

Astro 250: Extragalactic Stellar Population

Globular Cluster Age Dating

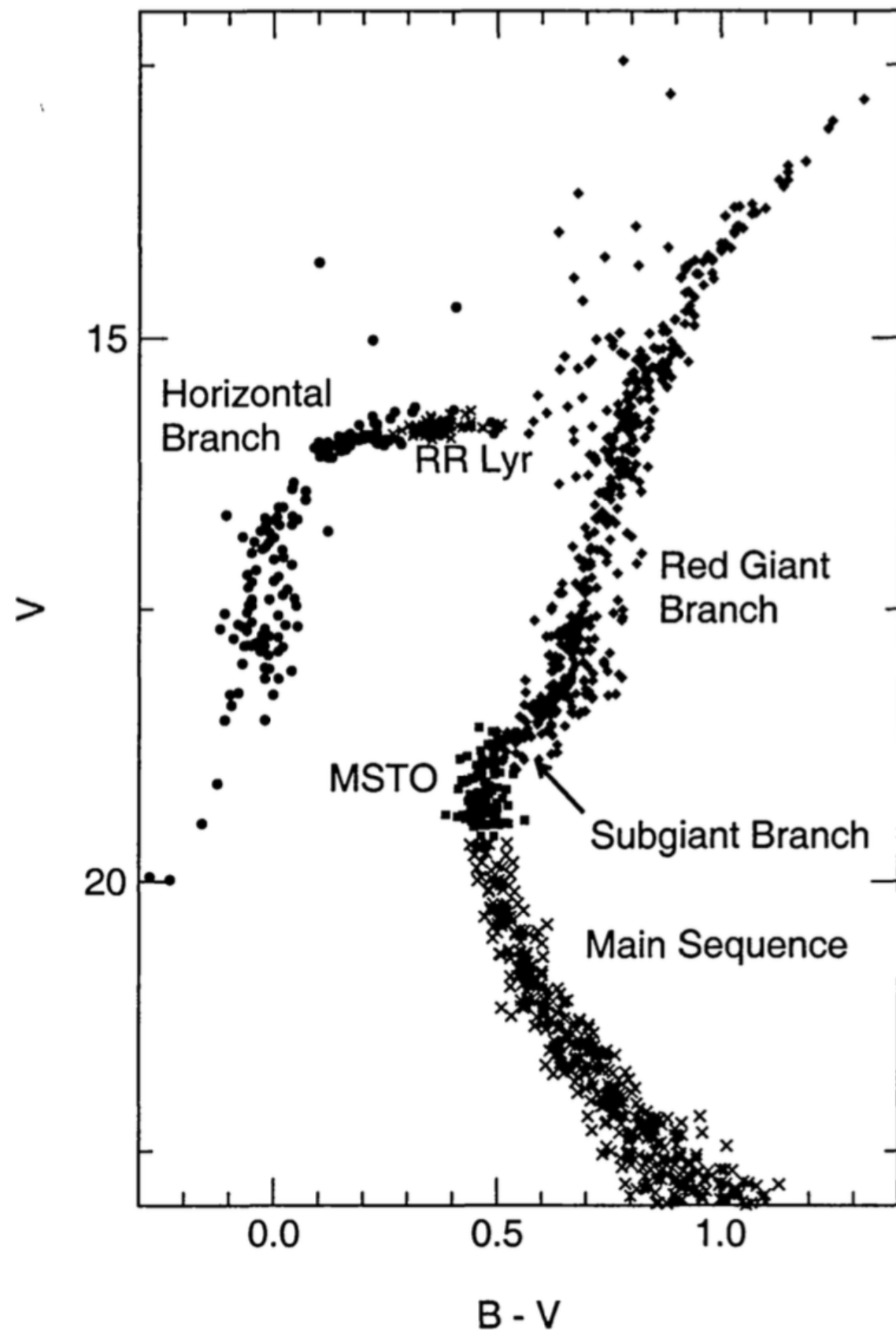
Brain Chaboyer 2001

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Why to determine ages of globular clusters

