The star formation history of *Gaia* white dwarf population through its colour-magnitude diagram

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Introduction

The *Gaia* mission has provided a wealth of valuable information about our Galaxy. In particular, nearly 360,000 white dwarfs are available with accurate astrometric and photometric data [1]. Of those, ~12,000 objects form part of the volume-complete 100 pc from the Sun sample [2].

The excellent data provided by Gaia allows us to build an accurate colour-magnitude diagram of the white dwarf population. This diagram contains all imprints within the history of the Solar neighbourhood. The use of already tested methodologies to derive the formation history of galaxies [3] can be also applied to the white dwarf population of the solar neighbourhood. In this work we present the first preliminary results of this methodology.

1. Methodology

To obtain the star formation rate (SFR) of the Solar neighbourhood, colour-magnitude diagrams (CMDs) of synthetic samples of white dwarfs were generated [4]. Stars were selected by their total age and the corresponding CMD per burst is discretized in 100x100 boxes. The number of stars per box S_{ij} is calculated. In parallel, the same discretization is applied to the CMD of the thin disk dwarf population obtained from *Gaia* data, deriving thus the observed CMD distribution, O_{ij}.

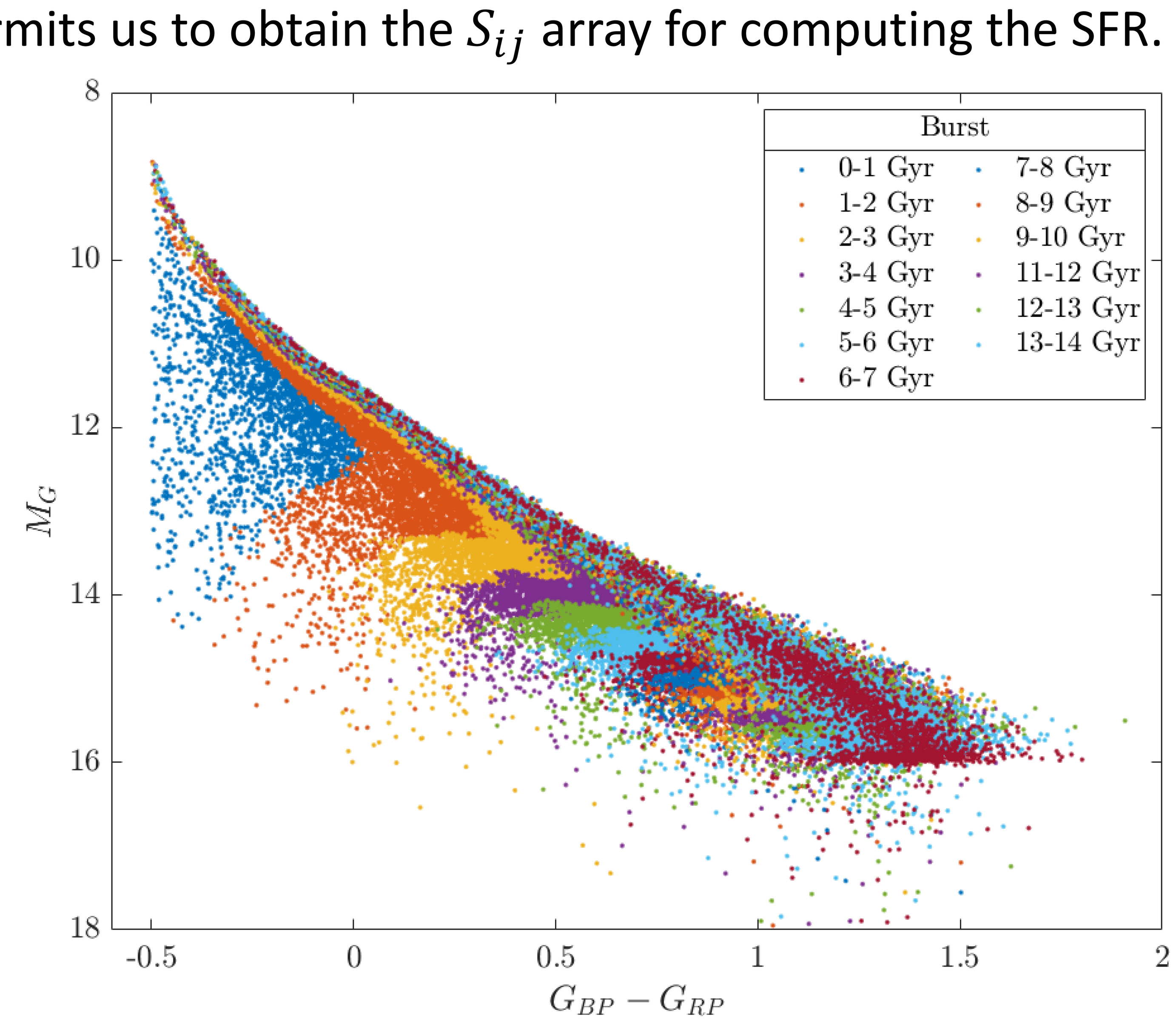
With these arrays, the Mighell's χ^2_γ, which is used as a merit function to compute the SFR, is computed for each burst [3]:

