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Stellar streams in the Solar neighbourhood

Gaia Early Data Release 3

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INTRODUCTION

Open clusters, tidal tails, star associations and the Gaia mission.

INTRODUCTION

OPEN CLUSTERS AND OTHER DYNAMICAL STRUCTURES

OPEN CLUSTERS

Open cluster NGC 2164
Credit:ESA/Hubble & NASA, J. Kalirai, A. Milone

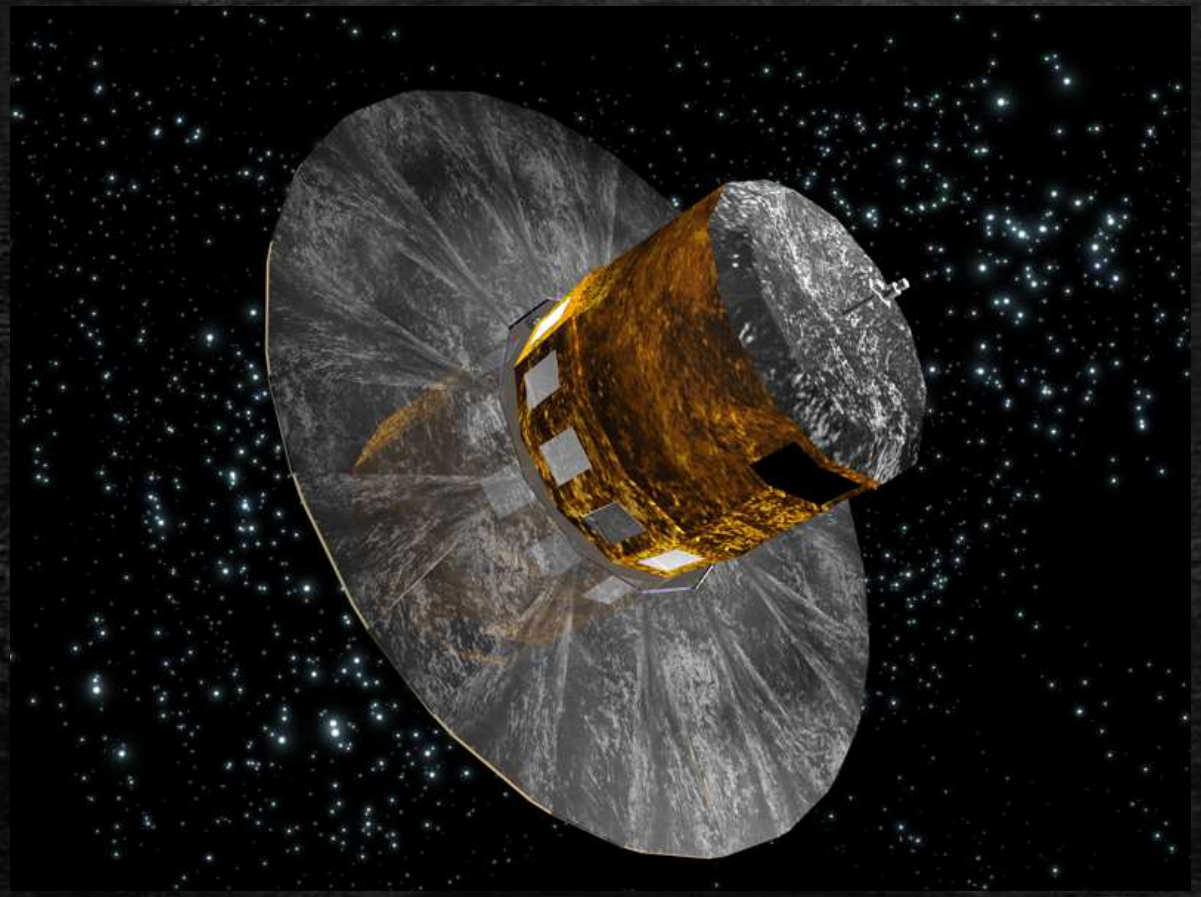
POPULATION : From 10 to 1000 stars
AGE : ~100Myr

NOT bound by gravity => open clusters disrupt with time

INTRODUCTION

GAIA EDR3

THE GAIA MISSION



Artist’s impression of the Gaia satellite
www.esa.int

Launched on 06 December 2013

3D map of the sky (positions, parallaxes, space motions)

PART I - Methods

Finding potential groups of stars among the Gaia EDR3

PART I

METHODS TO ISOLATE COMOVING GROUPS IN GAIA DATASET

CONSTRAINED PARAMETERS :

- 3D velocity
- 3D positions
- Density

TYPICAL VALUES :

- velocity dispersion of an open cluster around 1.5 km/s
- average star density in the galactic disk : 10 stars in a $(10\ pc)^3$

PART 2 – Groups constitution

Internal match with TOPCAT and cross-matching with catalogues.

PART II

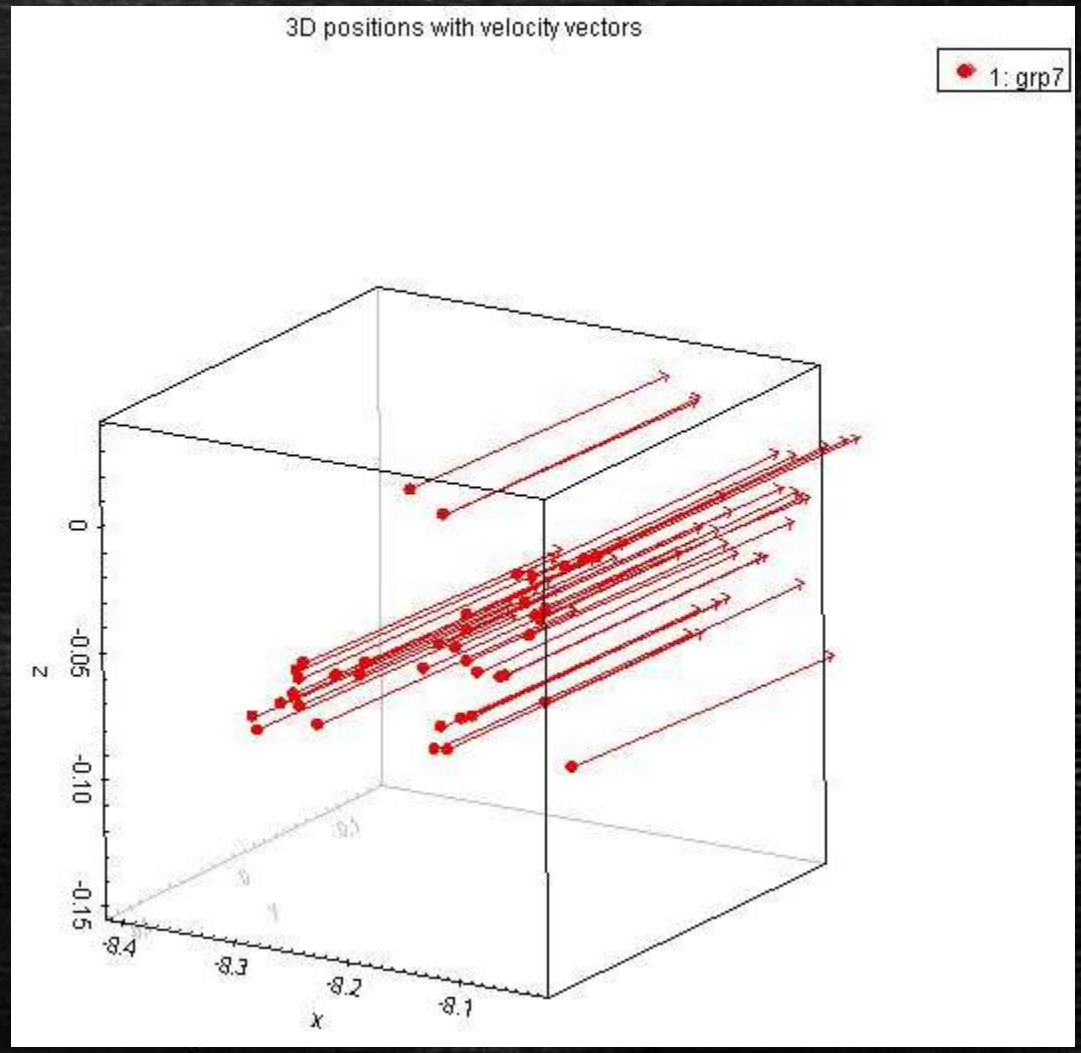
DENSITY AND VELOCITY CONSTRAINTS

APPLIED CONSTRAINT

Velocity space restriction :

