Scientific workflow in astrophysics: Testing different sets of isochrones

Schedule - Seminar

- Thursday 05.10. 18:00 - 19:50
- Thursday 12.10. 18:00 - 19:50
- Thursday 19.10. 18:00 - 19:50
- Thursday 26.10. 18:00 - 19:50
- Thursday 02.11. 18:00 - 19:50
- Thursday 09.11. 18:00 - 19:50
- Thursday 16.11. 18:00 - 19:50
- Thursday 23.11. 18:00 - 19:50
- Thursday 30.11. 18:00 - 19:50
- Thursday 07.12. 18:00 - 19:50
- Thursday 14.12. 18:00 - 19:50
- Thursday 21.12. 18:00 - 19:50

Organisation

- First online, but we can meet in person later on if needed
- All slides and lessons are accessible via the IS https://is.muni.cz/auth/el/sci/podzim2023/F3501/um/?lang=en
- First, we go through the basics of the topics, and in parallel, there are some tasks to do
- When we have all the results, we discuss them
- Start writing a paper for Astronomy & Astrophysics

Topic: seminar - MUNI

Time: Oct 5, 2023 06:00 PM Amsterdam, Berlin, Rome, Stockholm, Vienna

Every week on Thu, until Dec 21, 2023, 12 occurrence(s)

Oct 5, 2023 06:00 PM

Oct 12, 2023 06:00 PM

Oct 19, 2023 06:00 PM

Oct 26, 2023 06:00 PM

Nov 2, 2023 06:00 PM

Nov 9, 2023 06:00 PM

Nov 16, 2023 06:00 PM

Nov 23, 2023 06:00 PM

Nov 30, 2023 06:00 PM

Dec 7, 2023 06:00 PM

Dec 14, 2023 06:00 PM

Dec 21, 2023 06:00 PM

Please download and import the following iCalendar (.ics) files to your calendar system.

Weekly: https://univienna.zoom.us/meeting/u5Ytc-2trTspGNTD2jW2j0rnmLrNiNpzAVku/ics?icsToken=98tyKu-qrj8uH9eVsxuHR_MQAo-gLO_ztmJejY1puE3vNHJZMhH4O85QHLtRAMLx

Join Zoom Meeting

https://univienna.zoom.us/j/62044530320?pwd=L2JBYzgzMnJNVVVlWVN5UU5rYS8wdz09

Meeting ID: 620 4453 0320

Passcode: 862750

Former seminars

Received: 28 December 2018 | Accepted: 18 January 2019

DOI: 10.1002/asna.201913547

ORIGINAL ARTICLE

Astronomische Nachrichten

An analysis of four stellar rings

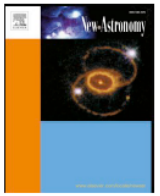
Ernst Paunzen[1,*] | Jan Florian[2] | Anna Gütl-Wallner[2] | Andreas Herdin[2] | Erwin Kralofsky[2] | Kieran Leschinski[2] | Michael Mach[2] | Hans Michael Maitzen[2] | Michal Prišegen[1] | Markus Rockenbauer[2] | Monika Rode-Paunzen[4] | Stefan Wallner[2,3]

New Astronomy 68 (2019) 39–44

Contents lists available at ScienceDirect

New Astronomy

journal homepage: www.elsevier.com/locate/newast



TYC 3637-1152-1 – A high amplitude δ Scuti star with peculiar pulsational properties

Ernst Paunzen[*,a], Klaus Bernhard[b,c], Moriz Frauenberger[d], Santiago Helbig[d], Andreas Herdin[d], Stefan Hümmerich[b,c], Jan Janík[a], Andreas Karnthaler[d], Richard Komžík[e], Beatrice Kulterer[d], Hans-Michael Maitzen[d], Stefan Meingast[d], Sebastian Miksch[d], Theodor Pribulla[e], Monika Rode-Paunzen[d], Wolfgang Sakuler[d], Carla Schoder[d], Eugene Semenko[f], Nikolaus Sulzenauer[d]

Former seminars

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TYC 3637-1152-1 – A high amplitude δ Scuti star with peculiar pulsational properties

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[b] Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. (BAV), Berlin, Germany
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ARTICLE INFO

Keywords:
Stars: variables: delta Scuti
Stars: individual: TYC 3637-1152-1

ABSTRACT

In some δ Scuti stars, only one or two radial modes are excited (usually the fundamental mode and/or first overtone mode) and the observed peak-to-peak amplitudes exceed 0.3 mag (V). These stars are known as High Amplitude Delta Scuti (HADS) variables.

We here present a detailed photometric and spectroscopic analysis of the HADS star TYC 3637-1152-1. We have derived a metallicity close to solar, a spectral type of F4 V and an age of $\log t = 9.1$. Employing archival time series data from different sources, two frequencies $f_0 = 10.034$ c/d and $f_1 = 12.681$ c/d and their harmonics and linear combinations were identified. The period ratio of $f_0/f_1 = 0.791$ puts this star into a peculiar position in the Petersen diagram, from which we conclude that TYC 3637-1152-1 is a unique object with peculiar pulsational properties that indicate a transitional state between HADS stars pulsating in the fundamental and first overtone modes and stars pulsating in higher overtones.

Former seminars

A&A 645, A13 (2021)
https://doi.org/10.1051/0004-6361/202039276
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Astronomy & Astrophysics

White dwarf-open cluster associations based on *Gaia* DR2

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Received 27 August 2020 / Accepted 13 October 2020

ABSTRACT

Context. Fundamental parameters and physical processes leading to the formation of white dwarfs (WDs) may be constrained and refined by discovering WDs in open clusters (OCs). Cluster membership can be utilized to establish the precise distances, luminosities, ages, and progenitor masses of such WDs.
Aims. We compile a list of probable WDs that are OC members in order to facilitate WD studies that are impractical or difficult to conduct for Galactic field WDs.
Methods. We use recent catalogs of WDs and OCs that are based on the second data release of the *Gaia* satellite mission (GDR2) to identify WDs that are OC members. This crossmatch is facilitated by the astrometric and photometric data contained in GDR2 and the derived catalogs. Assuming that most of the WD members are of the DA type, we estimate the WD masses, cooling ages, and progenitor masses.
Results. We have detected several new likely WD members and reassessed the membership of the literature WDs that had been previously associated with the studied OCs. Several of the recovered WDs fall into the recently reported discontinuity in the initial-final mass relation (IFMR) around $M_i \sim 2.0\,M_\odot$, which allows for tighter constrains on the IFMR in this regime.

Key words. open clusters and associations: general – white dwarfs – catalogs – surveys

Former seminars

A&A 656, A125 (2021)
https://doi.org/10.1051/0004-6361/202141534
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Astronomy & Astrophysics

A case study of ACV variables discovered in the Zwicky Transient Facility survey★

N. Faltová[1], K. Kallová[1], M. Prišegen[1], P. Staněk[1], J. Supíková[2], C. Xia[1], K. Bernhard[3,4], S. Hümmerich[3,4], and E. Paunzen[1]

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e-mail: epaunzen@physics.muni.cz
[2] Faculty of Informatics, Masaryk University, Brno, Czech Republic
[3] Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. (BAV), Berlin, Germany
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Received 12 June 2021 / Accepted 17 August 2021

Former seminars

A&A 657, A27 (2022)
https://doi.org/10.1051/0004-6361/202037789
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Astronomy & Astrophysics

A *Kepler* K2 view of subdwarf A-type stars

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[2] Department of Theoretical Physics and Astrophysics, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic
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[3] Institut für Physik und Astronomie, Universitätsstandort Golm, Karl-Liebknecht-Str. 24/25, 14467 Potsdam, Germany
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Received 21 February 2020 / Accepted 28 September 2021

ABSTRACT

Context. The spectroscopic class of subdwarf A-type (sdA) stars has come into focus in recent years because of their possible link to extremely low-mass white dwarfs, a rare class of objects resulting from binary evolution. Although most sdA stars are consistent with metal-poor halo main-sequence stars, the formation and evolution of a fraction of these stars are still matters of debate.
Aims. The identification of photometric variability can help to put further constraints on the evolutionary status of sdA stars, in particular through the analysis of pulsations. Moreover, the binary ratio, which can be deduced from eclipsing binaries and ellipsoidal variables, is important as input for stellar models. In order to search for variability due to either binarity or pulsations in objects of the spectroscopic sdA class, we have extracted all available high precision light curves from the *Kepler* K2 mission.
Methods. We have performed a thorough time series analysis on all available light curves, employing three different methods. Frequencies with a signal-to-noise ratio higher than four have been used for further analysis.
Results. From the 25 targets, 13 turned out to be variables of different kinds (i.e., classical pulsating stars, ellipsoidal and cataclysmic variables, eclipsing binaries, and rotationally induced variables). For the remaining 12 objects, a variability threshold was determined.

Key words. subdwarfs – white dwarfs – binaries: general – stars: evolution – stars: variables: general

Former seminars

Astronomy & Astrophysics manuscript no. output
July 22, 2022
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The Apparent Non-Variable Stars from the Kepler Mission

E. Paunzen[1,2], F. Binder[1], A. Cyniburk[1], M.N. Duffek[1], F. Haberhauer[1], C. Heinreichsberger[1], H. Kohlhofer[1], L. Kueß[1], H.M. Maitzen[1], T. Saalmann[1], A.M. Schanz[1], S. Schauer[1], K. Schmidt[1], A. Tokareva[1], and I. Wizani[1]

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ABSTRACT

Context. The analysis of non-variable stars are mostly neglected in the literature. However such objects are not only needed for many calibration purposes, but also for testing pulsational models, for example. The photometric time-series of the *Kepler* satellite mission are still the most accurate available and excellently suited to search for non-variable stars.
Aims. We analysed all Long Cadence light curves for stars not reported as variable so far from the *Kepler* satellite mission. Using the known characteristics and flaws of these data sets, we defined three different frequency ranges in which we searched for non-variability.
Methods. We used the Lomb-Scargle periodogram and the False-Alarm probability (FAP) to analyse the cleaned data sets of 138 451 light curves. We then used $\log FAP \geq -2$ for defining a star not being variable in the ranges of below 0.1 c/d, 0.1 to 2.0 c/d, and 2.0 to 25.0 c/d, respectively. Furthermore, we also calculated the standard deviation of the mean light curve to provide another parameter.
Results. In total, we found 14 154 stars which fulfil the set criteria. These objects are mainly cooler than 7000 K populating the whole Main Sequence to the Red Giant Branch.

