White Dwarf Synthetic Population

Dataset preparation-

Data Extraction-

Using **TOPCAT** Software, the dataset from GAIA DR3 is used to create a preliminary dataset for the project.

Data Modification-

- N.G Fusillo Paper was used to define the conditions for the dataset modification.
- The new dataset is modified using the following equation-

$$G_{\mathrm{abs}} > 6 + 5 \times (G_{\mathrm{BP}} - G_{\mathrm{RP}})$$
$$\text{AND PARALLAX_OVER_ERROR} > 1$$

- This reduced data was further used for analysis.

Standard Dataset-

The Standard dataset is taken from the SDSS DR16 which also contains the parameters introduced by N.G Fusillo.

Dataset Comparison-

These two datasets are compared on the basis of parameters like logg, Teff, absolute g magnitude etc.

Probability Density Analysis of Parameters

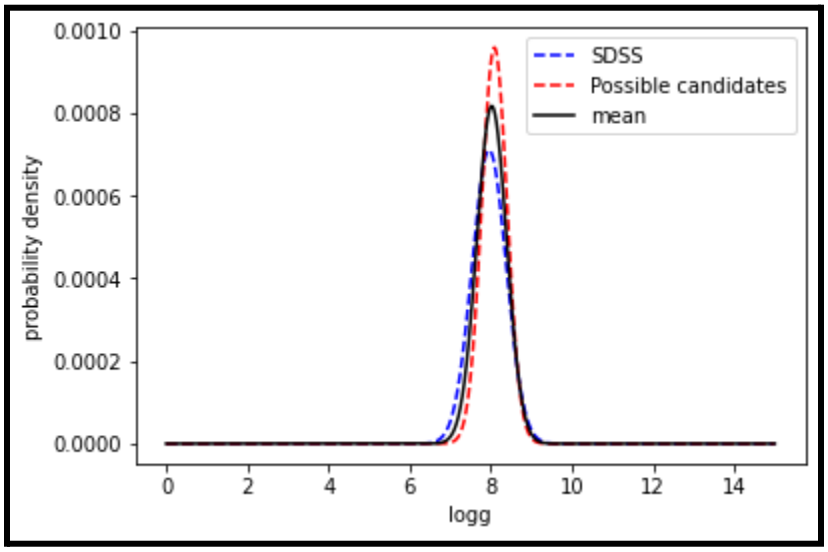
These plots include the analysis of different parameters from two datasets namely,

- Gentile Fusillo dataset
- Our dataset including the possible candidates from GAIA DR3.

In each plot there is a comparison between the datasets and a resultant mean curve showing the resultant dataset of the two datasets.

All the curves in the doc are normalized.

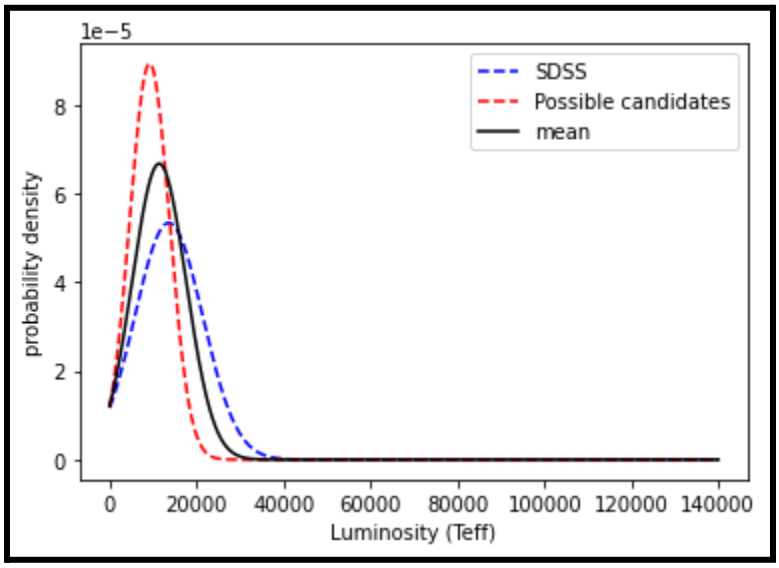
Surface Gravity (log g)



