



Isochrones of M67 with an Expanded Set of Parameters

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Abstract

We create isochrones of M67 using YREC (The Yale Rotating Stellar Evolution Code). In addition to metallicity, parameters that are traditionally held fixed, such as the mixing length parameter and initial helium abundance, also vary. The amount of convective overshoot is also changed in different sets of isochrones. Models are constructed both with and without diffusion. From the resulting isochrones that fit the cluster, the **age range is between 3.6 and 4.8 Gyr** and the **distance is between 755 and 868 pc**. We also confirm Michaud et al. (2004) claim that M67 can be fit without overshoot if diffusion is included.

M67

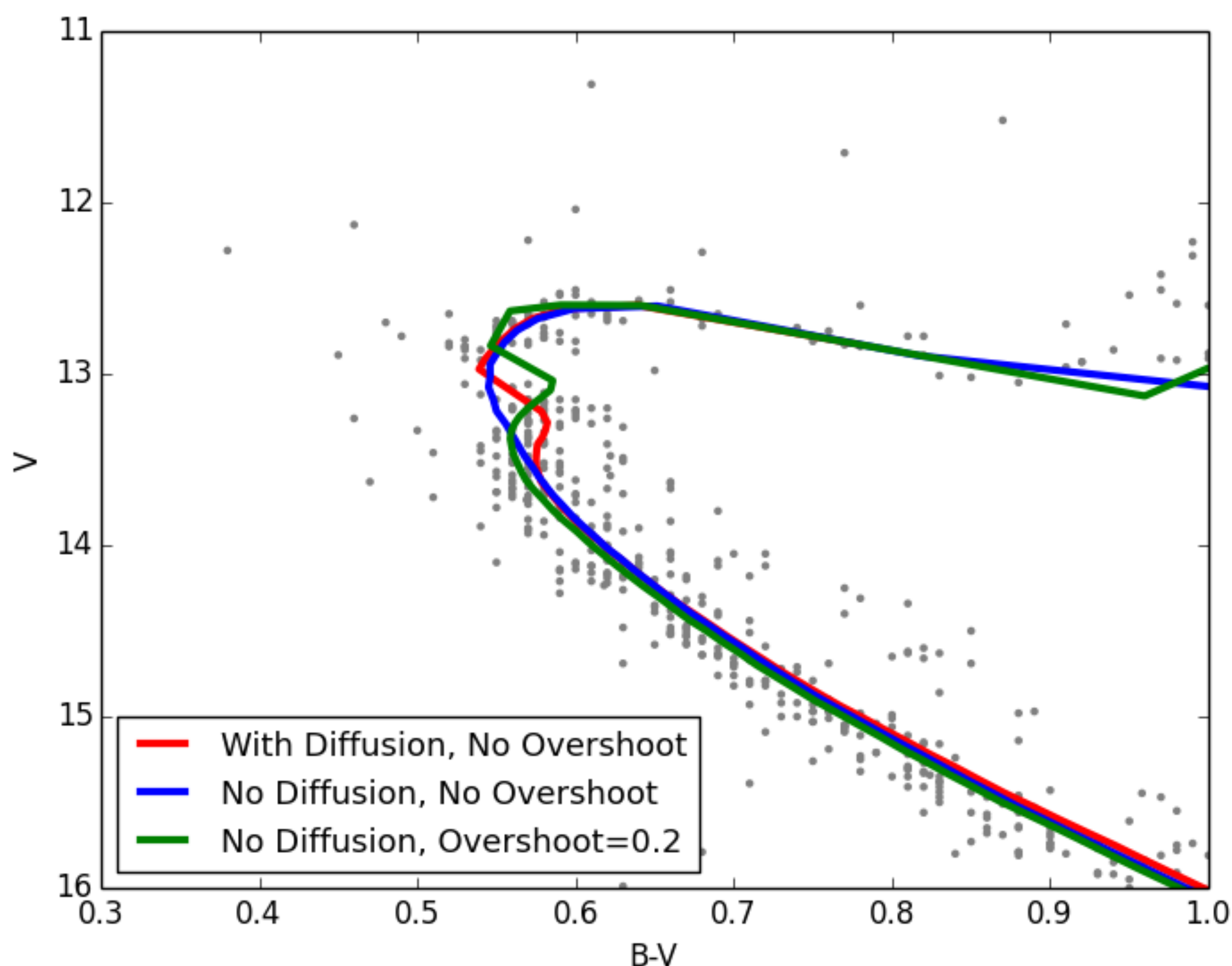
- Around 4 Gyr
- 800 to 900 pc away
- Nearest old open cluster
- $[Fe/H]=0.00\pm 0.06$ [3]
- CMD has distinct “hook” feature

Model Parameters

- With and without diffusion
- Mixing length: 1.5 to 2.0
- Y_0 : 0.248 to 0.320
- Overshoot: 0.0, 0.2, and mass-dependent
- $[Fe/H]$: -0.1, 0.0, and 0.1
- Mass: 0.65 to 1.50 M_{\odot}

Effects of Model Physics on the M67 “Hook”