Key words. Stars: variables: general – Hertzsprung-Russell and C-M diagrams – Catalogs – Methods: data analysis

Former seminars

Astronomy & Astrophysics manuscript no. output
October 4, 2023
©ESO 2023

New ACV variables discovered from the Zwicky Transient Facility survey

B. Bauer-Fasching[1], K. Bernhard[2,3], E. Brändli[1], H. Burger[1], B. Eisele[1], S. Hümmerich[2,3], J. Neuhold[1], E. Paunzen[4], M. Piecka[1], S. Ratzenböck[1,5], and M. Prišegen[6]

[1] Department of Astrophysics, Vienna University, Türkenschanzstraße 17, 1180 Vienna, Austria
[2] Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. (BAV), Berlin, Germany
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[5] University of Vienna, Research Network Data Science at Uni Vienna, Kolingasse 14-16, 1090 Vienna, Austria
[6] Advanced Technologies Research Institute, Faculty of Materials Science and Technology in Trnava, Slovak University of Technology in Bratislava, Bottova 25, 917 24 Trnava, Slovakia

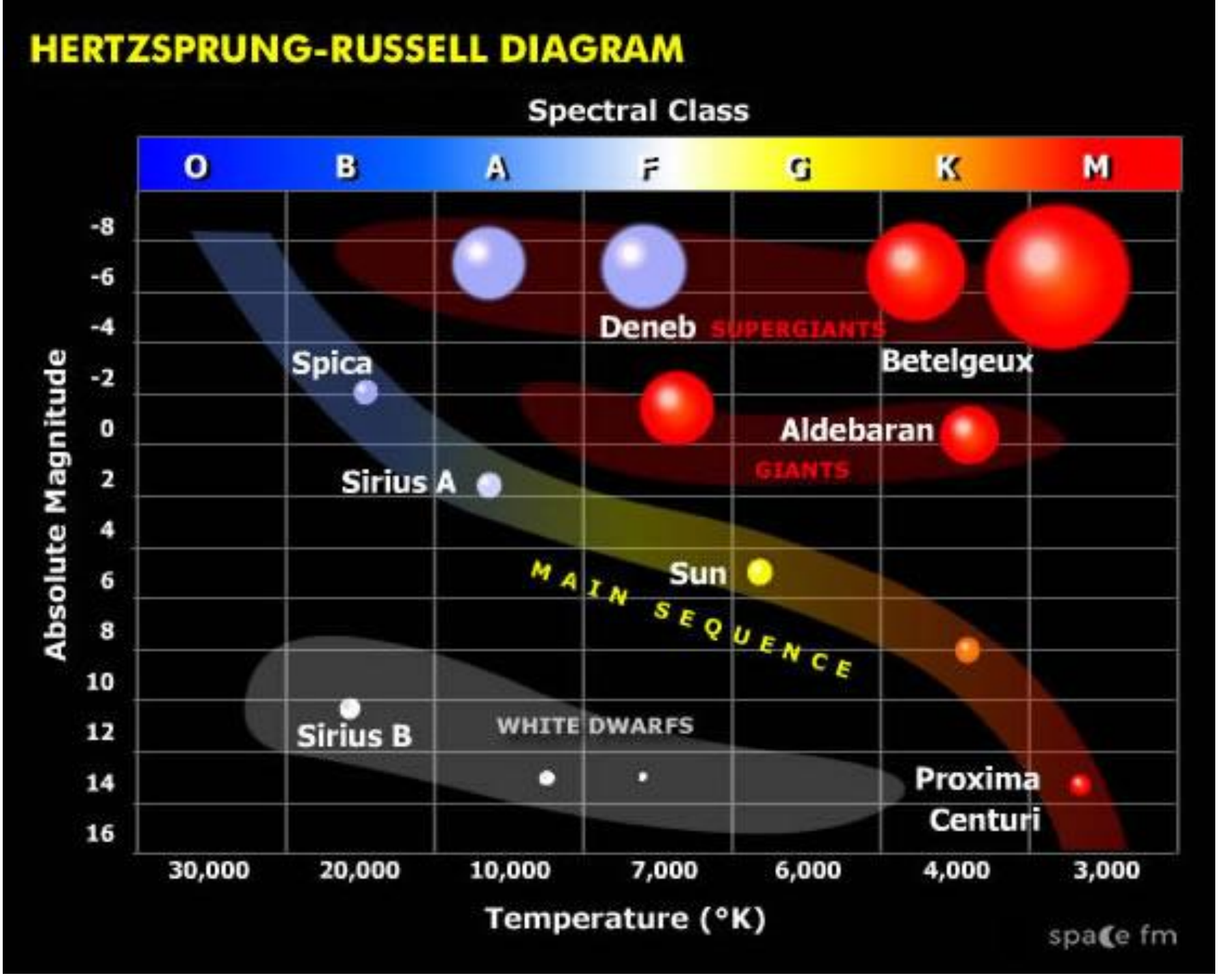
ABSTRACT

Context. The manifestation of surface spots on magnetic chemically peculiar (mCP) stars is most commonly explained by the atomic diffusion theory, which requires a calm stellar atmosphere and only moderate rotation to work. While very successful in explaining this scenario, it still needs to be revised and fine-tuned to the observations.
Aims. Our study aims to discover hitherto overlooked photometrically variable mCP stars (ACV variables) and derive accurate physical parameters of these objects.
Methods. Suitable candidates were selected from the ZTF catalogue of periodic variables via light curve characteristics (single variability frequency, limited amplitude, overall shape, and stability over time) and the location in the colour-magnitude diagram. Spectroscopic data from the LAMOST and *Gaia* missions were used to confirm the chemically peculiar nature of our sample stars; in particular, the well-known flux depression at 5200 Å was probed.
Results. We present a sample of 1232 new ACV variables, including information on fractional age on the main-sequence, stellar mass, and radius. The available spectral data confirm that our sample is a pure sample of mCP stars.
Conclusions. Our study confirms that the employed selection process is highly efficient for detecting mCP stars. We identified 38 stars with $v_{\rm equ}$ in excess of 150 km s^{-1} (with extreme values up to 260 km s^{-1}). This challenges current theories that need to explain the occurrence of such fast-rotating mCP stars.

Key words. stars: chemically peculiar – stars: variables: general – stars: rotation

Topic – this semester

- Get all available isochrones sets from the literature
- Get cluster parameters from these sets
- Get astrophysical parameters for field stars from these sets
- Compare and analyse the results from the different sets
- Write a paper for A&A


HERTZSPRUNG-RUSSELL DIAGRAM
Spectral Class
O
B
A
F
G
K
M
Absolute Magnitude
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16
Deneb
SUPERGIANTS
Betelgeux
Spica
Aldebaran
GIANTS
Sirius A
Sun
MAIN SEQUENCE
WHITE DWARFS
Sirius B
Proxima
Centuri
30,000
20,000
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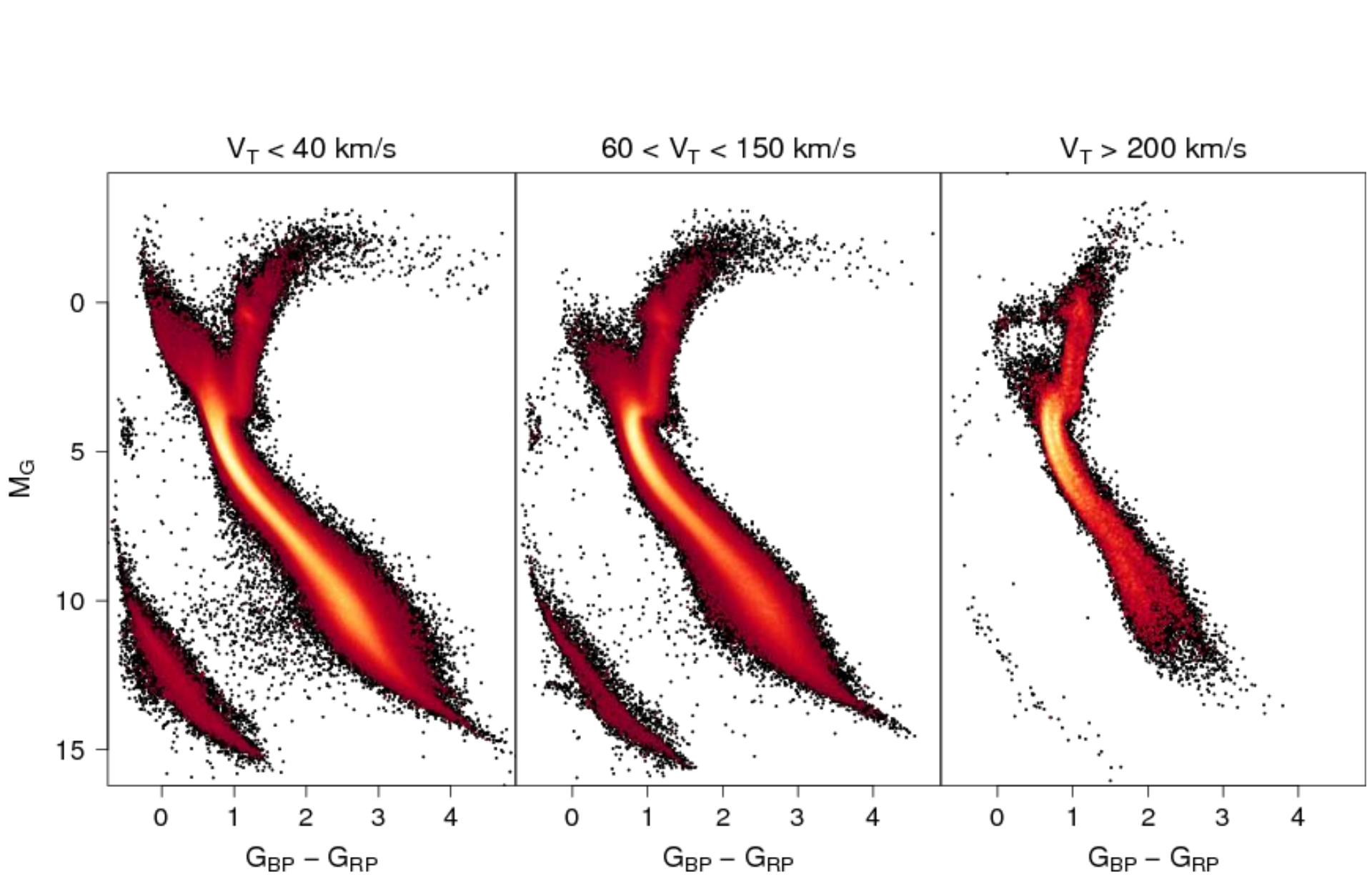
7,000
6,000
4,000
3,000
Temperature (°K)
space fm