- ☐ **SDSS** = It is the dataset from Gentile Fusillo and SDSS.
- ☐ SDSS sample size= 179201
- ☐ **Possible candidates**= It is our dataset obtained from GAIA DR3.
- ☐ Possible candidates sample size= 55620

	SDSS	Possible candidates	Mean (Resultant)
Mean Value	7.9624	7.79	7.87
Standard deviation	0.4215	1.54	0.98

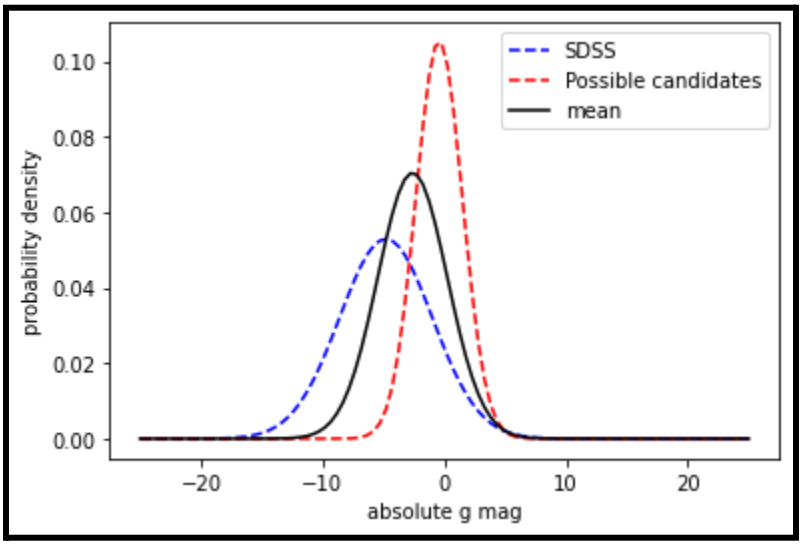
Luminosity (Teff)



- SDSS sample size= 179201
- Possible candidates sample size= 55620

	SDSS	Possible candidates	Mean (Resultant)
Mean Value	13603.26	9196.39	11399
Standard deviation	7794.03	4571.23	6182.31

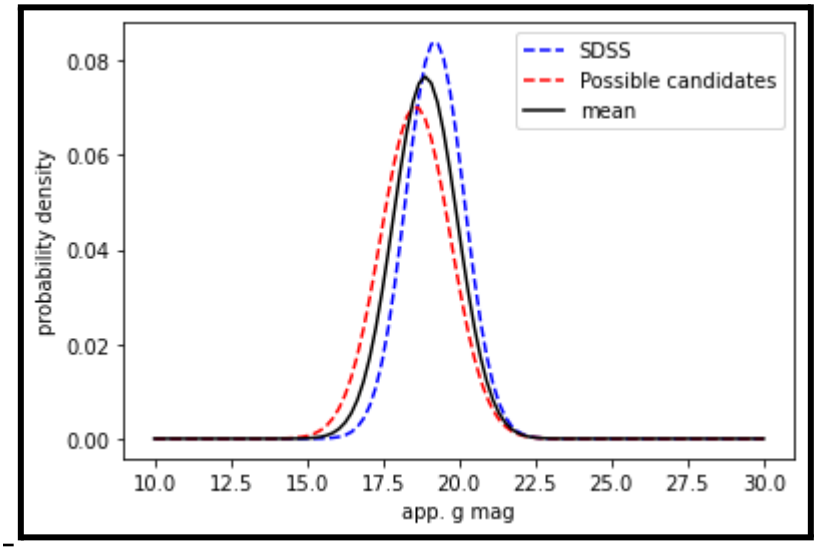
Absolute G magnitude



- SDSS sample Size= 238683
- Possible candidates sample size= 57727

	SDSS	Possible candidates	Mean (Resultant)
Mean Value	-4.805	-0.44	-2.622
Standard deviation	3.808	1.91	2.859

