The Montreal White Dwarf Database: a Tool for the Community

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Abstract. We present the "Montreal White Dwarf Database" (MWDD), an accessible database with sortable/filterable table and interactive plots that will, when fully completed, allow the community to explore the physical properties of all white dwarfs ever analyzed by the Montreal group, as well as display data and analyses from the literature. We present its current capability and show how it will continuously be updated to instantly reflect improvements made on both the theoretical and observational fronts.

1. Introduction

The last decade or so has seen a dramatic increase in the number of spectroscopically identified white dwarf stars, going from about 2500 at the beginning of the millennium to around 30,000 at the time of this writing. For many years, one of the most important places to look for information about white dwarf stars has been the George P. McCook and Edward M. Sion White Dwarf Catalog (www.astronomy.villanova.edu/WDcatalog/). However, this catalog currently contains "only" 14294 objects (it was last updated in 2013), leaving many new SDSS white dwarfs behind. Moreover, this invaluable resource contains very little information on the physical parameters published in the literature.

As a result of the huge amount of data and analyses now available, keeping an eye on the big picture has become increasingly difficult. Many basic questions now require a tremendous amount of work just to get updated and obtain accurate answers. Questions such as: How complete is the census of white dwarfs within a given distance of the Sun? How many have metals, are magnetic, are in binary systems, or are He-rich? What fraction of these are there as a function of effective temperature? What are the properties of any given population? What are their mass distributions, luminosity functions, etc.? To answer those questions, one usually needs to compile all the information from the literature, double check it, look out for updates, and assess how recent data/models change the picture. This is a very time-consuming task that has to be repeated again and again as time moves forward. Even the most comprehensive efforts are practically out-of-date very soon after they are published (for the local sample, Holberg et al. 2008; Giammichele et al. 2012, come to mind).

1 www.montrealwhitedwarfdatabase.org
A tool that would allow to easily get answers to those basic questions would certainly be useful to all of us. This is why we decided to make good use of the little surplus money from our organization of the previous workshop in Montreal and give it back to the community by creating this database. In what follows we present the main characteristics of MWDD as well as our vision of it in the near future.

2. Database Description

The Montreal White Dwarf Database aims to gather in one place all the information and available data about the spectroscopically identified white dwarf that have been discovered to this day. Interactive tables and tools to easily make plots, histograms or display data have also been implemented (see below). The structure and philosophy behind MWDD was inspired in parts by other databases available to the exoplanets community such as http://www.openexoplanetcatalogue.com/ and http://exoplanets.org/.

We constructed a compilation of known white dwarf stars by simply copying in spreadsheets (one .csv file per paper/source) all the information (names, magnitudes, effective temperature, surface gravity, abundances etc.) contained in the tables of well known papers that analyzed large samples (we also included compilations from a few review papers and websites). Since a star can be published under many different names, each star is assigned a unique identifier via Simbad. This allows us to automatically merge together as one entry in the database objects entered under different names in different papers. MWDD currently includes data compiled from 120 papers for a total approaching 30,000 white dwarfs. As more papers are linked to the database its degree of completeness will improve.

2.1. Search Filters

We implemented numerous filtering options to allow anyone to quickly isolate certain types of white dwarfs of interest or do some statistics. It is currently possible to filter by numerous parameters such as coordinates, effective temperature, mass, distance and magnitude as well as some important white dwarf characteristics such as their spectral type, surface composition, variability or magnetism. Plots, histograms, statistics and the table (see below) are automatically updated to reflect the choices made in the search filter section.

![Filter interface in MWDD.](image-url)
2.2. Table

All the properties compiled in the database can be selected and viewed via the "Table" tab. Table columns are drageable and sortable. Clicking on "Options" allow the user to select among a long list of available parameters. One can also search by name, or enter a list of names. It is also possible to export the data of all objects that pass the filters.

The values presented in the table are the last published ones (except for a few sources which have been given lower priority). In the future, a quality flag to use what we consider the best values will be implemented. Meanwhile, we encourage users to go on the individual white dwarf page in order to view the various literature values included in the database and assess themselves which parameters are to be trusted most.