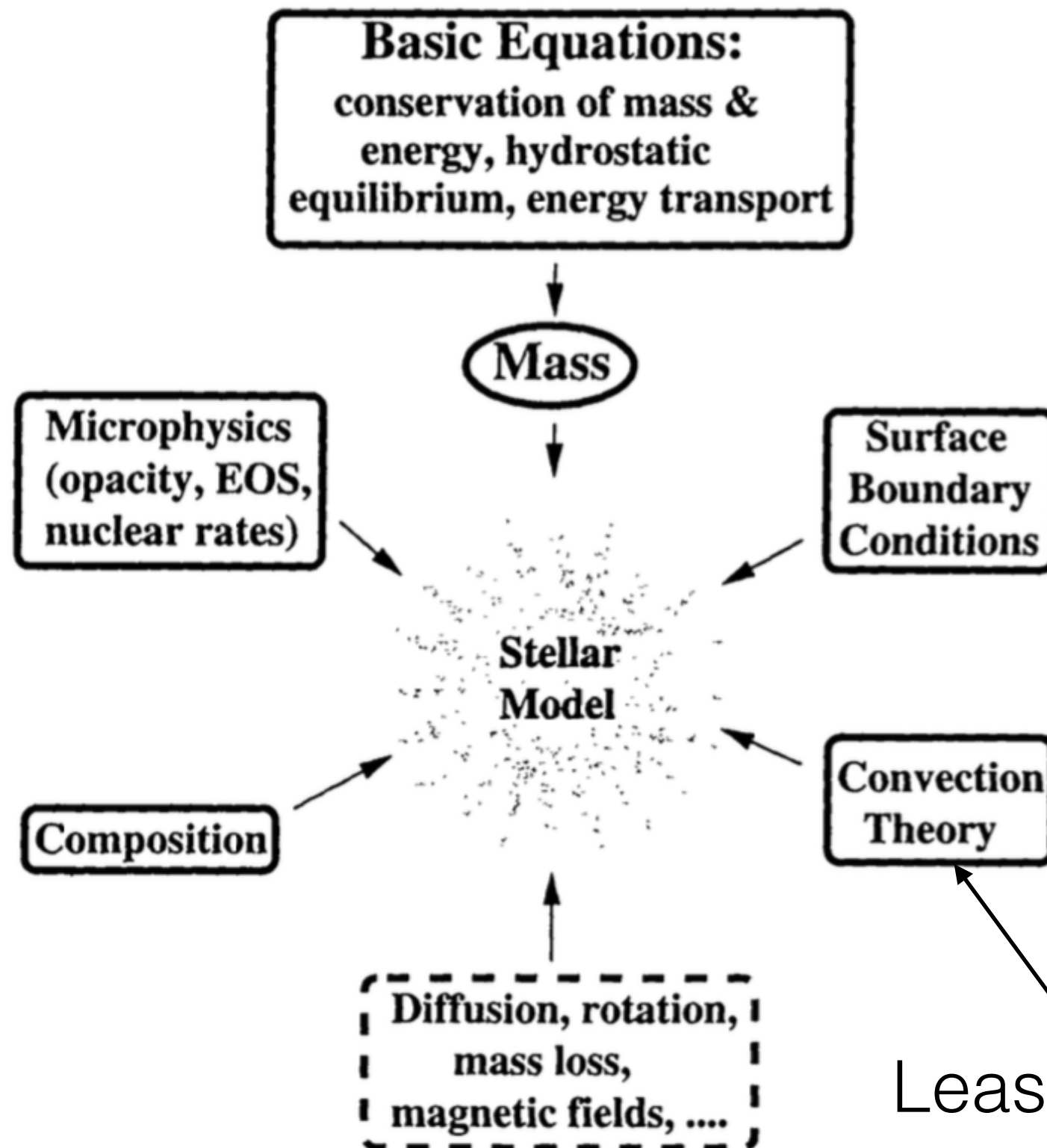
- Globular clusters are among the oldest objects in the universe.
- Relative age:
 - How did Milky Way form?
- Absolute age:
 - How old is the universe?
- globular cluster:
 - lie at the same distance
 - single-age, single-metallicity system

Observation: CMD (color-magnitude diagram)



- MS:
main sequence
- MSTO:
main sequence turnoff
- SGB:
sub giant branch
- RGB:
red giant branch
- HB:
horizontal branch