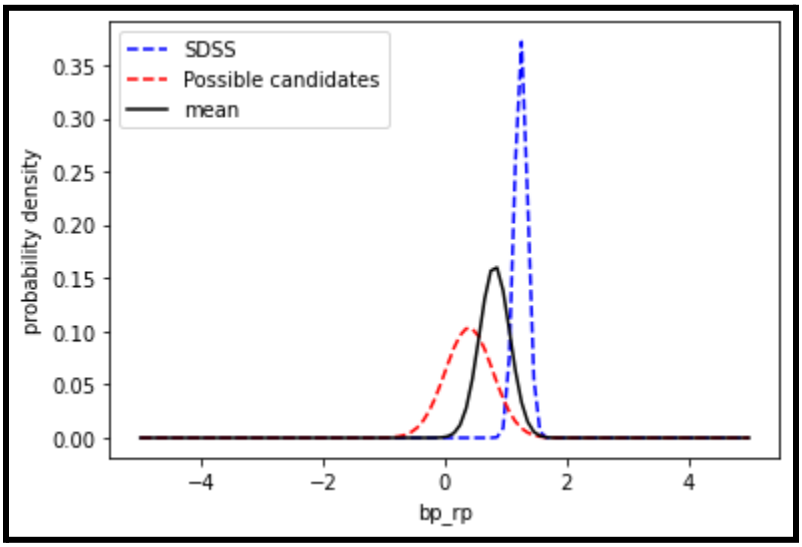
Apparent G magnitude



- SDSS Sample Size= 238683
- Possible candidates sample size= 57727

	SDSS	Possible candidates	Mean (Resultant)
Mean Value	19.210	18.573	18.89
Standard deviation	0.958	1.147	1.052

Bp-rp



- SDSS Sample Size= 238683
- Possible candidates sample size= 57727

	SDSS	Possible candidates	Mean (Resultant)
Mean Value	1.254	0.40	0.82
Standard deviation	0.108	0.39	0.25

WD Phottools Toolkit

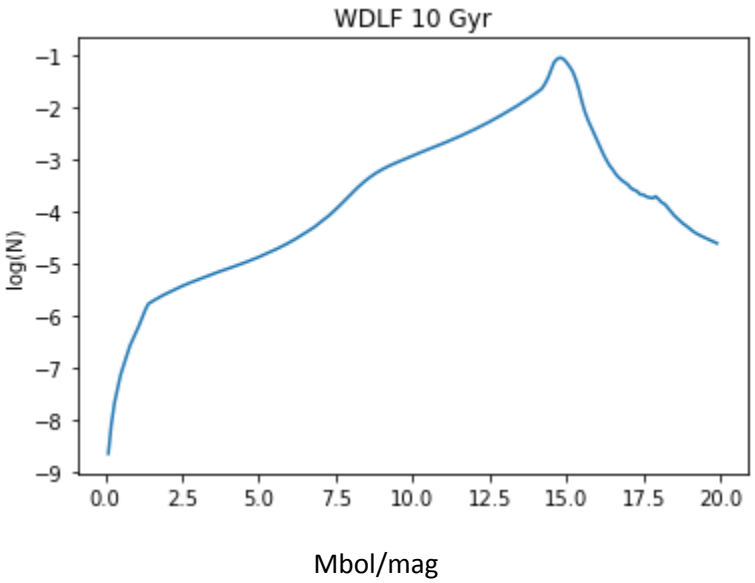
WD Phottools is a toolkit developed by Marco Lam for the photometry of the white dwarfs and also generating WDLF (White Dwarf Luminosity Function). This toolkit is still new in the community but its capabilities are unmatched for white dwarfs.

