



# Main Sequence Fitting

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# Where are we in the CDL?



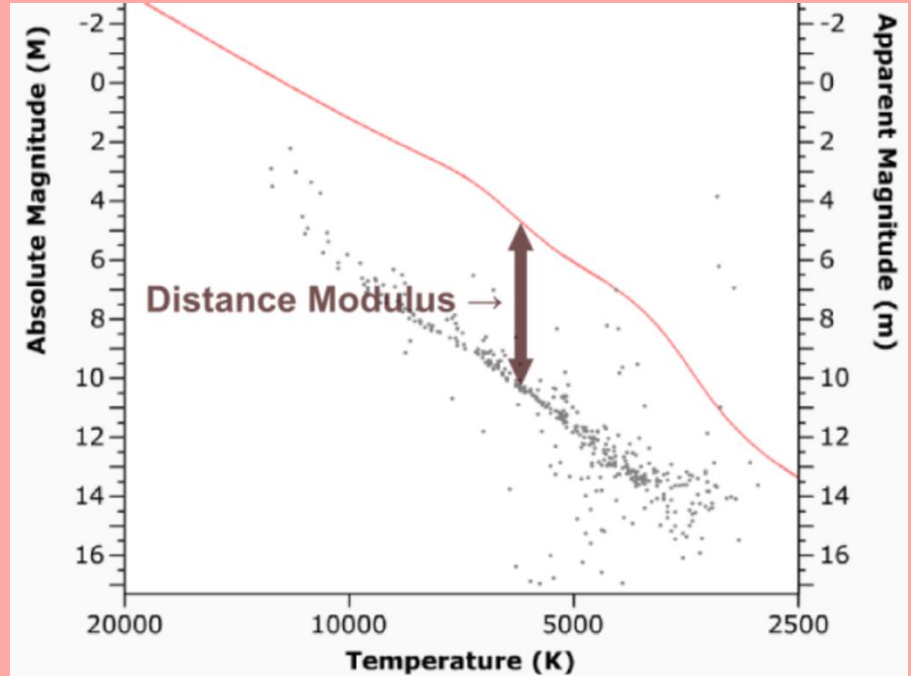
# Basics of Technique

Measure apparent magnitude for target cluster

Define the main sequence on the CMD

Compare to a calibration cluster

Calculate the distance modulus



UNL



# Distance Modulus Equation



How do you find the distance to a star cluster?

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

Solve for distance

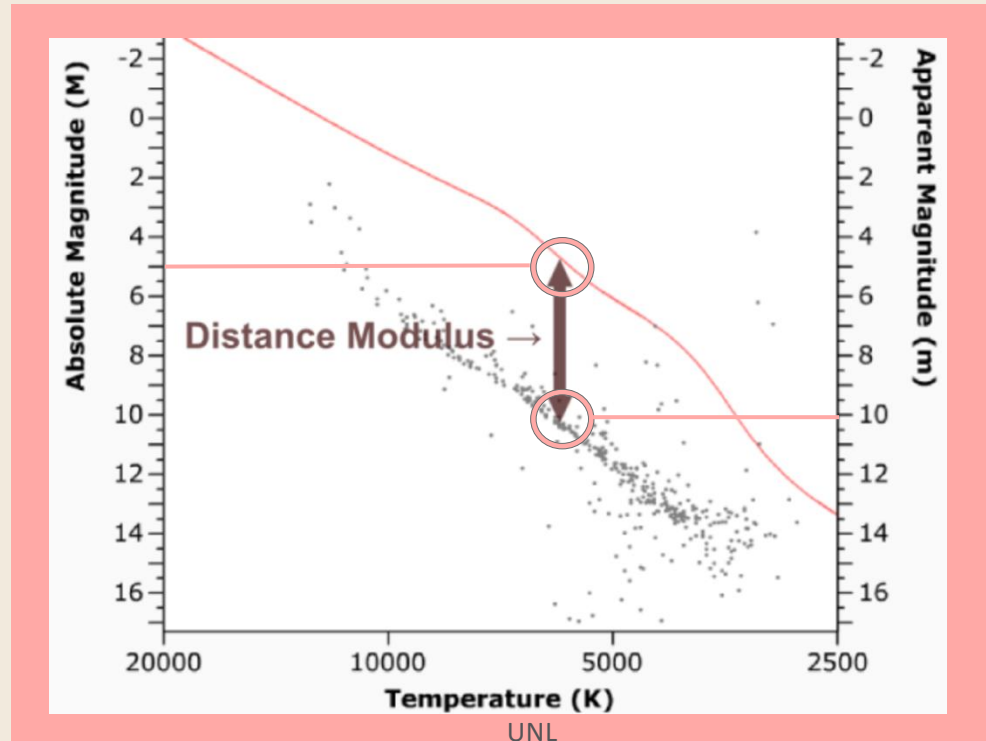
$$d = 10^{\frac{m - M + 5}{5}}$$

# Distance Modulus Equation

How do you find the distance to a star cluster?