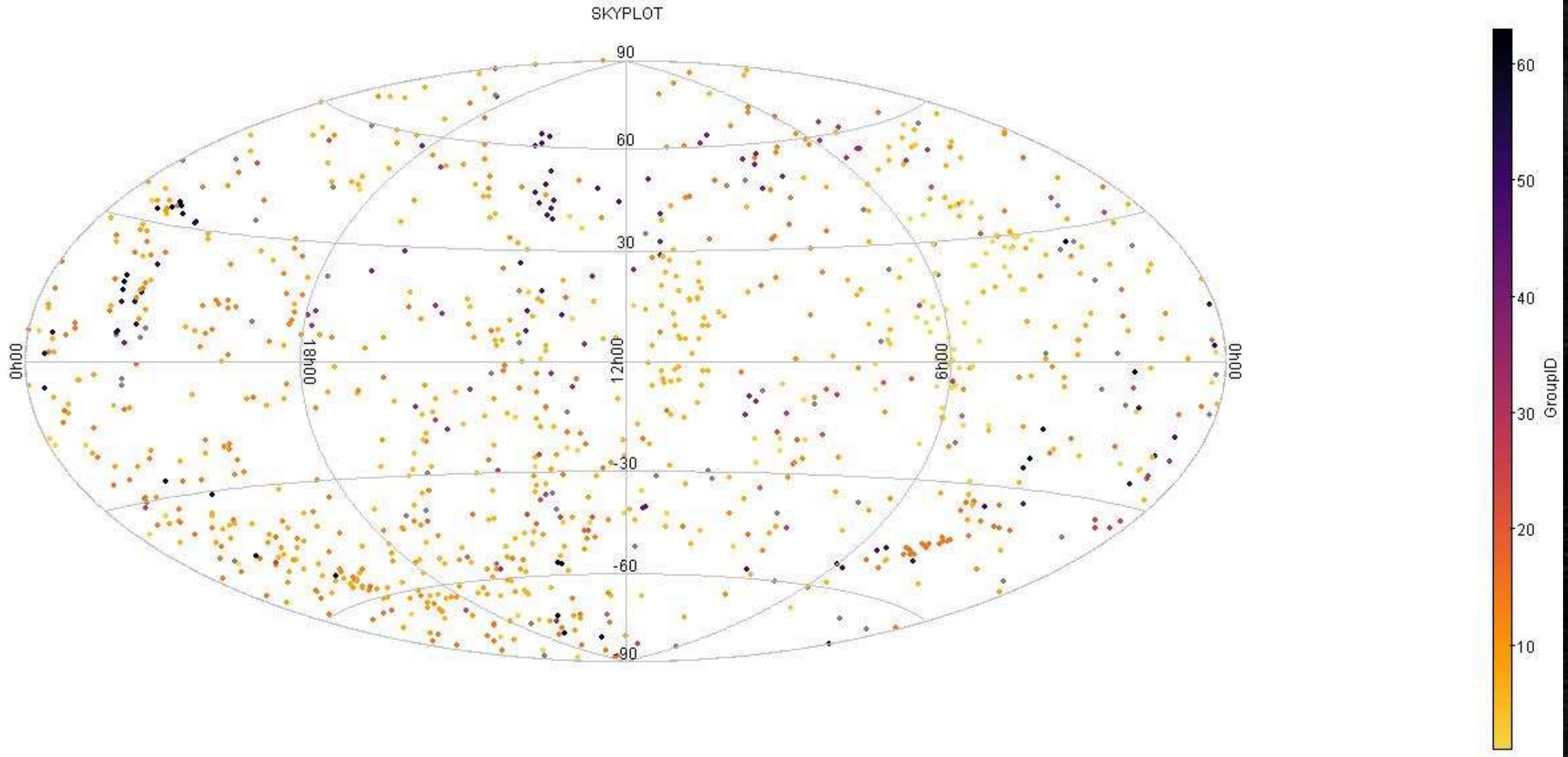
3D velocity dispersion < 2,5km/s

Internal match in TOPCAT :
MORE THAN 60 GROUPS



PART II

Internal match



PART II

Unindexed group research - 1

KOUNKEL CATALOGUE

Lists comoving groups in a 1 kpc radius region around the Sun.

Relying on Gaia’s DR2 datas.

SIMBAD

Astronomical database gathering basics properties of stars and their names in different catalogues.

PART II

Unindexed group research - 2

OH CATALOGUE

Lists comoving pairs in a 10pc region around the Sun.

CASTRO-GINARD & CANTAT-GAUDIN CATALOGUES

Both list clusters in the galactic disk.

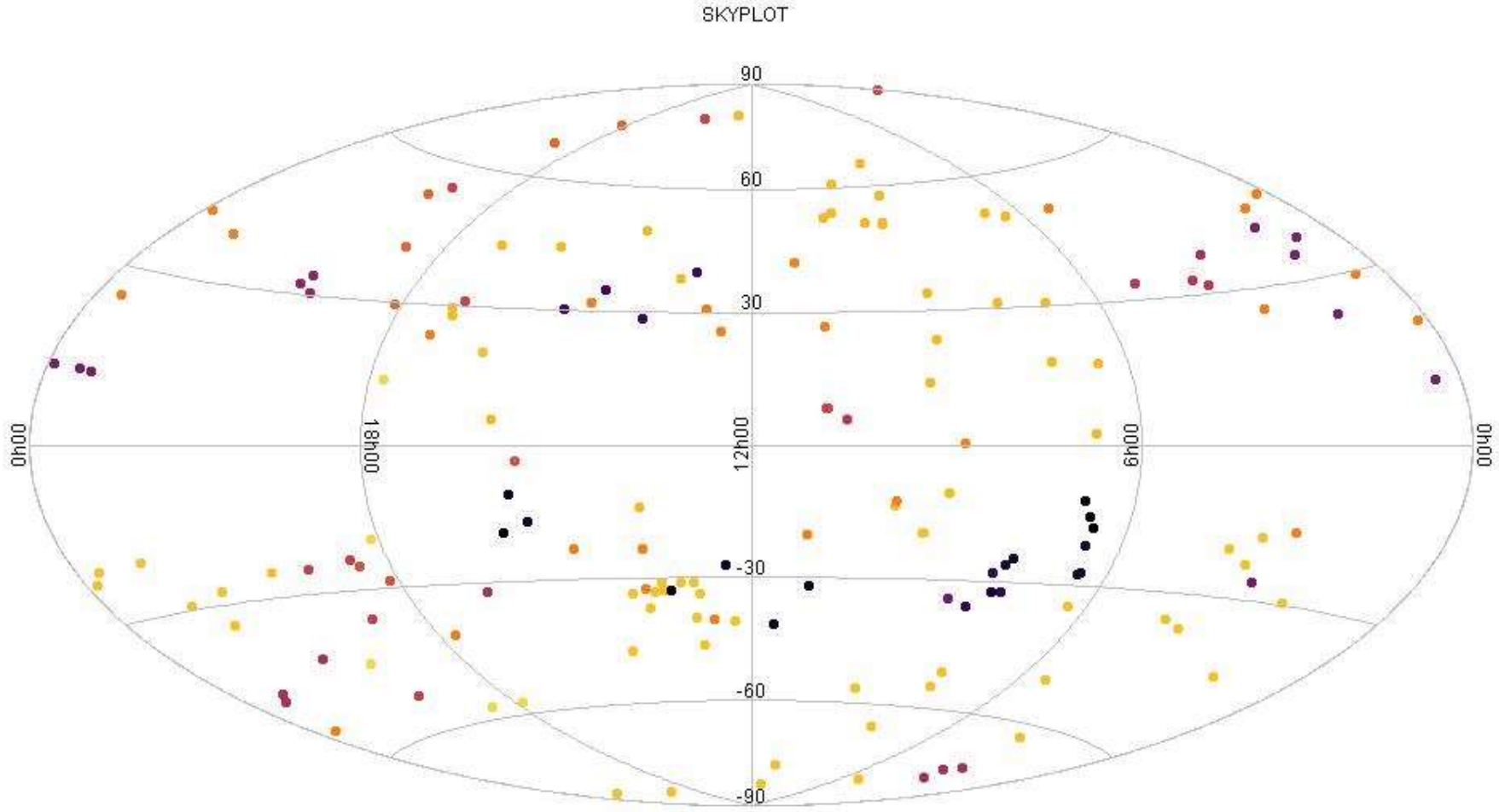
Rely on Gaia DR2.

HIERARCHY PARAMETER IN SIMBAD

Parameter derived from bibliography. Indicates hierarchical links with other Simbad objects.

