Vienna **A**tomic **L**ine **D**ata–Base

Electronic Mail Service

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Contents

1 Rationale

The Vienna Atomic Line Database (VALD) is a collection of atomic line parameters of astronomical interest and provides tools for selecting subsets of lines for typical astrophysical applications: line identification, chemical composition and radial velocity measurements, model atmosphere calculations etc.

The VALD Electronic Mail Service (VALD–EMS) is the main interface for accessing VALD by external users. VALD–EMS is aimed to endorse the following main principles of VALD access.

- subsets of spectral line lists are extracted with tools consistent with the specific astronomical problem. VALD strongly discourages bulk data transfer for the case of an external access to the data base and concentrates more on intelligent search and extraction procedures.
- VALD provides data sets and extraction tools suitable for several spectroscopic applications.
- VALD is regularly updated with critically evaluated data sets. The VALD project team experts investigate the statistical properties of the data, extensively compare the results obtained with different data sources, and establish the quality rating for each new source.
- VALD computers are not dedicated to the VALD project alone, so the correct scheduling is important.

Mail access lets VALD automatically process requests and queue them for execution on VALD computers at the most convenient time. It also allows us to have control over the size of the data traffic and to register VALD users. Apart from the mail service, a WWW interface has been developed to facilitate extraction of data from VALD and to contact the VALD staff for troubleshooting and registration.

2 How to become a VALD client?

If you would like to register as a new user, or for any other reason would like to contact one of the managers of VALD, please complete the VALD contact form on our web-page **http://ams.astro.univie.ac.at/~vald/**.

To access VALD via VALD–EMS one should register in the list of VALD clients. This list contains e–mail addresses from where VALD–EMS will accept the requests. For registration, please send the following information to the VALD administrator :

1. The email address at which you would like to receive the results of your VALD database queries
2. Your name and affiliation

Example:

```
I would like to become a client of VALD. Please register
me as James Fine. My e-mail address is:
jfine@not.from.this.world

Best regards, James Fine
University of Fine City
```

If you intend to access VALD–EMS from different computers, send **all** e–mail addresses that you intend to use. Note that the address actually extracted from an e–mail to VALD is provided through the very first line of the envelope/header of an e-mail.

3 The VALD interface

On top of the VALD–EMS, a World–Wide–Web interface was developed. This interface allows interactive creation of the request and will notify the user of inconsistencies or omissions in the request before converting the request to an ordinary VALD–EMS request. Just like any VALD–EMS, access to the WWW interface is limited to registered clients only. The interface will resolve the hostname of the connecting computer and attempt to match the combination of the provided username and resolved hostname against the list of email addresses in the client register. If this is successfull, access is granted to the WWW interface. In this way, the interface also determines the clients email address to which VALD–EMS will send the result of the request. It is therefore important that the client provides his or her **user@host** addresses to the client register and that the client can receive email on this address.

Another addition to the user interface is the personal configuration file which was primarily dictated by the quick evolution of the content of our data base. With the addition of new line data of higher accuracy it is often impossible to reproduce the same selection with the standard VALD configuration file that controls the merging of different line lists according to the ranking system. One can still get the same selection with the old configuration file, but until VALD–2 a user had no control over the content of the configuration file when using the EMS interface to access the data base. Now each client can choose between the standard configuration, created by VALD experts, or a personal configuration file that is modified only by the owner. A personal configuration file is first created as a copy of the standard configuration in response to a VALD–EMS request that contains the 'personal configuration' option or via the WWW interface. The WWW interface also provides a convenient editing tool. The VALD client can select a subset of the line lists that will be searched for extraction requests, set the ranking of different parameters that determines the merging procedure etc. (see Piskunov et al. 1995, Ryabchikova et al. 1999, Kupka et al. 1999). The latest copies of the personal configuration files are automatically distributed to all VALD servers as part of the synchronization procedure (see below).

The use of mirror sites is a logical way to distribute the work load and reduce VALD response time. It is particularly important for massive extraction that is performed, e.g. for model atmosphere calculations. One VALD mirror site became operational in 1998, Uppsala Astronomical Observatory (vald@astro.uu.se), another one in 2005, vald.inasan.ru . In order to achieve coherence of all VALD servers we developed an additional layer of the software that runs automatically on top of the VALD email service and ensures the synchronization of all sites. Currently, synchronization is performed twice a day which means that within less than a day after registration a new client will have EMS access to all VALD sites.

Due to the massive increase off spam mail we recommend that you also use the contact page of the WWW interface when contacting the VALD staff, since we cannot guarantee that emails sent the traditional way will pass our spam filters.
Links to the WWW interfaces of VALD (Vienna, Uppsala and Moscow) can be found at

http://vald.astro.univie.ac.at/

http://www.astro.uu.se/~vald/

http://vald.inasan.ru/~vald/

4 VALD data sets

In this section we provide a compilation of all the line lists currently used within VALD. This list also serves to connect reference labels provided by VALD–EMS(and termed 'source list') with literature references.

