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Stellardb: A Stellar Abundances Database

C. J. Ödman[1,2] and R.G. Izzard[1]

[1] Carolune Institute for Quality Astronomy, http://www.carolune.net/ciqua/
[2] Dipartimento di Fisica, Universitá di Roma "La Sapienza", Ple Aldo Moro 2 – 5, 00185 Roma, Italy

Abstract. We present *Stellardb*, a database of astronomical observations of various objects from stars to Lyman-α clouds. We describe its web-based interface and features. The database is designed to be an interactive and searchable compilation of published stellar abundance surveys. This project is work in progress.

Key words. Database – Observations – Stellar Abundances – Abundances

1. Motivation

It is now possible to model entire populations of single and binary stars with nucleosynthesis (Izzard 2004). This represents an important progression in our understanding of the chemical evolution of the interstellar medium. The importance of binary stars for the origin of heavy elements in the ISM is significant and such yields should be accounted for (Izzard, these proceedings) Accounting for multiple stellar systems provides plausible explanations for dim carbon stars (Izzard & Tout 2004) and some chemically peculiar stars might originate in interacting systems.

On the observational front many data still need theoretical explanations. Available observations are limited by several factors including magnitude, object selection or even the taste of the astronomer. Magnitude limitation of surveys is critical because distances are measured through magnitudes and the subsequent bias towards bright objects makes it difficult to limit a sample of objects according to volume.

The measurement of the abundances of various isotopes in stars and other objects is a difficult task. Observed objects can be dimmed by the presence of contaminants in the stellar environment. Multiple systems might not be resolved and mechanisms of feedback of enriched material into the ISM are not fully understood.

Stellar population nucleosynthesis models depend on a large number of input parameters which have to be calibrated somehow to observed populations. The inclusion of binary parameters in such an analysis increases the number of dimensions to be investigated and a correspondingly large amount of accurate data are needed to constrain the free parameters.

In an ideal world theoretical stellar populations would be generated. Perfect observations would be obtained with no loss of information or measurement errors. These two sets could be compared with each other and the constraints obtained on the multiple parameters of the theoretical models could serve as a basis for more

Send offprint requests to: C.J. Ödman
Correspondence to: Dipartimento di Fisica, Universitá di Roma "La Sapienza", Ple Aldo Moro 2 – 5, 00185 Roma, e-mail: carolina.odman@roma1.infn.it

Fig. 1. *Stellardb* home page: each paper is linked to the ADS database.

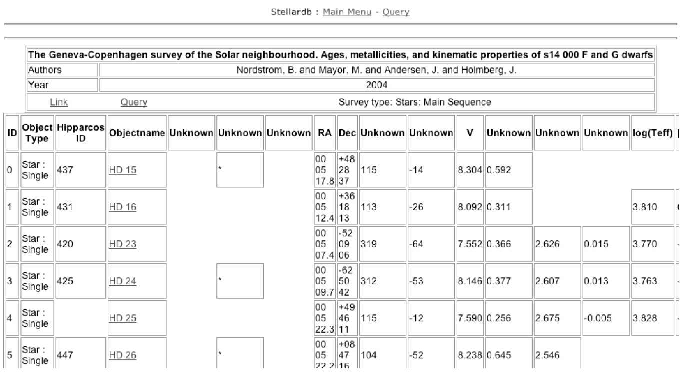

Fig. 2. The data in each paper can be examined without downloading the entire paper.

detailed stellar evolution modelling. In reality this is not the case. The theoretical populations depend more or less strongly on a plethora of parameters of physical and numerical nature, as well as prescriptions concerning the behaviour of the stars. Uncertainty pervades the results.

Population synthesis allows the effect of each parameter to be investigated. Once a complete population is generated, the bias and limits of the observations can be simulated to mimic the observational selection effects. This reproduction of observational parameters is in itself a difficult task.

Astronomical observations are equally challenging. They rely on high-quality instruments with constantly evolving technology, good weather and other atmospheric or spatial conditions. The pipeline leading from the capture of light to the published abundances contains uncertainties and approximations. Large amounts of data can help reduce uncertainties.

In order to make data available we started the development of *Stellardb* a database of stellar abundance determinations taken from the literature with a web front end. We present it here in its status as of August 2004. It contains about 20,000 objects from over 40 pub-

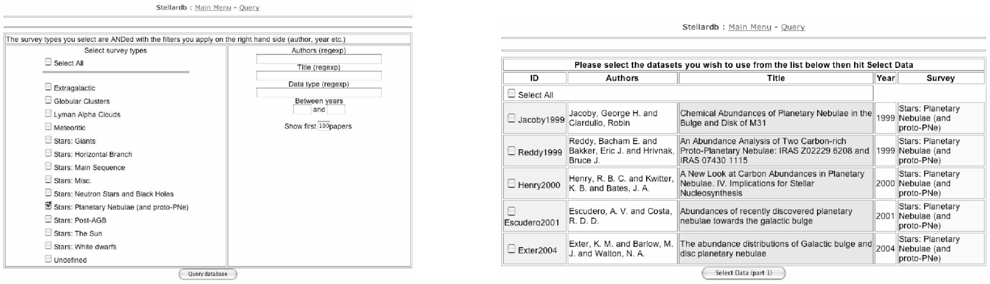

Fig. 3. The database query: the first selection is performed according to object type, by paper or both. The query results are displayed as a list of papers. See text for details.