I have used this toolkit to create a WDLF for a synthetic population after giving some models into the toolkit. It basically creates the whole population for you and also simulates it for the time set by you for eg. 1 Gyr. After simulation it gives out the luminosity of the population at

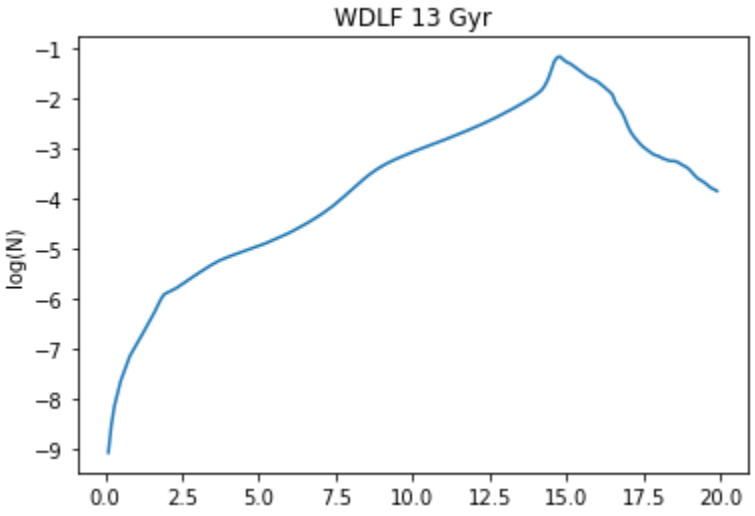
the end of the lifetime in the form of bolometric magnitude. This bolometric magnitude can be converted into Teff of the population.