![Figure 2](image.png)

**Figure 2.** An example of the table interface.

2.3. Plots, Histograms and Statistics

JavaScript is used to make the numerous interactive plots and histograms in the user interface. The "Scatter Plot" tab allows to plot any physical quantities as a function of another. Only stars passing the selected filters will appear. Moving the mouse on an object highlights its basic atmospheric properties and clicking on it opens an individual white dwarf page (see below). It is possible to export the stars data present in a plot in order to make your own plot by selecting "Show only stars visible in Scatter Plot" in the "Table" tab.

The "Histogram" tab allows, for example, to quickly get the mass distribution of selected objects or distribution of any other variable of interests. One can also easily get a measure of the current status of our census of white dwarfs within a given distance from the Sun in the "Cumulative Number" tab (see Holberg et al. 2008). For example, by clicking on "40 pc sample" in the Presets options, one can see that we estimate a 50.0% completeness within that distance. These numbers are automatically updated as new papers are published and included in the database, allowing the community to get an instant picture of our neighborhood.

2.4. Individual white dwarf page

Each object in the database has an individual page (accessible via the "Table" tab, or by clicking on an object in the "Scatter Plot" tab). All the references included in the database that contain that object are listed for an easy comparison between parameters.
from different sources. Spectroscopic data, when available, can also be visualized interactively. This includes all SDSS spectra, IUE archive data, and many of the spectra secured by the Montreal group in the last 3 decades. Optical spectra for more than 97% of the stars included in the database can currently be viewed and downloaded. We hope MWDD eventually becomes a standard repository of spectra for everyone to use. If you are in possession of worthy data and wish to share them with the community, we will be glad to link them to the database.

2.5. Evolutionary models and diffusion timescales

One of the most frequent request we routinely receive concerns the white dwarf properties (mass, radius, cooling age etc.) for a given surface gravity, temperature and composition. These numbers can now be easily accessed directly on the MWDD webpage. For pedagogical purpose, a cartoon of the white dwarf size relative to Earth also automatically appears when the user enters \( \log \frac{g}{T_{\text{eff}}} \). Another frequent request concerns the diffusion timescale of heavy elements at the surface of white dwarf stars.
Figure 5. An example of an individual white dwarf page (van Maanen 2).

Some 25 years after Paquette et al. (1986), we improved significantly on their calculations of diffusion coefficients by 1) using a much more accurate numerical scheme for estimating the so-called collision integrals, and 2) introducing a more physical prescription of the screening length used as the independent variable in the evaluation of these coefficients. Details of these improved calculations will be provided elsewhere. An interpolation routine allows the users to enter log $g$ and $T_{\text{eff}}$ and obtain the settling timescales for all 27 elements from Li to Cu in the periodic table (also downloadable as a plain text file).

2.6. What's next?

The next step, among other things, to improve the usefulness of the database to the community will be to add the possibility to make luminosity functions and filter with S/N ratio, wavelength range coverage and resolution of the spectroscopic observations. A comment section to discuss individual object or general topics will also be implemented. We also plan to include our own results from model atmosphere fitting. In the near future, we will include photometric/spectroscopic fits and distance estimate for every single objects present in the database (i.e. stars that can easily be fitted with a standard grid such as single DA, DB, DC and DQ stars). The homogeneity of the analysis should allow a much clearer view of the properties of white dwarf stars in general. Moreover, once all the data from the database will be directly linked with our fitting routine, it will be much easier to update the parameters whenever new data, or new grids become available. For example, when Gaia’s parallaxes become available, it will be possible to provide instantly to the community the mass distribution of cool white dwarfs by simply adding one single file to the database (white dwarf names + parallaxes) and then running our fitting routines (which typically takes a few seconds per objects). More complicated stars that stand out will then be treated accordingly and included once we are satisfied with the results.

We should stress that the database is not complete (it only includes data found in a few selected papers) and should not replace in any way a thorough search through the
literature. It is nevertheless a good place to start to quickly get information about any
given star. While we will periodically link new paper’s data to the database, it is our
hope the members of the community will participate in our efforts to make the database
as complete as possible by submitting .csv files (templates are available) for their own
work or interesting papers not included yet. We welcome contributions and corrections
from all professional astronomers and white dwarf aficionados.

If using MWDD was useful for your research, please cite this manuscript and
include an appropriate acknowledgment, a very simple action that will help us tremen-
dously in getting the funding necessary to maintain/improve MWDD in the future.

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