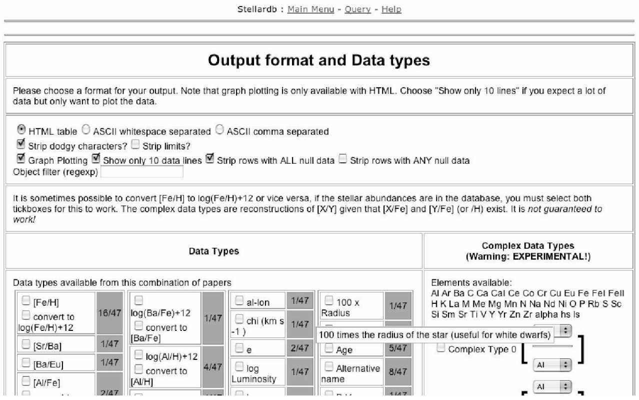

Fig. 4. The user is presented with an interface to select the parameters available from the selected surveys. See text for details.

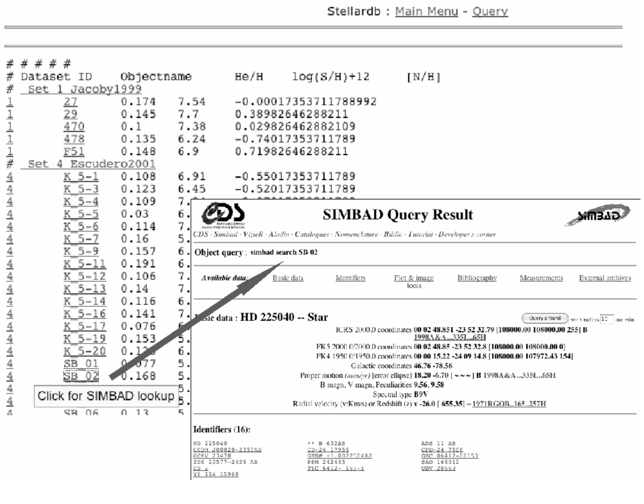

Fig. 5. The table of data is ready to be copied by the user. Each object is linked to a query to the SIMBAD object database.

Stellardb : Main Menu - Query

Dataset ID	Objectname	He/H	log(S/H)+12	[N/H]
	Plot histogram 1 Number of bins? 10	Plot histogram 2 Number of bins? 10	Plot histogram 3 Number of bins? 10	Plot histogram 4 Number of bins? 10
X column				
Y columns XY plot Link colours to dataset ID?				
1 Jacoby1999	1	0.087	*	0.029826462882109
1	23	0.126	*	-0.10017353711789
1	27	0.174	7.54	-0.00017353711788992
1	29	0.145	7.7	0.38982646288211
1	33	0.05	*	-8.0001735371179
1	75	*	*	-0.21017353711789
1	125	0.132	*	0.26982646288211
1	177	0.136	*	0.09982646288211
1	179	0.129	*	0.38982646288211
1	455	*	*	-8.0001735371179
1	470	0.1	7.38	0.029826462882109
And 82 more lines				

Fig. 6. Interactive table limited to 10 data lines. The data can be plotted here in one (histogram) or two (scatter plot) dimensions.

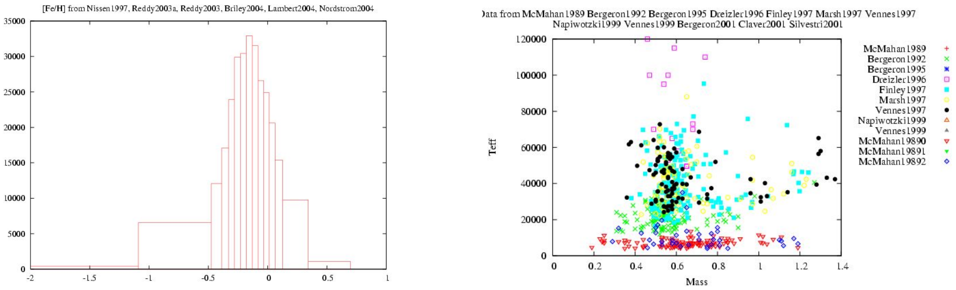

Fig. 7. The plotting utility: on the left is an example of a histogram. On the right is an example of a two-dimensional scatter-plot colour-coded according to survey. See text for details.

lished papers. *Stellardb* is a flexible tool which could prove useful to the community at large and the aim of this presentation is gather comments and remarks from that community.