The output of some of the simulations is given below-

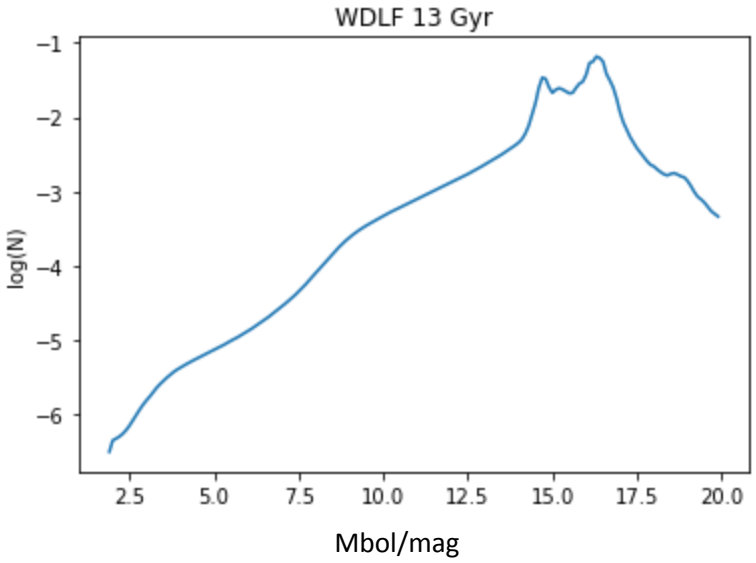
WDLF plots



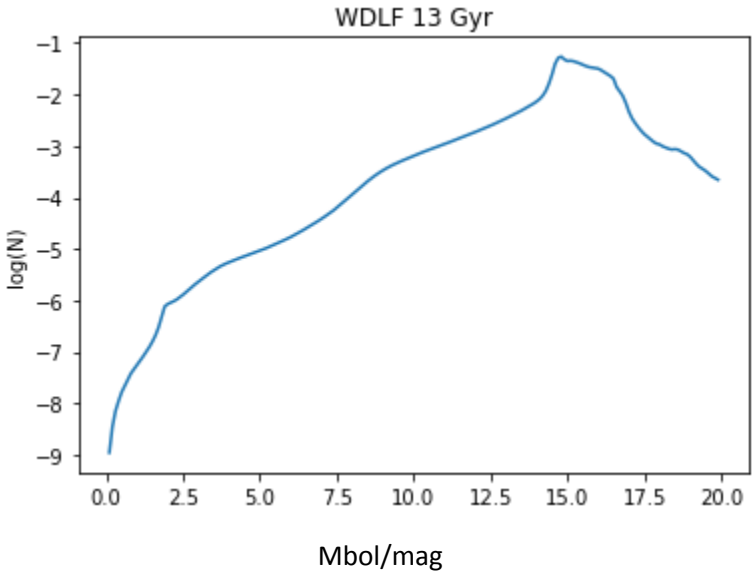
- Cooling model- **montreal_co_da_20**
- IMF model- **Chabrier 2003**
- Stellar evolution model- **PARSECz0017**
- IMFR model- **Kalirai**
- SFR model- **Constant**



- Cooling model- **montreal_co_da_20**
- IMF model- **Kroupa 2001**
- Stellar evolution model- **PARSECz0017**
- IMFR model- **Katalan model**
- SFR model- **Constant**

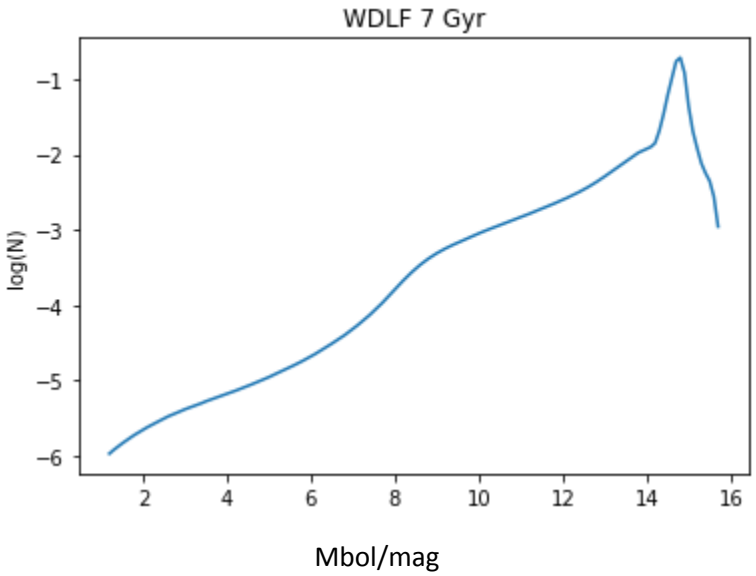


- Cooling model- **montreal_co_da_20**
- IMF model- **Kroupa 2001**
- Stellar evolution model- **PARSECz0017**
- IMFR model- **Katalan model**
- SFR model- **Burst**



- Cooling model- **montreal_co_da_20**
- IMF model- **Kroupa 2001**
- Stellar evolution model- **PARSECz0017**

- IMFR model- **Katalan model**
- SFR model- **Exponential decay**



- Cooling model- **montreal_co_da_20**
- IMF model- **chabrier 2003**
- Stellar evolution model- **PARSECz001**
- IMFR model- **Salaris model 2009**
- SFR model- **Burst**

Further Planning

New Dataset

- Creating a complete catalog of this new dataset made from the mean curves in the plots.
- Random choice functions can be used on the dataset to generate a new synthetic population catalog.
- Producing a Synthetic H-R diagram from that population.
- Simulations on this population to predict the existence of new white dwarfs.

WDLF (using Toolkit)

- Using the simulated WDLF to get the Teff.
- Creating a Catalog using this Teff by fetching the parameters from standard catalogs and datasets after matching their Teff (Luminosity).
- This new catalog can further be used for the simulation and predicting new populations in the cosmos.

Important Links

- Standard Dataset- Standard Dataset from SDSS DR 16
- Our Dataset- Dataset from GAIA DR3
- N.G Fusillo paper- Paper
- WD Phottools Toolkit Manual/Paper- Marco Lam Paper