Note that some spectral lines may appear in several of these lists. The method of log gf determination for new line data of VALD–2 is indicated as well as the total number of lines in each list. The references corresponding to the abbreviations can be found in section 14.
Currently VALD includes atomic lines from the following lists

Source List	Elements / Ions	Number of Lines	abbr.	meth.	References
Bell light:	Li to K	66794			Kurucz CDROM 18 (1993)
Bell heavy:	Cu to U	38453			Kurucz CDROM 18 (1993) Reader & Sansonetti (1986 - WL corrections for Hg II lines)
DREAM:	La III, Ce II, Ce III, Pr II, Pr III, Nd II, Nd III, Sm II, Eu III, Gd III, Tb III, Dy III, Ho III, Er II, Er III, Tm II, Tm III, Yb II, Yb III, Lu I, Lu II, Lu III, Th III	64210	DRMa DRMb	exp calc	Biemont, Palmeri & Quinet (1999), Quinet & Biemont (2004)
Garcia & Campos: Sr 1	Sr I	55	GC	exp	Garcia & Campos (1988)
GFIRON ext.:	Ca to Ni	406889			from Kurucz CDROM 20-22 (1994)
Nd 2 Wisconsin:	Nd II	708	HLSC	exp	Den Hartog et al. (2003)
NLTE lines:	H, He, B, C, O, Na, Mg, Al, Si, K, Ca	39791			Kurucz CDROM 18 (1993)
NBS/NIST:	Sc to Ni	8124			Martin, Fuhr & Wiese (1988), A. Gulliver (included in Kurucz, 1993), Fuhr, Martin & Wiese (1988)
NIST (JPCR 7)	C,N,O	11545			Wiese, Fuhr & Deters (1996)
NBS Mono 145:	La II, Ce II, Pr II, Nd II, Sm II, Er II	4367			Meggers et al. (1975), Magazzu & Cowley (1986 - Ce II calibration), Cowley (1994 - Pr II, Nd II, Sm II, Er II calibration), Bord et al. (1996 - La II calibration)

Source List	Elements / Ions	Number of Lines	abbr.	meth.	References
Smith & Raggett: Ca 1	Ca I	37	SR	exp	Smith & Raggett (1981)
Raassen & Uyling:	Fe II, Cr II, Co II	75785	RU	calc	Raassen & Uyling (1998)
VALD 2: Si 2	Si II	35	CSB	exp	Calamai et al. (1993)
			BBC	exp	Blanco et al. (1995)
			BLa	exp	Bergeson & Lawler (1993)
					Lanz et al. (1988, Stark damp. const.)
VALD 2: P 1	P I	27	BSB	exp	Berzinsh et al. (1997)
VALD 2: Ca 2	Ca II	23	T	calc	Theodosiou (1989)
VALD 2: Sc	Sc I, Sc II	246	LD	exp	Lawler & Dakin (1989)
VALD 2: Ti	Ti II, Ti III	281	BHN	exp	Bizzarri et al. (1993, Ti 2)
			BMP	exp	Blackwell et al. (1982, Ti 2)
			RHL	ast	Ryabchikova et al. (1994, Ti 2)
			RU	calc	Raassen & Uylings (1997, Ti 3)
VALD 2: V 2	V II	147	BGF	exp	Biemont et al. (1989)
VALD 2: Cr	Cr II, Cr III	1961	BL	exp	Bergeson & Lawler (1993b, Cr 2)
			SL	ast	Sigut & Landstreet (1990, Cr 2)
			PGBH	exp	Pinnington et al. (1993, Cr 2)
			E	calc	Ekberg (1997, Cr 3)
VALD 2: Mn 3	Mn III	7442	UR	calc	Uylings & Raassen (1997)
VALD 2: Fe	Fe I, Fe II	3483			for details see text
VALD 2: Co	Co I, Co II	104	LWG	exp	Lawler et al. (1990, Co 1)
			CUNJ	exp	Crespo L.-Urrutia et al. (1994b, Co 2)
			SLW	exp	Salih et al. (1985, Co 2)
			MCL	exp	Mullman et al. (1998, Co 2)
VALD 2: Ni 1	Ni I	151	WLa	exp	Wickliffe & Lawler (1997a)
			BBPL	exp	Blackwell et al. (1989)
VALD 2: Cu 2	Cu II	71	CKNJ	exp	Crespo Lopez-Urrutia et al. (1994a)
VALD 2: Zn 2	Zn II	2	BL	exp	Bergeson & Lawler (1993b)
VALD 2: Ga 2	Ga II	16	RSb	e+a	Ryabchikova & Smirnov (1994)
			LADM	calc	Lanz et al. (1993)
VALD 2: Y 3	Y III	39	R	calc	Redfors (1991)
			MCT	exp	Maniak et al. (1994)
VALD 2: Zr 3	Zr III	493	R	calc	Redfors (1991)
			RA	calc	Reader & Acquista (1997)
VALD 2: Ru	Ru I, Ru II	502	WSL	exp	Wickliffe et al. (1994, Ru 1)
			JJL	exp	Johansson et al. (1994a, Ru 2)
VALD 2: Xe 2	Xe II	33	RSa	exp	Ryabchikova & Smirnov (1989)
			WM		Wiese & Martin (1980)
			HP		Hansen & Persson (1987)
VALD 2: Ce	Ce II, Ce III	73	sol	sol	solar averaged gf-values (Ce 2, sol., cf. Piskunov et al. 1995)
			BCN	calc	Bord et al. (1997, Ce 3)