Theoretical Stellar Models



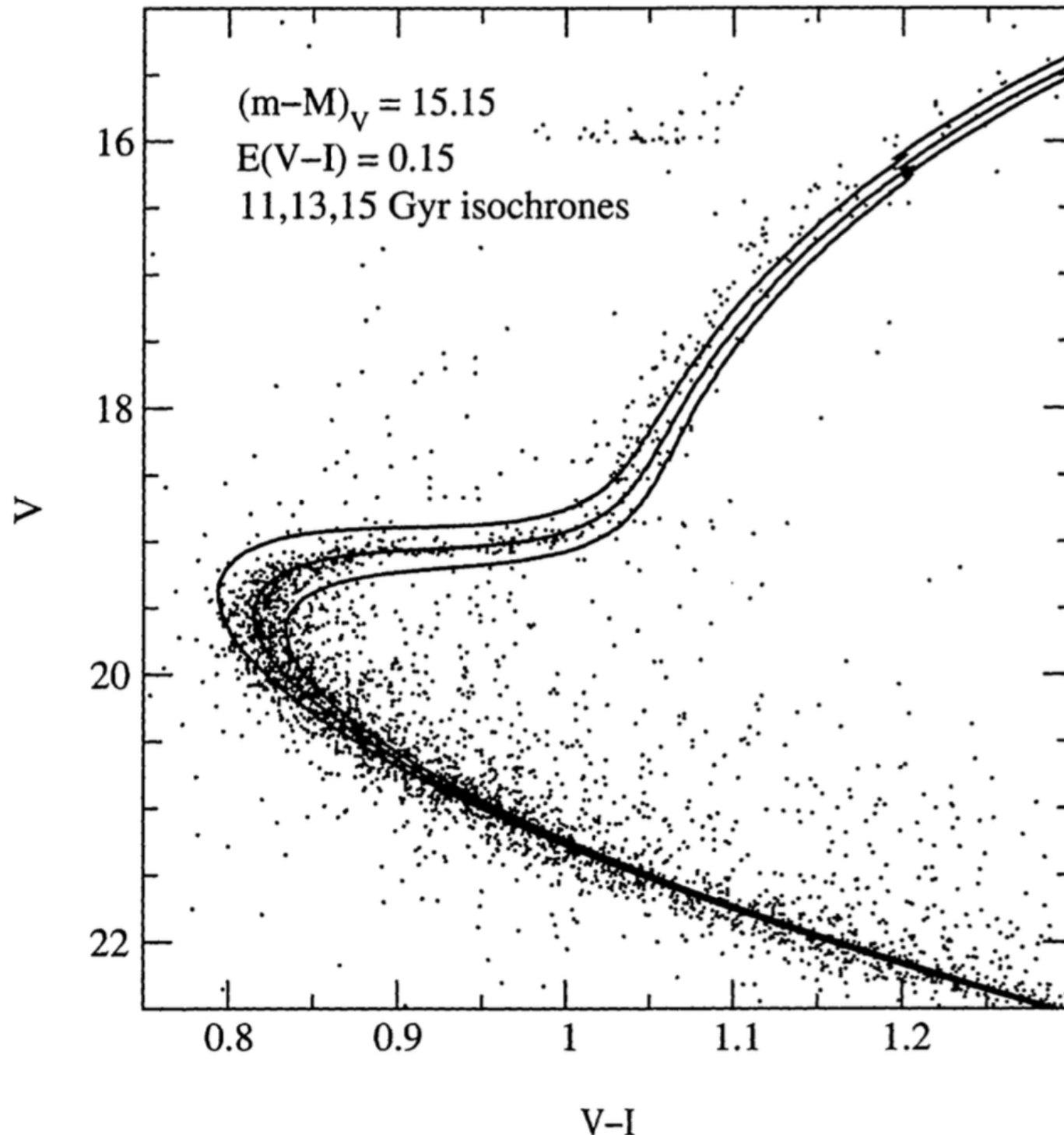
-> isochrones

compare with CMD

Least understood aspect

Age Determination Techniques

1. Isochrone fitting:



change distance modulus, reddening and age until a good match to CMD

Advantage

- use all the available observation data

Disadvantage:

