Albireo: hierarchical triple or optical pair?

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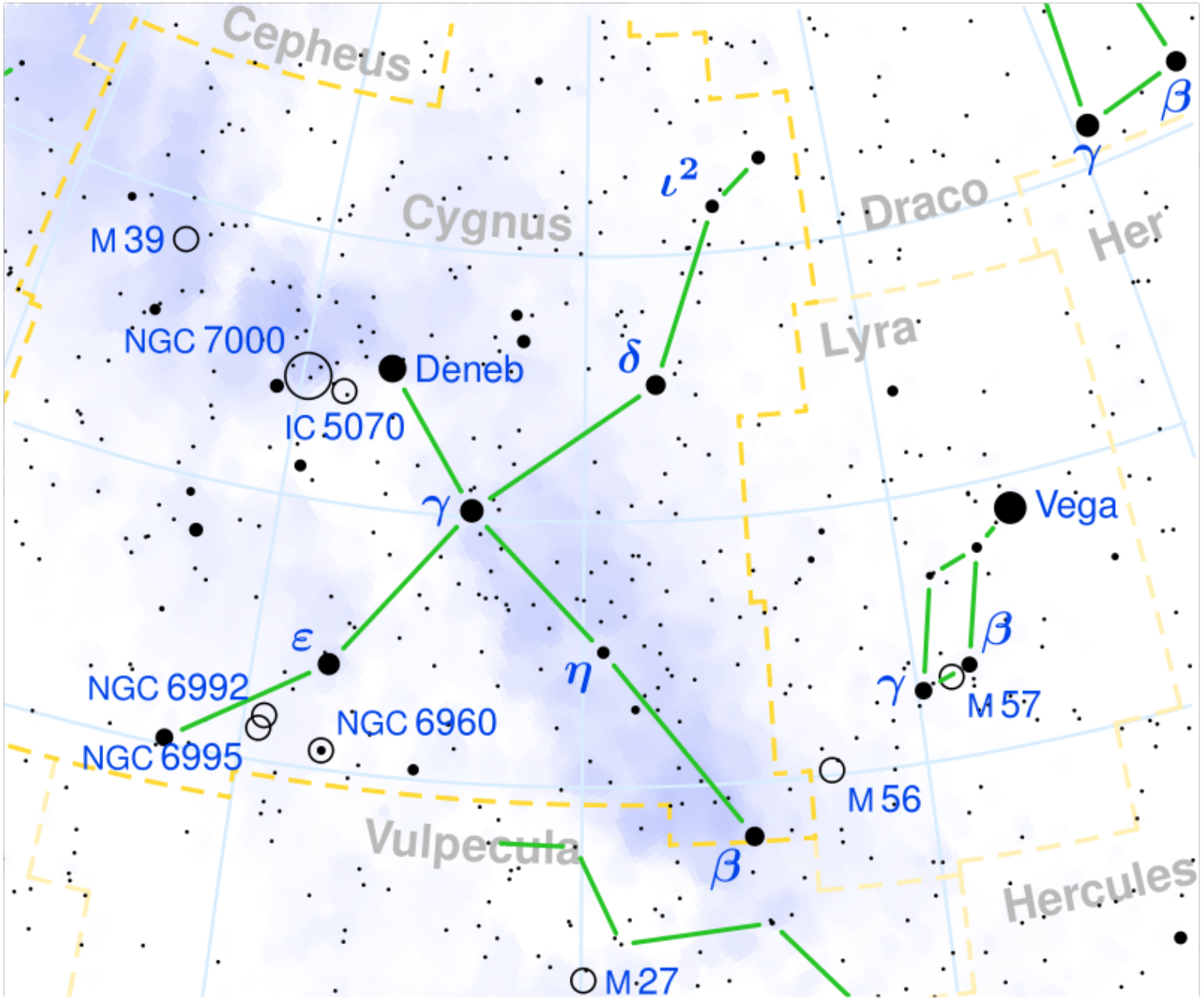
November 2019

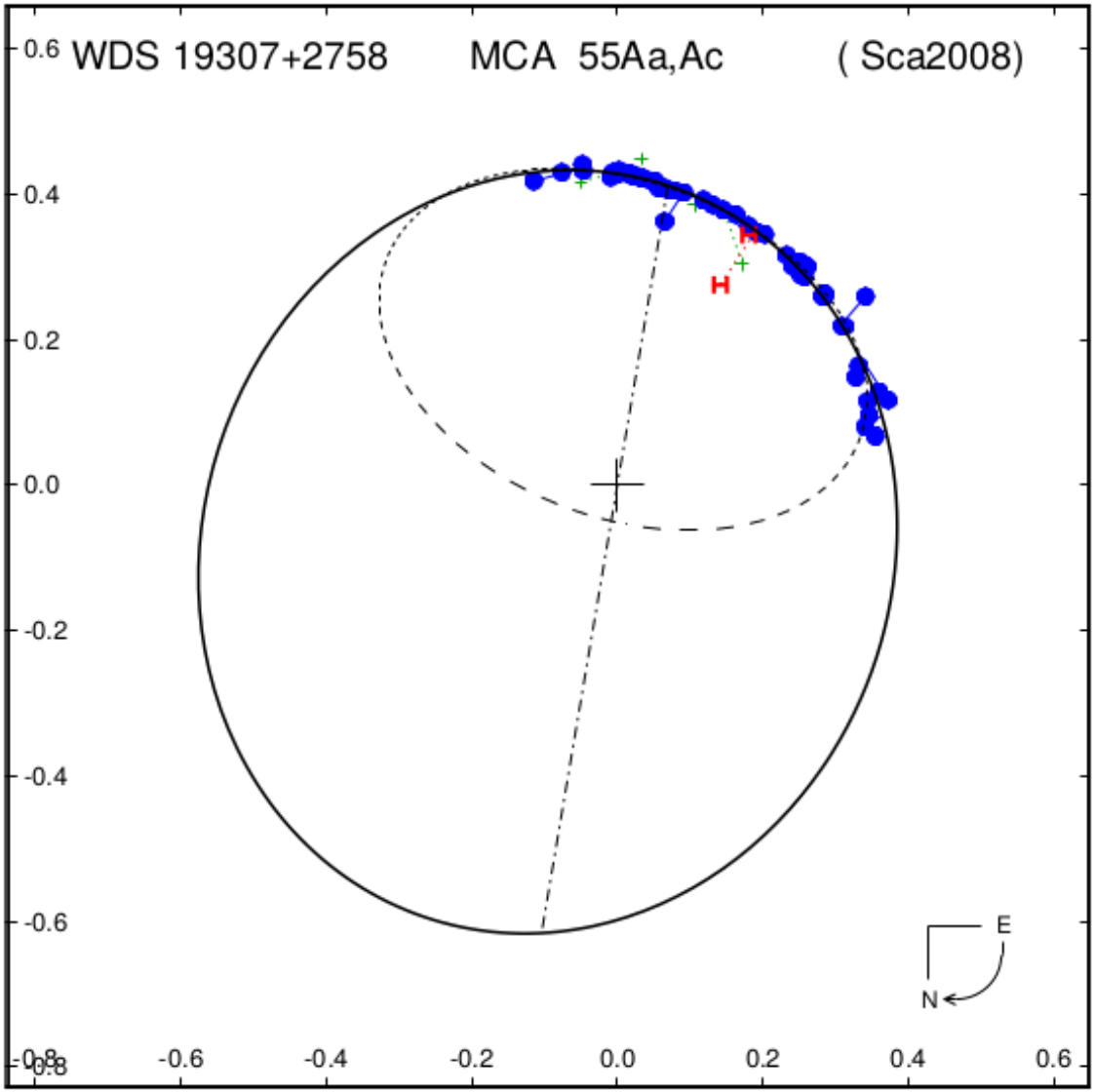
Albireo


Cepheus
Cygnus
Draco
Her
Lyra
Vulpecula
Hercules
M 39
NGC 7000
IC 5070
Deneb
Vega
NGC 6992
NGC 6995
NGC 6960
M 57
M 56
M 27
ι^2
δ
γ
β
ε
η