Source List	Elements / Ions	Number of Lines	abbr.	meth.	References
VALD 2: Pr	Pr I, Pr II	52	K	exp	Komarovskij (1991)
VALD 2: Nd	Nd I, Nd II, Nd III	121	K CB	exp calc	Komarovskij (1991, Nd 1 & Nd 2) Cowley & Bord (1998, Nd 3)
VALD 2: Sm	Sm I, Sm II	367	K	exp	Komarovskij (1991)
VALD 2: Eu	Eu I, Eu II, Eu III	74	K RPS	exp ast	Komarovskij (1991, Eu 1 & Eu 2) Ryabchikova et al. (1999, Eu 3)
VALD 2: Gd	Gd I, Gd II	110	KSa BBLP	exp exp	Komarovskij & Smirnov (1992, Gd 1) Bergstrom et al. (1988, Gd 2)
VALD 2: Dy	Dy I, Dy II	105	BL KSc	exp exp	Biemont & Lowe (1993, Dy 2) Komarovskij & Smirnov (1994)
VALD 2: Ho 2	Ho II	4	K	exp	Komarovskij (1991)
VALD 2: Er	Er I, Er II, Er III	427	KSb K WBBC	exp exp calc	Komarovskij & Smirnov (1993, Er1) Komarovskij (1991, Er 2) Wyart et al.(1997, Er 3)
VALD 2: Tm	Tm I, Tm II	522	WLb	exp	Wickliffe & Lawler (1997b)
VALD 2: Yb 1	Yb I	19	K	exp	Komarovskij (1991)
VALD 2: Lu	Lu I, Lu II	31	K BCM DCWL	exp calc exp	Komarovskij (1991, Lu 1) Bord et al. (1998, Lu 2) Den Hartog et al. (1998, Lu 2)
VALD 2: Re 2	Re II	1	WJL	exp	Wahlgren et al. (1997)
VALD 2: Pt	Pt I, Pt II, Pt III	799	WLJ WB DSJ WL RWJ	calc calc ast calc	Wahlgren et al. (1995, Pt 1) Wyart & Blaise (1995, Pt 2) Dworetsky et al. (1984, Pt 2) Blaise & Wyart (1992, Pt 2) Ryabtsev et al. (1993, Pt 3)
VALD 2: Au	Au II, Au III	672	RW WLJ WJT	calc L+c calc	Rosberg & Wyart (1997, Au 2) Wahlgren et al. (1995, Au 2, LIF & calc) Wyart et al. (1996, Au 3)
VALD 2: Hg 3	Hg III	42	URJ	calc	Uylings et al. (1993)
VALD 2: Pb 2	Pb II	37	AMa AMb WL	exp exp	Alonso-Medina (1996) Alonso-Medina (1997) Reader & Corliss (1980)
VALD 2: Vander-Waals	Be to Ba	280		calc	Van-der-Waals constants from P. Barklem, see Kupka et al. (1999)

Source List	Elements / Ions	Number of Lines	abbr.	meth.	References (Update Jan.2008)
New Kurucz:	Si I	10610	K07	calc	http://cfaku5.cfa.harvard.edu /ATOMS/1400
	Ca I	89	SR	exp	Smith G., Raggett D.St.J. 1981, J. Phys., B14, 4015
	Ca I		S	exp	Smith G. 1988, J. Phys. B. At. Mol. Opt. Phys., 21, 2827-2834
	Ca I		SN	exp	Smith G., O'Neil J.A. 1975, A&A, 38, 1
	Ca I		ABH	exp	Ahmad I., Baig M.A., Hormes J. 1994, Phys. Rev., A49, 3419
	Ca I		Sh	exp	Shabanova L.N. 1963, Opt. Spektrosk., 15, 829
	Ca I		SG	exp	Smith G., Gallagher A. 1966, Phys. Rev., 145, 26
	Ca I		DIKH	exp	Drozdowski R., Ignaciuk M., Kwela J., Heldt J. 1977, Z. Phys., D41, 125
	Ca I		Sm	exp	Smith G. 1981, A&A, 103, 351 (VdW constants)
	Ca II		Td	exp	Theodosiou, C.E. 1989, Phys. Rev., A39, 4880
	Ca II		TB	exp	Cunto, W., & Mendoza, C. 1992, Rev. Mex. Astrofis., 23, 107 (TOPBASE)
New Kurucz:	Fe I to Fe VI	241415	K06 K07	exp	http://cfaku5.cfa.harvard.edu /ATOMS/26XX
	Ti II	1034	PTP	exp	Pickering J.C., Thorne A.P., Perez R. 2001, ApJS 132, 403
	Mn II	187	KG	exp	Kling, R., Griesmann, U., 2000, ApJ 531, 1173-1178
			KSG	exp	Kling, R., Schnabel, R., Griesmann, U., 2001, ApJS 134, 173-178
Lund:	Zr II	617	SLW	exp	Sikström C.M., et al. 1999, A&A 343, 297
	Zr II		LNAJ	exp	Ljung G., Nilsson H., Asplund M., & Johansson S. 2006, A&A 456, 1181
	Mo II		SPN	exp	Sikstrom C. M., et al. 2001, J. Phys. B34, 477, 490
	Th II		NZL	exp	Nilsson H., et al., 2002, A&A 382, 368
	U II		NIJL	exp	Nilsson H., Ivarsson S., Johansson S., Lundberg H. 2002, A&A 381, 1090
Wisconsin:	Ni II	4611	FW	exp	Fedchak J.A., Wiese L.M., & Lawler J.E. 2000, ApJ 538, 773
			FL	exp	Fedchak J.A., & Lawler J.E. 1999, ApJ 523, 734
	La II		ZZZ	exp	Zhiguo, Z., Zhongshan, L., Zhankuia, J., 1999, EPJD 7, 499-502
			LBS	exp	Lawler, J. E., Bonvallet, G., Sneden, C., 2001, ApJ 556, 452-460
	Nd II		HLSC	exp	Den Hartog, et al., 2003, ApJS 148, 543
	Sm II		LD-HS	exp	Lawler, Den Hartog, et al., 2006, ApJS 162, 227
	Eu I		DHWL	exp	Den Hartog, et al., 2002, ApJS 141, 255-165
	Eu II		ZLLZ	exp	Zhiguo, et al., 2000, Jour. Phys. B33, 521-526
			LWHS	exp	Lawler, et al., 2001, ApJ 563, 1075-1088
	Gd II		DLSC	exp	Den Hartog, et al., 2006, ApJS 167, 292
	Tb II		LWCS	exp	Lawler, et al., 2001, ApJS 137, 341-349
	Dy I , Dy II		WLN	exp	Wickliffe, M. E., Lawler, J. E., Nave, G., 2000, JQSRT 66, 363
	Ho II		LSC	exp	Lawler, J. E., Sneden, C., Cowan, J. J., 2004, ApJ 604, 850-860
	Tm I, Tm II		WL	exp	Wickliffe, M. E., Lawler, J. E., 1997, JOSA B14, 737
	Lu I		FDLP	exp	Fedchak, et al., 2000, ApJ 542, 1109-1118
	Hf II		LDLS	exp	Lawler, et al., 2007, ApJS 169, 120
	Pt I		DHL	exp	Den Hartog, et al., 2005, ApJ 619, 639