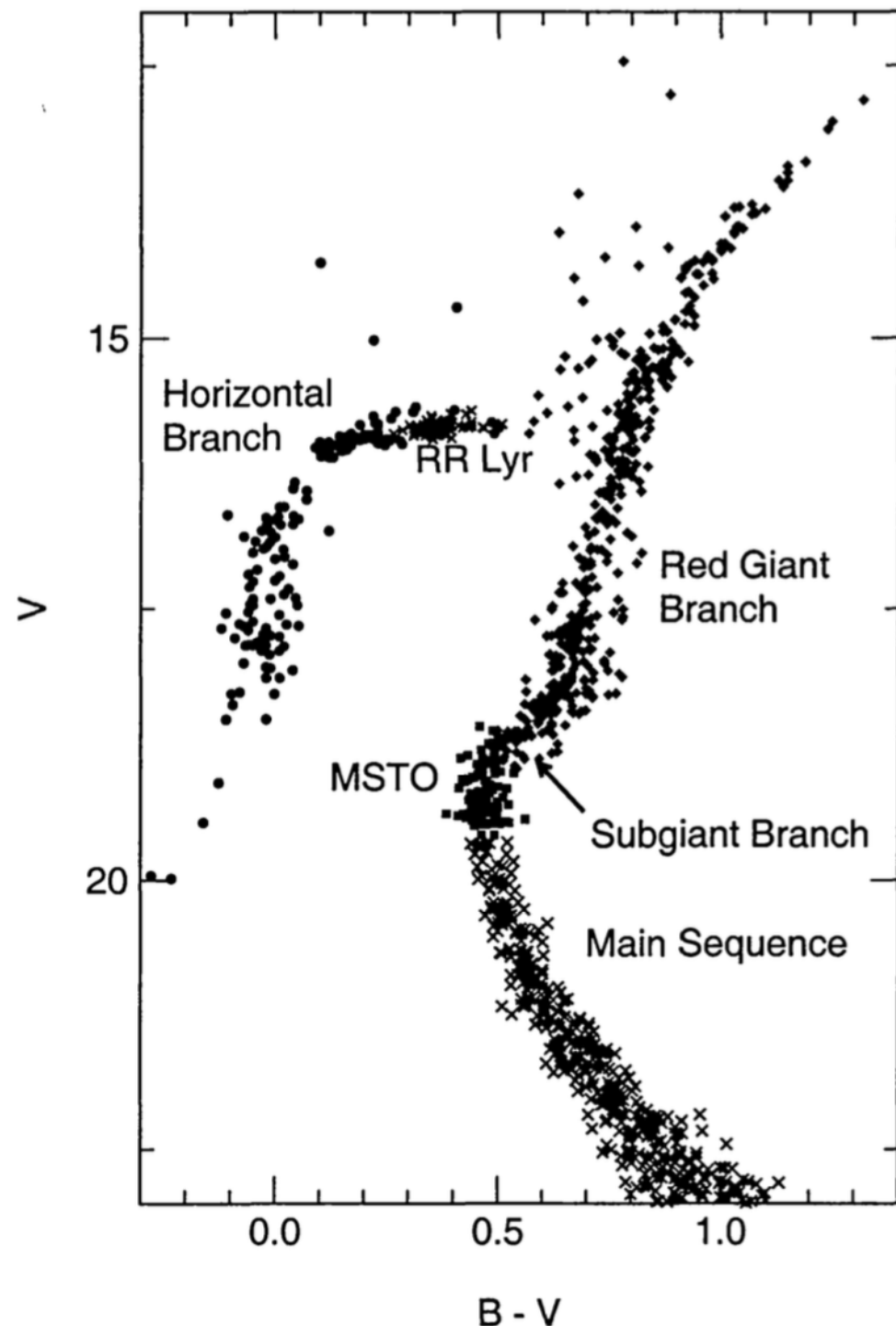
- sensitive to reddening, distance, metallicity

Conclusion:

- don't provide robust absolute age
- may provide estimate of relative age with large error bar

Age Determination Techniques

2. Δ Color (MSTO - RGB)



Δ Color(MSTO - RGB) is sensitive to age

Advantage

- independent of distance and reddening
- easy to determine in observation

Disadvantage:

