THE VIENNA ATOMIC LINE DATABASE: PRESENT STATE AND FUTURE DEVELOPMENT

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Abstract. We describe the main structure of the Vienna Atomic Line Database, the tools provided for the users and the statistics of its use in the last two years. Our plans for future developments of the database are discussed.

Key words: databases: atomic line parameters – stellar spectroscopy

The Vienna Atomic Line Database (VALD) is a product of cooperation between Austrian and Russian astronomers. The database, which was first created for the internal needs of a small group involved in the abundance analysis of Ap stars, proved to be very useful for different spectroscopic studies, and in the middle of 1994 VALD became available to the world astronomical community at no cost.

Presently the VALD team consists of five members, including the authors of this paper and A. Pavlov (Russia). The VALD team is working in a close contact with laboratory spectroscopists and astronomers from different countries, such as USA, Sweden, Yugoslavia, Russia, the Netherlands and Poland.

VALD is a collection of atomic line parameters of astronomical interest and has tools for selecting subsets of lines for typical astrophysical applications: line identification, chemical composition,
radial velocity measurements, model atmosphere calculations, etc. VALD contains data for more than 2 million spectral lines with experimentally measured energy levels. About 40 million predicted lines from Kurucz's CD-ROMs are also included in VALD and are available on special request. All atomic parameters are stored in a special compressed format which allows very fast access to any subset of the database.

VALD contains the following information for each spectral line:
- wavelength in Å,
- element code,
- lower and upper energy levels in eV,
- inner quantum number $J$ of the lower and upper levels,
- oscillator strength, radiative, Stark and Van der Waals damping constants,
- Lande factors for the lower and upper levels,
- term designation.

VALD extraction tools are accessible locally or remotely, via VALD Electronic Mail Service (VALD-EMS). VALD-EMS is the main interface for external users connected to the Internet. VALD-EMS currently supports four types of requests:

- **show line** - extracts all information, available in VALD, about specific spectral line (although more than one line can appear in the output);
- **extract all** - extracts best atomic parameters for all spectral lines in a given spectral window;
- **extract element** - extracts best atomic parameters for all spectral lines of the particular chemical element or ion in a given spectral window;
- **extract stellar** - extracts all spectral lines (with best parameters), which produce significant absorption in a stellar atmosphere with given temperature and gravity.

For the last three types of request, VALD performs automatic merging on multiple line lists according to the ranking assigned by VALD experts. The last type of request also involves fast calculation of the radiative transfer at the center of any plausible line. Mail access lets VALD automatically process requests and queue them for execution on VALD computers at the most convenient time (primarily during night time). It also allows the VALD administrator to control the size of the data traffic and to register VALD users. All

Below we give some statistics for two years of VALD activity.

The total number of the registered clients – 98 from 24 countries;
The number of real users – 59 (more than 2 requests).

Among them:

- astrophysicists - 91
- laboratory spectroscopists - 3 (USA, Spain, Sweden)
- laser physics/optical technology - 4 (Australia, Canada, Germany)
- plasma physics - 1 (Israel)

The total number of e-mail requests – 1846, including:

- extract stellar - 879
- showline - 420
- extract all - 304
- extract element - 243

Fig. 1 shows the distribution in time of the VALD-EMS requests. There is an evident steady increase in the number of requests. A rapid rise occurred in October 1995 after the publication in A&AS.
In addition to standard e-mail requests, VALD includes fast and accurate SYNTH spectral synthesis code (Piskunov 1992), a set of programs for computing opacity distribution functions and model atmospheres (based on ATLAS 9, Kurucz 1993) and two sets of programs for automatic and interactive fitting of observed spectra.

VALD is regularly updated with critically evaluated data sets. A user can find the information about the actual references and the corresponding labels in the most recent version of the VALD-EMS document, which is sent to registered clients. The VALD team experts investigate the statistical properties of the data, compare extensively the results obtained with different sources of data and establish the quality ranking for each new source.

Our plans for the next year include:
1. revision of gf-values for Mn II and Fe II;
2. compilation of gf-values for the second ions of the elements heavier than Ca;
3. preparation of a list of Stark damping constants for the elements not belonging to iron-group;
4. preparation of a list of “wrong” lines (lines with high theoretical gf-values from Kurucz’s CD-ROMs that are not observed in stellar spectra);
5. refinement of the reference list.

Internally we will add a code for computing hydrogen line profiles, based on the occupation probability formalism (Stehlé & Jacquemot 1993) for both spectral synthesis and model atmosphere codes. We also intend to incorporate into VALD the latest version of the SME program (Valenti & Piskunov 1996), which is capable of handling molecular lines and Zeeman splitting in magnetic field. The incorporation of a molecular line list into the VALD database with external access will be considered in the more distant future.

REFERENCES
Kurucz R. L. 1993, Model atmosphere program ATLAS9 published on CDROM13