Source List	Elements / Ions	Number of Lines	abbr.	meth.	References (Update Jan.2008)
VanderWaals	Cr	41776		calc	Barklem, P. S.; Piskunov, N.; O'Mara, B. J. 2000, A&AS 142, 467 Barklem, P.S., & Aspelund-Johansson, J. 2005, A&A 435, 373 plus new unpublished data

Data for lines of Fe I and II have been compiled from numerous lists. Fe I data has been distributed in VALD 'FeI NMT Whaling and Bard & Kock' and is now part of the new Fe list of VALD-2. Here, we summarize the abbreviations used

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BWL:	O'Brian T.R., Wicklife M.E., Lawler J.E., Whaling W., Brault J.W. 1991, JOSA B8, 1185 (Fe 1, exp)
BKK:	Bard A., Kock A., Kock M. 1991, A&A 248, 315 (Fe 1, exp)
BK:	Bard A., Kock M. 1994, A&A 282, 1014 (Fe 1, exp)
JNG:	Johansson S., Nave G., Geller M., Sauval A.J., Grevesse N., Schoenfeld W.G., Chang E.S., Farmer C.B. 1994b, ApJ 429, 419 (Fe 1, calc)
SCG:	Shoenfeld W.G., Chung E.S., Geller M., Johansson S., Nave G., Sauval A.J., Grevesse N. 1995, A&A, 301, 593-601 (Fe 1, calc)
BML:	Bergeson S.D., Mullman K.L., Lawler J.E. 1994, ApJ 435, L157-L159 (Fe 2, exp)
BMW:	Bergeson S.D., Mullman K.L., Wickliffe M.E., Lawler J.E., Litzen U., Johansson S. 1996, ApJ 464, 1044-1049 (Fe 2, exp)
MSL:	Mullman K.L., Sakai M., Lawler J.E. 1997, A&AS 122, 157 (Fe 2, exp)
JBL:	Johansson S., Brage T., Lecrone D., Nave G., Wahlgren G.M. 1995, ApJ 446, 361-370 (Fe 2, improved gf for a few UV lines)
BJP:	Biemont E., Johansson S., Palmeri P. 1997, Phys. Scripta 55, 559-564 (Fe 2, calc IR)
RJ:	Rosberg M., Johansson S. 1992, Phys. Scripta 45, 590-597 (Fe 2, calc)
W:	Whaling W. 1983, Technical Report 84 A, Calif. Inst. of Techn., Pasadena (USA) (Fe 2, exp, corrected by +0.04 dex)
PGH:	Pauls U., Grevesse N., Huber M.C.E. 1990, A&A 231, 536 (Fe 2, exp)
KK:	Kroll S., Kock M. 1987, A&AS 67, 225 (Fe 2, exp)
HK:	Heise C., Kock M. 1990, A&A 230, 244 (Fe 2, exp)
HLGN:	Hannaford P., Lowe R.M., Grevesse N., Noels A. 1992, A&A 259, 301-306 (Fe 2, exp)

BSS: Blackwell D.E., Shallis M.J., Simmons G.J. 1980, A&A 81, 340-343 (Fe 2, solar, corrected by +0.19 dex)

B: Bridges J.M. 1973, in Int. Conf. on Phenom. in Ionezed Gases, 11th, ed. I. Stoll, Czech. Acad. Sci., Inst. Phys., Prague, p. 418 (Fe 2, exp)

BGHR: Baschek B., Garz T., Holweger H., Richter J. 1970, A&A 4, 229 (Fe 2 exp, corrected by +0.16 dex)

av: data averaged from 2 to 4 above cited references for Fe 2 (see VALD2 paper, Kupka et al. 1999)

GC: Garcia G. & Campos J., 1988, JQSRT 39, 477

HLSC: Den Hartog E.A., Lawler J.E., Sneden C., & Cowan J.J., 2003, ApJS, 148, 543

SR: Smith G. & Raggett D.St.J., 1981, J. Phys. B: At. Mol. Phys., 14, 4015

RU: Raassen A.J.J. & Uylings P.H.M. 1998, A&A, 340, 300

DRMa: Biemont E., Palmeri P. & Quinet P., 1999, Astrophys. Space Sci. 269-270, 635

