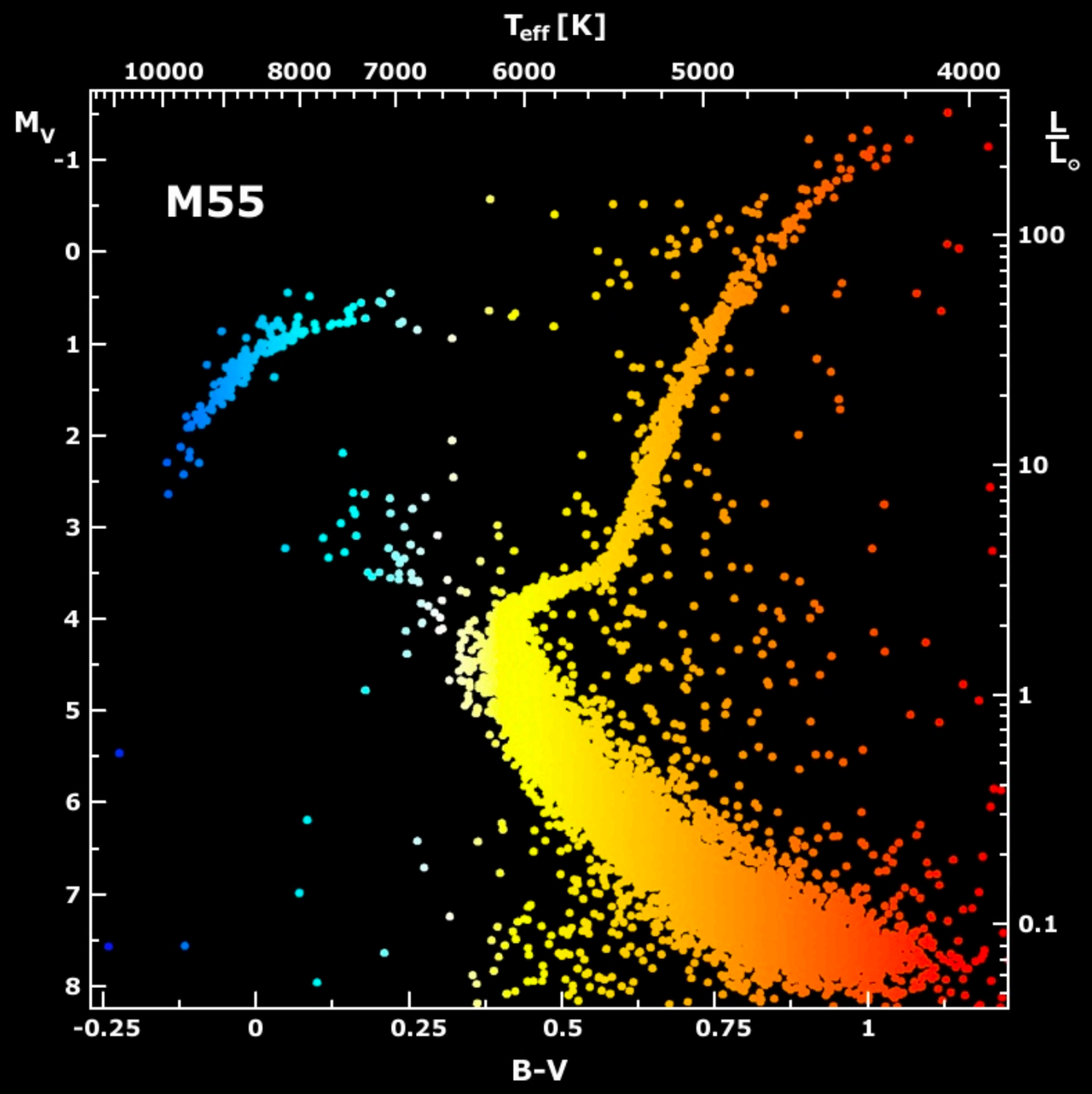
- Apparent magnitude: Magnitude of star as observed from Earth.

- Absolute magnitude: Magnitude of star if observed at 10 parsecs from Earth.