$$\chi^2_\gamma = \sum_{i,j} \frac{\left(O_{ij} + \min(O_{ij},1) - S_{ij}\right)^2}{O_{ij}+1}$$

Finally, the SFR is retrieved as the sum of the SFR for each burst weighted by the inverse of the χ^2_γ value.

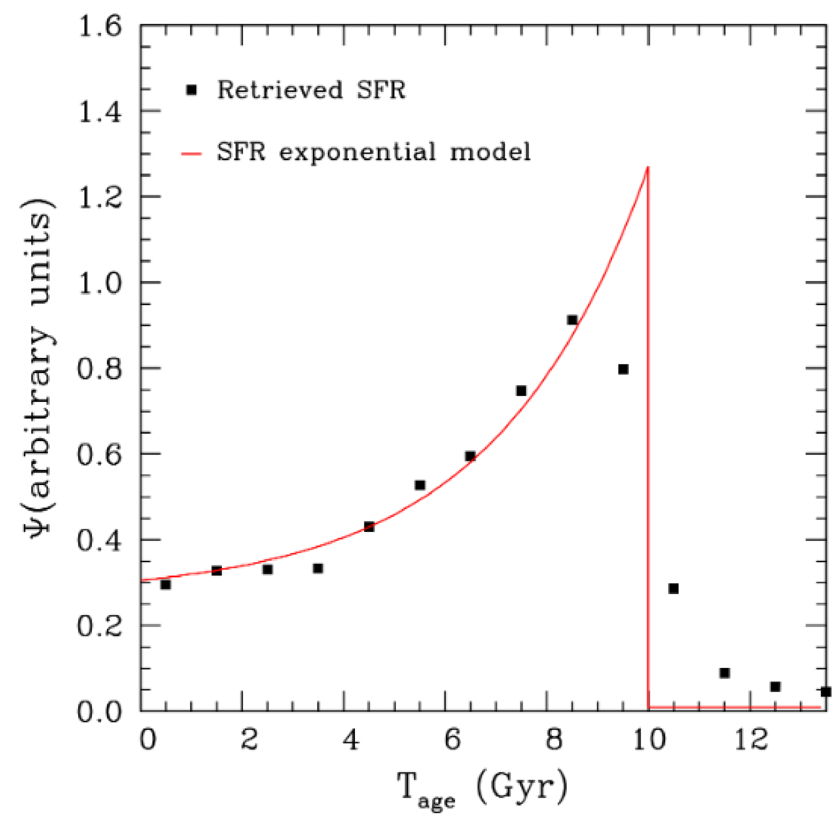
2. The synthetic sample

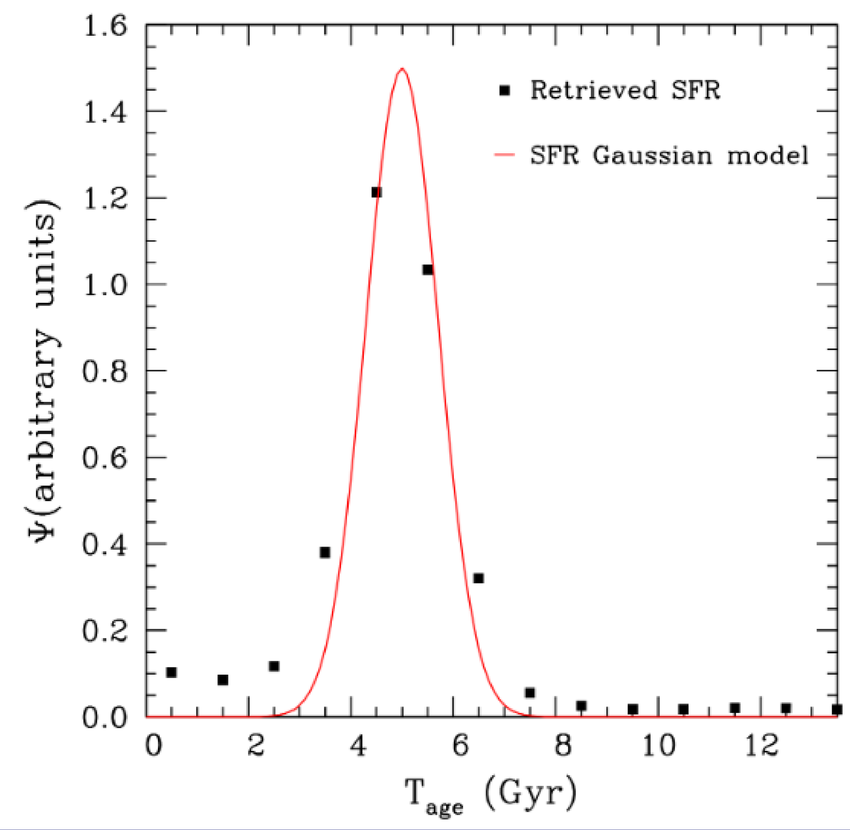
A synthetic CMD of DA white dwarfs is generated [4]. Stars are classified in 1 