DRMb: Quinet P. & Biemont E., 2004, At. Data Nucl. Data Tables 87, 207-230

K07 http://cfaku5.cfa.harvard.edu /ATOMS/1400

SR Smith G., Raggett D.St.J. 1981, J. Phys., B14, 4015

S Smith G. 1988, J. Phys. B. At. Mol. Opt. Phys., 21, 2827-2834

SN Smith G., O'Neil J.A. 1975, A&A, 38, 1

ABH Ahmad I., Baig M.A., Hormes J. 1994, Phys. Rev., A49, 3419

Sh Shabanova L.N. 1963, Opt. Spektrosk., 15, 829

SG Smith G., Gallagher A. 1966, Phys. Rev., 145, 26

DIKH Drozdowski R., Ignaciuk M., Kwela J., Heldt J. 1977, Z. Phys., D41, 125

Sm Smith G. 1981, A&A, 103, 351 (VdW constants)

Td Theodosiou, C.E. 1989, Phys. Rev., A39, 4880

TB Cunto, W., & Mendoza, C. 1992, Rev. Mex. Astrofis., 23, 107 (TOPBASE)

K06 http://cfaku5.cfa.harvard.edu /ATOMS/26XX

K07

PTP Pickering J.C., Thorne A.P., Perez R. 2001, ApJS 132, 403

KG Kling, R., Griesmann, U., 2000, ApJ 531, 1173-1178

KSG Kling, R., Schnabel, R., Griesmann, U., 2001, ApJS 134, 173-178

SLW Sikström C.M., et al. 1999, A&A 343, 297

LNAJ Ljung G., Nilsson H., Asplund M., & Johansson S. 2006, A&A 456, 1181

SPN Sikstrom C. M., et al. 2001, J. Phys. B34, 477, 490

NZL Nilsson H., et al., 2002, A&A 382, 368

NIJL Nilsson H., Ivarsson S., Johansson S., Lundberg H. 2002, A&A 381, 1090

FW	Fedchak J.A., Wiese L.M., & Lawler J.E. 2000, ApJ 538, 773
FL	Fedchak J.A., & Lawler J.E. 1999, ApJ 523, 734
ZZZ	Zhiguo, Z., Zhongshan, L., Zhankuia, J., 1999, EPJD 7, 499-502
LBS	Lawler, J. E., Bonvallet, G., Sneden, C., 2001, ApJ 556, 452-460
HLSC	Den Hartog, et al., 2003, ApJS 148, 543
LD-HS	Lawler, Den Hartog, et al., 2006, ApJS 162, 227
DHWL	Den Hartog, et al., 2002, ApJS 141, 255-165
ZLLZ	Zhiguo, et al., 2000, Jour. Phys. B33, 521-526
LWHS	Lawler, et al., 2001, ApJ 563, 1075-1088
DLSC	Den Hartog, et al., 2006, ApJS 167, 292
LWCS	Lawler, et al., 2001, ApJS 137, 341-349
WLN	Wickliffe, M. E., Lawler, J. E., Nave, G., 2000, JQSRT 66, 363
LSC	Lawler, J. E., Sneden, C., Cowan, J. J., 2004, ApJ 604, 850-860
WL	Wickliffe, M. E., Lawler, J. E., 1997, JOSA B14, 737
FDLP	Fedchak, et al., 2000, ApJ 542, 1109-1118
LDLS	Lawler, et al., 2007, ApJS 169, 120
DHL	Den Hartog, et al., 2005, ApJ 619, 639

The wavelengths contained in VALD are in vaccum for $\lambda < 2000$ Å and in air from $\lambda = 2000$ Å up to the infrared.

For Fe I lines wavelengths, energies, classification and multiplet numbers or any of these values are taken from New FeI Multiplet Tables

> Nave, G., Johansson, S., Learner, R.C.M., Torne, A.P.,
> Brault, J.W., 1994, Astron. Astrophys. Suppl., 94, 221

If a spectral line does not exist in NMT, its multiplet number is taken from Moore MT and put in . For cases where the accuracy from BWL, BKK and BK differs by less than 2%, gf–values for the same line are averaged in the final list.
Linelists for REE elements are supplemented by experimental Lande factors taken from

> Blaise, J., Wyart, J.-F. 1984, Physica Scripta, 29, 119 – NdII lines
> Ginibre, A. 1989, Physica Scripta, 39, 694 – PrII lines
> Martin, W.C., Zalubas, R., Hagan, L. 1978, NSRDS-NBS 60 –

other REE elements (from NIST atomic line database, AEL section)

For all second ions of the rare-earth elements and for CeII Lande factors are now available thanks to calculations of the DREAM-team

P. Quinet & E. Bimont, At. Data Nucl. Data Tables 87, 207-230 (2004)

For Pb II lines Lande factors are taken from

Moore C.E. 1958, NSRDS-NBS 35, Vol. III

VALD is constantly adding more lines, so look for the most recent version of this document for the actual references and the corresponding labels. Please take into account that for all modes of data extraction except for SHOW LINE (see Section 5), data is merged from different lists. If you need detailed information on a line from all sources known, you have to use the SHOW LINE request (see Section 6), which enables you to see how the data from various sources are merged for a particular line.

5 VALD–EMS request

A VALD–EMS request is an ordinary electronic mail, sent via INTERNET to

`vald@astro.univie.ac.at`
or
`vald@astro.uu.se`
or
`vald@hypatia.gsfc.nasa.gov`

An e–mail for VALD–EMS can either be prepared and sent to any of these VALD sites using a standard e–mail program or by using one of the VALD Web interfaces (which submit the e–mail to a fixed site, usually that one running the Web interface).