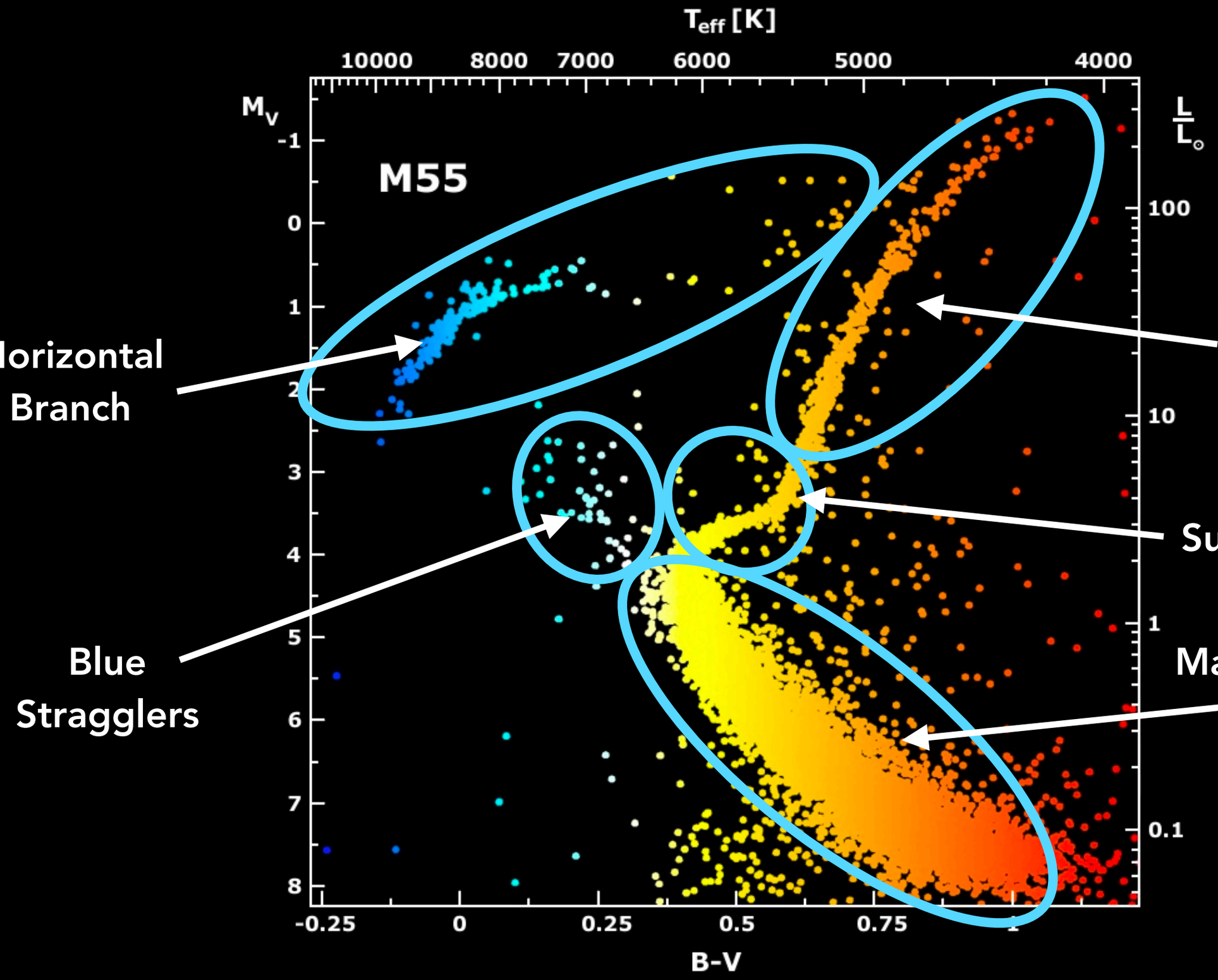
# COLOR-MAGNITUDE DIAGRAM

- CMD plots stars as a function of B-V vs. V (using magnitude system).

- This is analogous to Temperature vs. Luminosity.