$V_T < 40$ km/s
$60 < V_T < 150$ km/s
$V_T > 200$ km/s
M_G
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5
10
15
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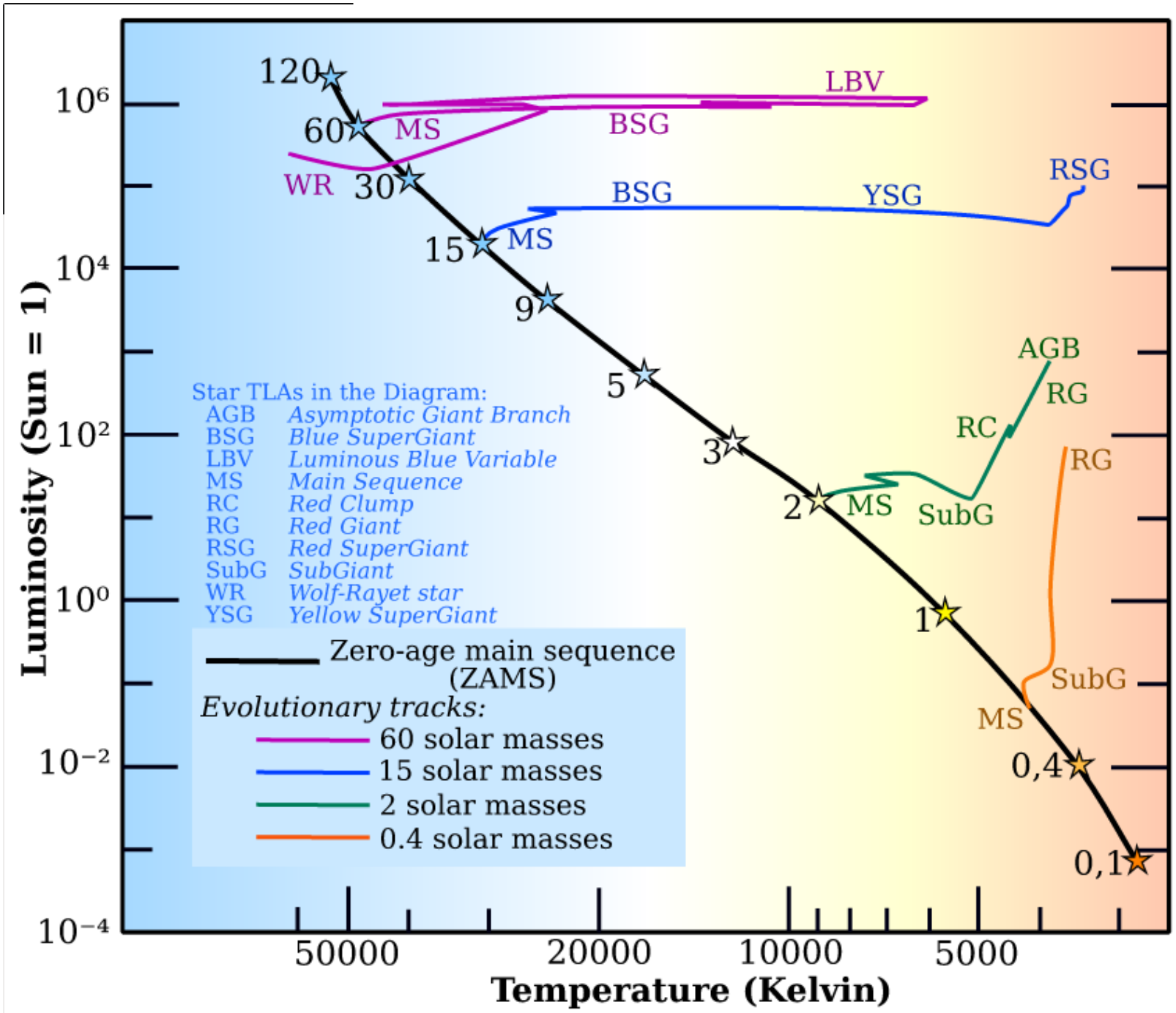
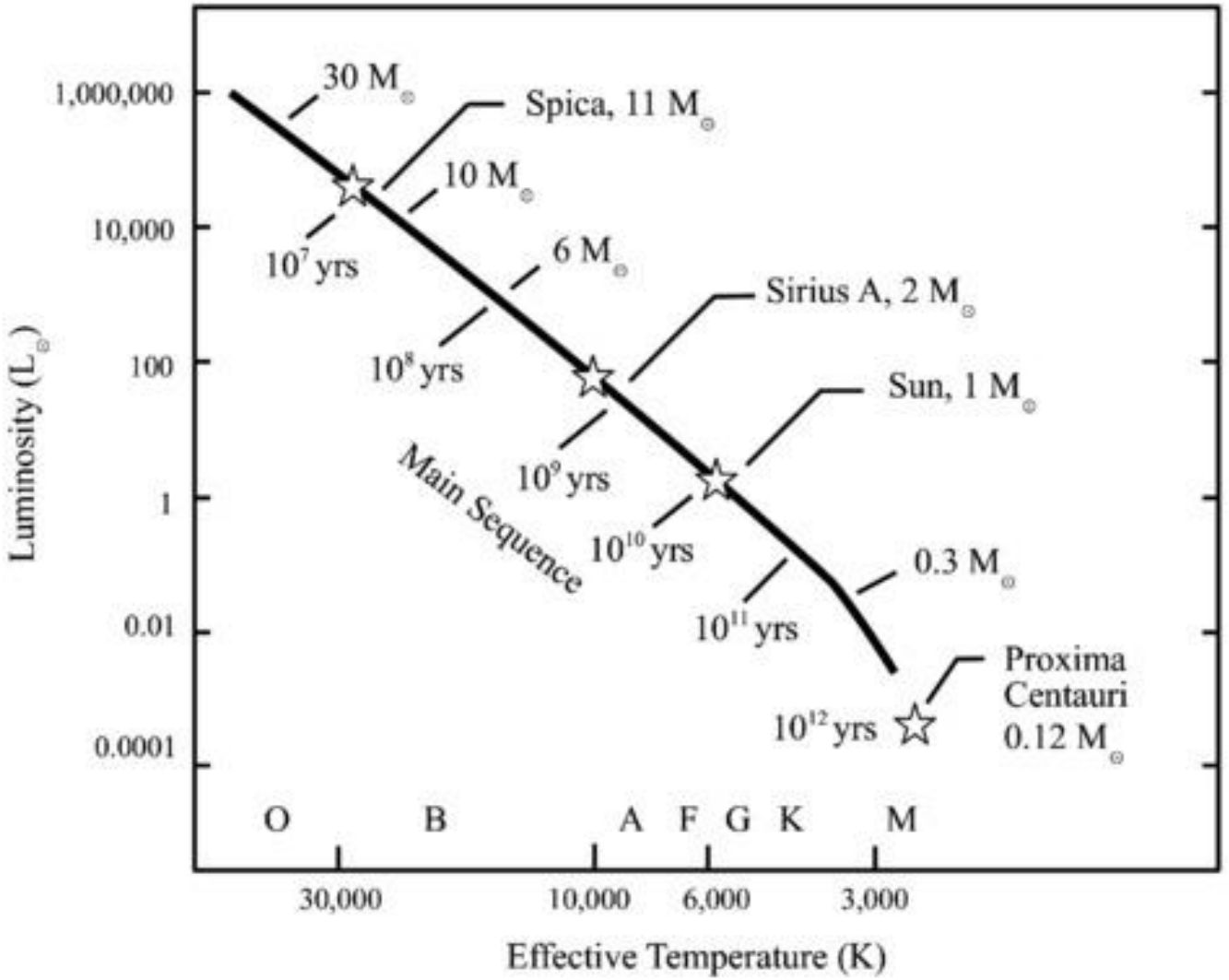
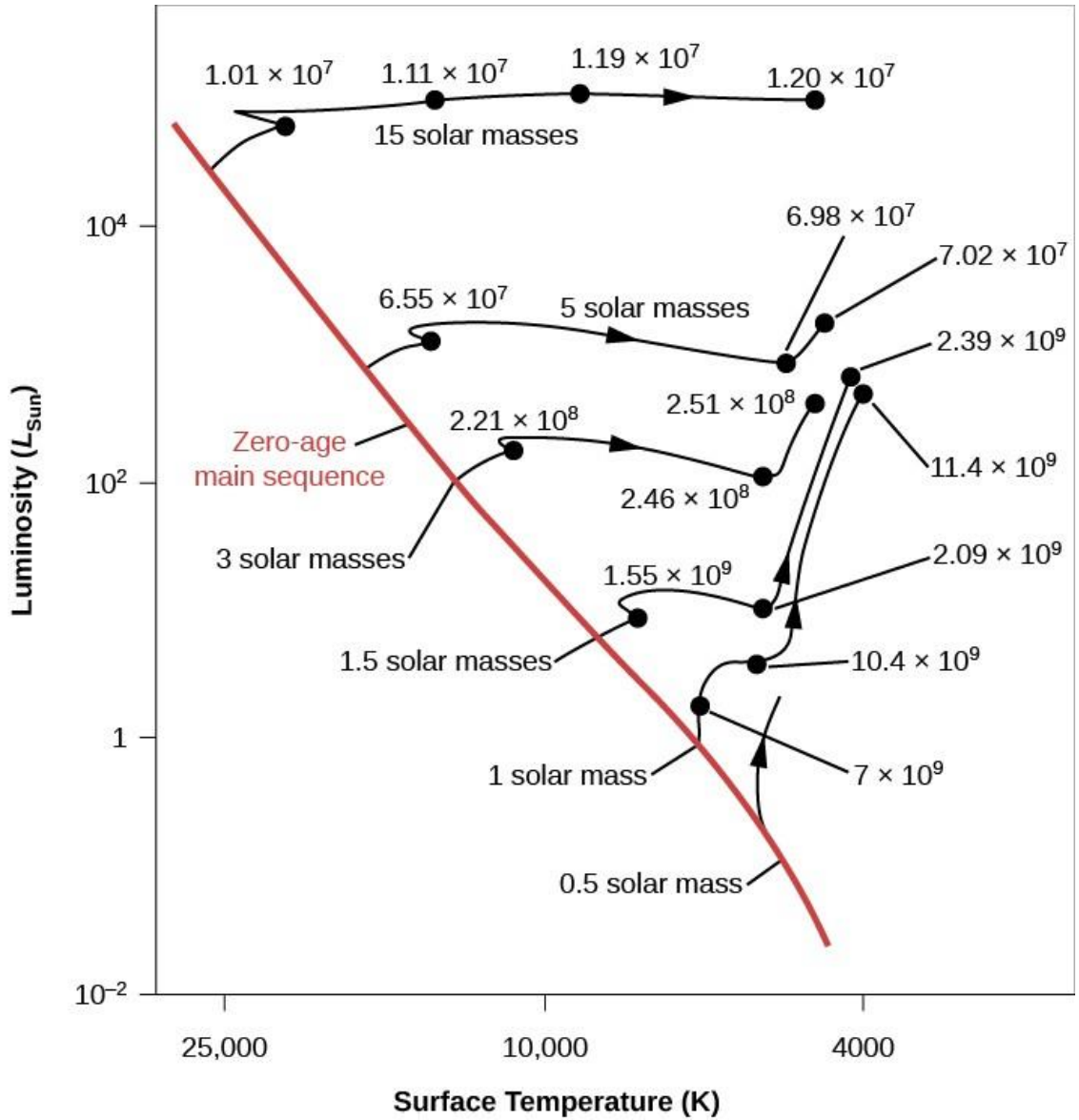
1
2
3
4
$G_{BP} - G_{RP}$