Each mail can include **only one** request. The request consists of a number of lines. **only the first 80 characters of each line are interpreted by** VALD–EMS. The request starts with a line containing a string

```
begin request
```

and ends with a line

```
end request
```

Spaces are ignored and VALD is case insensitive, so the line

```
EndRequest
```

is also a valid termination for the request. All characters on a line of text in a request to VALD following the symbol # are ignored by VALD. This can be used for comments. For example

```
Begin request      # this is a comment for the first line
```

All mail is processed at certain times of the day and valid requests are interpreted and submitted for execution in the order of arrival. After the request has been processed, the output file is mailed back to the client. This file contains: VALD-EMS REQUEST NUMBER, all diagnostic information (syntactic errors, wrong parameter values, etc.) and the extracted parameters. If the client has difficulty identifying the problem with his/her request, he/she should address the VALD administrator and supply the VALD-EMS request number, which appears on the first line of the reply mail.

6 Types of request

VALD-EMS currently supports 4 types of requests

show line	extracts all information, available in VALD, about a specific spectral line (or rather, the same species) in a small wavelength window (several spectral lines from the same species could 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 their best parameters), which produce significant absorption in a stellar atmosphere with given effective temperature and gravity.

The type of the request is indicated by one of the keywords, listed above, placed in the second line of the request. The content of the request depends on its type as described in the following sections. Compulsory parameters are inclosed in angle brackets <...> while optional parameters are put in square brackets [...].

7 Customization options

For all VALD-EMS requests there are some options to customize the request. These options can be inserted in the request after the request type statement. The options are

short format	the output will be in compressed form. For the extract all, extract element and extract stellar this means that only one entry per line is displayed.
long format	the output will be in extended form. This includes for each line the term designation, upper and lower Lande factors, quality estimate and additional reference data.
default configuration	use the VALD default configuration of quality ratings and selection of the atomic line lists.
personal configuration	use individual preferences. Each user can maintain his/her own list of quality ratings and line list selections, and VALD-EMS will store this information in a personal file. It can be edited through the VALD Web interface.

If no format and/or configuration is entered, VALD-EMS defaults to short format and default configuration.
It is possible to force VALD to include only lines for which certain atomic parameters are known. If the parameter is not present, then the line is simply not included. These options are not applicable to the show line request The options are

have rad	require a value of the radiation damping
have stark	require a value of the Stark broadening
have waals	require a value of the Van der Waals broadening
have lande	require a Lande factor
have term	require a term designation

8 SHOW LINE request

This request must have the following format

`begin request`
`show line`
$<$ *approximate wavelength* 1 $>$, $<$ *wavelength window* 1 $>$
$<$ *element* 1 $>$ [*spectral number* 1]
$<$ *approximate wavelength* 2 $>$, $<$ *wavelength window* 2 $>$
$<$ *element* 2 $>$ [*spectral number* 2]
`...`
`end request`

where $<$ *approximate wavelength* $>$ is the central wavelength of the line in Angstroems. $<$ *wavelength window* $>$ determines the spectral range (it must not exceed 1 Angstroem) from
$<$ *approximate wavelength* $> - <$ *wavelength window* $>$
to
$<$ *approximate wavelength* $> + <$ *wavelength window* $>$

where VALD will search for the line. $<$ *element* $>$ and $<$ *spectral number* $>$ are defined in a conventional way. $<$ *spectral number* $> = 1$ corresponds to neutral atoms, 2 to singly ionized, etc.

Show line requests for multiple spectral intervals may be combined in the same request. The current limit for multiple spectral intervals in one show line request is 100.

Example:

```
begin request          # Start the request
default configuration  # No special configuration
show line              # Select request type
4491.405, 0.02         # Search line between 4491.385
                       # and 4491.425 Angstroems
Fe 2                   # The line is formed by singly ionized iron
                       # Next request starts below
6439.07, 0.01          # Search line between 6439.06
                       # and 6439.08 Angstroems
Ca1                    # The line is formed by neutral calcium
end request            # The end of the request
```