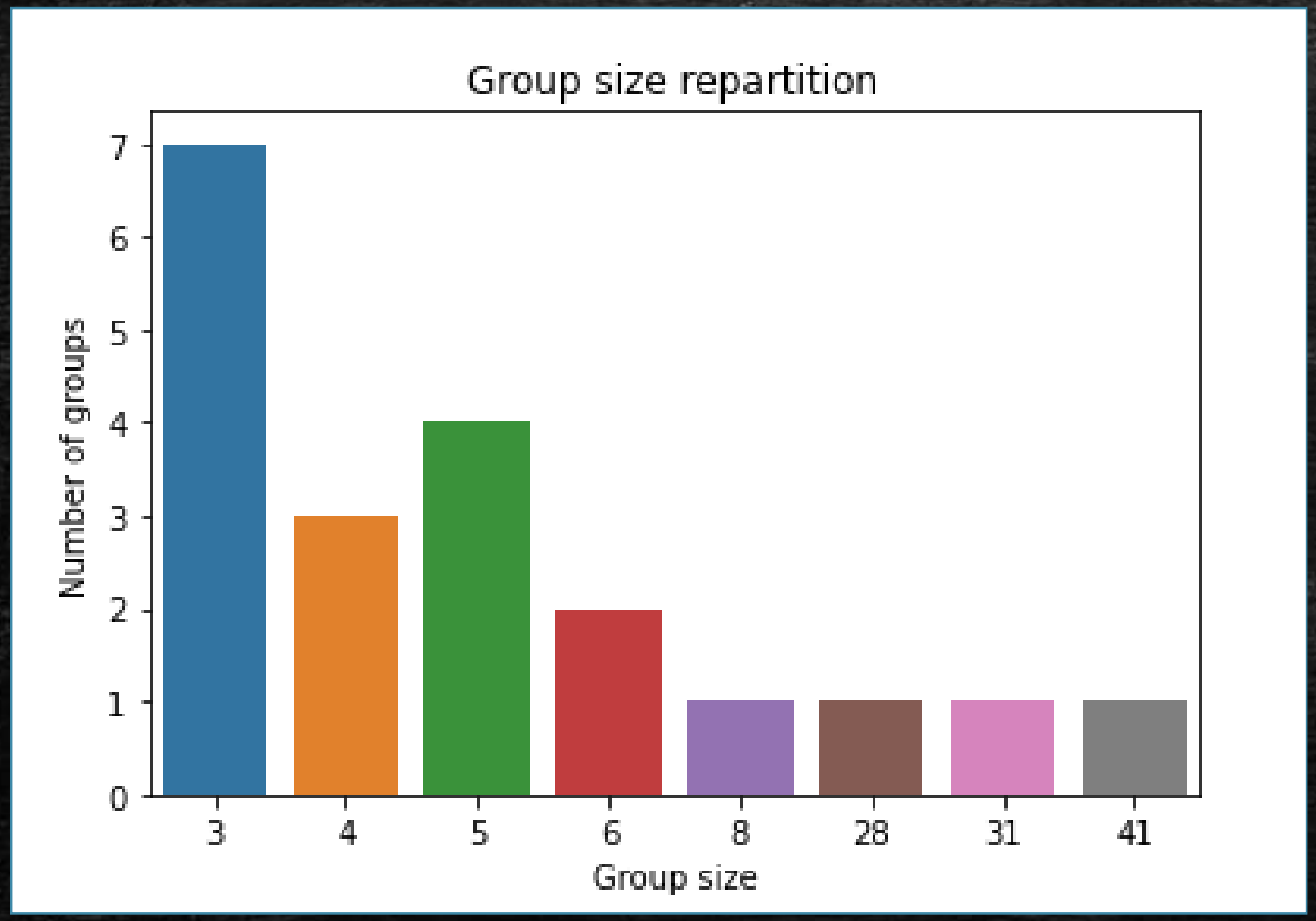
PART II

Unindexed group research - 2



PART II

Unindexed groups – 2nd cut

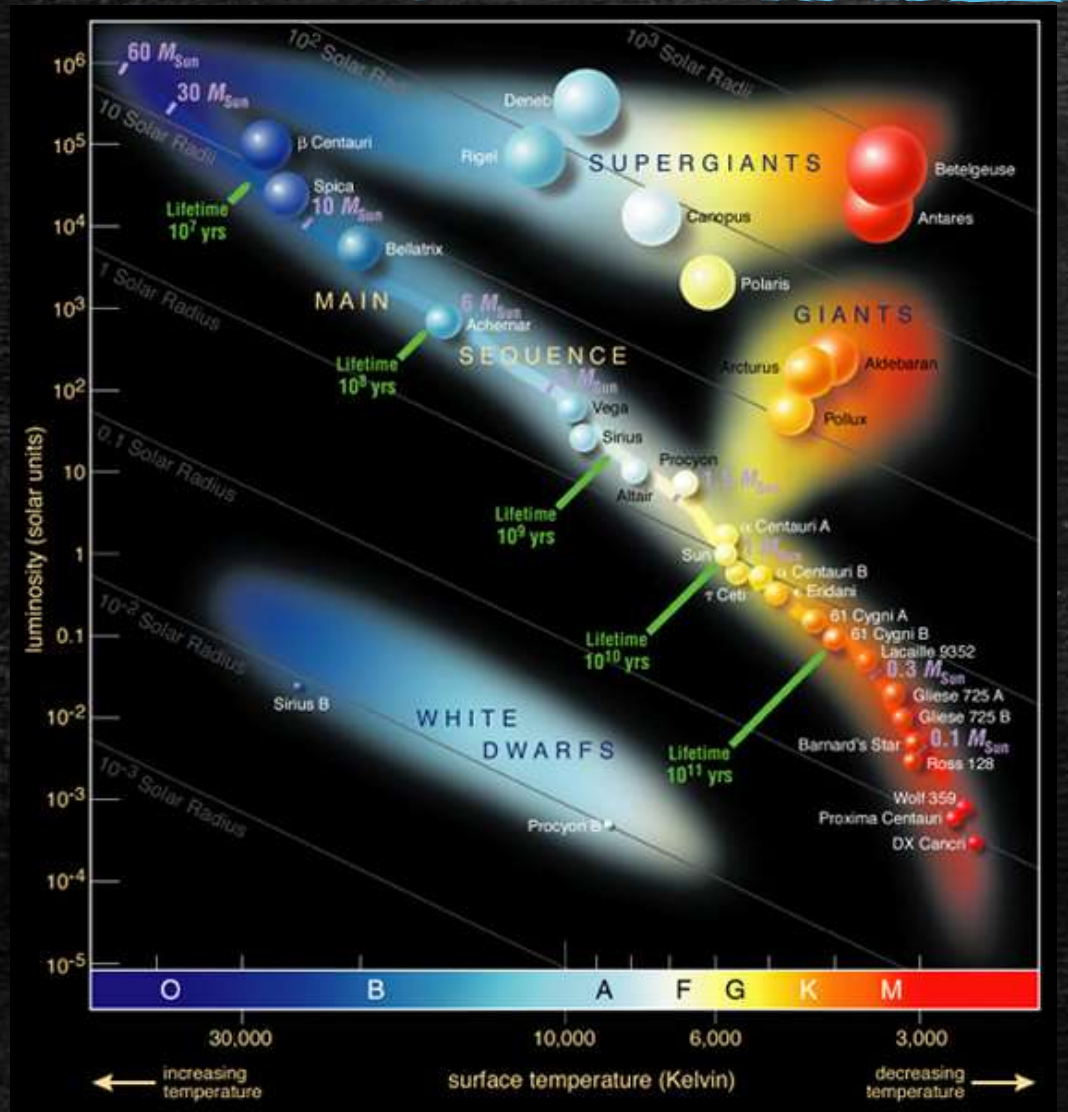


OPEN CLUSTER
~ 10 to 1000
stars

PART III - Dating

Dating attempt using Padova Stellar Evolutionary Tracks.

PART III
Color-Magnitude Diagram



KEY TOOL :

During its life, a star positionin the CMD shifts

=> Depending on its age, a stellar population follows a typical track, modelized by isochrone

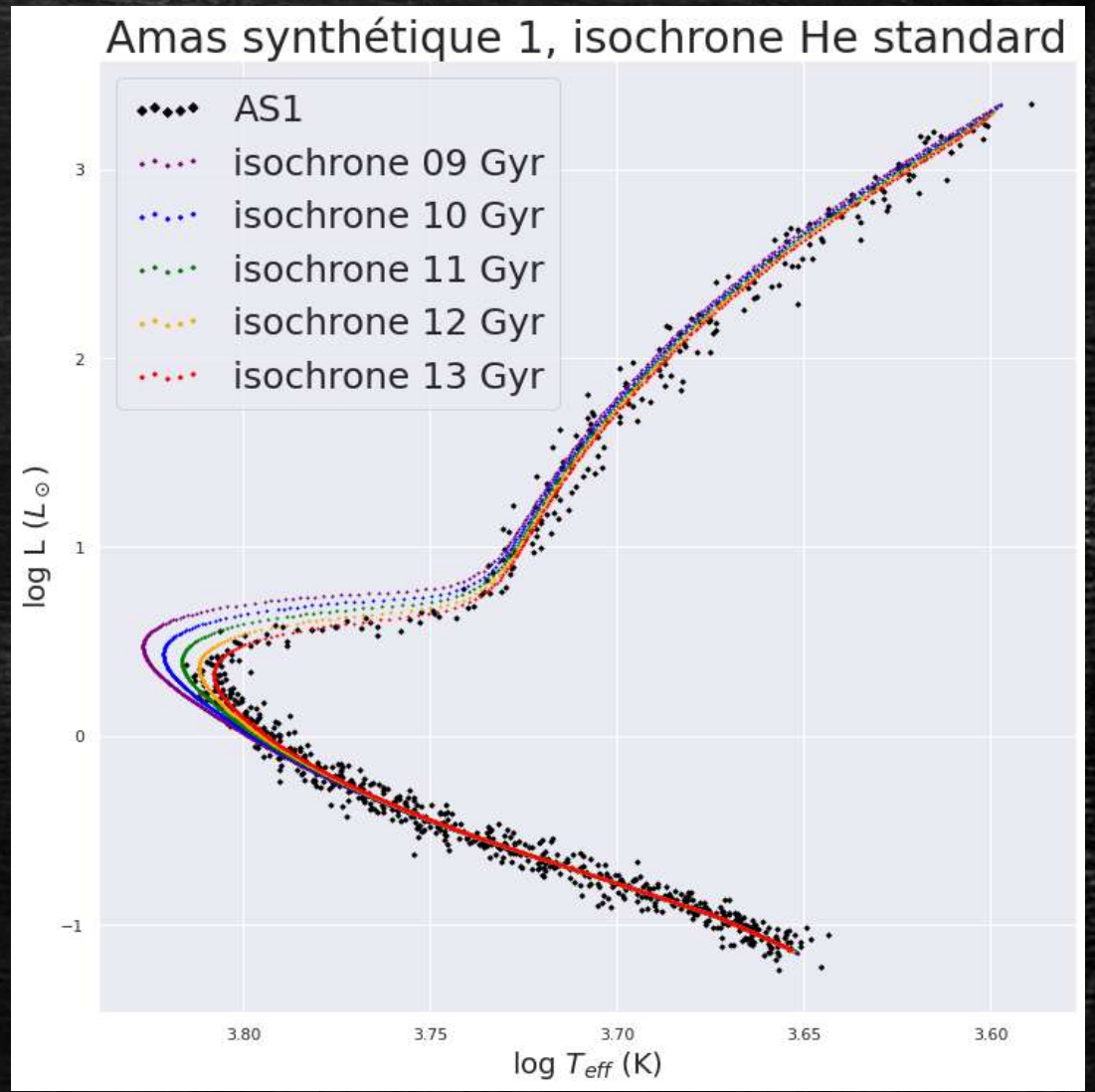
Credit: ESO (http://www.eso.org/public/images/)

PART III
Isochrone dating method

ISOCHRONE FIT :

Single stellar population expected (in theory) for open clusters.