Luminosity (Sun = 1)
10^{6}
10^{4}
10^{2}
10^{0}
10^{-2}
10^{-4}
50000
20000
10000
5000
Temperature (Kelvin)
120
60
30
15
9
5
3
2
1
0,4
0,1
LBV
BSG
MS
WR
BSG
YSG
RSG
MS
AGB
RG
RC
RG
MS
SubG
SubG
MS
Star TLAs in the Diagram:
AGB Asymptotic Giant Branch
BSG Blue SuperGiant
LBV Luminous Blue Variable
MS Main Sequence
RC Red Clump
RG Red Giant
RSG Red SuperGiant
SubG SubGiant
WR Wolf-Rayet star
YSG Yellow SuperGiant
Zero-age main sequence (ZAMS)
Evolutionary tracks:
60 solar masses
15 solar masses
2 solar masses
0.4 solar masses

Evolution of Stars



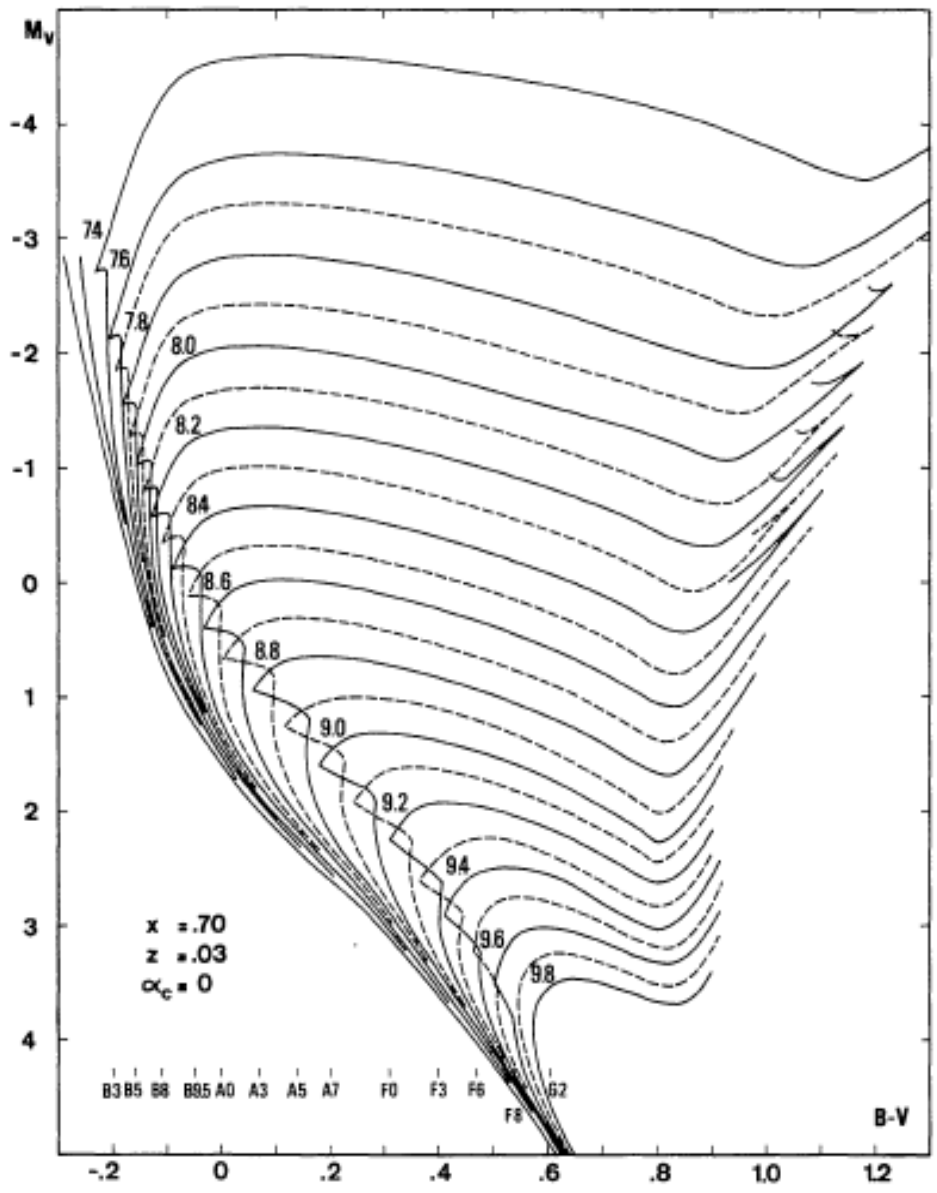
Evolution of Stars

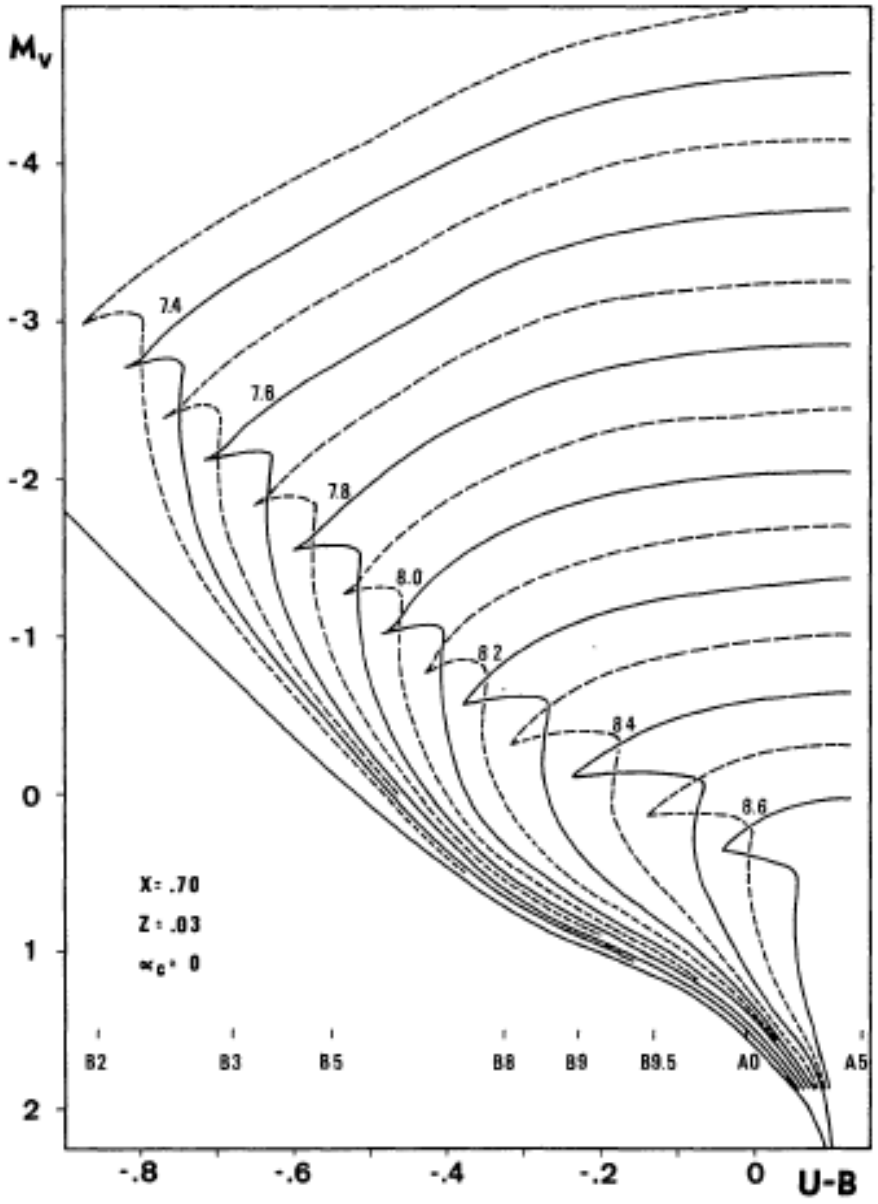