The reply mail from VALD will contain the following table

```
| ============= job.005492 =============
| # begin request
| # default configuration
| # show line
| # 4491.405, 0.02,
| # Fe 2
| # 6439.07, 0.01,
| # Ca1
| #
| # end request
| ==============================================================================
| Central wavelength:         4491.405 [A]ngstroem
| Wavelength range:              0.020 [A]
| Size of scan window:           0.050 [A]
| Highest ion number allowed:    5
| Maximum excitation potential
|     for lower energy level:   50.000 [eV]
| Species requested:            Fe 2
|-------------------------------------------------------------------------------
| Configuration file used:      default.cfg
| Date and time of extraction:  1999-02-24 at 12:53 (+01:00 relative to UTC)
|===============================================================================
|
|
|Spectral lines found (4 text lines per transition listed in a given source, the
|VALD internal ranking parameter is provided in parentheses next to each value):
|
|===============================================================================
|1) Database reference for the line
|2) Wavelength[A]  Element/Ion   log gf     E(low)[eV] J(low) E(high)[eV] J(high)
|3) Lande: eff.    low   high  Gamma.Rad     Gamma.Stark       Gamma.VdW
|4)      term design. (lower -> upper)      accuracy  (multiplet or comments)
|-------------------------------------------------------------------------------
|NBS: Iron
|  4491.400 ( 0)   Fe 2       -2.700 ( 5)    2.855 ( 0)   1.5  5.615 ( 0)  1.5
|     99.00 ( 0)  99.00 99.00  0.000 ( 0)    0.000 ( 0)        0.000 ( 0)
|                b 4F        z 4F*       C    (37)       ( 2)
|
|GFIRON obs. energy level: Fe
```

```
|  4491.405 ( 3)   Fe 2       -2.684 ( 3)    2.856 ( 3)   1.5   5.615 ( 3)   1.5
|      0.42 ( 3)   0.40  0.44  8.481 ( 3)   -6.599 ( 3)        -7.946 ( 3)
|                 (3F)4s b4F   (5D)4p z4F                     ( 3)
|
|VALD 2: Fe
|  4491.405 ( 4)   Fe 2       -2.700 ( 6)    2.856 ( 4)   1.5   5.615 ( 4)   1.5
|      0.42 ( 0)   0.40  0.44  8.481 ( 0)   -6.599 ( 0)        -7.946 ( 0)
|                 (3F)4s b4F   (5D)4p z4F    0   .10  KK     ( 4)
|===============================================================================
|
|
| These data should be combined to the following set of lines (the output for
| long format without lower and upper Lande factors etc. is displayed):
|
|===============================================================================
|1) Wl[A]  El/Ion log(gf)  Ei[eV]   Ji  Ek[eV]   Jk   gl   gam.r   gam.s   gam.w
|2) term designation i -> k              references (except for El/Ion, Ji & Jk)
|-------------------------------------------------------------------------------
|  4491.405  Fe 2  -2.700   2.856  1.5   5.615  1.5  0.42  8.481  -6.599  -7.946
|        (3F)4s b4F(5D)4p z4F 0.10  KK    1   1   1   1   2   2   2   2   1
|-------------------------------------------------------------------------------
|Key to references:
|-------------------------------------------------------------------------------
|  1. VALD 2: Fe
|  2. GFIRON obs. energy level: Fe
|===============================================================================
|===============================================================================
| Central wavelength:         6439.070 [A]ngstroem
| Wavelength range:              0.010 [A]
| Size of scan window:           0.050 [A]
| Highest ion number allowed:    5
| Maximum excitation potential
|     for lower energy level:   50.000 [eV]
| Species requested:            Ca 1
|-------------------------------------------------------------------------------
| Configuration file used:      default.cfg
| Date and time of extraction:  1999-02-24 at 12:55 (+01:00 relative to UTC)
|===============================================================================
|
|
|Spectral lines found (4 text lines per transition listed in a given source, the
|VALD internal ranking parameter is provided in parentheses next to each value):
|
|===============================================================================
|1) Database reference for the line
|2) Wavelength[A]  Element/Ion   log gf     E(low)[eV] J(low) E(high)[eV] J(high)
|3) Lande: eff.    low   high  Gamma.Rad     Gamma.Stark       Gamma.VdW
|4)      term design. (lower -> upper)      accuracy  (multiplet or comments)
|-------------------------------------------------------------------------------
|NLTE lines: Ca
|  6439.075 ( 2)   Ca 1        0.470 ( 2)    2.526 ( 2)   3.0   4.451 ( 2)   4.0
|     99.00 ( 0)  99.00 99.00  7.730 ( 1)   -5.350 ( 1)         0.000 ( 1)
|                 3d4s 3D      3d4p 3F           NBS         ( 3)
|
|GFIRON obs. energy level: Ca
|  6439.075 ( 3)   Ca 1        0.394 ( 3)    2.526 ( 3)   3.0   4.451 ( 3)   4.0
|      1.12 ( 3)   1.33  1.25  7.649 ( 3)   -6.072 ( 3)        -7.788 ( 3)
|                 3d4s 3D      3d4p 3F                        ( 3)
|===============================================================================
|
|
```

```
| These data should be combined to the following set of lines (the output for
| long format without lower and upper Lande factors etc. is displayed):
|
|===============================================================================
|1) Wl[A] El/Ion log(gf)  Ei[eV]   Ji  Ek[eV]   Jk   gl   gam.r   gam.s   gam.w
|2) term designation i -> k             references (except for El/Ion, Ji & Jk)
|-------------------------------------------------------------------------------
|  6439.075  Ca 1   0.394   2.526  3.0   4.451  4.0  1.12  7.649  -6.072  -7.788
|       3d4s 3D   3d4p 3F                 1   1   1   1   1   1   1   1   1
|-------------------------------------------------------------------------------
|Key to references:
|-------------------------------------------------------------------------------
| 1. GFIRON obs. energy level: Ca
|===============================================================================
|===============================================================================
```

0 in place of a damping parameter and 99 in place of a Lande factor mark the absence of the corresponding data in VALD. The label given after the parameters for each line indicates the source of the data. For the section of SHOW LINE output following 'lines found' all quantities for one line originate from the same source. The last section of SHOWLINE output shows the combination of all sources, as it will appear for all the other types of VALD request.

9 EXTRACT ALL request

This request must have the following format

```
begin request
extract all
[long format]
[short format]
<wavelength 1>,<wavelength 2>
end request
```

where $< wavelength\ 1 >$,$< wavelength\ 2 >$ are the limits of the spectral interval in Angstroems. Note that VALD limits the total number of lines per single mail to 1000, therefore the actual extraction may end somewhat shorter of $< wavelength\ 2 >$. [*long format*] tells VALD to include an extra line of data with term designation, Lande factors, and accuracy description into the output file. [*short format*] does not include these data and is the default.