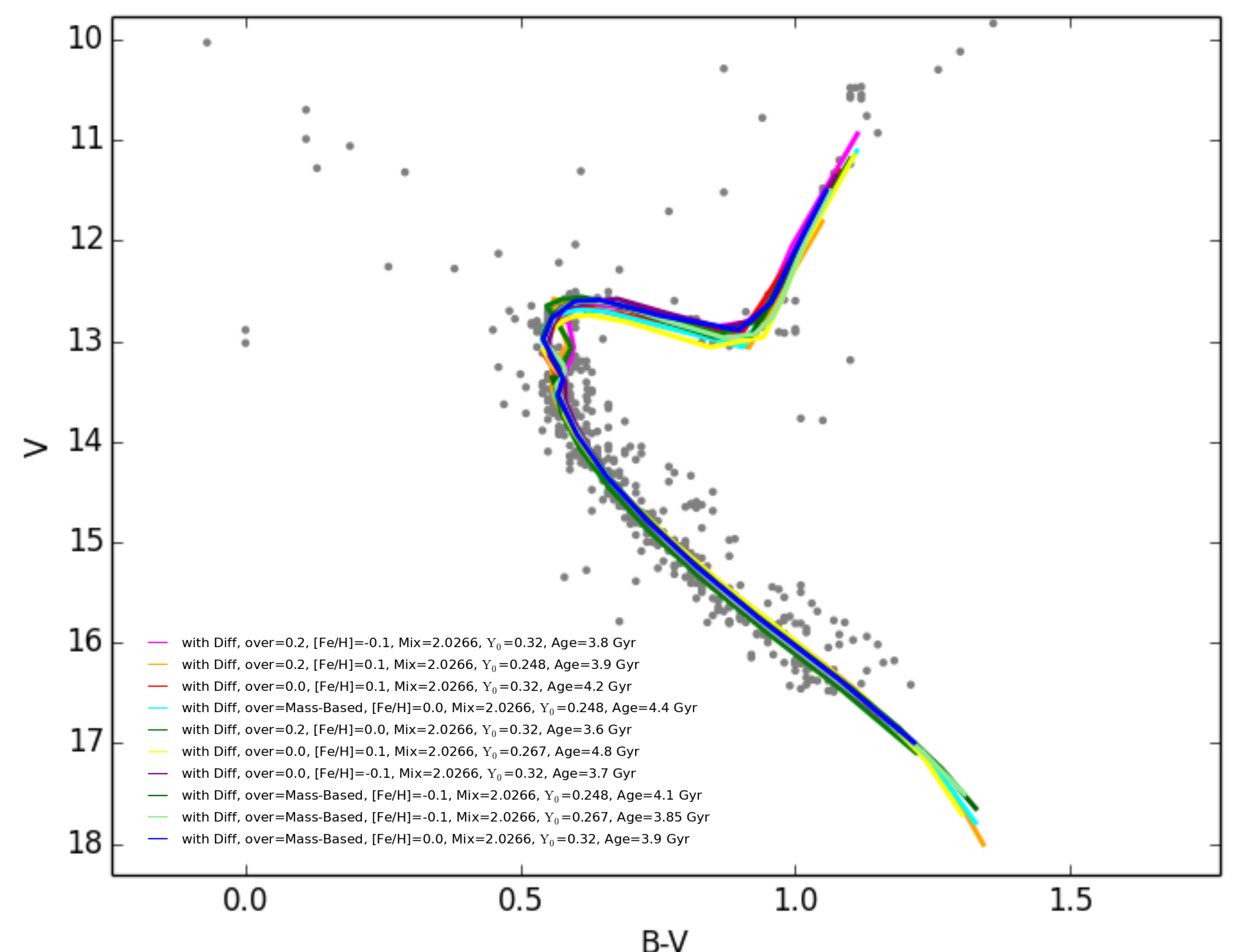
We see that overshoot is not required to reproduce the hook-like feature in the M67 CMD if diffusion is used in the models. This confirms Michaud et al. (2014) claim that convective overshoot is not needed to model M67 if diffusion is implemented. The explanation for this is that diffusion increases the core’s size. In the case without diffusion and without overshoot the hook is not reproduced.



Results of Isochrones that Fit the Cluster

The properties of the isochrones that fit the cluster (fit the main sequence, turn off, giant branch, and reproduce the “hook”) are listed in the table below and plotted on the CMD.

Model Physics					Best Fit Values		
Diffusion	Overshoot	[Fe/H]	Mixing Length	Y_0	Age (Gyr)	E(B-V)	Distance Modulus
Yes	0.0	0.1	2.0266	0.267	4.80	0.00002	9.6163
Yes	0.0	0.1	2.0266	0.320	4.20	0.02200	9.4952
Yes	0.0	-0.1	2.0266	0.320	3.70	0.09590	9.3981
Yes	0.2	0.1	2.0266	0.248	3.90	0.01477	9.6927
Yes	0.2	0.0	2.0266	0.320	3.60	0.06201	9.5266
Yes	0.2	-0.1	2.0266	0.320	3.80	0.08687	9.3903
Yes	Mass-Based	0.0	2.0266	0.248	4.40	0.03466	9.6081
Yes	Mass-Based	0.0	2.0266	0.320	3.90	0.05856	9.4432
Yes	Mass-Based	-0.1	2.0266	0.248	4.10	0.07125	9.5200
Yes	Mass-Based	-0.1	2.0266	0.267	3.85	0.08495	9.5126



Conclusion / Discussion

From the isochrones that fit the cluster we can get an age, distance, and reddening range:

- Ages: 3.6 to 4.8 Gyr
- Distance: 755 to 868 pc
- E(B-V): 0.00002 to 0.0959

The parameters of the best-fitting (χ^2) model are:

- Physics: with diffusion, mass-based overshoot, $[Fe/H]=0.0$, mixing length=2.0266, $Y_0=0.248$
- Age=4.4 Gyr
- Distance=834.9 pc
- E(B-V)=0.0347

References

- [1] Demarque, P., Guenther, D. B., Li L. H., et al., 2008, Ap&SS, 316, 31
- [2] Demarque, P., Woo, J.-H., Kim, Y.-C., Yi, S., 2004, ApJS, 155,667
- [3] Heiter, U, Soubiran, C., Netopil, M., Paurzen, E., 2014, A&A, 561, A93
- [4] Michaud, G., Richard, O., Richer, J., VandenBerg, D.A., 2004, ApJ, 606, 452