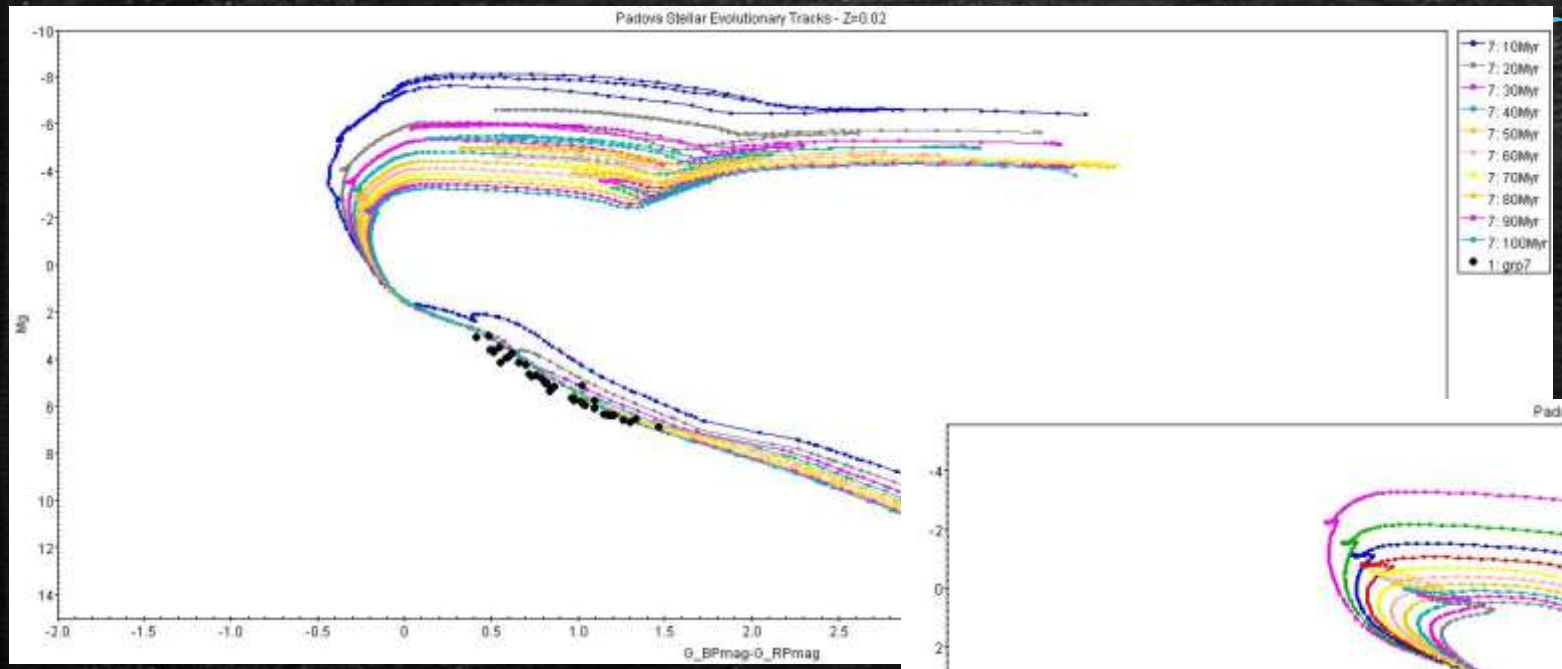
In reality, an age heterogeneity can appears.



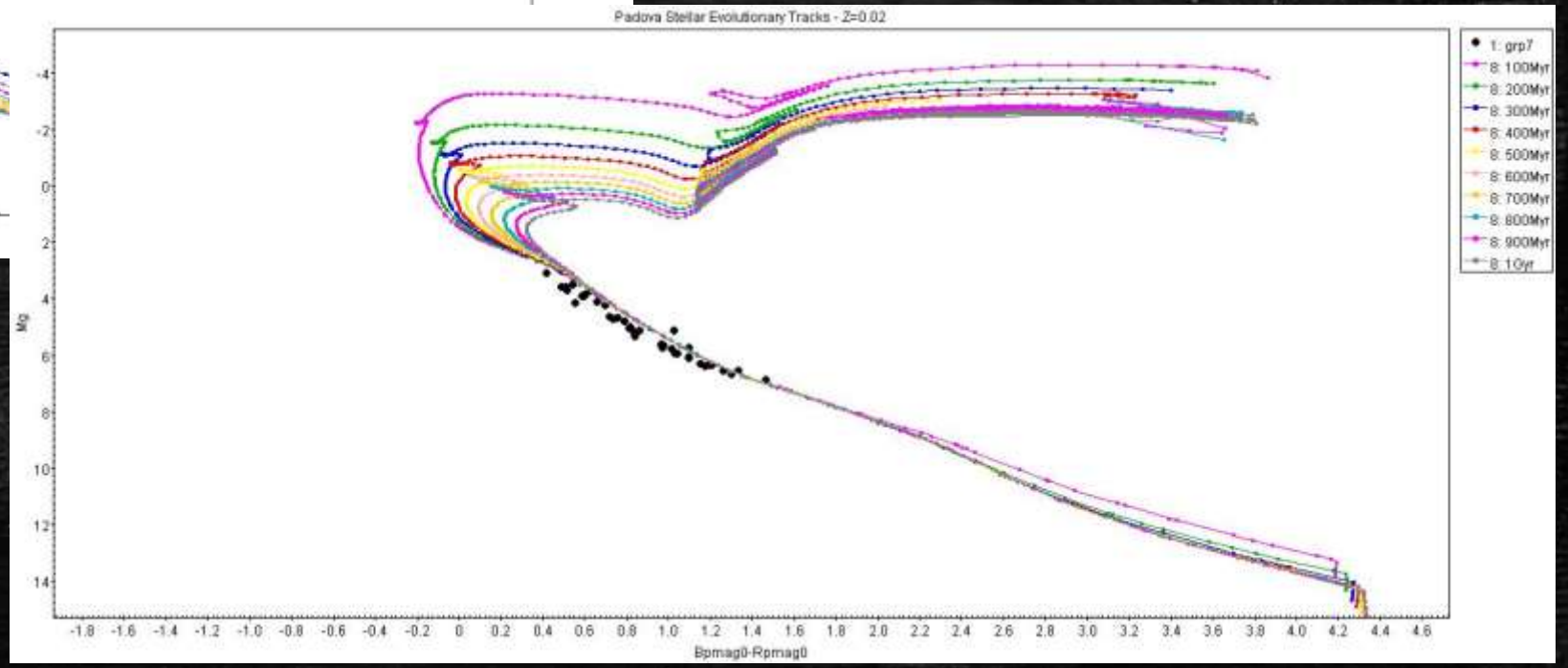
Synthetic globular cluster and SYCLIST isochrones for Solar metallicity.