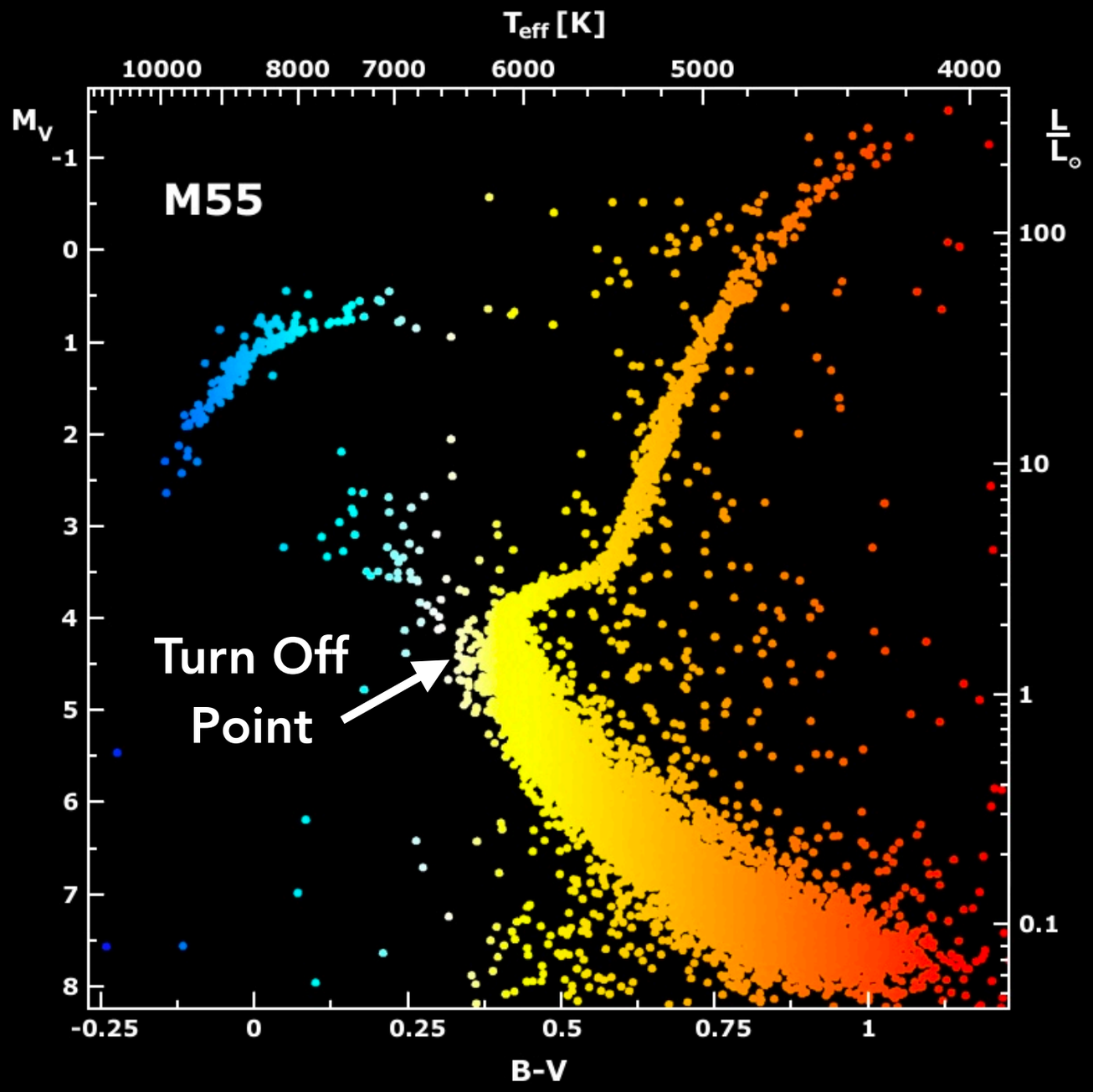


# COLOR-MAGNITUDE DIAGRAM



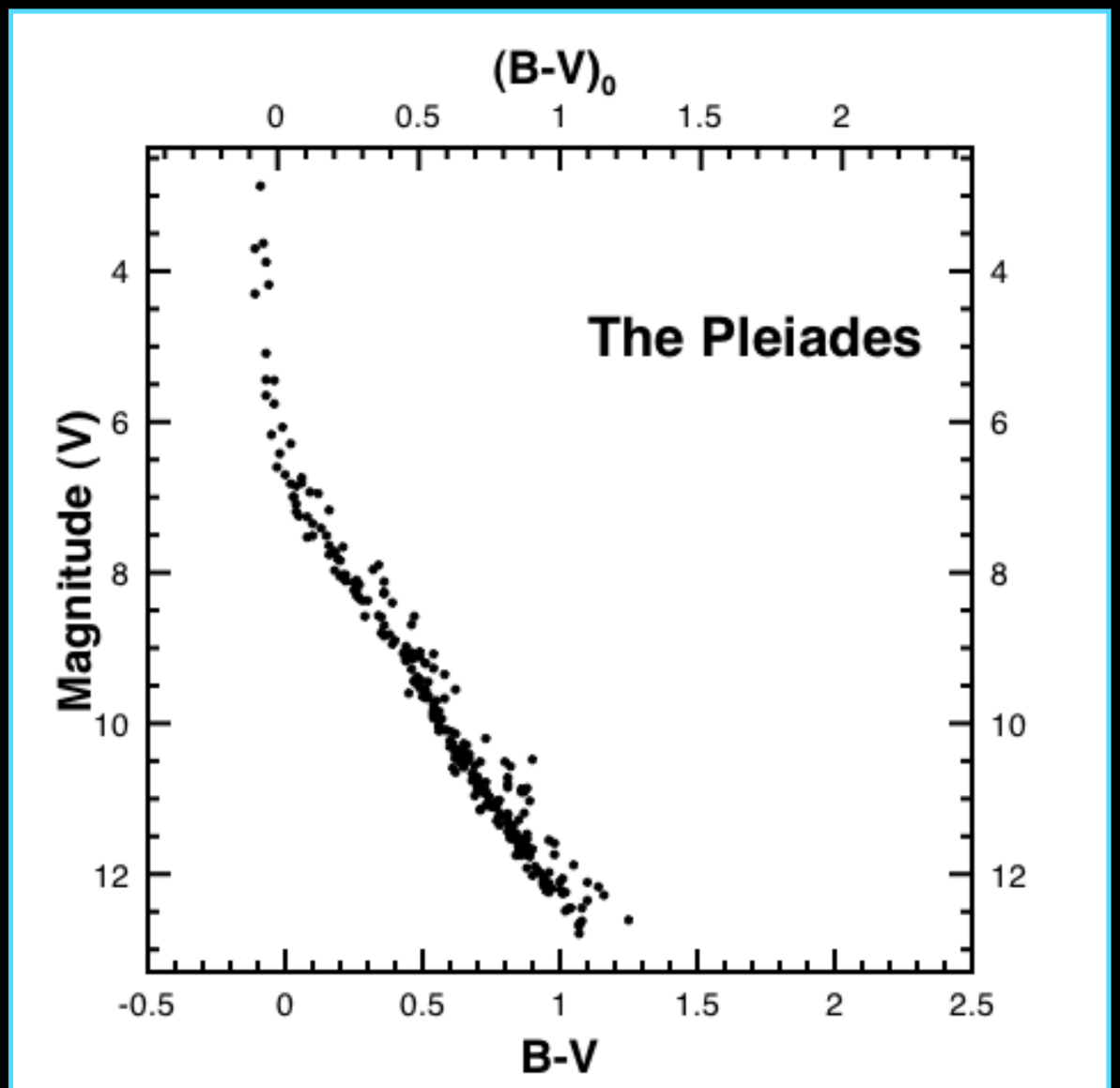
# CLUSTER AGE

- Larger/bluer stars have shorter lifespans than smaller/redder stars.
- Because all of these stars are roughly the same age, bluer stars turn off the main sequence first. This creates whats called a “turn off” point.
- The turn off point can therefore tell us the age of the cluster.