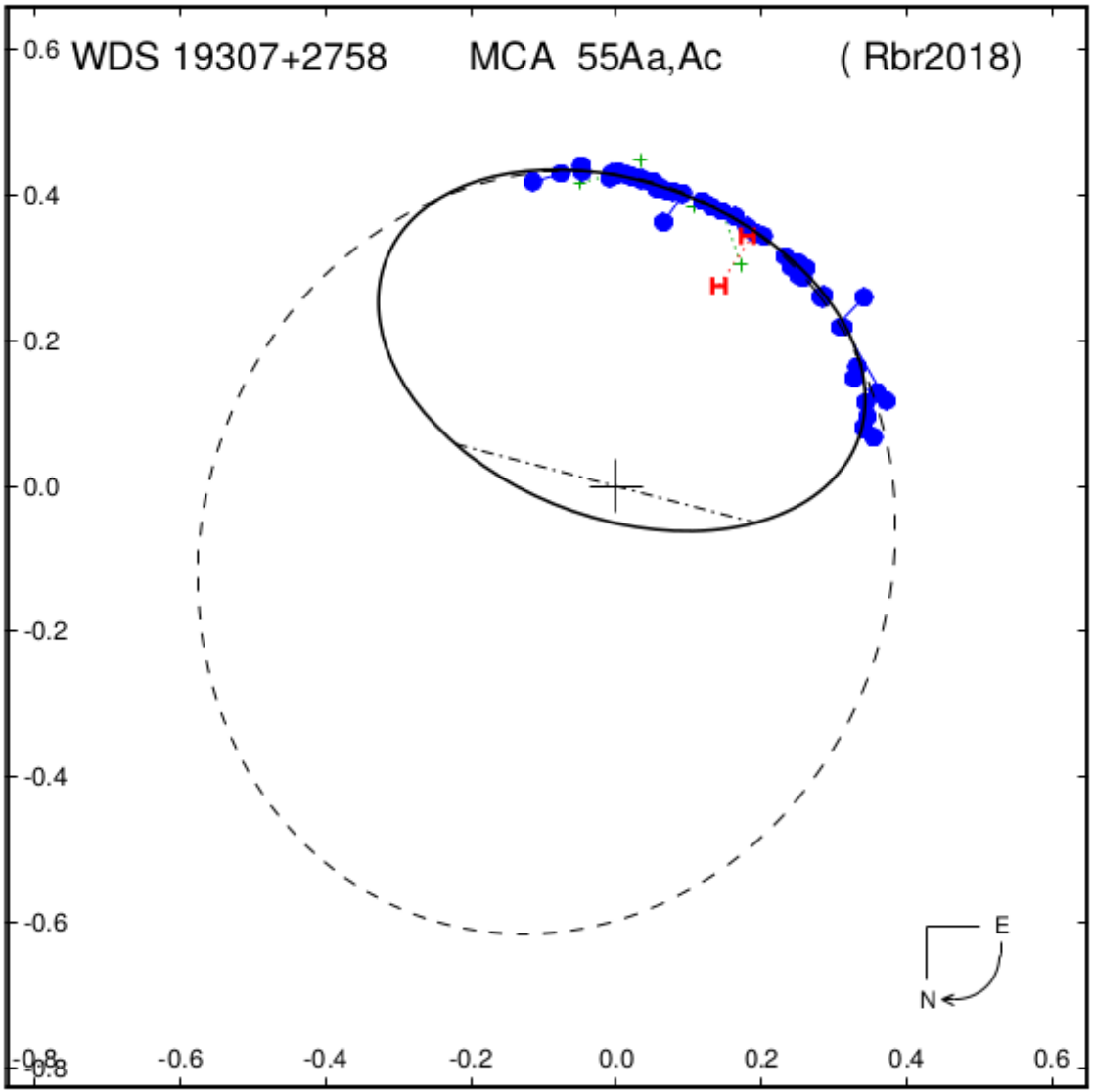
Albireo

- B $\rightarrow$ $B8$
- A
  - Aa $\rightarrow$ K3
  - Ac $\rightarrow$ B9

Bastian and Anton (2018) :



Albireo

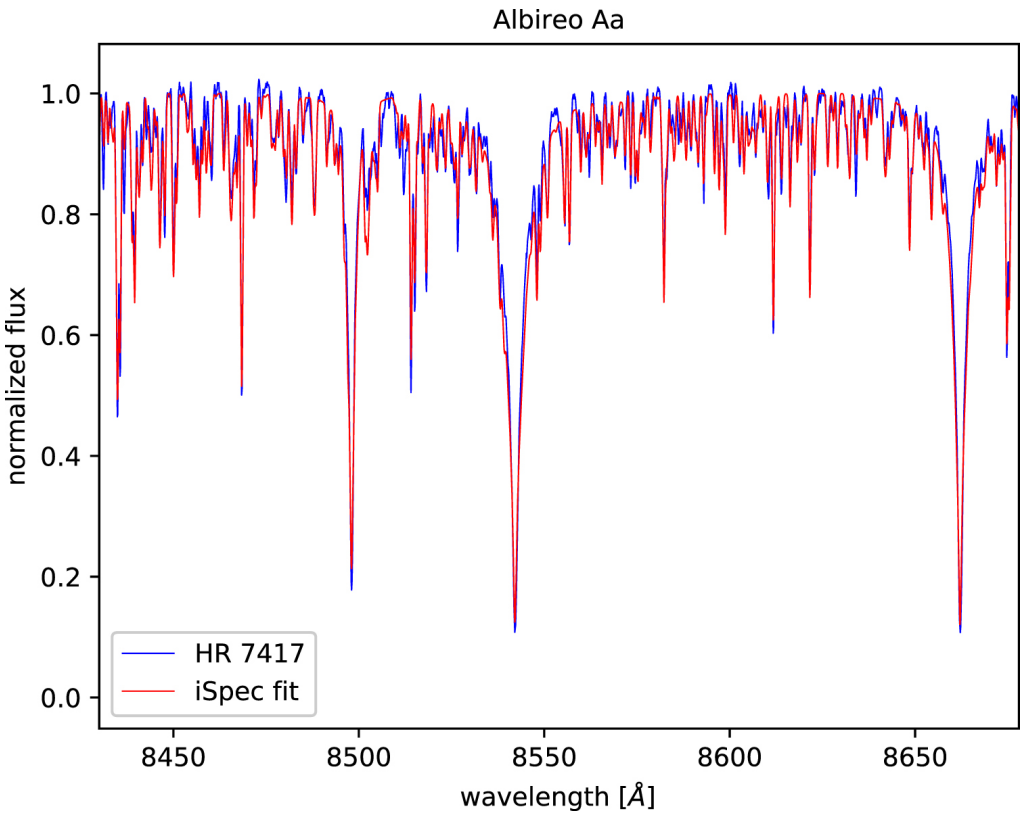

WDS 19307+2758
MCA 55Aa,Ac
(Rbr2018)
H
H
E
N
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6

Roberts and Mason (P=214 years) :
-Hipparcos $\rightarrow$ 87 $M_{\odot}$
-Gaia $\rightarrow$ Completely excluded

Scardia et. al. (P=69 years) :
-Hipparcos $\rightarrow$ 5.7 $M_{\odot}$
-Gaia $\rightarrow$ 3.3 $M_{\odot}$

$M_{\mathrm{Aa}} < 0.75 M_{\odot}$? $\Rightarrow$ TIGRE

Dennis Jack et al. (2018) :



$\Rightarrow T_{\text{eff}} = 4364 \pm 14$ K

Some parameters of the system
Component *Aa*

- $T_{\rm eff} = 4364 \pm 14$ K
- $B = 4.21\,;\, V = 3.08 \Rightarrow B - V = 1.13$

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- par $= 7.51 \pm 0.33$ mas (Hipparcos, 2007)

$$\Rightarrow d = \frac{1}{p''} = \frac{1}{(0.001)(7.51[\pm 0.33])} = 133.15579 \pm 5.85105 \text{ pc}$$

- $T_{\text{eff}} = 4364 \pm 14$ K
- $B - V = 1.13$
- $d = 133.15579 \pm 5.85105$ pc
- $$M_V = 3.08 - 5 \log \left(\frac{133.15579[\pm 5.85105]}{10} \right)$$
$$\Rightarrow M_V = -2.5418 \pm 0.0954$$

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- $B - V = 1.13$
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- $BC = -0.707$ (P. Flower, 1996)

$$\Rightarrow M_{bol} = (-0.707 + 3.08) - 5 \log \left(\frac{133.15579[\pm 5.85105]}{10} \right)$$

$$\Rightarrow M_{bol} = -3.2488 \pm 0.0954\,;$$

$$\frac{L}{L_\odot} = 10^{\frac{4.74-(-3.2488[\pm 0.0954])}{2.5}}$$

$$\Rightarrow L = 1568.6281 \pm 137.8546\ L_\odot$$

$$\Rightarrow \log \left(\frac{L}{L_\odot} \right) = 3.19552 \pm 0.03817$$

- Visibility problems !
- $B = 5.25 \pm 0.1\,;\, V = 5.16 \pm 0.1 \Rightarrow B - V = 0.09 \pm 0.14$

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Some parameters of the system
Component B

- $T_{\rm eff} = 13200 \pm 600$ K (R. S. Levenhagen and N. V. Leister, 2003)
- $B = 5.01\,;\, 5.11 \Rightarrow B - V = -0.1$