The cluster parameters

1. Reddening
2. Distance modulus
3. Age
4. Metallicity

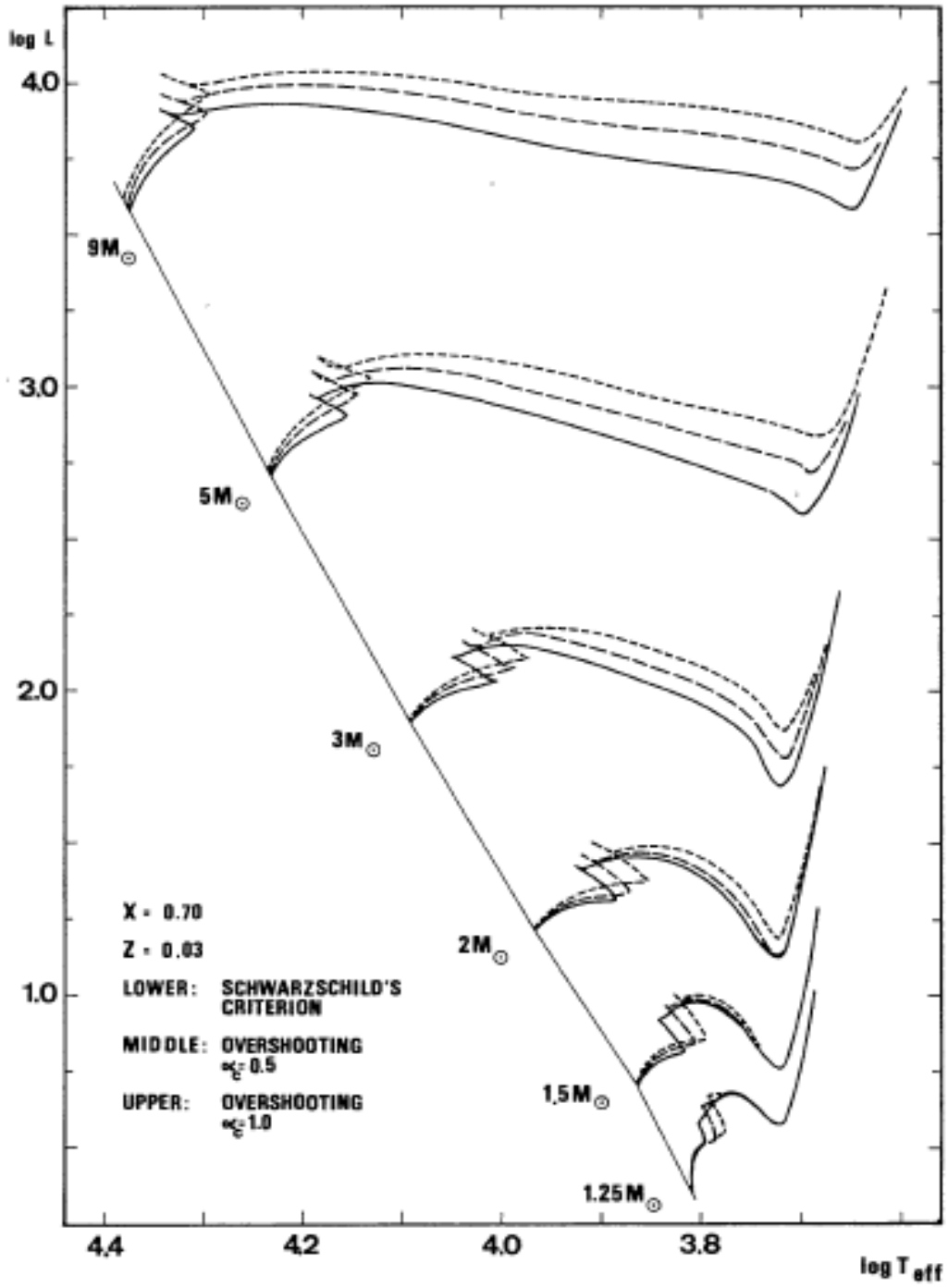
Maeder & Mermilliod (1981, A&A, 93, 136)





Maeder & Mermilliod (1981, A&A, 93, 136)

Different treatment of convection



An example – Gaia et al.

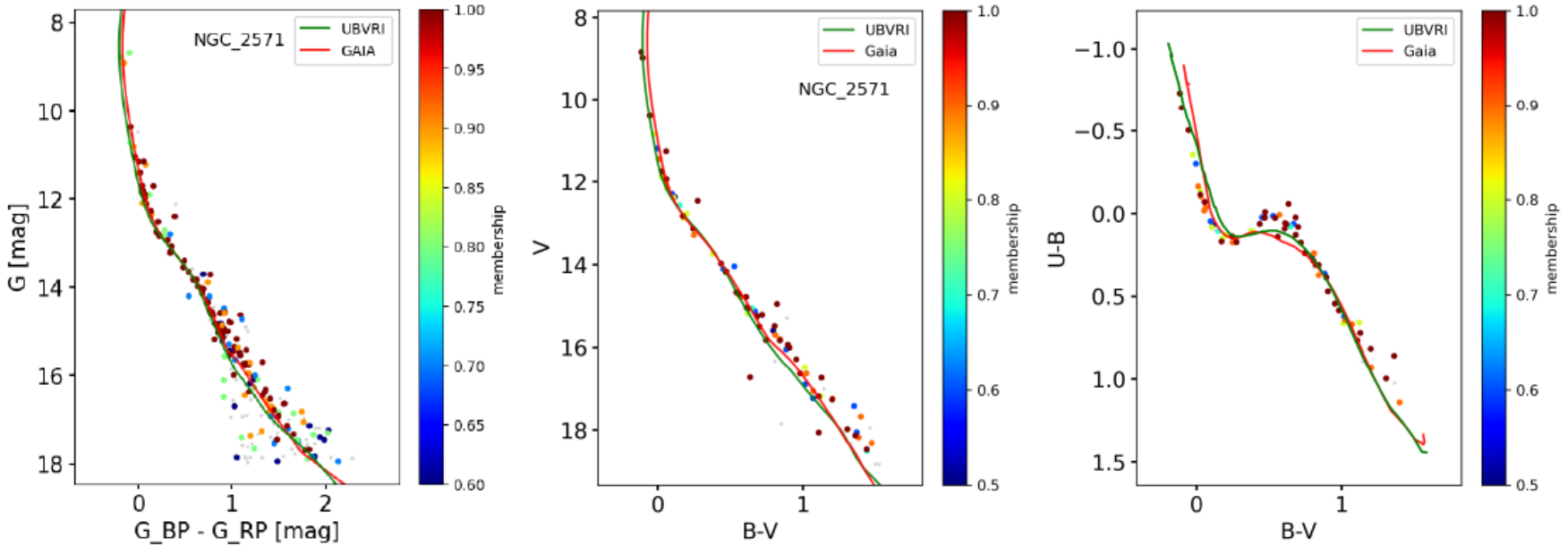


Figure 13. Comparison of the parameters obtained from *Gaia* data (red isochrones) and from UBVRI data (green isochrones) for NGC 2571. The memberships from Cantat-Gaudin & Anders (2020) are proportional to the color in the sense of redder indicating higher membership probability.

Dias et al. (2021, MNRAS, 504, 356)

An example – Gaia et al.