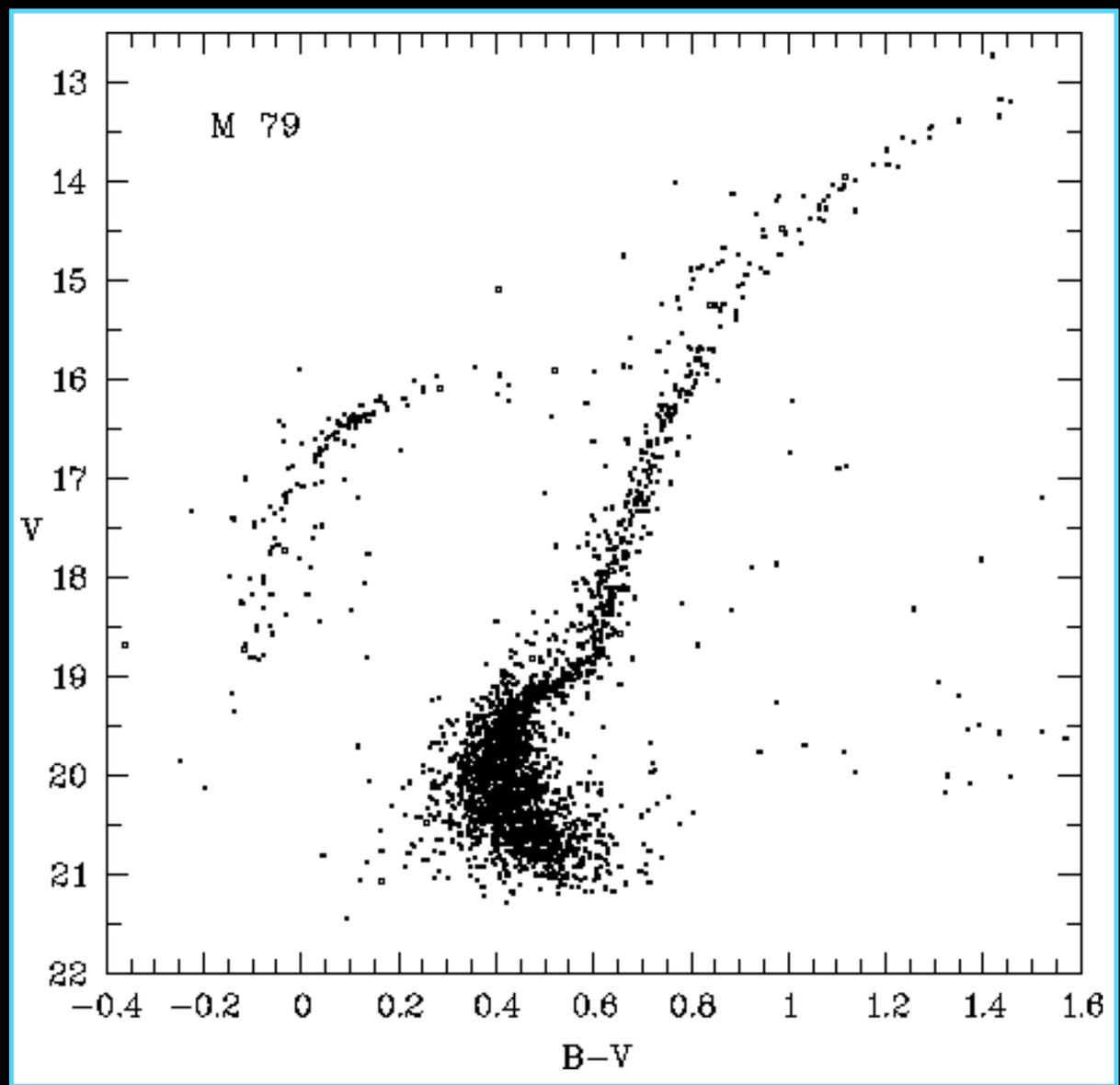


# CLUSTER AGE

## Younger Cluster




## Older Cluster



# CLUSTER DISTANCE

- We can measure the distance to the cluster if we have both the apparent and absolute magnitudes.

- One way to calculate distance; We know the (B-V) value of the sun and its absolute magnitude, we can project it onto a CMD of a particular cluster to obtain its apparent magnitude if it was in that cluster.

- We can then plug the calculated apparent magnitude and absolute magnitude (known) into the distance modulus equation.