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Component B

- $T_{\rm eff} = 13200 \pm 600$ K
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- par $= 8.3779 \pm 0.1696$ mas (Gaia DR2, 2018)

$$\Rightarrow d = \frac{1}{p''} = \frac{1}{(0.001)(8.3779[\pm 0.1696])} = 119.3616 \pm 2.4163 \text{ pc}$$

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- $M_V = -0.2743 \pm 0.0439$
- $BC = -0.923$ (P. Flower, 1996)

$$\Rightarrow M_{bol} = (-0.923 + 5.11) - 5 \log \left(\frac{119.3616[\pm 2.4163]}{10} \right)$$

$$\Rightarrow M_{bol} = -1.1973 \pm 0.0439\,;$$

$$\frac{L}{L_\odot} = 10^{\frac{4.74-(-1.1973[\pm 0.0439])}{2.5}}$$

$$\Rightarrow L = 237.0937 \pm 9.5865\ L_\odot$$

$$\Rightarrow \log \left(\frac{L}{L_\odot} \right) = 2.3749 \pm 0.0175$$

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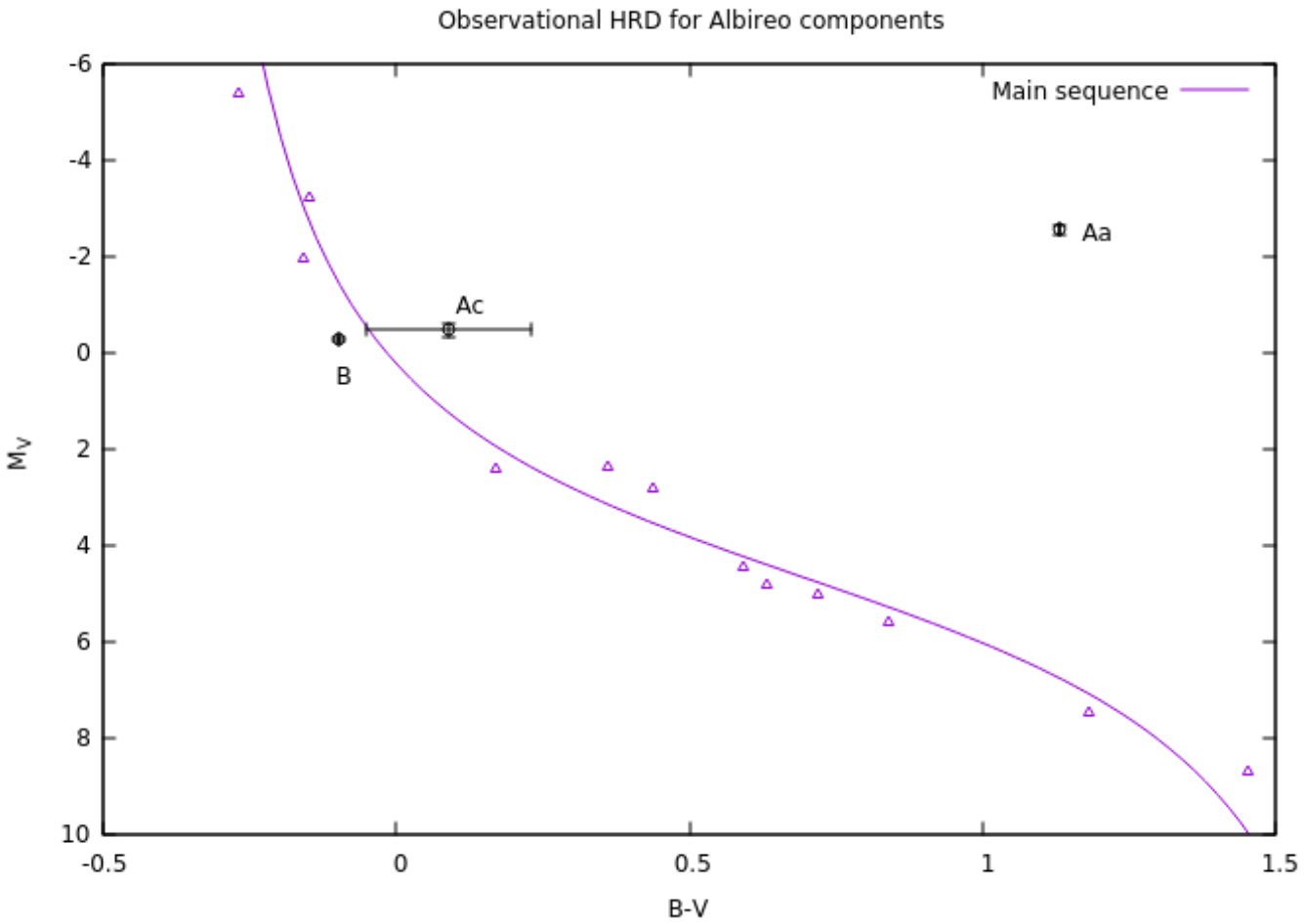
Evolution tracks

	Aa	Ac	B
T_{eff} [K]	4364 ± 14	–	13200 ± 600
B	4.21	5.25 ± 0.1	5.01
V	3.08	5.16 ± 0.1	5.11
Parallax [mas]	7.51 ± 0.33	7.51 ± 0.33	8.3779 ± 0.1696
Distance [pc]	133.15579 ± 5.85105	133.15579 ± 5.85105	119.3616 ± 2.4163

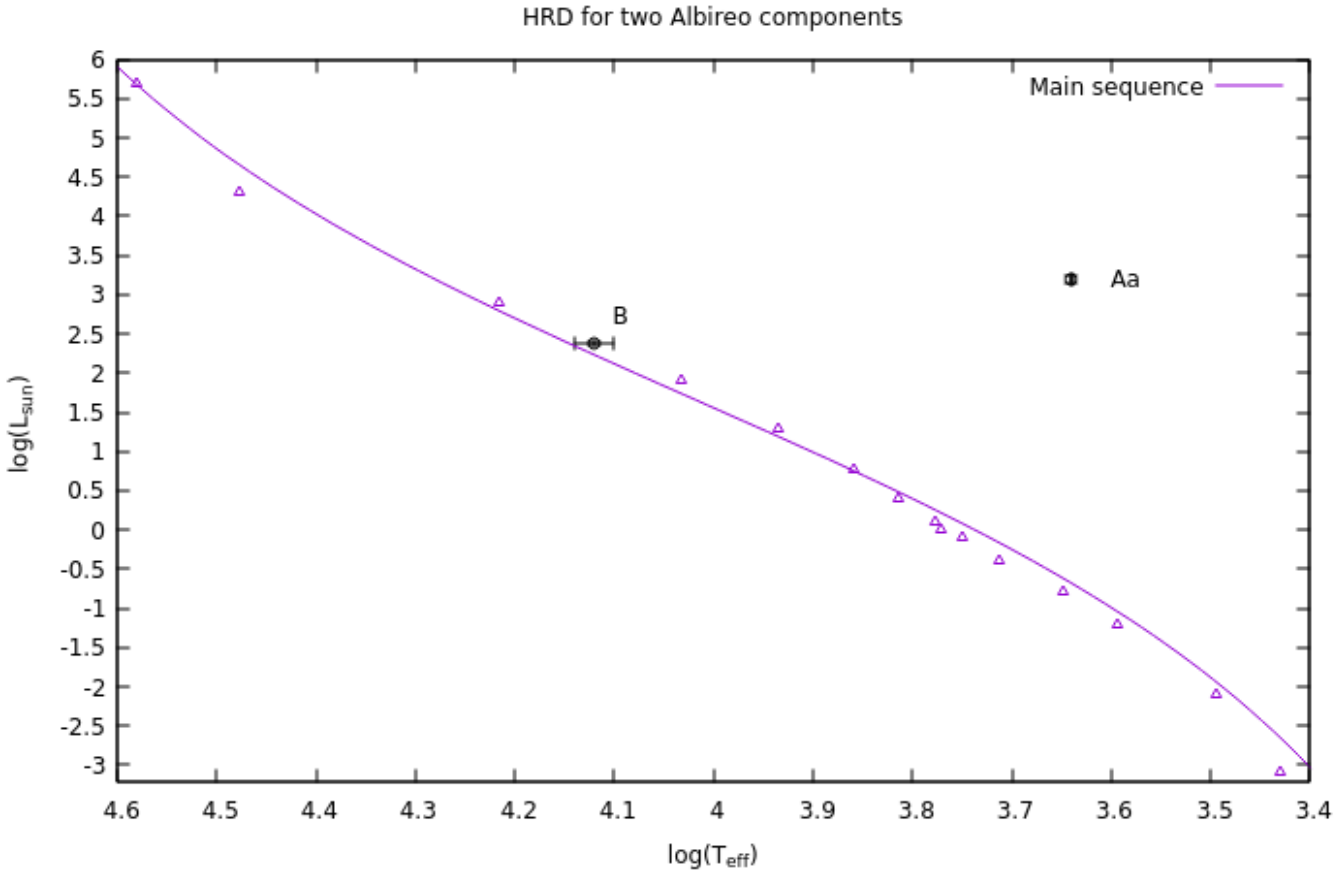
Evolution tracks

	Aa	Ac	B
$\log(T_{\rm eff})$	3.6399 ± 0.0014	–	4.1206 ± 0.0197
$B-V$	1.13	0.09 ± 0.14	-0.1
$\log(\frac{L}{L_\odot})$	3.19552 ± 0.03817	–	2.3749 ± 0.0175
M_V	-2.5418 ± 0.0954	-0.4618 ± 0.1382	-0.2743 ± 0.0439