PART II

CMD AND ISOCHRONES



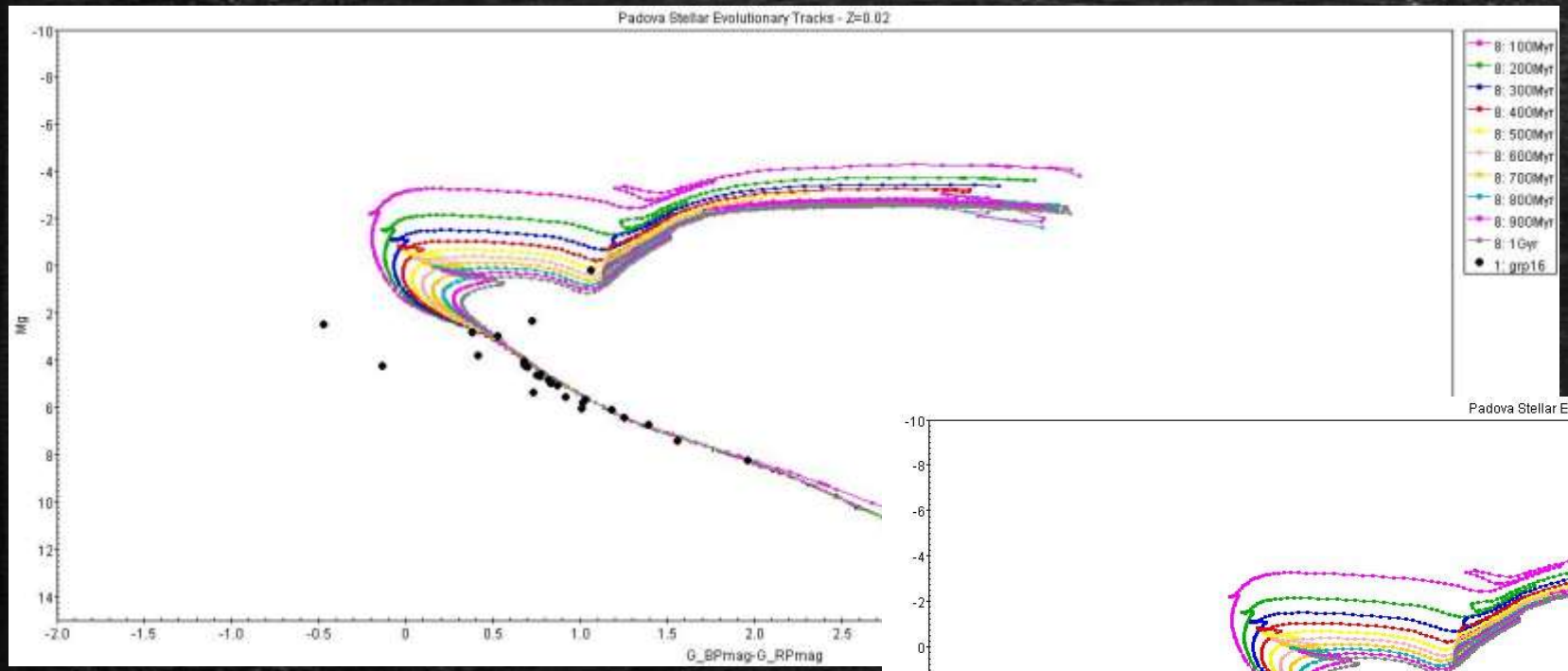
Group 7 : 46 objects

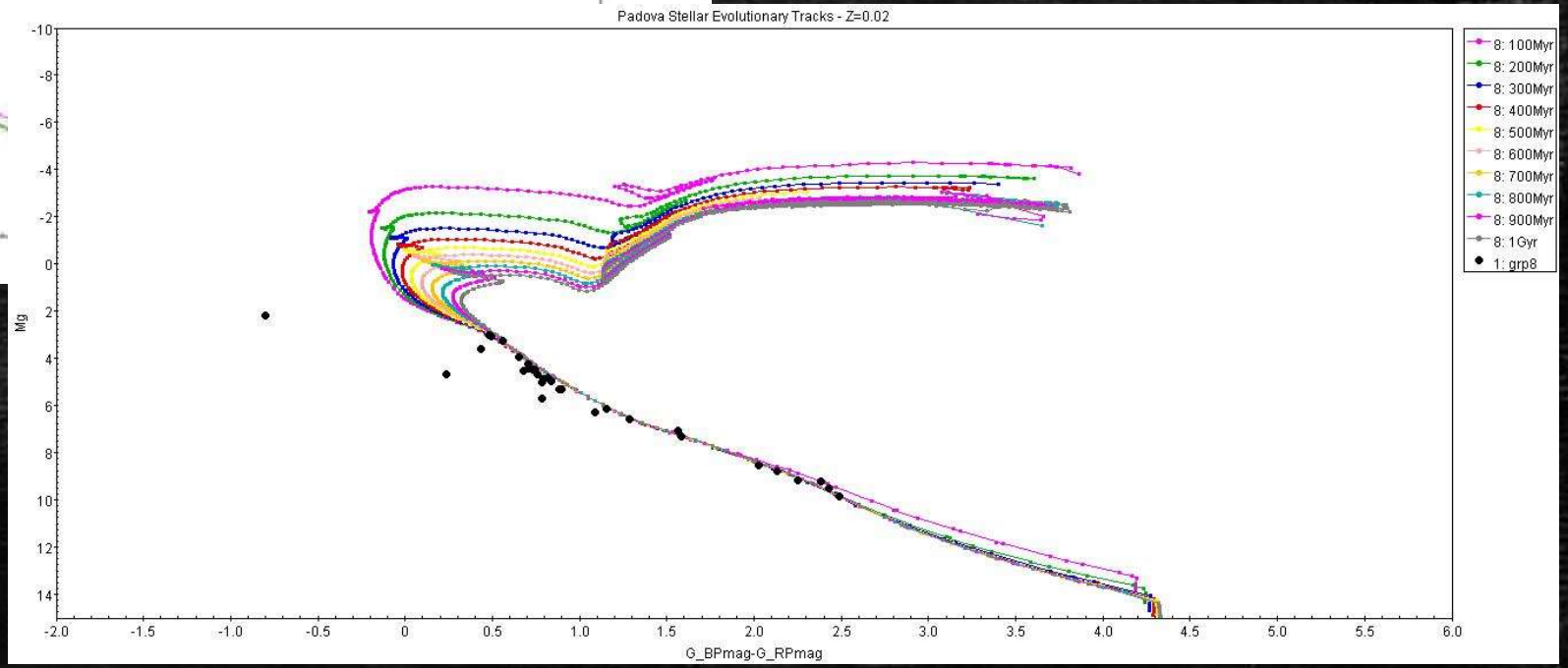


Padova Stellar Evolutionary Tracks : From 10Myr to 1Gyr Solar metallicity Z=0.02

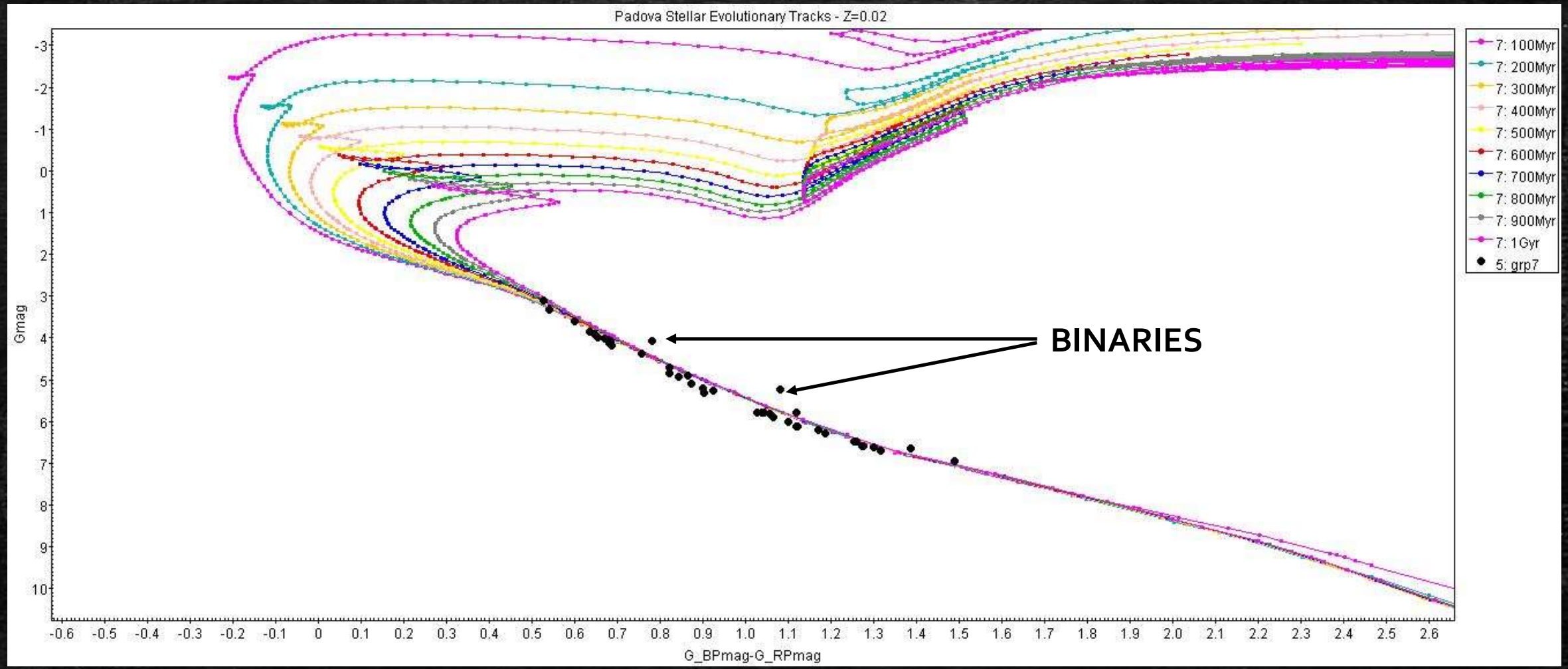
PART II

CMD AND ISOCHRONES - CONTAMINANTS





PART II
CMD AND ISOCHRONES



PART IV – Mass Function

Mass interpolation and repartition functions.

PART IV
MASS FUNCTION

Salpeter's mass function :

Mass in $M_\odot$

$$\xi(\mathfrak{M}) \approx 0.03 \left(\frac{\mathfrak{M}}{\mathfrak{M}_\odot}\right)^{-1.35}$$