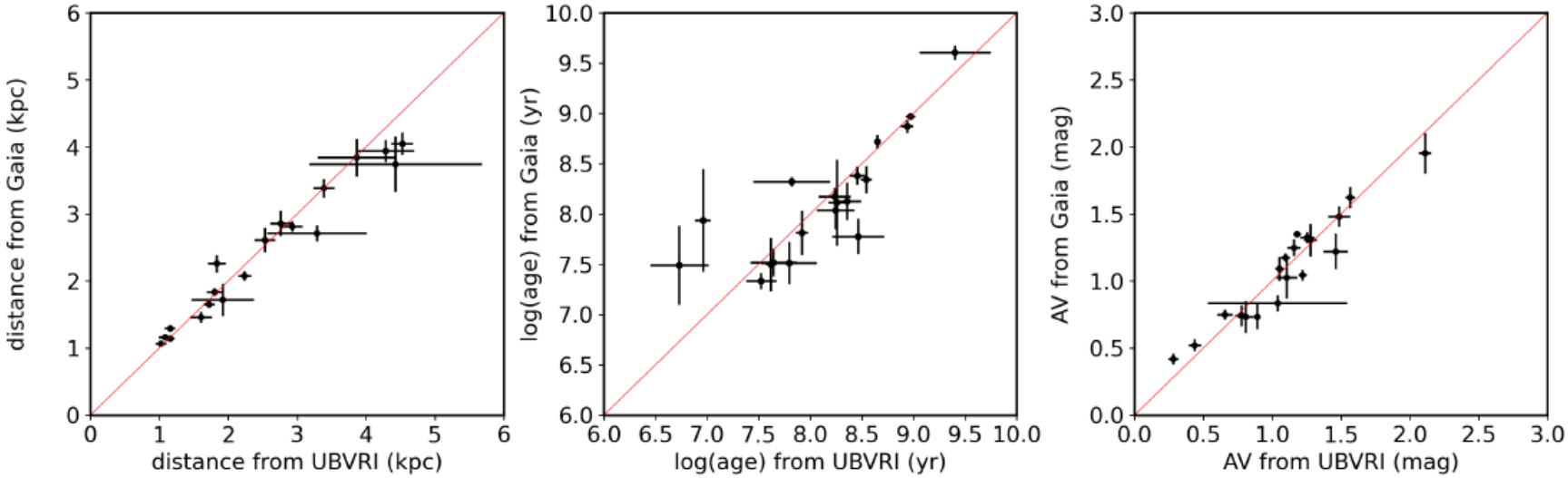
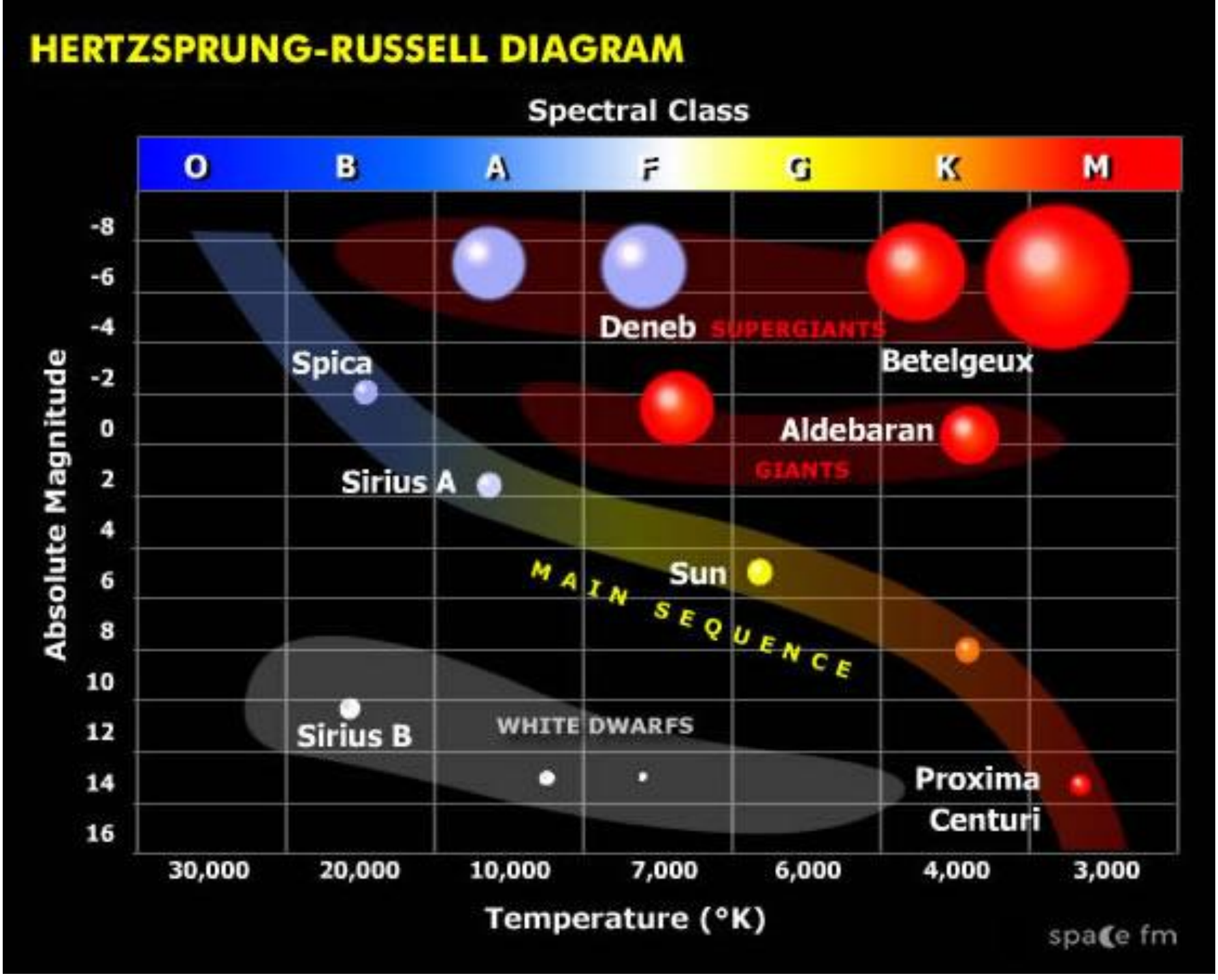


Figure 14. Comparison of the parameters obtained from *Gaia* G_{BP}, and G_{RP} and UBVRI data for a sample of 20 open clusters from Moitinho (2001).

Dias et al. (2021, MNRAS, 504, 356)


HERTZSPRUNG-RUSSELL DIAGRAM
Spectral Class
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Absolute Magnitude
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-2
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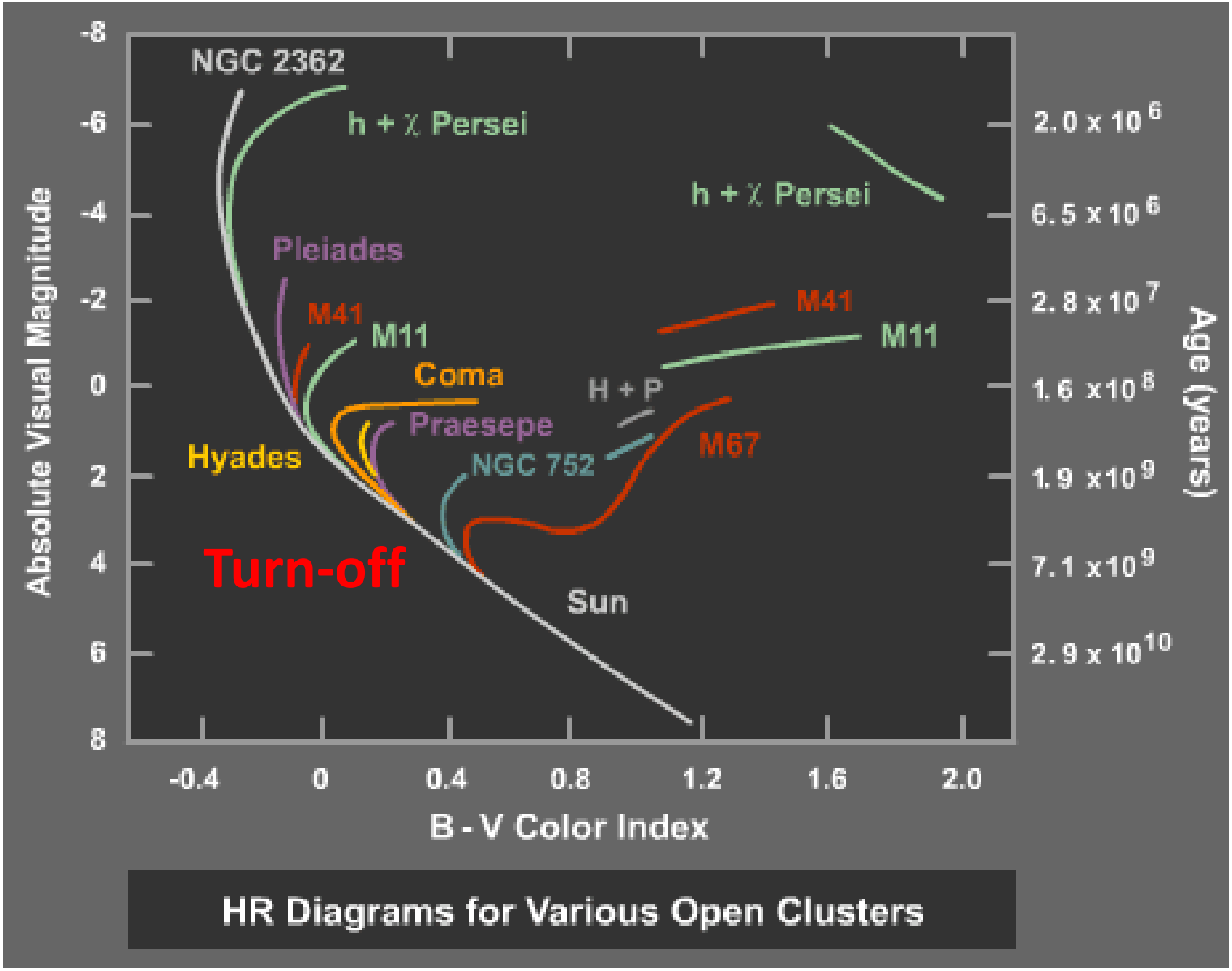
10
12
14
16
Deneb
SUPERGIANTS
Betelgeux
Spica
Aldebaran
GIANTS
Sirius A
Sun
MAIN SEQUENCE
WHITE DWARFS
Sirius B
Proxima
Centuri
30,000
20,000
10,000
7,000
6,000
4,000
3,000
Temperature (°K)
space fm