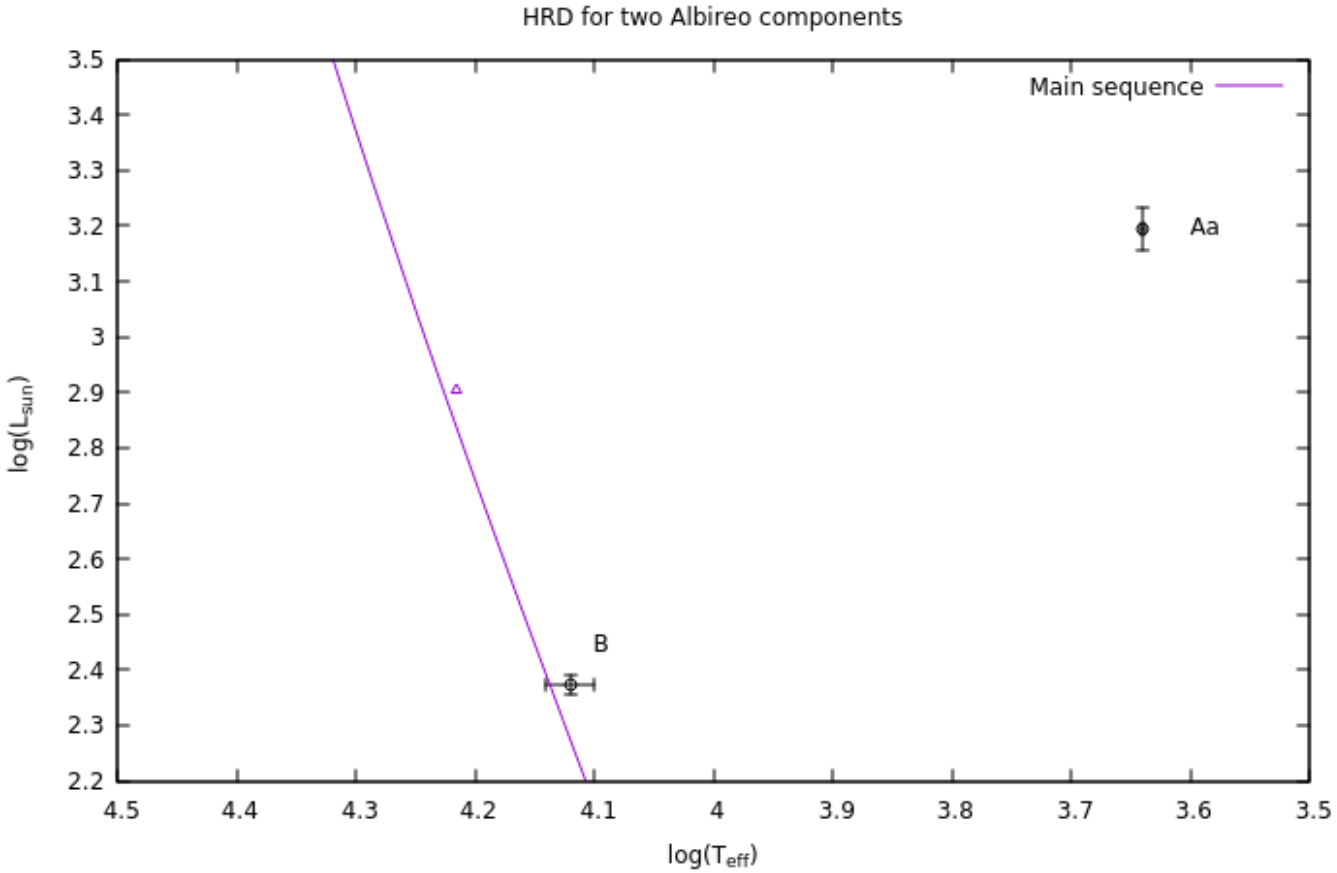
Evolution tracks



Evolution tracks

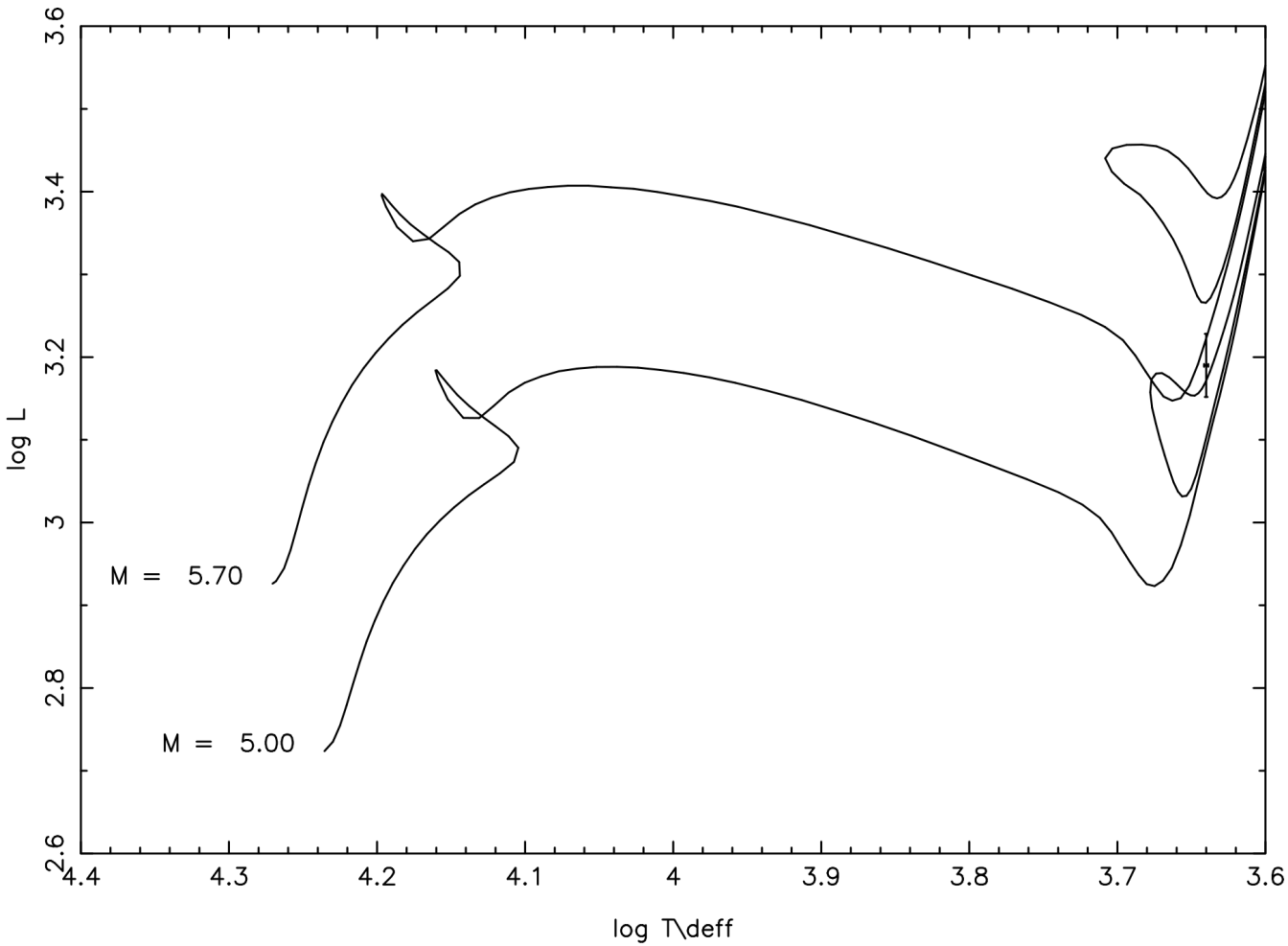