$$d = 10^{\frac{m - M + 5}{5}}$$

$$d = 100pc$$



# Range of Relevant Distances

Most reliable up to  $\sim 4 - 6\text{kpc}^*$

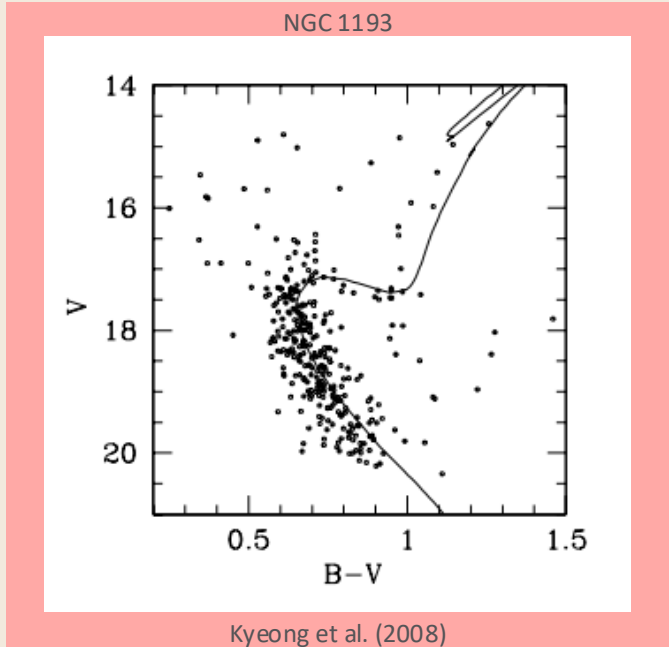
Table 4. Published  $(m - M)_V$  Values

Cluster	This Work	$\langle\text{GS03}\rangle$	Twarog et al.	Kalirai et al. <sup>a</sup>	Percival et al. <sup>b</sup>	Distance (pc)
NGC 2516	$8.44 \pm 0.06$	...	8.70	...	8.45	487.5
M 35 (NGC 2168)	$10.21 \pm 0.12$	$10.05 \pm 0.11$	10.30	$10.42 \pm 0.16$	...	1101.5
M 34 (NGC 1039)	$8.98 \pm 0.06$	...	8.98	...	...	625.2
NGC 3532	$8.59 \pm 0.06$	...	8.59	...	...	522.4
M 37 (NGC 2099)	$11.57 \pm 0.16$	$11.51 \pm 0.07$	11.55	$11.55 \pm 0.13$	...	2060.6
M 67 (NGC 2682)	$9.74 \pm 0.06$	$9.66 \pm 0.07$	9.80	...	9.72	887.2
NGC 188	...	...	11.35	...	11.45	

Sarajedini et al. (2003)

\*Beyond this, stars become more faint and photometric errors increase

# Calibration with Hyades



Often used for calibration

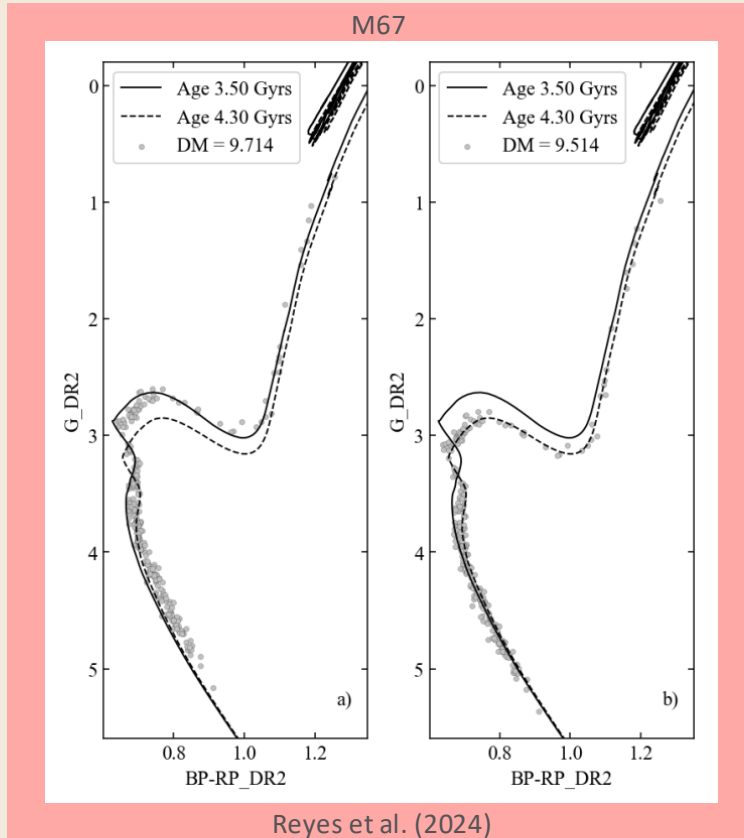
Precise distance from parallax ( $\sim 0.02\text{mag}$ )