Gyr-bursts according to their total ages. This permits us to obtain the S_{ij} array for computing the SFR.



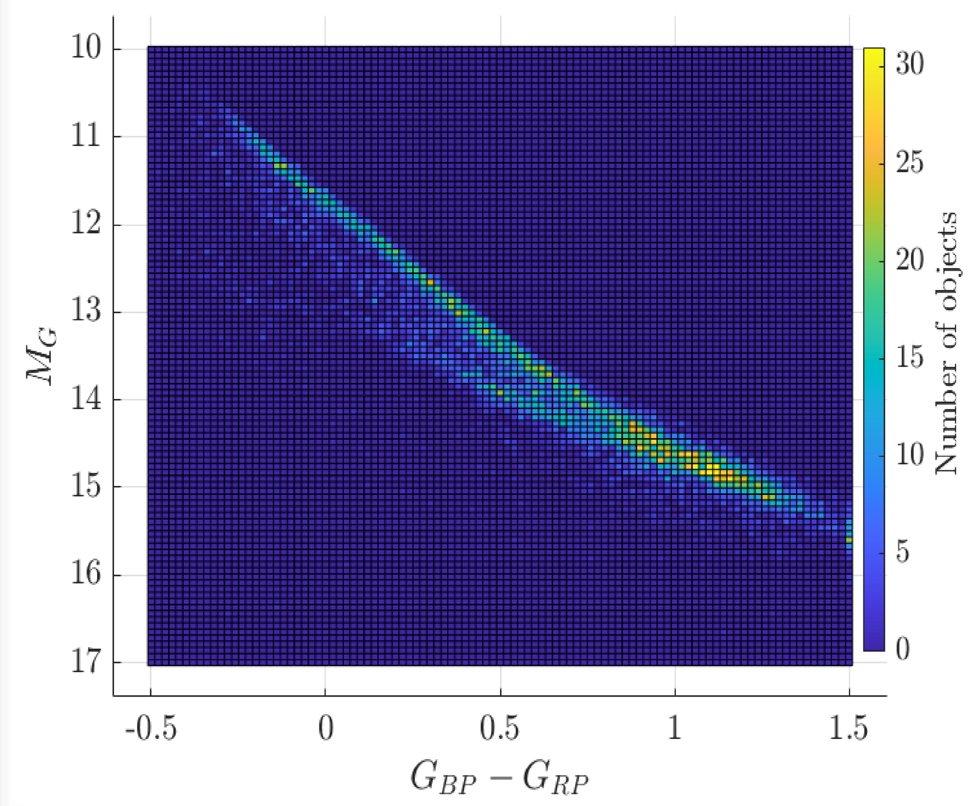
3. Testing the method

The validity and goodness of the method previously described was tested using different simulated sets, $\tilde{O}_{ij}$, retrieving the SFR (black dots) in good agreement with the theoretical SFR model (red line).