Evolution tracks

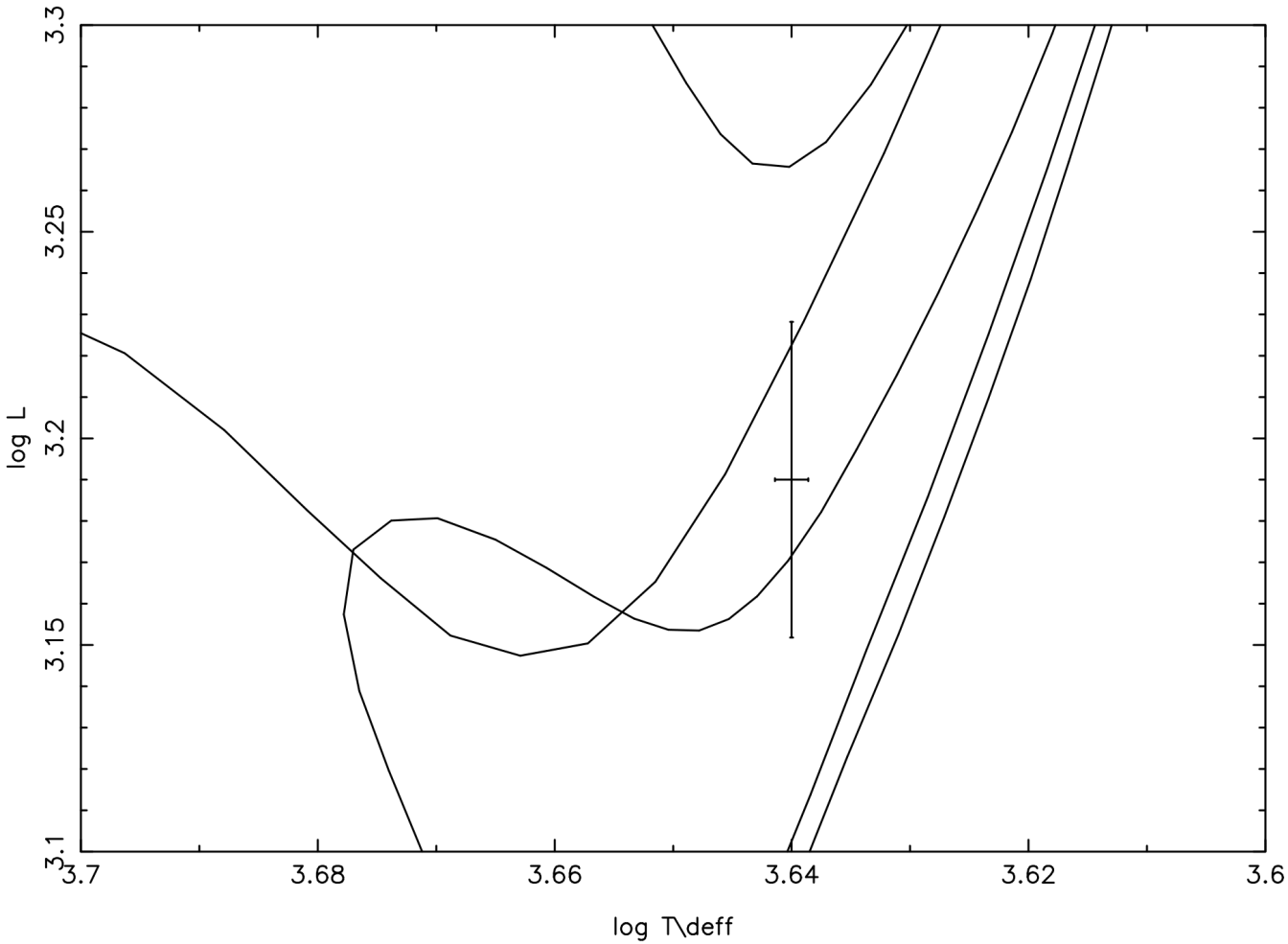


Evolution tracks

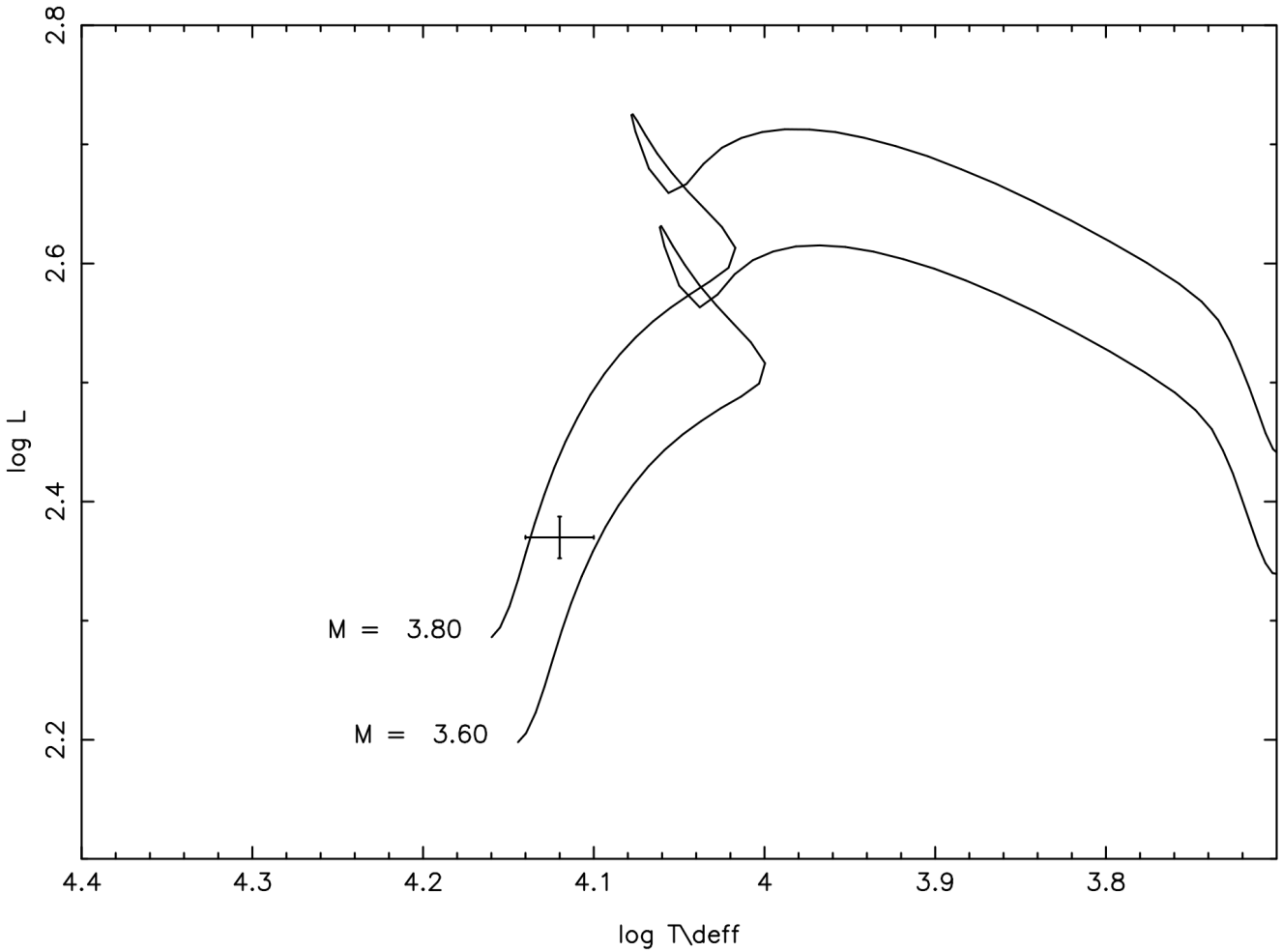
Schröder et al.



