TOPbase/TIPbase

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1 Introduction

TOPbase/TIPbase is an atomic database service that has been available on the Internet since January 1993 from both the Centre de Données Astronomiques de Strasbourg (CDS), France, `http://cdsweb.u-strasbg.fr/OP.html`, and HEASARC, Goddard Space Flight Center, NASA, USA, `http://asca.gsfc.nasa.gov/docs/topbase/home.html`. Direct access to the command-based database can be managed by `telnet` to `cdsarc.u-strasbg.fr` (IP=130.79.128.5) in France and `topbase.gsfc.nasa.gov` (IP=128.183.126.111) in the USA with account id= `topbase` and PW = `Seaton+`. TOPbase [1, 2] contains term energies, f-values and photoionization cross sections computed in LS coupling in the Opacity Project (OP) [3] for astrophysically abundant ions (Z=1–14; Z=16, Z=18; Z=20; Z=26). This database has averaged over 100 calls a month since it became operational. TIPbase (under development) will offer the data from the current IRON Project (IP) [4], namely level energies, radiative transition probabilities, electron impact excitation collision strengths and rates for fine structure transitions of ions of astrophysical interest, with emphasis on the iron group. In the present paper, we briefly discuss the atomic data, the database design, work in progress and some important points that have emerged during our five-year experience offering such a service.

2 Atomic data

The atomic data contained in TOPbase/TIPbase are calculated by an international group of experts from Canada, France, Germany, UK, USA and Venezuela with more than 15-year experience in large collaborative computational projects. State-of-the-art numerical methods are used such as those implemented in the atomic structure codes CIV3 [5] and SUPERSTRUCTURE [6] and collisional approaches based on the R-matrix method [7, 8, 9]. The emphasis is both on accuracy and completeness of massive datasets thus leading to series of papers where such issues are extensively discussed, namely the series "Atomic Data for Opacity Calculations (I–XXIII)" in the *Journal of Physics B* and the series "Atomic Data from the IRON Project (I–XXVIII)" in *Astronomy & Astrophysics*. A measure on the quality of the data produced by the OP and IP is given, for instance, by the large number of f-values computed in the former that have been selected for the NIST reference compilations (e.g. [10]).

3 Database design

TOPbase was one of the first on-line atomic databases that became operational on the Internet. Due to a general lack of standards and having taken the practical resolution to avoid the commercial packages in order to ensure portability at low costs, the design of the TOPbase database management system has been entirely homemade [1]. It is closely related to the physics of the atomic data and to the most frequent search patterns that are likely to be repeated by users and applications. In this respect, a bound state (i) is uniquely addressed by a key defined in terms of the following attributes: (`nz, ne, islp, ilv`), where `nz` and `ne` are respectively the atomic number and electron number of the ion; `islp` gives the quantum numbers (total spin multiplicity, orbital angular momentum and parity) of the spectroscopic series to which it belongs, defined as `islp` $= 100(2S+1) + 10L + P$; and `ilv` is the level energy position within the spectroscopic series. The key for a transition ($i \rightarrow j$) is similarly given in terms of the attributes (`nz, ne, islp, jslp, ilv, jlv`). The input selectors, based on numerical ranges of these keys, and the index structure have been devised to facilitate searches along isoelectronic and isonuclear series, in energy or wavelength ranges, within an ionic system or a spectroscopic series, or just for a single level or transition. As shown in Fig. 1 the data manipulation scheme has been implemented on two levels: the *view* where searches and time-consuming block data retrievals are performed from disk; and the *table* where fast and versatile functions (sorting, column and row selections, graphic display) are carried out iteratively in main storage to satisfy user requirements. Both data structures allow display, printing, disk downloading and graphic processing. The present user interface is command-based providing a fairly powerful yet simple query language. Although most regular users have not complained about this query environment, it does discourage the occasional user who is not really prepared to invest time in learning the commands. Thus, a web-based user interface has been developed for TOPbase which is to become operational by the beginning of 1998. In spite of the reduction in interactivity of a web interface, TOPbase keeps most of its design features, e.g. the numeric access codes and the *view* and *table* data structures. Furthermore, the design of TIPbase will follow the guidelines and scheme of TOPbase.

4 Recent developments

We summarize here recent work that has either been finished or is currrently in progress regarding updates of the data and improvements of the software.

4.1 Work concluded

- Improved radiative data (e-levels, f-values, photoionization cross sections) for the ions Fe I–IV.
- Improved radiative data for the ions of oxygen.
- The TOPbase web user interface. It will become operational in January 1998.

4.2 Work in progress

- New radiative data for the P and Cl isonuclear sequences.
- Radiative data in intermediate coupling for the isoelectronic sequences of Ne and Ar.
- Electron impact excitation rates for fine structure transitions in the isonuclear sequence of Fe.
- The TIPbase database management system and user interface.