$$d = 10^{0.2(m-M)+1}$$

- d=distance (pc)
- m=apparent magnitude
- M=absolute magnitude

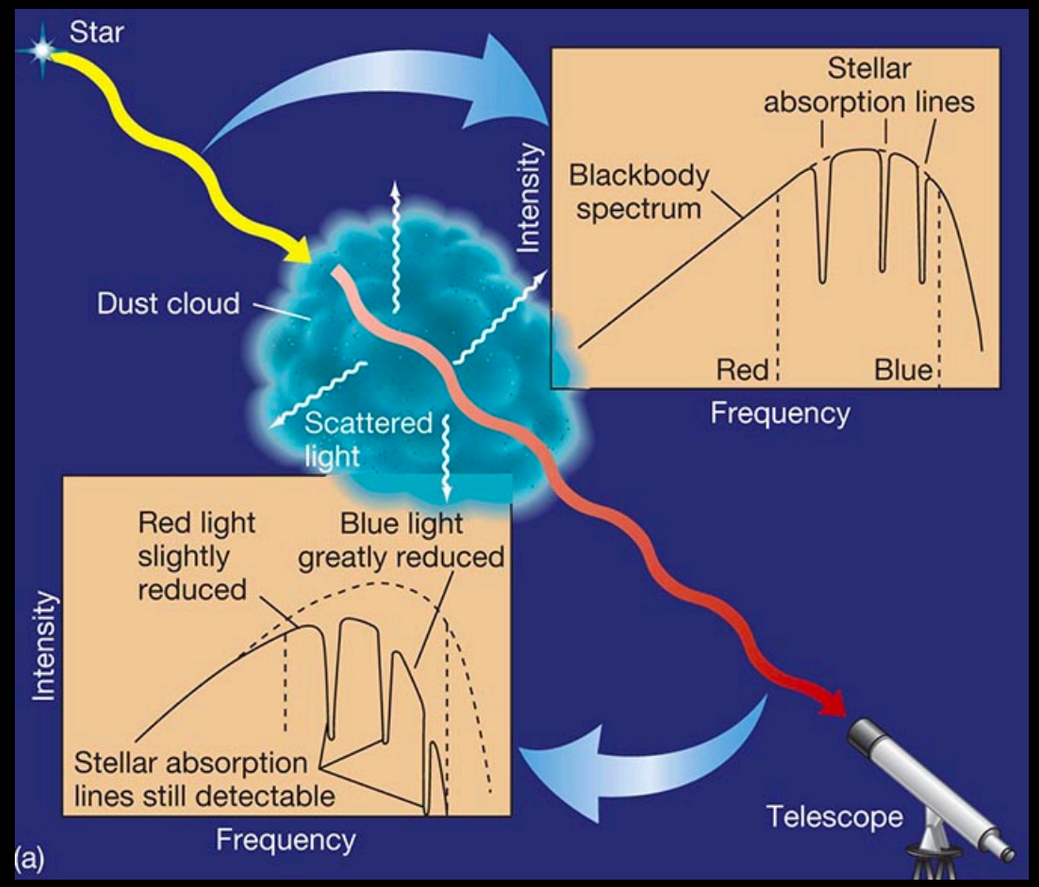
# DUST EXTINCTION

- Need to take into consideration there might be interstellar dust obscuring the cluster.

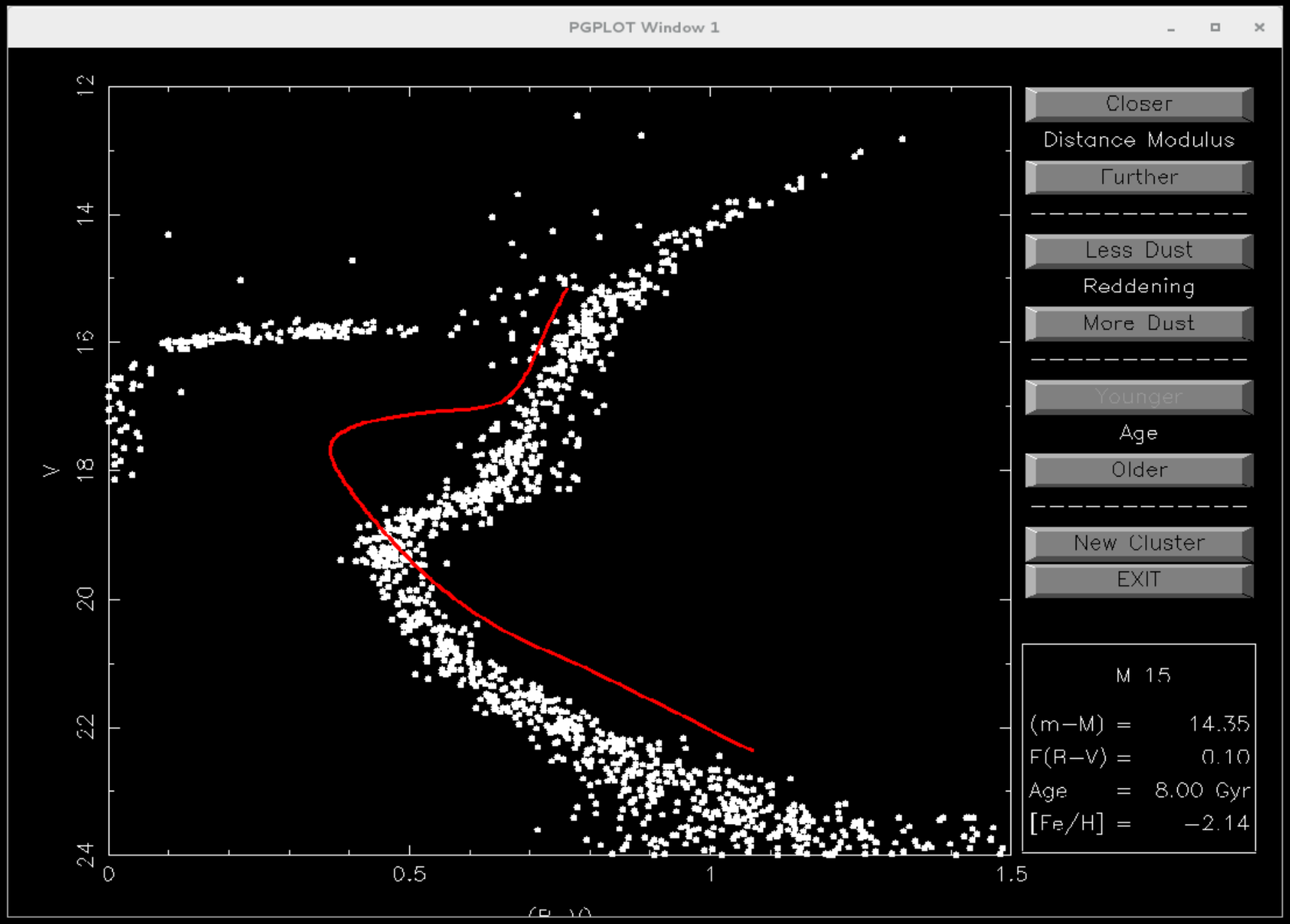
- This dust absorbs shorter wavelengths, and re-emits light at redder wavelengths, hence reddening the cluster.