2. Use and features

Stellardb is written in Perl and runs on a MySQL database through an Apache web server. Open-source, standard and commonly used tools ensure flexibility of development of the database. The database itself is centred around surveys. Each survey has different characteristics, such as magnitude limit, selection bias etc.

Data can also be selected using object type (asymptotic giant branch (AGB) stars, globular clusters, Lyman-α clouds, etc.) or by survey. Below is a step-by-step description of how to use *Stellardb* and what features are available.

Figures 1 – 7 show screen captures of the interface to the database. The home page of *Stellardb* shows the latest papers included. Every paper is linked to the NASA ADS Abstract service as shown in Figure 1. This allows the user to access the original papers in which the data were published. If he only wishes to browse through the associated data it is not necessary to download the full paper. The *data* link next to each paper allows him to browse the data displayed in a table (see Figure 2).

Errors given in the papers are not yet provided in the query output but this feature will be implemented soon. The *query* link next to each paper listed on the home page is a shortcut to selecting data from each paper (as in Figure 2).

The main query link leads to the first data selection as shown in the right panel of Figure 3. The user is given the choice of selecting objects by type or a paper search. The two can be combined. The paper search acts as a filter. If no object types are chosen but papers are selected, any object can be included in the query results. If he wishes to select object types from anywhere, the paper search can be left void. If the user knows exactly whose surveys to include, the paper selection tool narrows the search.

Once the query criteria have been transmitted, the results are displayed as a list of papers. Those papers can be viewed and selected by hand as shown in the left panel of Figure 3. Surveys are chosen by ticking the corresponding papers.

The user is then asked to select the data and output format as shown in Figure 4. The output can be generated as an HTML or ASCII table. Figure 5 shows an example of the ASCII output. The first column shows the survey the object comes from. The second shows the name of the object which is automatically linked to a query to the SIMBAD Astronomical database. There is also a graph plotting option described below. The lower part of the page represents the data selection. The left column shows the list of data types, e.g. [Fe/H], available in the selected surveys. Not all the selected papers may contain all the parameters so availability is colour-coded to the right.

Stellar abundances are sometimes given in different units e.g. $[X/H]$ or $\log(X/H)+12$. The *Stellardb* interface accounts for this and provides an automatic conversion tool (Figure 4). This conversion works when both the original and the converted units are selected. For example, one survey might give the abundance of some element X in units of $[X/H]$ and another survey in $\log(X/H) + 12$. To obtain $[X/H]$ in the final output select both the $[X/H]$ and the $\log(X/H) + 12$ cells. *Stellardb* recognises that they are the same and the final output contains one column for $[X/H]$.

The right column on the data selection page is experimental. This feature uses the web interface to produce other abundance ratios when those ratios can be linked through their relative abundance in the data.

If the user wishes to look at the data before generating a table to download, the *Stellardb* interface offers a graph plotting utility (Figure 4). It is recommended to chose the "Show only 10 data lines" option which shortens the loading time of the table. When those two options are chosen and the data are selected as described above, an interactive table appears where the user can plot the data. This table is captured in Figure 6. Although only 10 data lines appear, any subsequent graph contains all the data.

Histograms show the range of values the data covers. They are designed such that each bin contains the same number of data points and the number of bins is chosen by the user. As an example, the left panel of Figure 7 shows the metallicity distribution of a sample of main-sequence stars from a number of surveys. This tool allows the user to ensure that the selected data is appropriate for his or her purpose.

The two-dimensional scatter plot comes with two features. For many variables plotted against one the colours are coded as one colour per variable. If one pair of variables is selected the data can be colour-coded by survey. This is useful as a check of the completeness of the data. A two-dimensional plot is shown on the right side of Figure 7 which shows $T_{\rm eff}$ against mass for several surveys of white dwarfs. Each colour represents a different survey. It is planned to implement three-dimensional surface density maps.

3. Conclusions

This communication presents *Stellardb*, a stellar abundances database. This project provides an interactive interface which makes astronomical abundance observations readily available to the astronomical community. Ideally we would like to design a tool that allows users to obtain representative volume-limited samples of objects and allows us to bias the sample according to certain criteria such as object type, metallicity, stellar duplicit etc.

One major advantage of this approach is that the observations have already been refereed and published. They are publicly available to the community.

Stellardb is designed to be flexible and is not limited to observations. We are considering including results of stellar models. Such a side-by-side comparison of models would be useful to stellar theoreticians.

Planned future improvements include error handling, surface density plots etc. The interface has already been slightly modified according to feedback we received at the Torino meeting and a help page is now available on the website.

We are open to comments and suggestions from the community. In particular we encourage colleagues to suggest features and to share their observational data. *Stellardb* is located at `http://www.carolune.net/ciqua/stellardb/`.

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NASA ADS Abstract service, `http://adswww.harvard.edu/`

SIMBAD Astronomical Database, `http://simbad.u-strasbg.fr/Simbad`