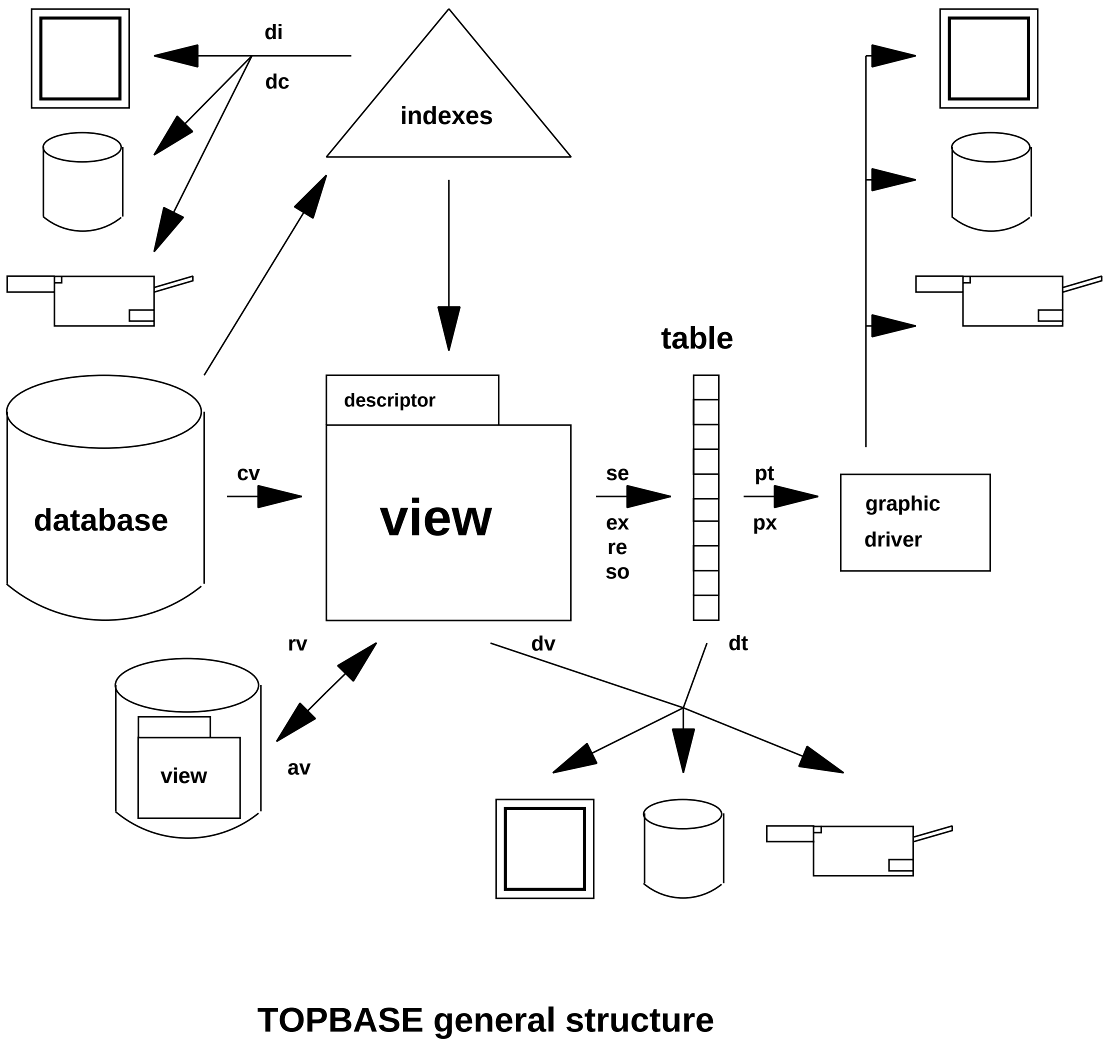

Figure 1: TOPbase data manipulation scheme showing the two main data structures, the *view* and the *table*, the display and graphic capabilities and query commands.

5 Comments

We would like to make here some comments, intended mainly for future entrepreneurs, regarding the development and maintenance of atomic database services which have arisen in our five-year experience running such a service.

We have found a sizable need for atomic data in the world-wide scientific community although we feel that the demand would sharply go down if it is addressed on business terms. Therefore it is unlikely that many outsiders will be attracted by the opportunities offered by the new atomic database projects, and therefore their development will have to rely mainly on inhouse initiatives that would have to apply for grants to the traditional funding agencies. In other words, nobody is bound to get rich from running an atomic data business.

In our opinion it is essential to offer atomic database services within the context of a data center. In the case of TOPbase, we have worked out a good relationship and operational terms with both the CDS and NASA. Furthermore, the concept of a data center appears to be undergoing an interesting evolution. Rather than being a center for data compilation and publication, it is now becoming a contractor, promoter and evaluator of distributed database portfolios which should be as close as possible to the data producers. Moreover, the marketing of the data and the establishment of new client bases are among their new responsibilities.

The general absence of standards surely is a deterement to the proliferation of atomic databases and makes life very difficult for both users and developers. Apart from the consensus on web-based user interfaces, we feel that it is timely to sort out some of the remaining key issues: data-entry and output formats, management systems, interactivity, data transfer and compression protocols, and documentation.

In the context of electronic data dissemination, there is the implicit responsibility of ensuring data integrity. Since the latter would eventually be passed on to the data producer, the source reference must always be quoted in all database transactions.

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