- This effect is called “Extinction”.

$$m_{V,corr} = m_{V,obs} - 3.1 \times E(B-V)$$

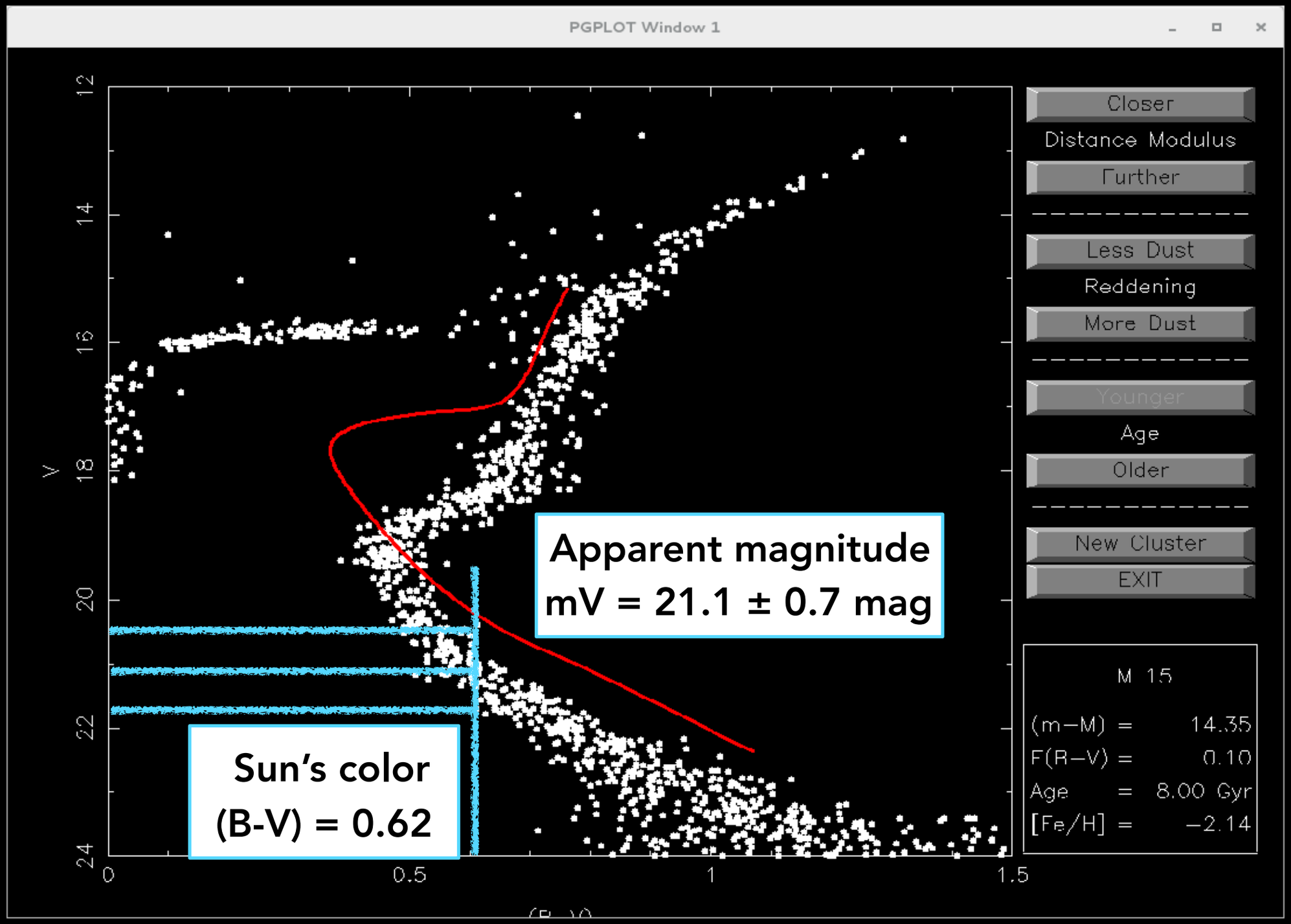


# PART 1: IDENTIFYING FEATURES



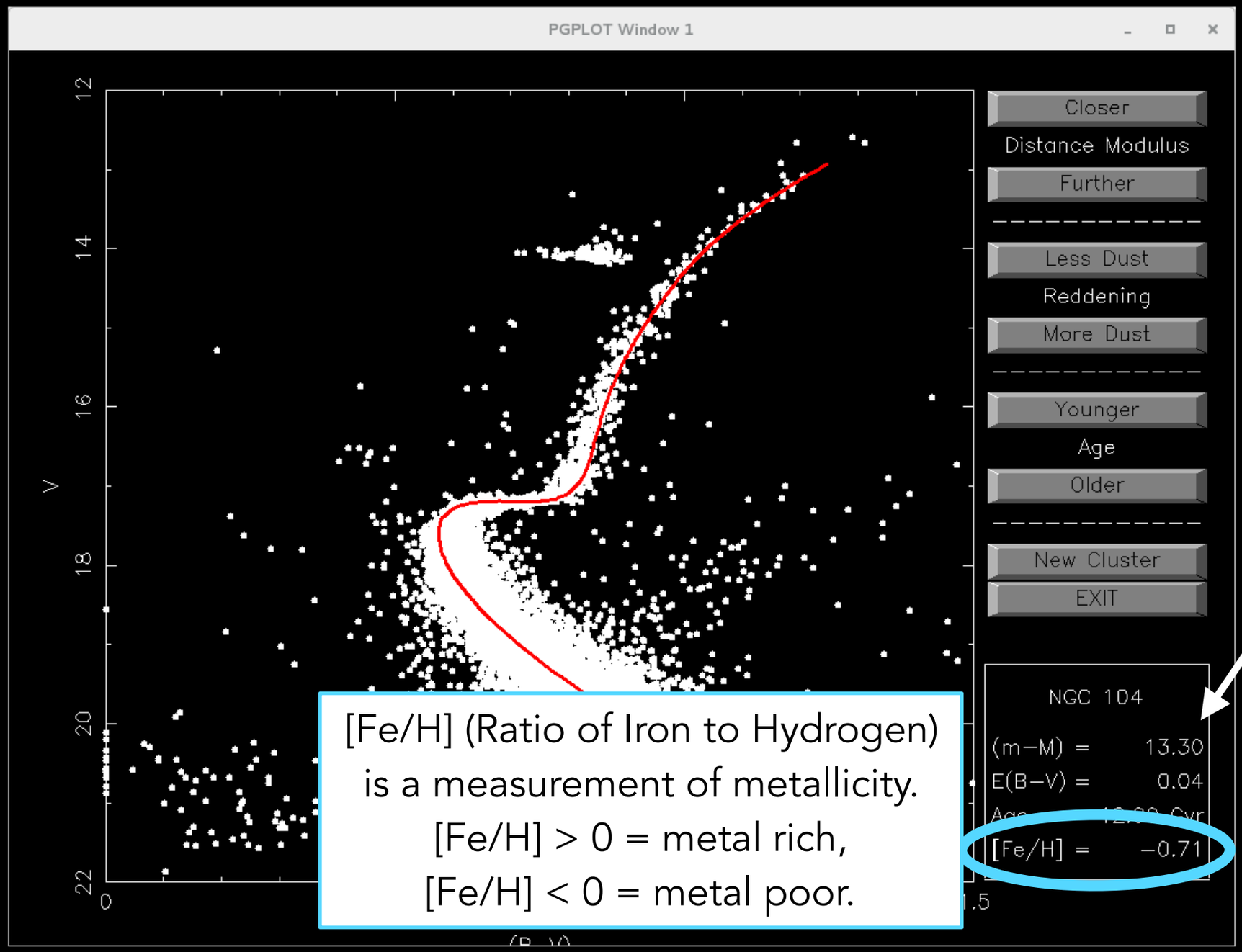

| Cluster | MS | TO | SG | RG | HB | BS |
|---|---|---|---|---|---|---|
| Example | ✔ | ✔ | ✔ | ✔ | ✔ | ✗ |

# PART 2: SUN IN A STAR CLUSTER



# PART 3: ISOCHRONE FITTING

- Adjust distance, extinction and age to get best fitting isochrone model.




[Fe/H] (Ratio of Iron to Hydrogen) is a measurement of metallicity.
[Fe/H] > 0 = metal rich,
[Fe/H] < 0 = metal poor.

**Best fitting parameters**