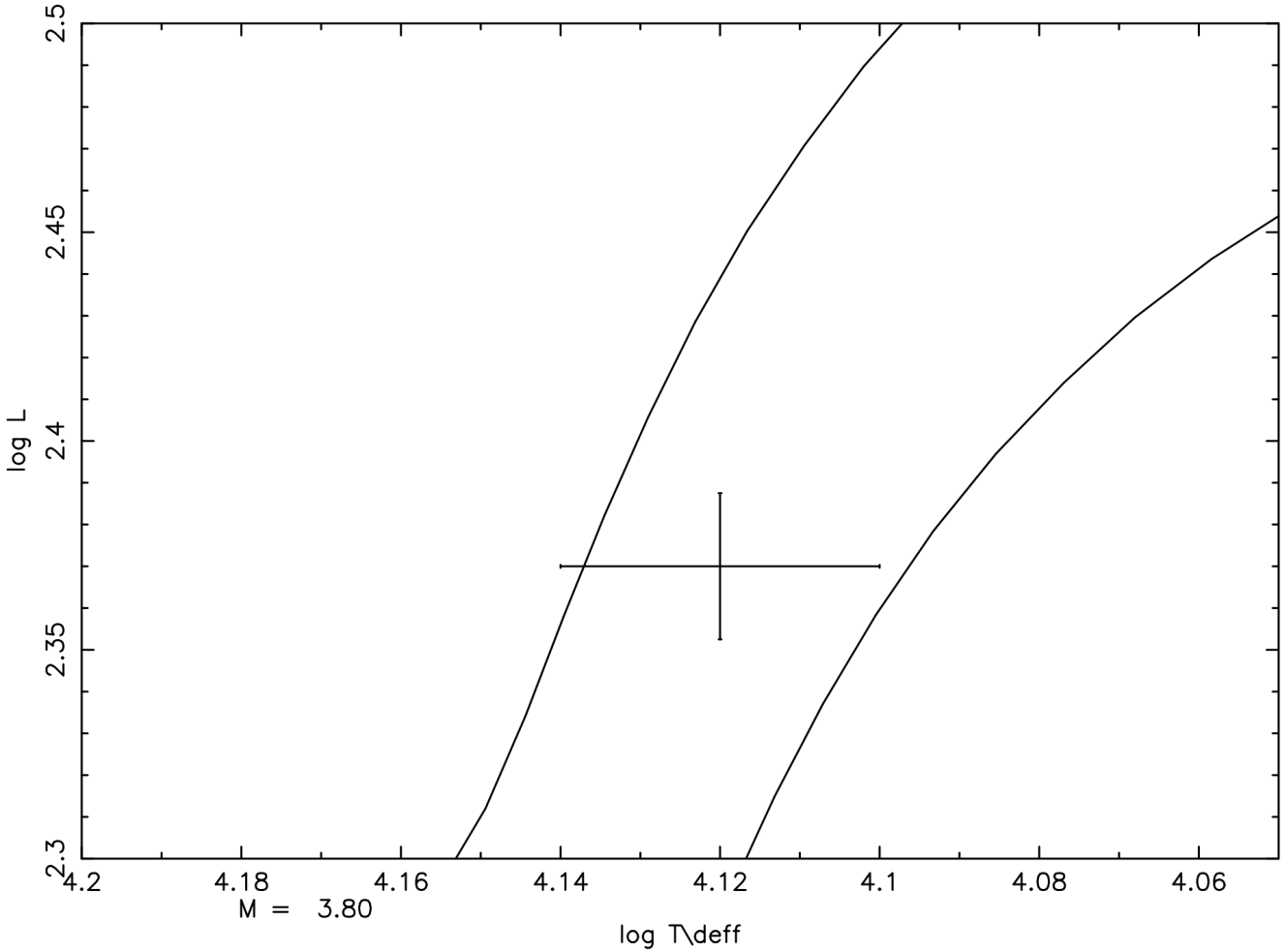
Evolution tracks



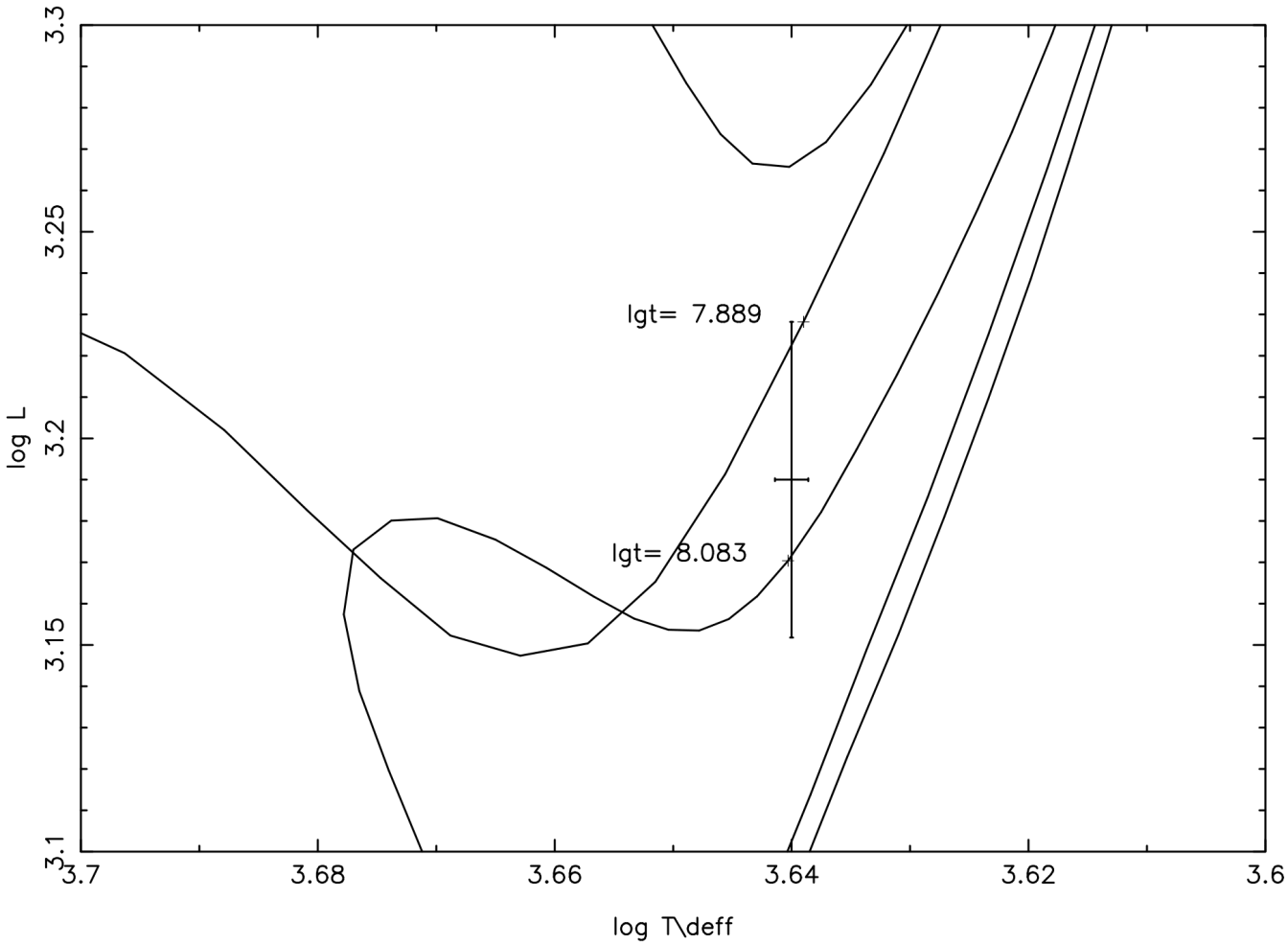
Evolution tracks



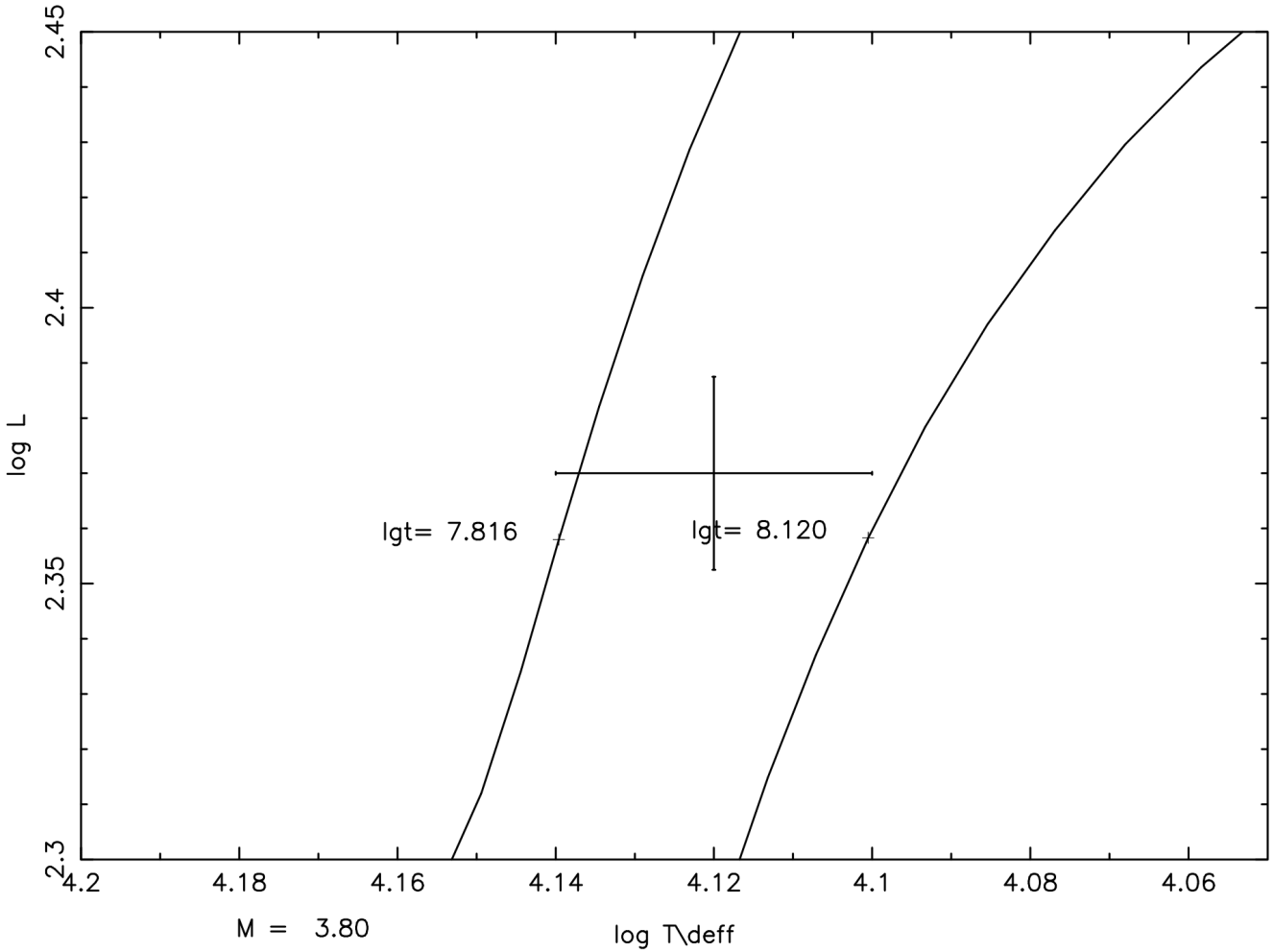
Evolution tracks



Evolution tracks