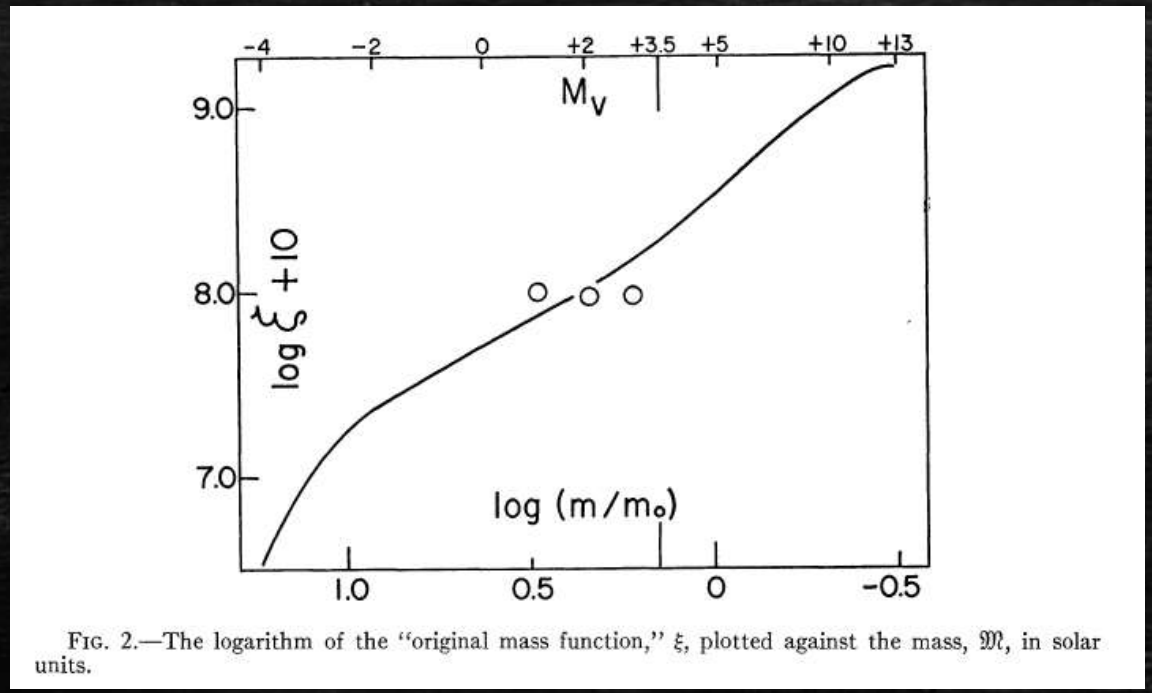
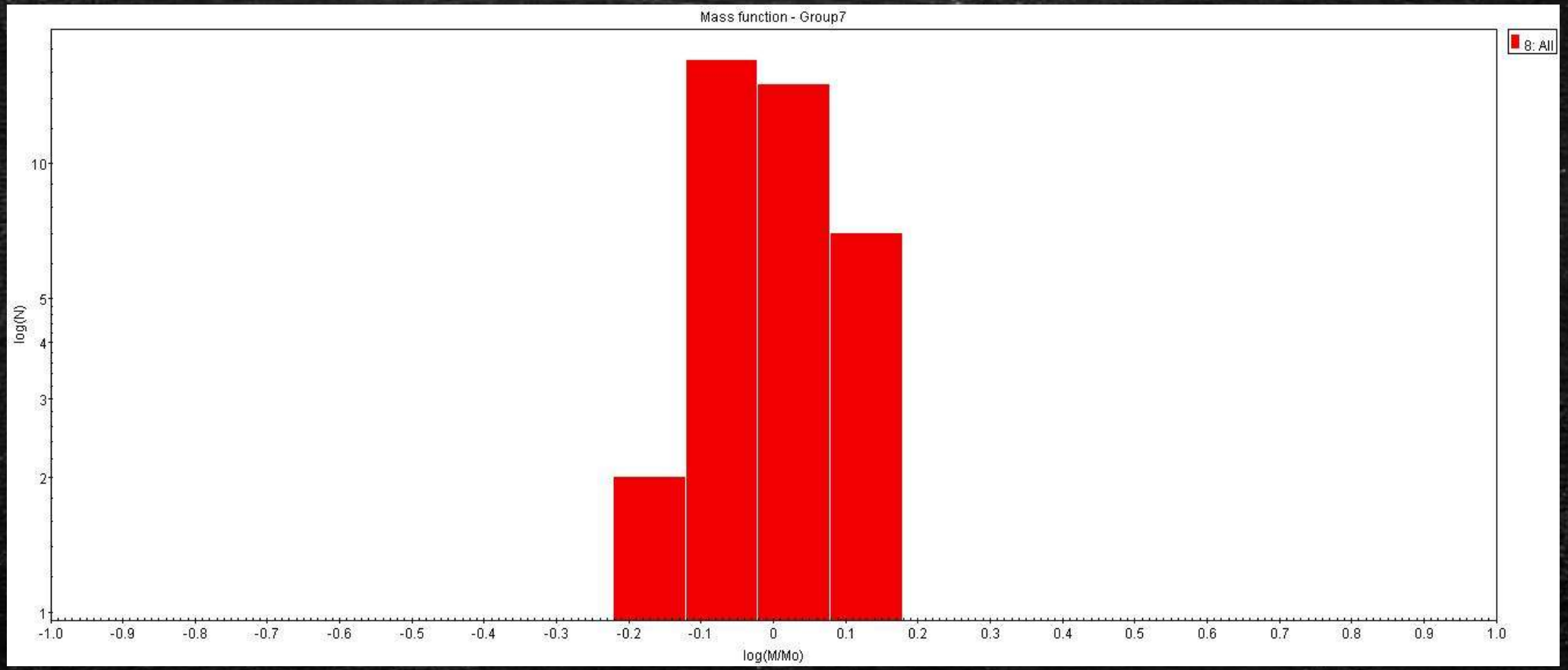


FIG. 2.—The logarithm of the "original mass function," ξ, plotted against the mass, $\mathfrak{M}$, in solar units.

PART IV
MASS FUNCTION

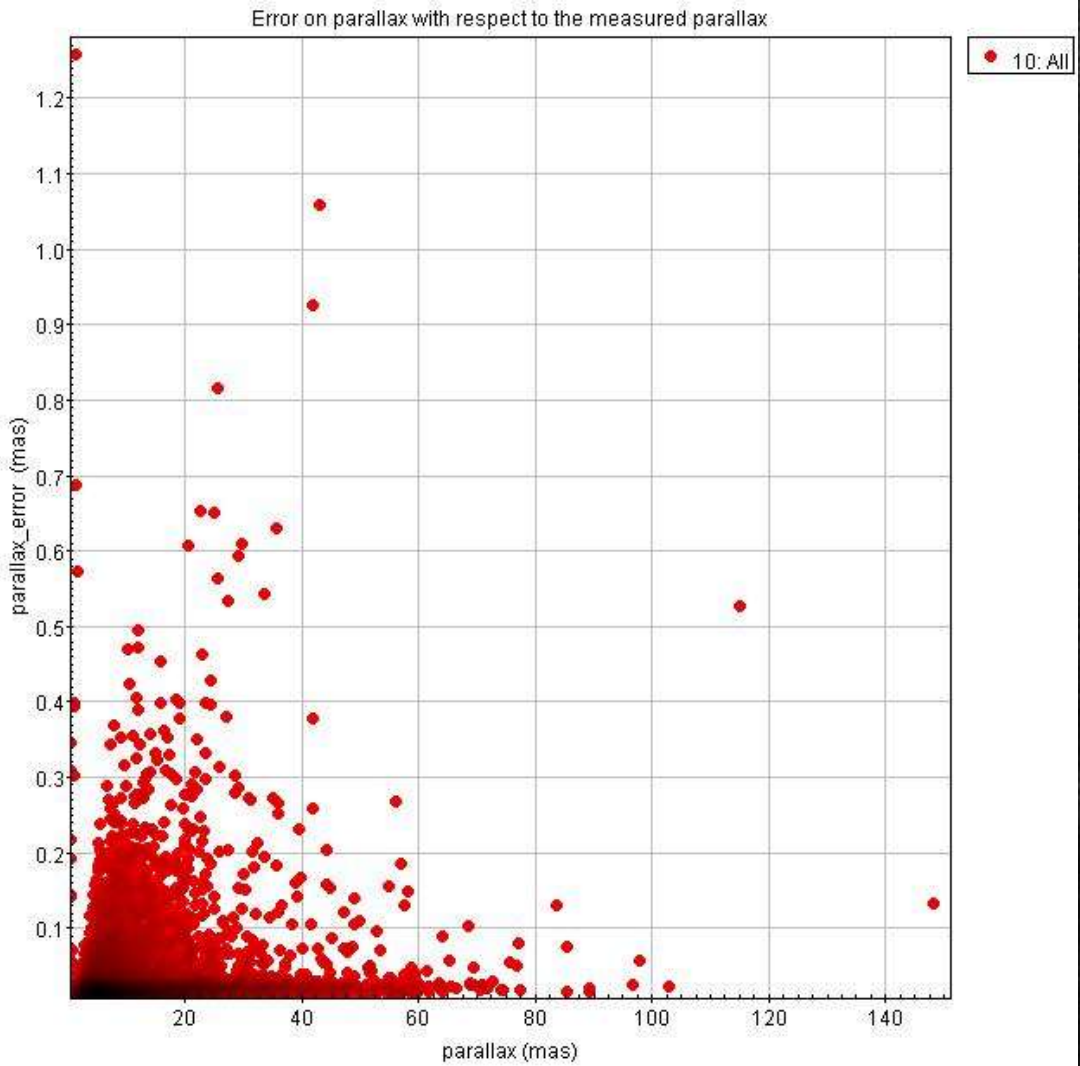


Interpolated mass from Padova Stellar Evolutionary Tracks

CONCLUSION

CONCLUSION

Incomplete data : error on parallaxes



The more distant the star, the more important the error on parallax :