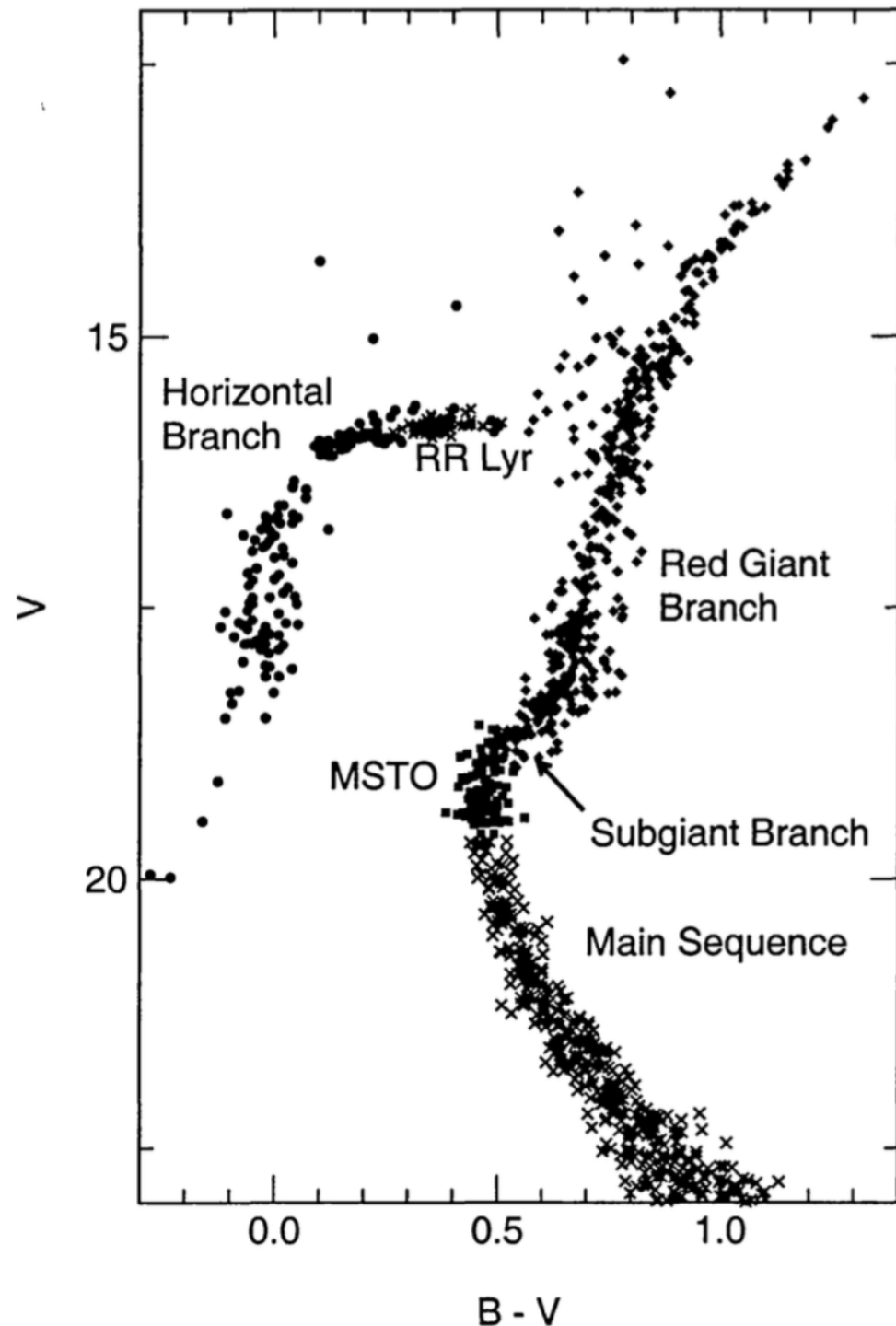
- depends solely on color which have large theoretical uncertainty

Conclusion:

- best used to determine relative age of cluster with similar compositions.

Age Determination Techniques

3. ΔV (SGB - HB)



ΔV (SGB - HB) is sensitive to age of old star clusters ($>7\text{Gyr}$)

Advantage

- theoretical calibration depends primary upon the stellar models and insensitive to the treatment of convection

Disadvantage:

- The absolute magnitude of RR Lyrae stars has a fair bit of uncertainty when calibrated using different methods.

Conclusion:

- best used to determine absolute age of cluster.

Absolute Globular Cluster Age

- Δ Color method found that all metal-poor clusters ($[\text{Fe}/\text{H}] < -1.7$) are the same age, so studies of absolute ages concentrate on the most metal-poor globular clusters.
- Δ magnitude method gives the mean age of a sample of 17 metal poor globular clusters is 13.2 ± 1.5 Gyr