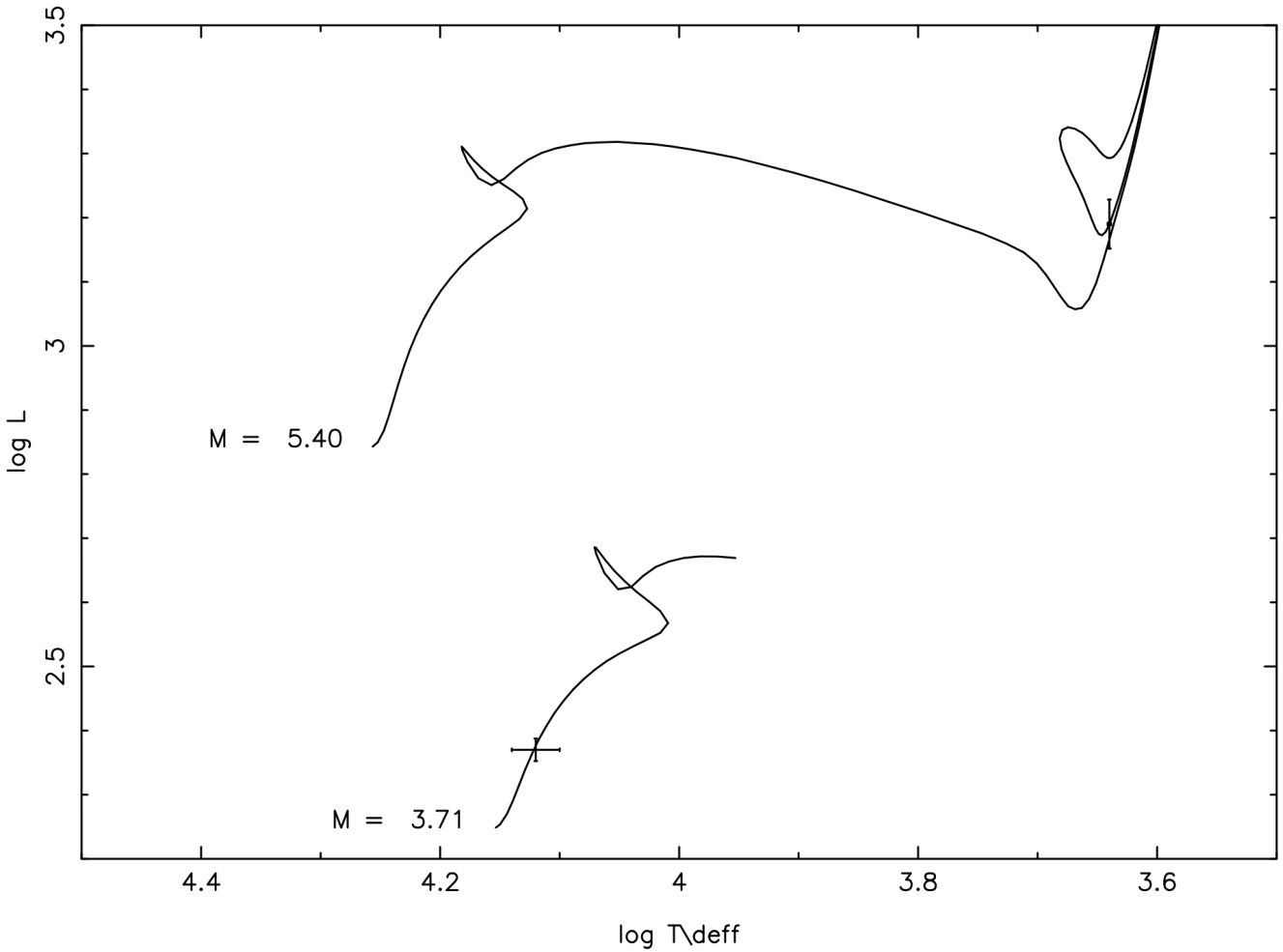


Evolution tracks



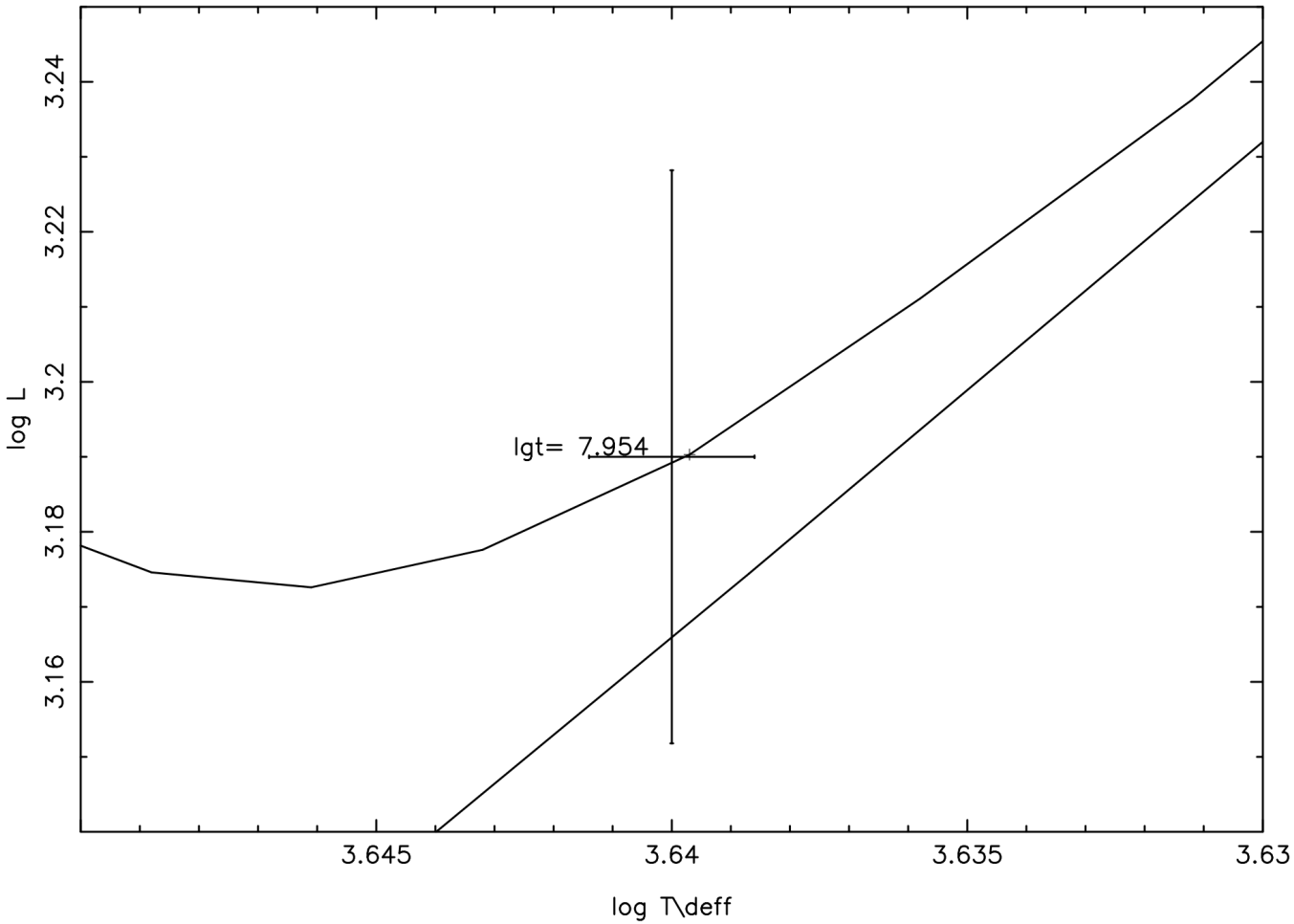
Evolution tracks

Best model $\rightarrow$ $M_{\mathrm{Aa}} = 5.4 M_{\odot}$, $M_B = 3.71 M_{\odot}$