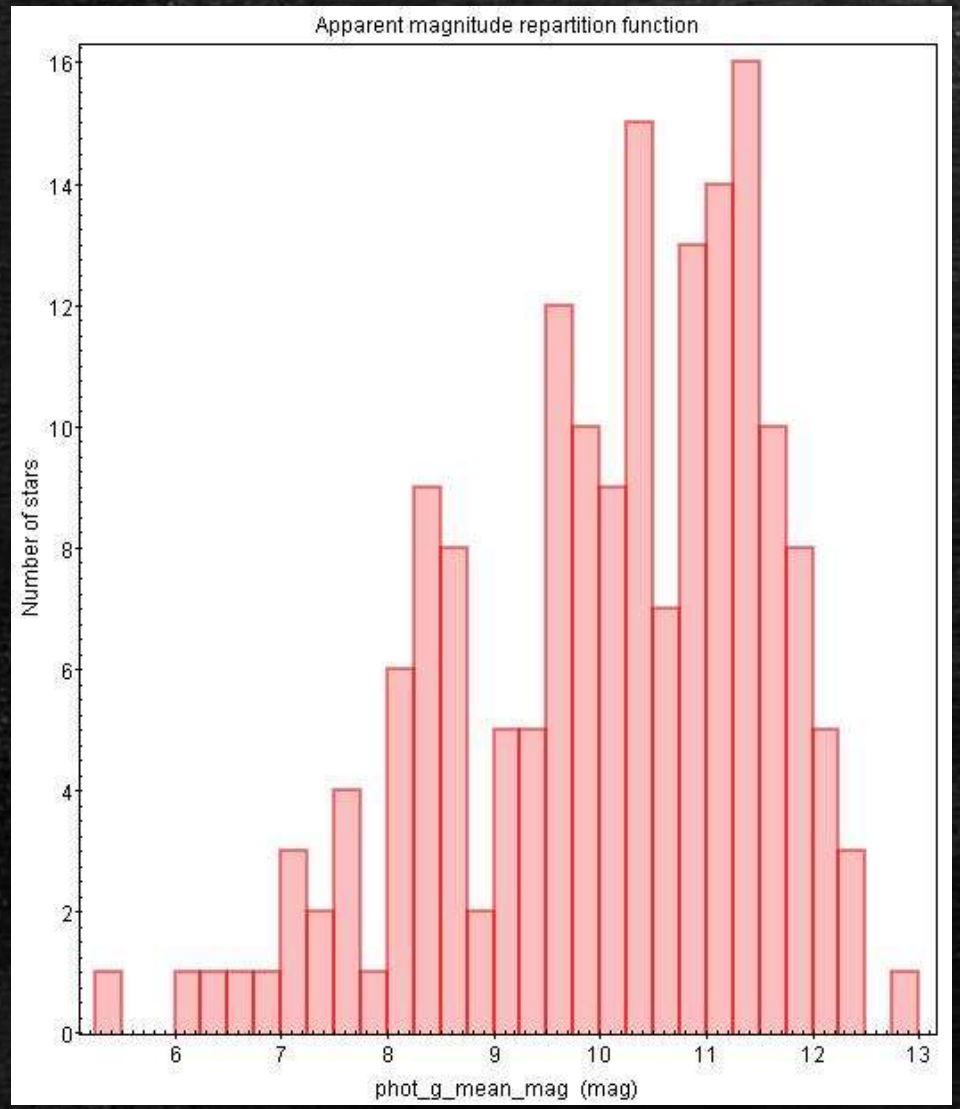
absolute magnitude is derived from parallax

$$M = m + 5\,(\log_{10} p + 1)$$

=> error propagation on interpolated mass

CONCLUSION

Incomplete data : cut on magnitudes



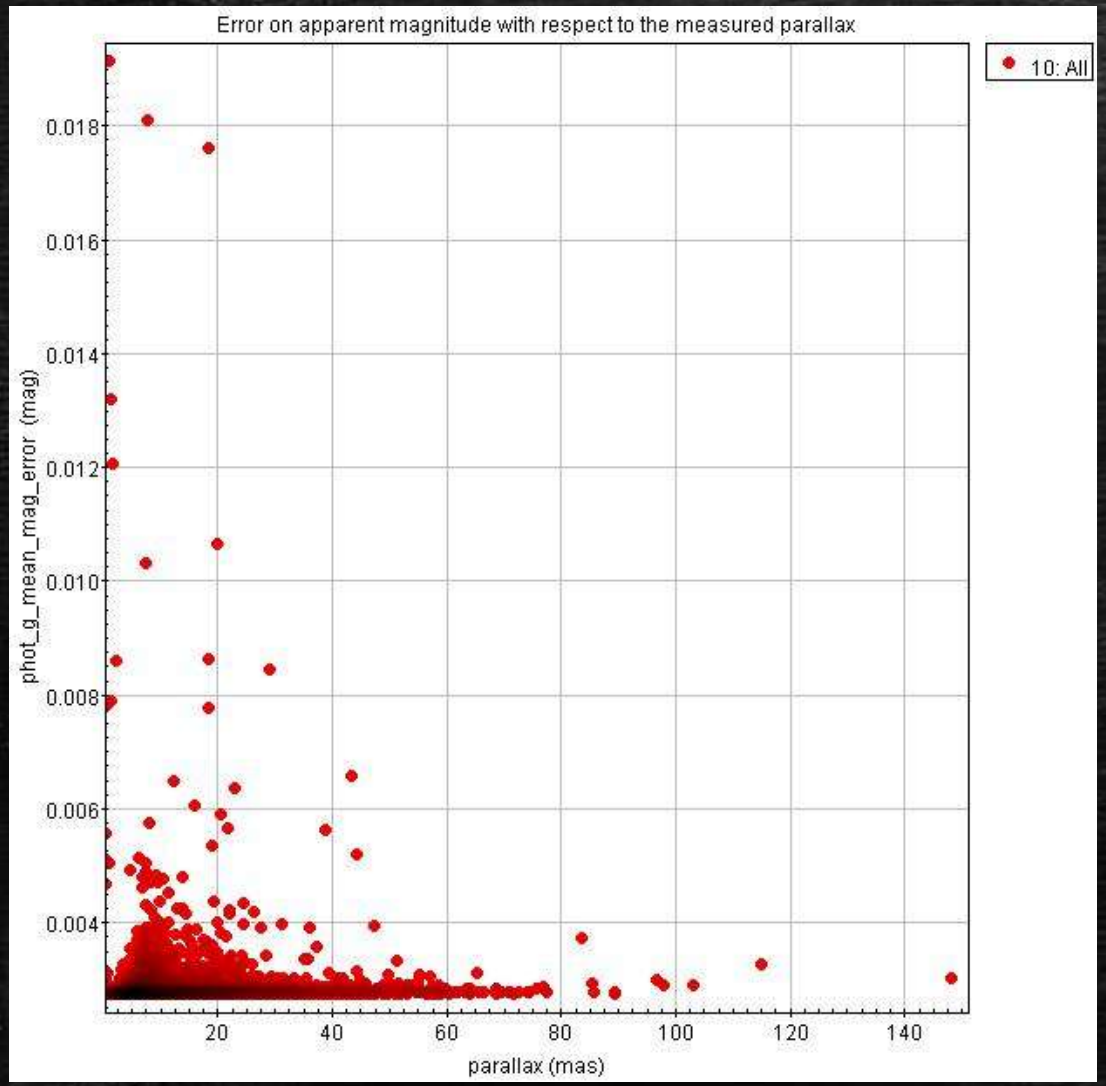
$3 \leqslant M_G \leqslant 13$

$$M = m + 5\left(\log_{10} p + 1\right)$$

=> Lack of data in distant and near stars

CONCLUSION

Incomplete data : cut on magnitudes



The fainter the object, the less acurate the astrometric data

=> Again, propagation error on mass function

CONCLUSION

Incomplete data and area for improvement

NO SIGNIFICATIVE NEW STRUCTURE

but

POTENTIAL NEW CANDIDATES TO KNOWN STRUCTURES (such like Ursa Major Comoving Group…)

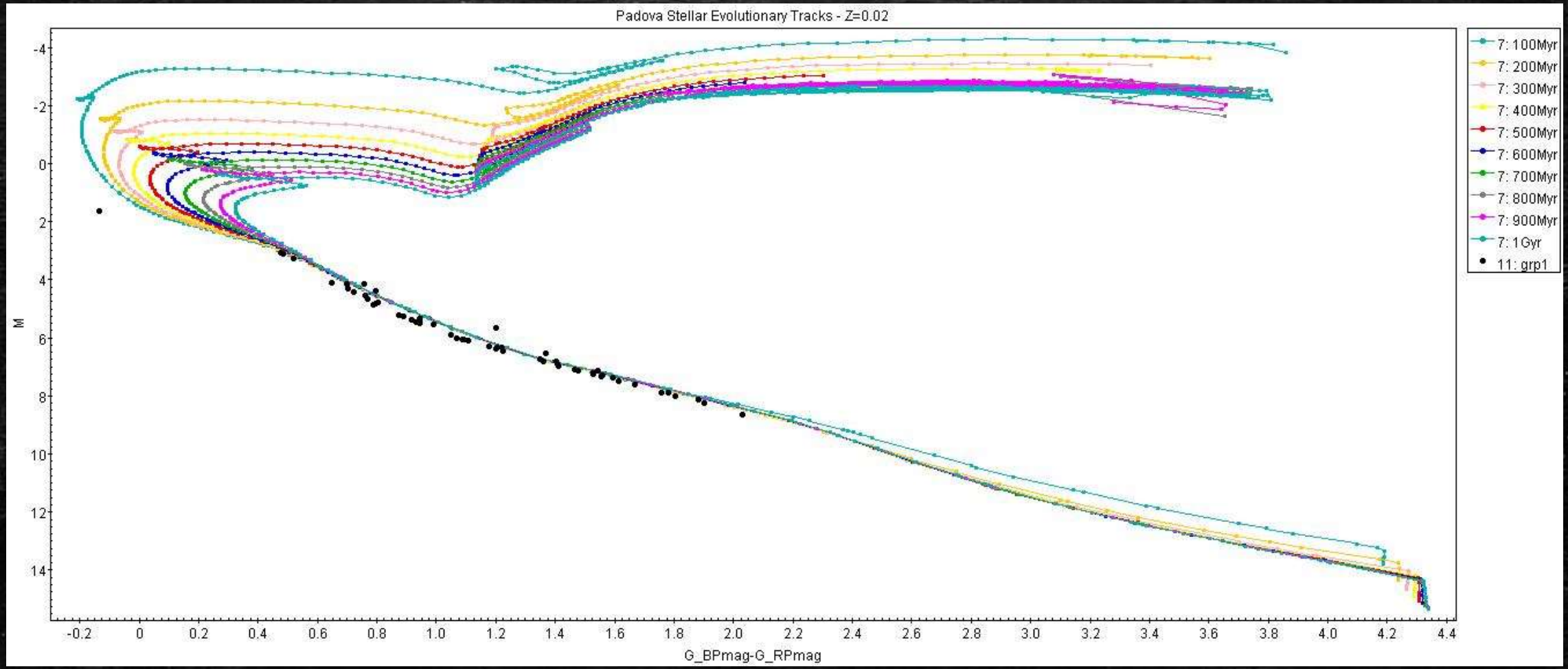
- Gaia's efficacity decreases for high magnitude
- No satisfying conclusion on age and mass function
- Area for improvement : larger sample of stars, consideration of stars with $13 \leqslant M_G \leqslant 21$ (actual limit of Gaia EDR3, but increasing error !)