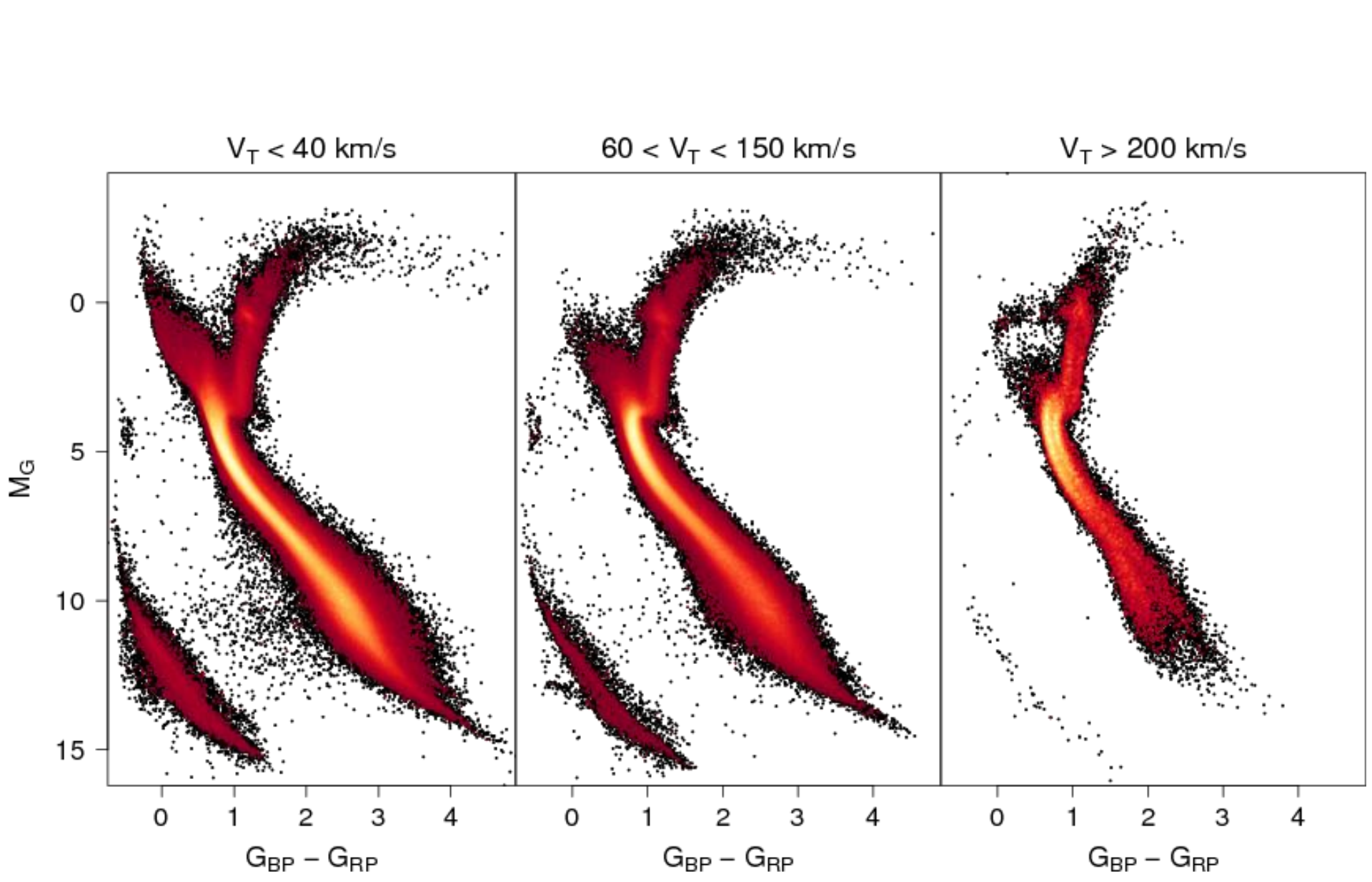


Distance: $V_0 - M_V$

$k \cdot A_V$

A_V

Reddening


$V_T < 40$ km/s
$60 < V_T < 150$ km/s
$V_T > 200$ km/s
M_G
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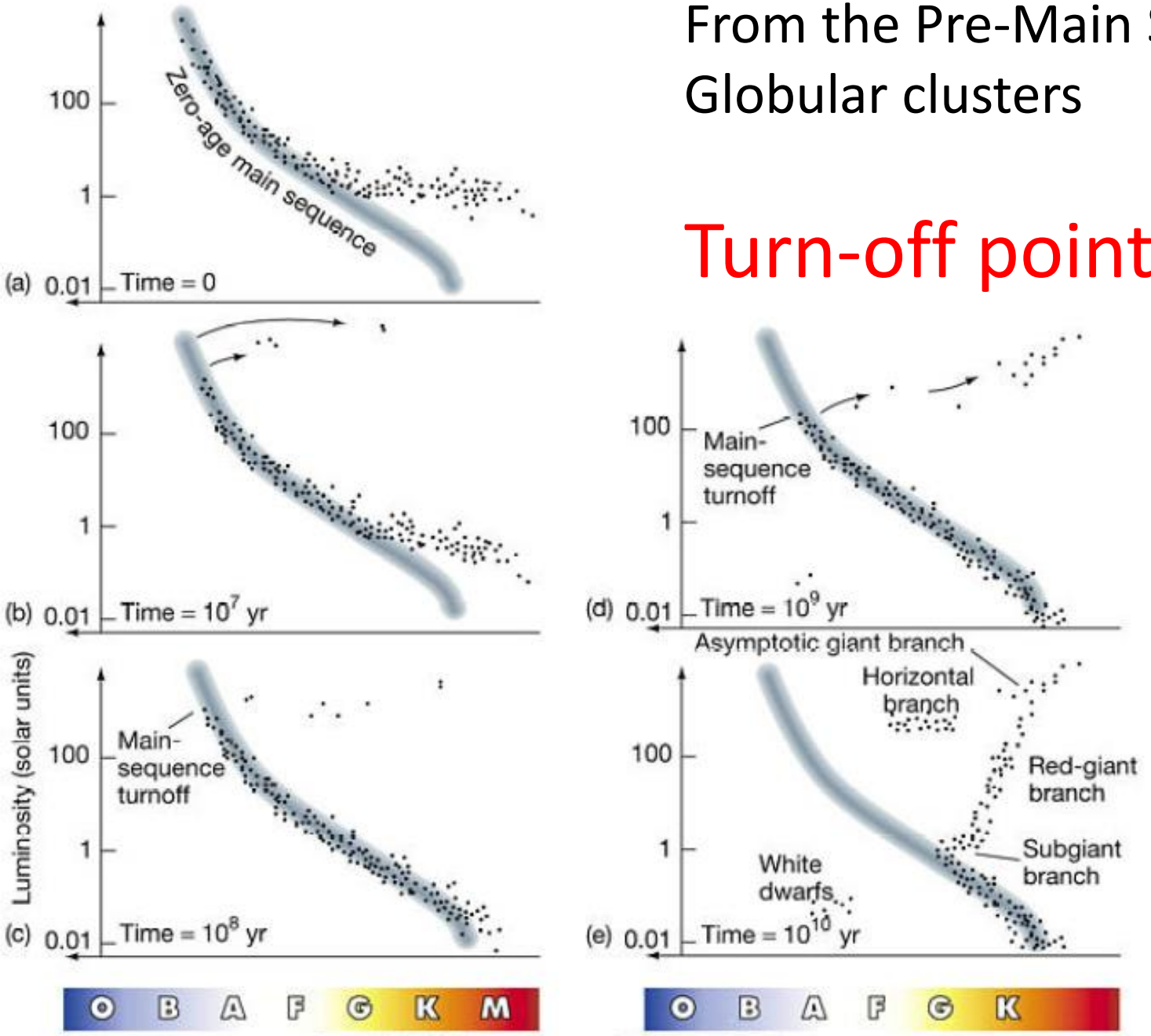
4
$G_{BP} - G_{RP}$