Evolution tracks

Best agemark $\rightarrow$ $\log(Age_{\rm yrs}) = 7.954 \rightarrow 8.995 * 10^7$ years



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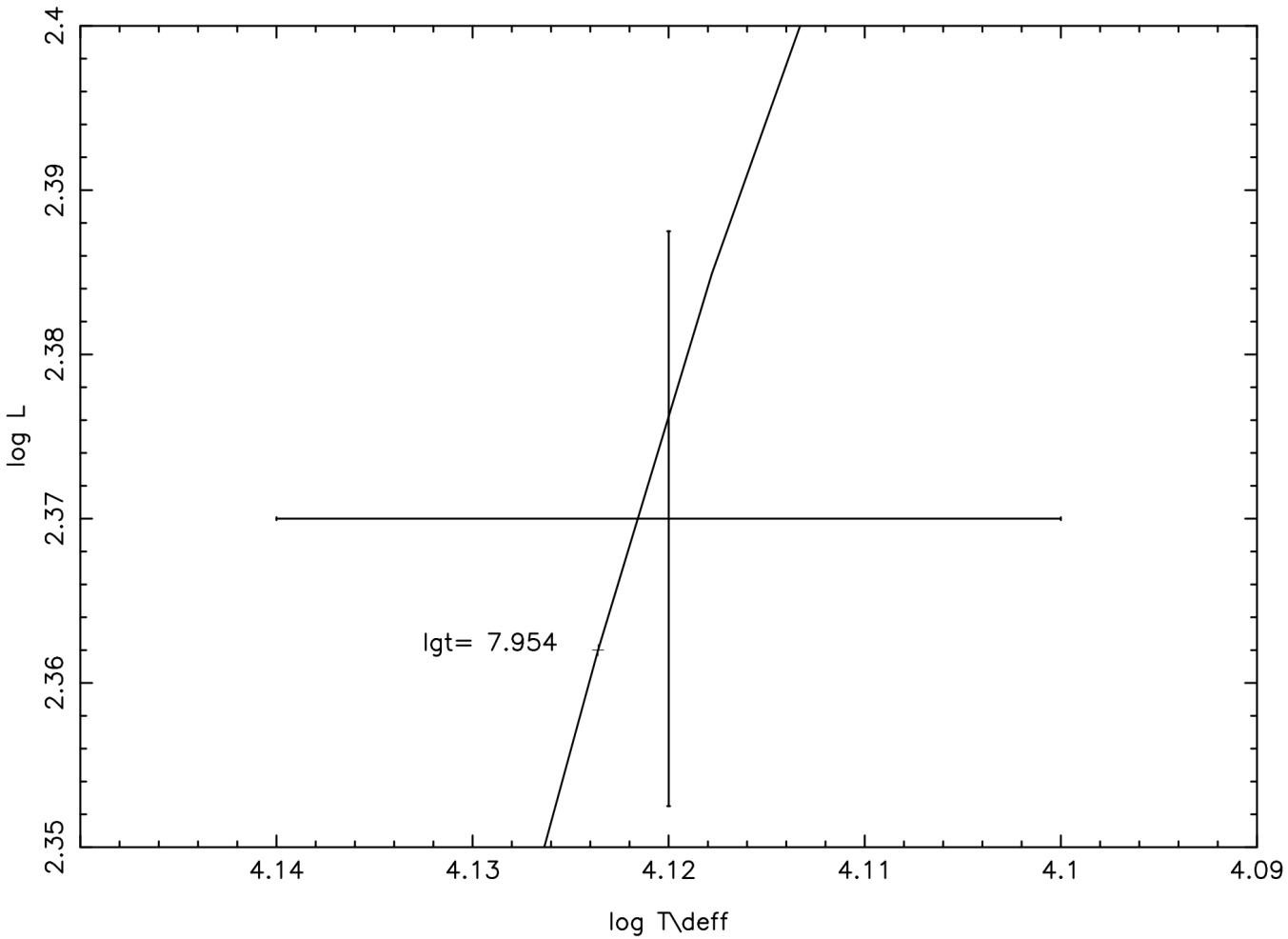
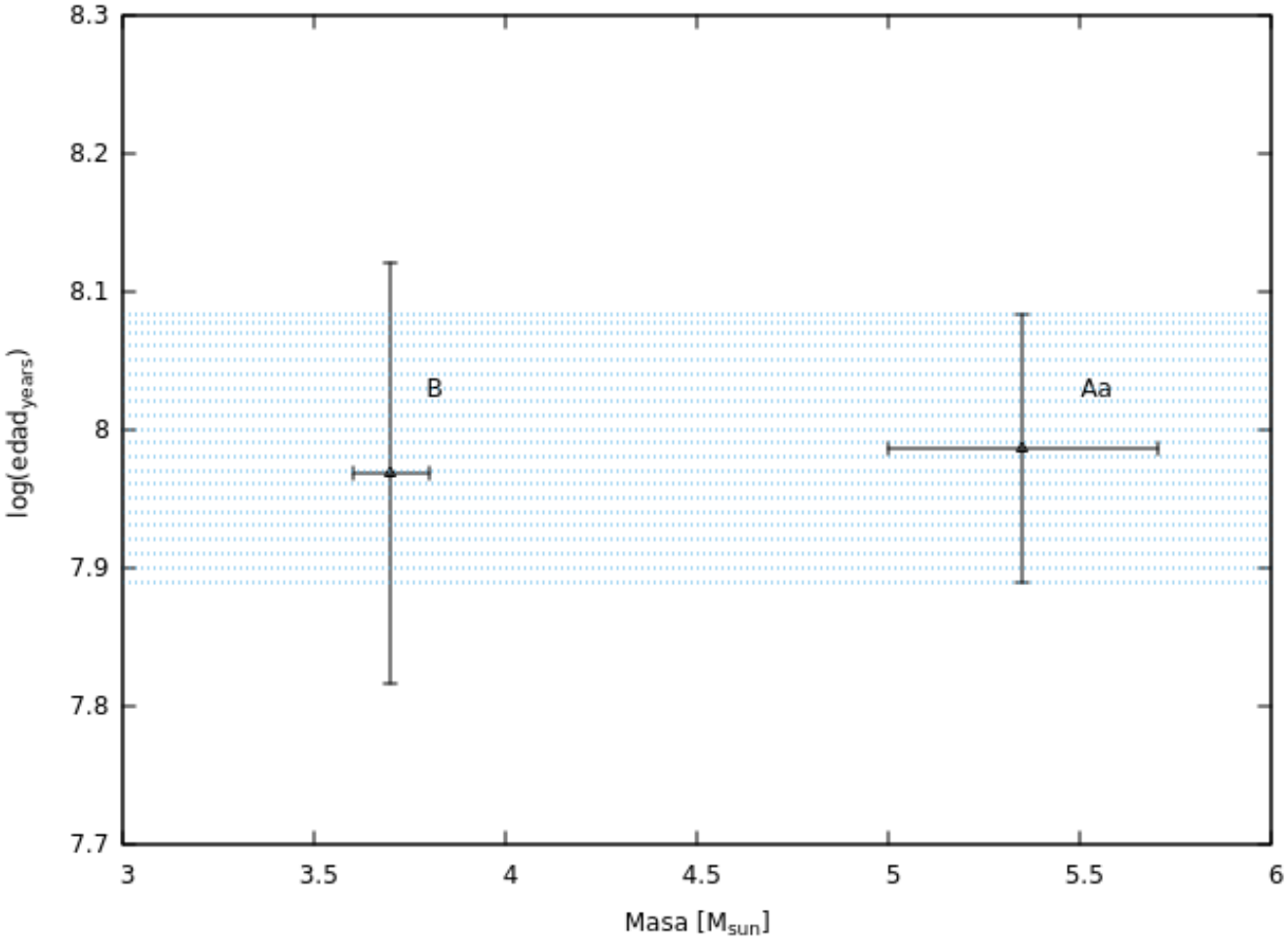


Results

	Component Aa	Component B
Mass $[M_\odot]$	5.35 ± 0.35	3.7 ± 0.1
$\log(Age_{\text{years}})$	7.986 ± 0.097	7.968 ± 0.152

Results



Results

✓Both Aa and B are the same age.

✓Giant Aa has not a surprisingly small mass.

TIGRE in ongoing research

Alessandro Sozzetti (2019) :