CONCLUSION

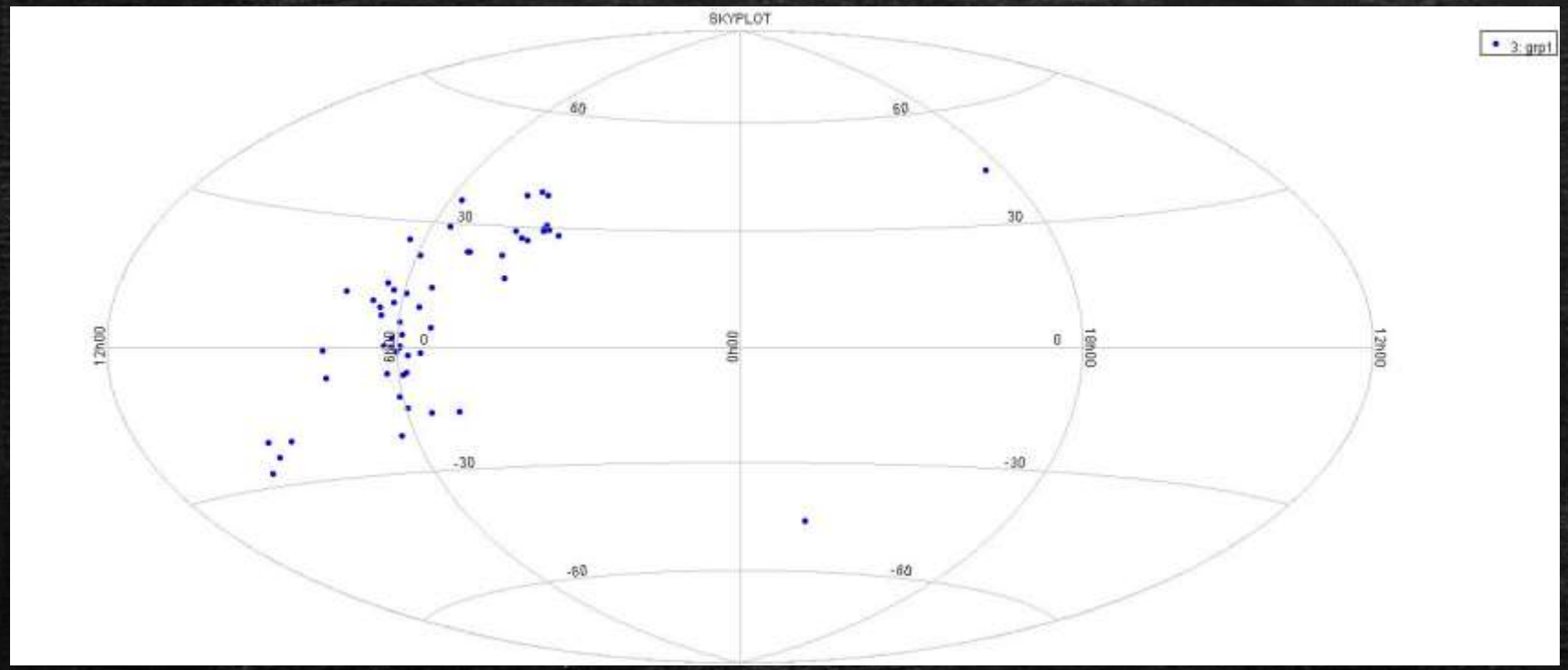
THANK YOU !

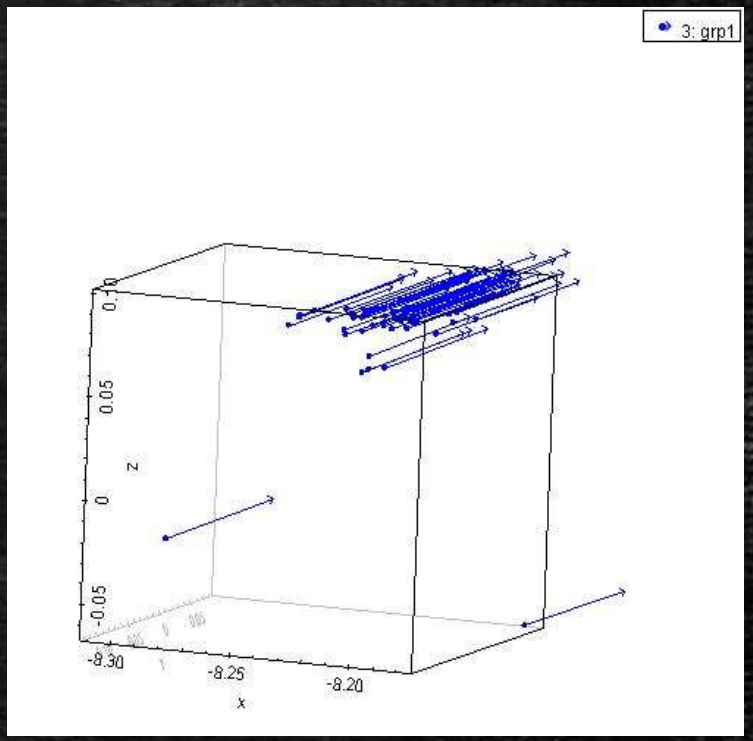
To be continued…

ANNEXES
Group 1

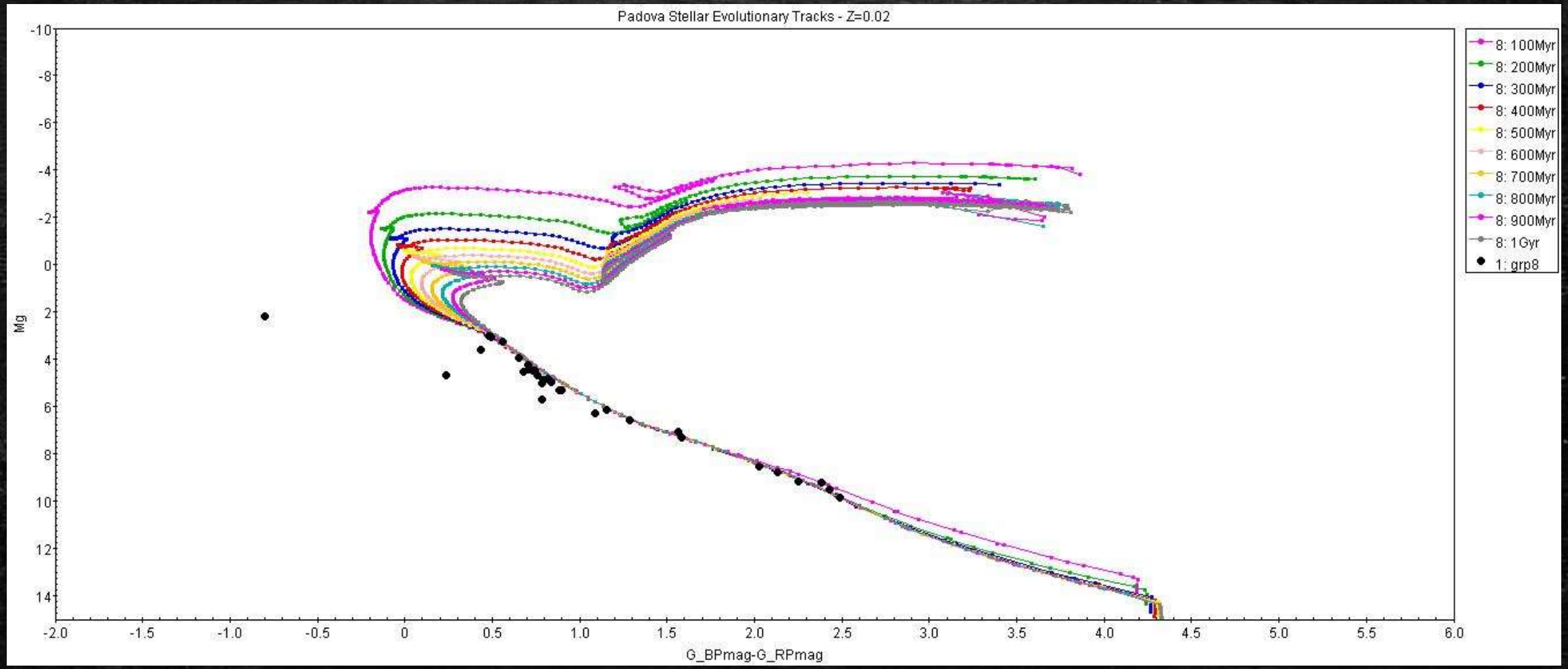


ANNEXES
Group 1





ANNEXES
Group 8



ANNEXES
Group 8