4. The *Gaia* observed sample

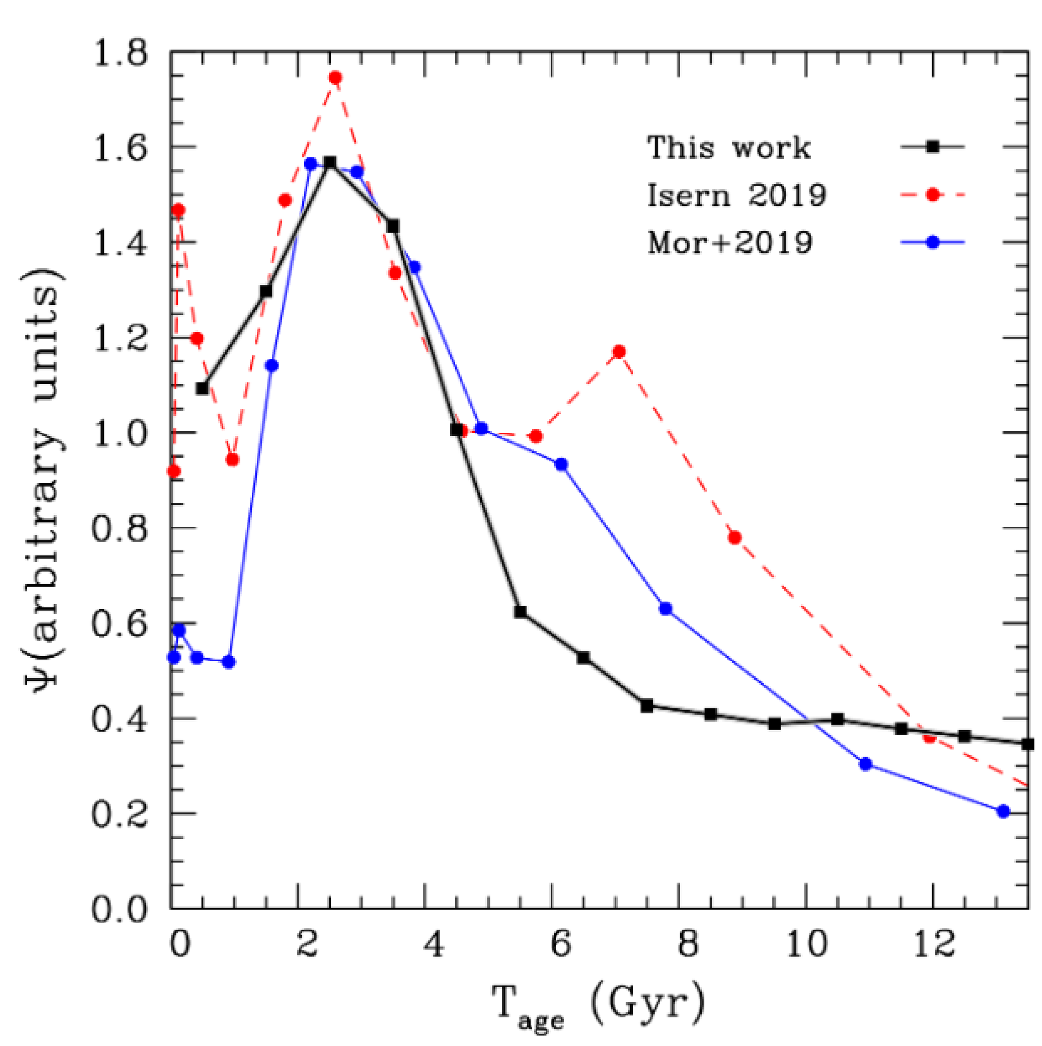


The last *Gaia* DR3 allowed us to derive the DA white population within 100 pc from the Sun [5].

Formed by ~12,000 objects, this sample is practically complete, thus being representative of the solar neighbourhood history.

Results and conclusions

After validation, the method has been applied to the DA white dwarf population of the Solar neighbourhood [5], allowing us to obtain the SFR for such sample of stars. The preliminary results show a good agreement with previous works [6, 7].



Ψ represents the quantity of mass, per unit time and unit volume, in arbitrary units. The Mor+2019[7] SFR is computed per unit area divided by a scale height law. All three SFRs are normalized to:

$$\Psi\left(\mathrm{T_{age}} = 5\ \mathrm{Gyr}\right) = 1$$

References

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