Not as many high mass stars  
left on MS

DM  $\rightarrow$  13.3

Distance  $\rightarrow$  4570.9pc

# Calibration with Isochrones



Theoretical main sequence from stellar models

Can change age & metallicity

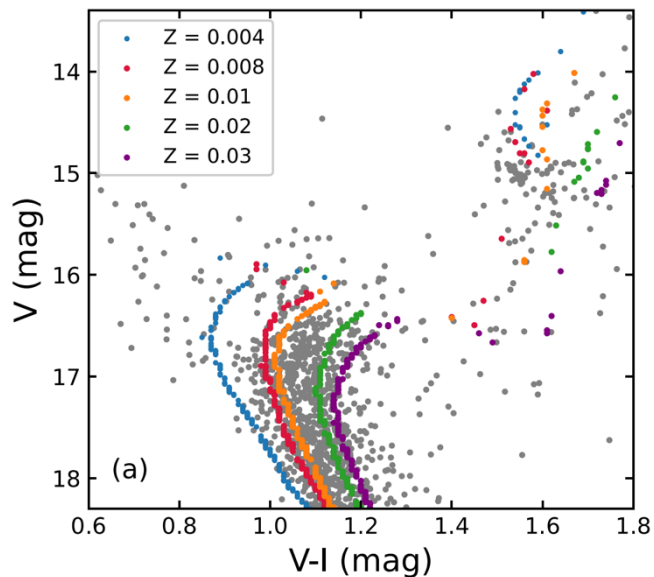
Not limited to one calibration cluster

Full CMD available

DM  $\rightarrow$  9.514 – 9.714  
Distance  $\rightarrow$  799.5pc – 876.6pc

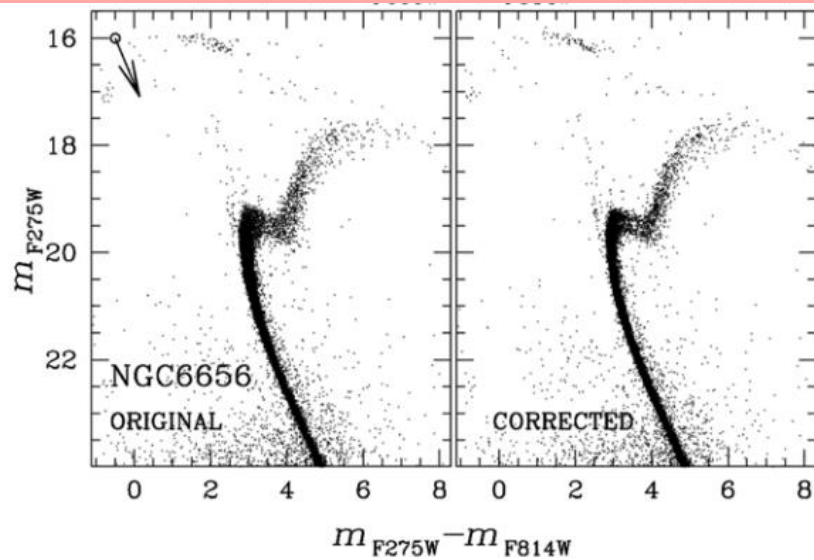
# Potential Problems

## Metallicity



Deng & Li (2023)

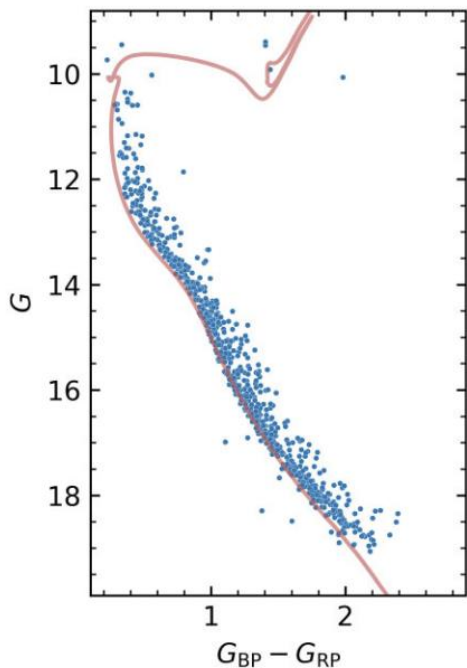
## Extinction



Piotto et al. (2012)

# Potential Problems

Unresolved Binaries



Griggio et al. (2023)

“Exact” Parameters of Calibration Cluster



Need well-constrained distance

# Sources of Error

Photometric error



Scatter in MS

Membership error



Off-sequence stars

Extinction correction



Incorrect MS shift

Vertical uncertainty



Distance uncertainty



Thank you!