From the Pre-Main Sequence to Globular clusters

Turn-off point



(a) $t = 0$

(b) $t = 10^7$yr

(c) $t = 10^8$yr

(d) $t = 10^9$yr

(e) $t = 10^{10}$yr

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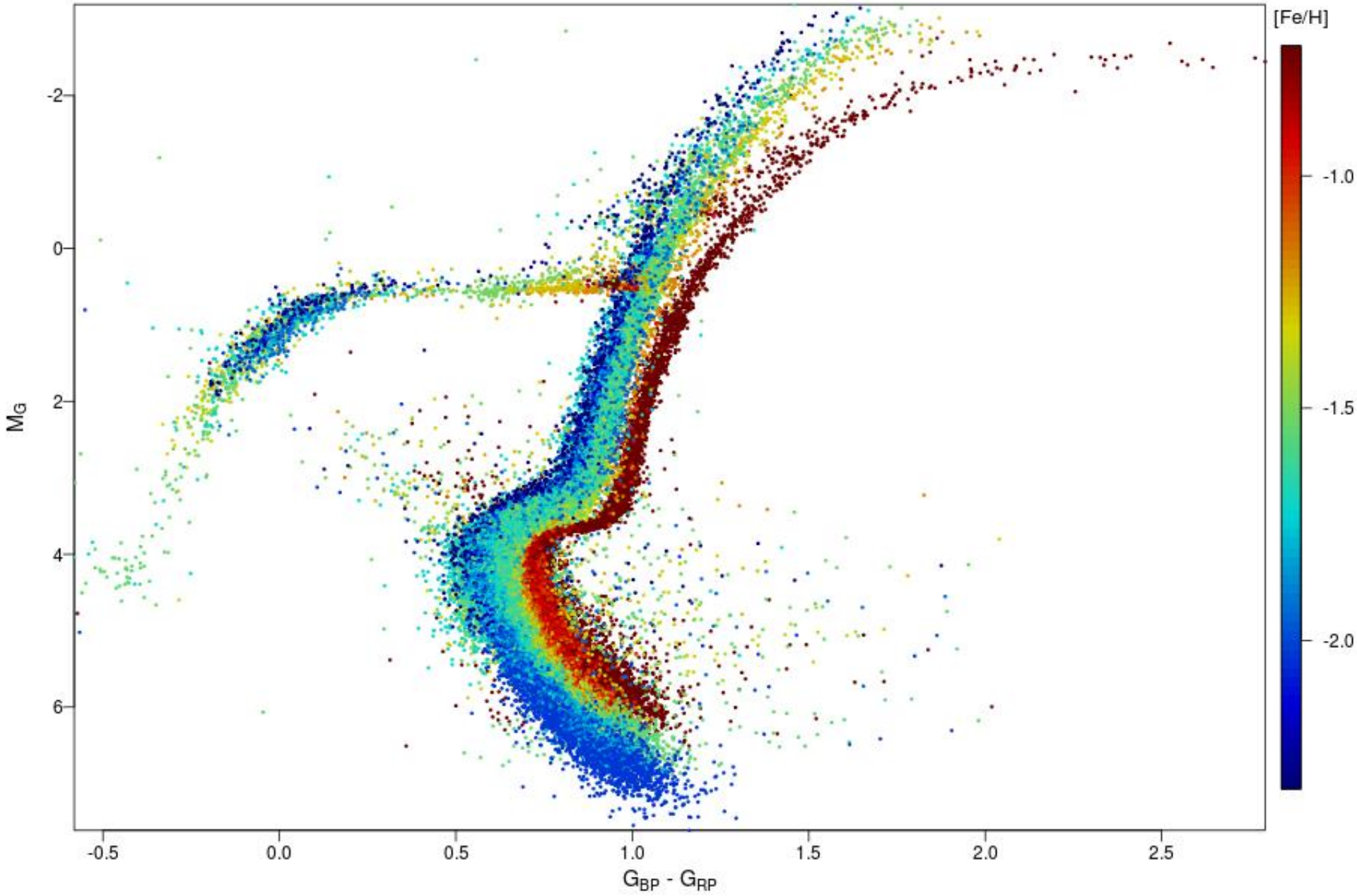
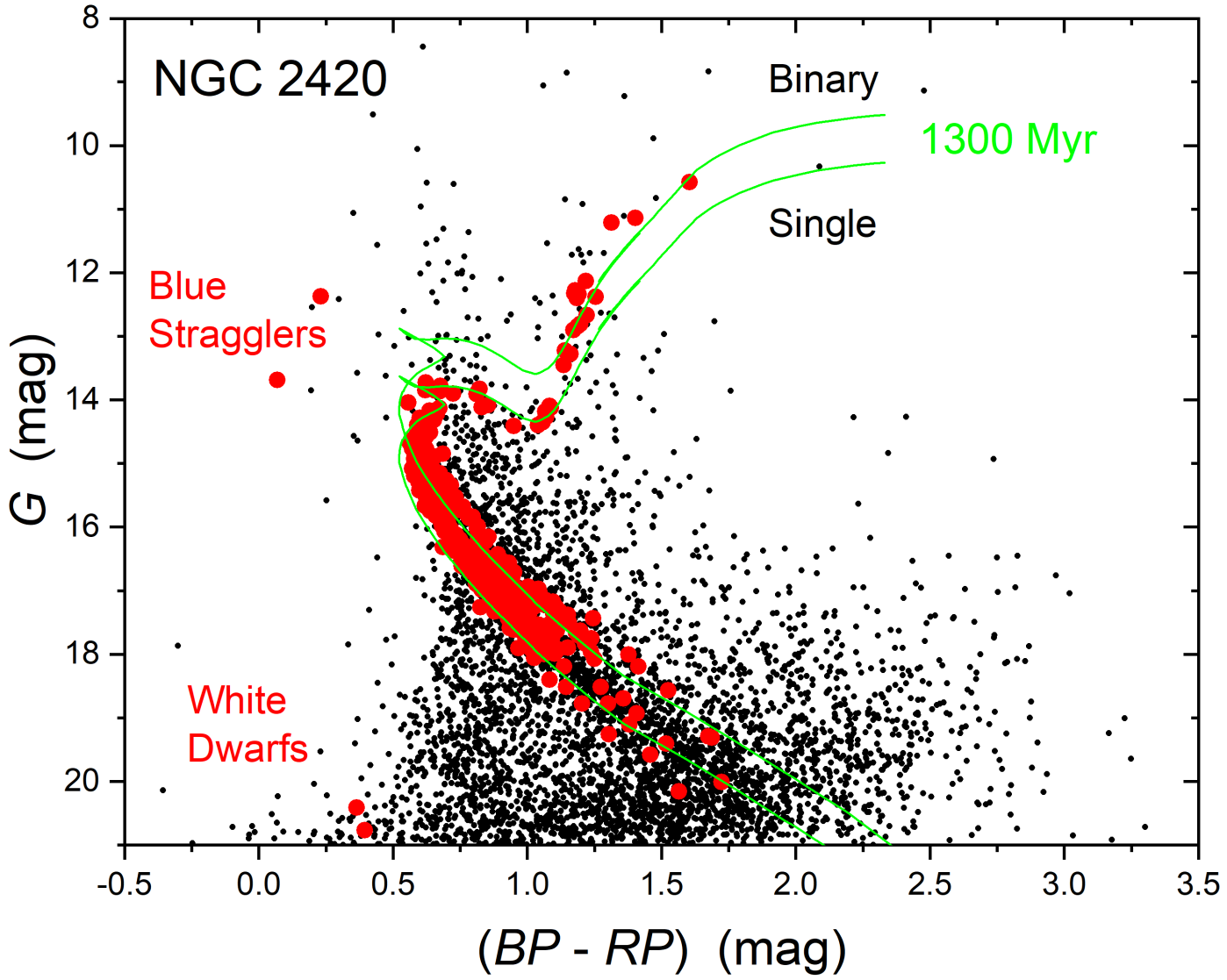

[Fe/H]
-1.0
-1.5
-2.0
M_G
-2
0
2
4
6
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
G_{BP} - G_{RP}

Gaia – before and after

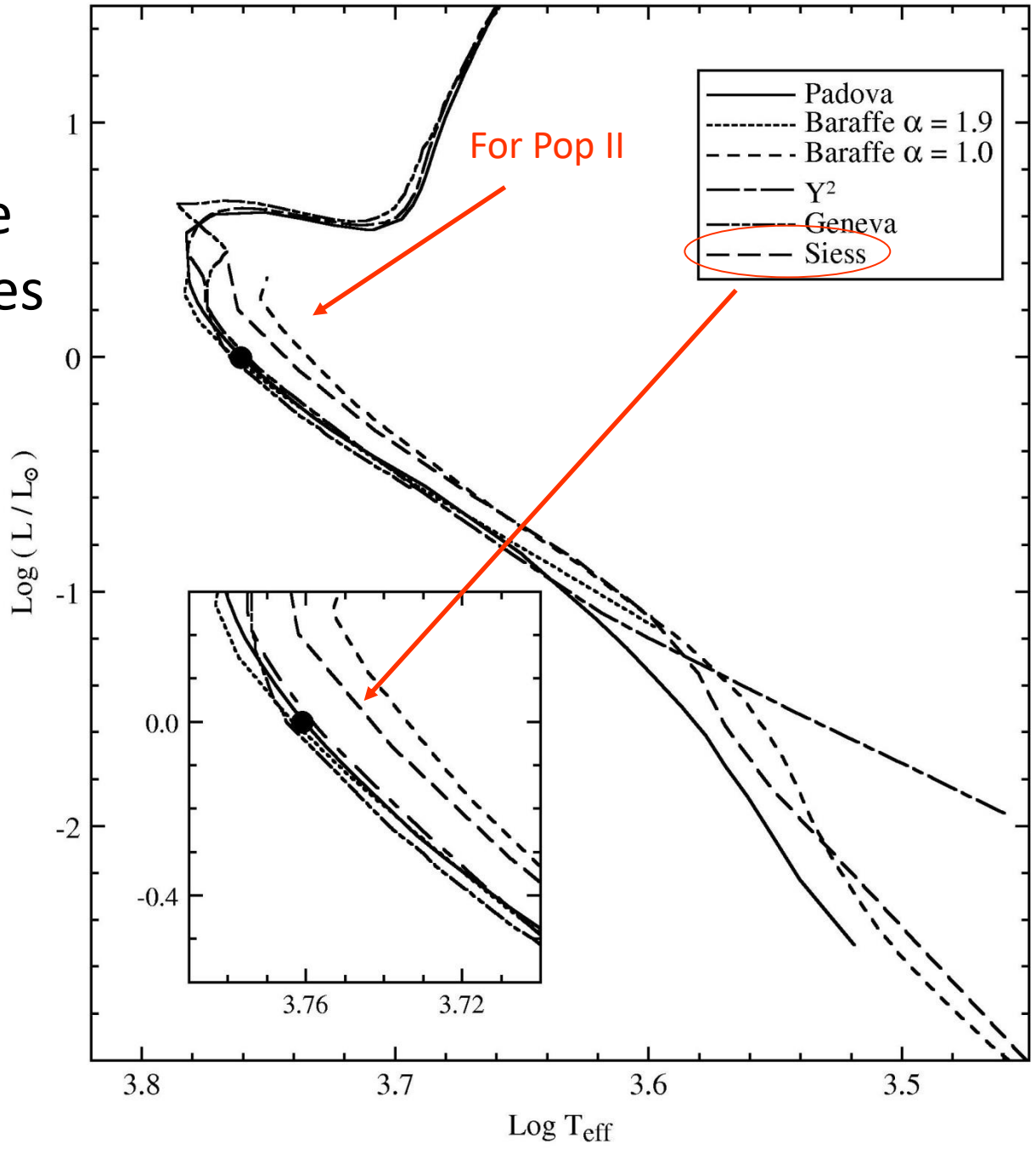


A comparison of isochrone sets

- Grocholski & Sarajedini (2003, MNRAS, 345, 1015) compared the following isochrones:
  1. "Padova": Girardi et al., 2002, A&A, 391, 195
  2. Baraffe: Baraffe et al., 1998, A&A, 337, 403
  3. "Geneva": Lejeune & Schaerer, 2001, A&A, 366, 538
  4. Y^2: Yi et al., 2001, ApJS, 136, 417
  5. Siess: Siess et al., 2000, A&A, 358, 593

The location of the Sun with isochrones of 5 Gyr

Isochrones by Siess et al. (1997) seem “to have a problem”



Cluster	Padova	Baraffe	Geneva	Y^2	Siess	Twarog et al.
M35 (NGC 2168)	10.16	10.41	9.81	9.91	9.96	10.30
M37 (NGC 2099)	11.55	11.40	11.50	11.35	11.75	11.55
NGC 1817	12.10	12.30	11.90	11.85	12.00	12.15
NGC 2477	11.55	11.60	11.30	11.15	11.45	11.55
NGC 2420	12.12	12.45	11.95	11.90	12.07	12.10
M67 (NGC 2682)	9.80	9.80	9.60	9.45	9.65	9.80

Transformation in distances [pc]

- M35: 1148 [916, 1208]; -20% +5%
- M37: 2042 [1905, 2239]; -7% +10%
- NGC 1817: 2692 [2344, 2884]; -13% +7%
- NGC 2477: 2042 [1698, 2089]; -17% +2%
- NGC 2420: 2630 [2399, 3090]; -9% +17%
- M67: 912 [776, 912]; -15% +0%
- Mean values: -13(5)% +7(6)%, for one free parameter!

Isochrones – evolutionary grids

- Isochrones: available for different ages and photometric systems
- Evolutionary grids: available for different masses (and photometric systems)