Example

```
begin request           # Start of the request
extract all             # Request type
default configuration   # No special configuration
short format            # Dislay each transition on only one line
5700, 5701              # Wavelength range in Angstroems
end request             # End of the request
```

As the result VALD will mail back to the client VALD-EMS request number, the copy of the request and a subset of spectral lines between 5700 and 5701 Angstroems as shown below

```
| ============= job.005493 =============
| # begin request
| # extract all
| # default configuration
| # short format
| # 5700, 5701
| # end request
|                                    Damping parameters  Lande
|Elm Ion  WL(A)    Excit(eV) log(gf) Rad.   Stark  Waals factor References
|’Ar 2’, 5700.0010, 23.6740, -2.570, 0.000, 0.000, 0.000,99.000,’   1   1   1   1   1   1   1’
|’Fe 1’, 5700.1280,  3.3010, -4.948, 7.623,-6.223,-7.870, 0.000,’   2   2   2   2   2   2   2’
```

```
|'F  1', 5700.1380, 14.6830, -2.550, 0.000, 0.000, 0.000,99.000,'   3   3   3   3   3   3   3'
|'Sc 1', 5700.1640,  1.4330,  0.254, 7.765,-6.129,-7.854, 0.920,'   4   5   4   5   5   5   5'
|'Ti 1', 5700.2140,  2.3050, -8.472, 6.806,-6.029,-7.851, 0.390,'   6   6   6   6   6   6   6'
|'Mn 2', 5700.2190, 11.0880, -3.078, 8.938,-5.730,-7.737, 1.830,'   7   7   7   7   7   7   7'
|'Cu 1', 5700.2370,  1.6420, -2.312, 0.000, 0.000, 0.000,99.000,'   8   8   8   8   8   8   8'
|'V  2', 5700.2380,  9.0310, -2.975, 8.949,-4.885,-7.708, 2.060,'   9   9   9   9   9   9   9'
|'Cu 2', 5700.2880, 16.2350, -3.909, 0.000, 0.000, 0.000,99.000,'   8   8   8   8   8   8   8'
|'Mn 2', 5700.3880, 11.2850, -4.142, 8.585,-4.359,-7.458, 1.810,'   7   7   7   7   7   7   7'
|'Th 2', 5700.4590,  1.2040, -2.148, 0.000, 0.000, 0.000,99.000,'  10  10  10  10  10  10  10'
|'Cr 1', 5700.5180,  3.5510, -1.440, 7.538,-5.991,-7.845, 1.330,'  11  11  11  11  11  11  11'
|'Cr 1', 5700.5500,  3.4490, -2.574, 7.812,-6.185,-7.822, 1.120,'  11  11  11  11  11  11  11'
|'S  1', 5700.5800,  7.8680, -1.040, 0.000, 0.000, 0.000,99.000,'   1   1   1   1   1   1   1'
|'Zn 3', 5700.5830, 27.3600, -0.727, 0.000, 0.000, 0.000,99.000,'   8   8   8   8   8   8   8'
|'Cr 2', 5700.5930, 12.1350, -3.593, 8.142,-4.126,-7.633,-0.320,'  11  11  11  11  11  11  11'
|'Th 2', 5700.6960,  1.2050, -1.549, 0.000, 0.000, 0.000,99.000,'  10  10  10  10  10  10  10'
|'F  1', 5700.8050, 14.3870, -1.060, 0.000, 0.000, 0.000,99.000,'   3   3   3   3   3   3   3'
|'Ar 1', 5700.8730, 13.1720, -1.680, 7.600, 0.000, 0.000,99.000,'   1   1   1   1   1   1   1'
|'Th 2', 5700.9170,  0.5140, -2.240, 0.000, 0.000, 0.000,99.000,'  10  10  10  10  10  10  10'
|'Ca 3', 5700.9210, 42.6830, -1.182, 9.204,-5.534,-7.668, 1.140,'  12  12  12  12  12  12  12'
|'V  1', 5700.9370,  1.9550, -3.200, 6.895,-6.248,-7.854, 1.170,'   9   9   9   9   9   9   9'
|'V  3', 5700.9730, 19.4250, -2.166, 9.522,-6.063,-7.793, 0.970,'   9   9   9   9   9   9   9'
| References:
|  1. Bell light: Si to K
|  2. GFIRON obs. energy level: Fe
|  3. Bell light: F to Al
|  4. VALD 2: Sc
|  5. GFIRON obs. energy level: Sc
|  6. GFIRON obs. energy level: Ti
|  7. GFIRON obs. energy level: Mn
|  8. Bell heavy: Cu to Zn
|  9. GFIRON obs. energy level: V
| 10. Bell heavy: Hf to U
| 11. GFIRON obs. energy level: Cr
| 12. GFIRON obs. energy level: Ca
| ============================================================================
```

The output columns contain element and ionization stage, central wavelength in Angstroem, excitation in electron–Volts, log(gf), 3 damping constants in logarithm (radiative, quadratic Stark and van der Waals) per sec and per perturber at 10000 K (in the case of Stark and van der Waals constants), mean Lande factor and reference labels. Zero in place of a damping parameter and 99 in place of the Lande factor marks the absence of the corresponding data in VALD. The labels at the end of each line show the source of the respective output column. The SHOW LINE request may be used to find out all values of transition parameters from different VALD lists and their corresponding ranking, assigned by the VALD team.

10 EXTRACT ELEMENT request

This request must have the following format

```
begin request
extract element
[long format]
[short format]
<wavelength 1>,<wavelength 2>
<element> [spectral number]
end request
```

where $< wavelength\ 1 >$,$< wavelength\ 2 >$ are again the limits of the spectral interval in Angstroem. Only the lines formed by $< element >$ in one or all ionization stages will be extracted. [*spectral number*] defines the ionization stage: 1 stands for neutral atoms, 2 for singly ionized, etc.
Currently VALD includes mostly lines up to the spectral number 5. If [*spectral number*] is omitted, the extraction is done for lines up to the four times ionized atom.

Example

```
begin request    # Start of the request
extract element  # Request type
5700, 5720       # Wavelength range in Angstroems
Fe 3             # Extract all lines of doubly ionized iron
end request      # End of the request
```

The mail reply will look similar to the one above, except that only lines of doubly ionized iron are included and each transition is supplemented with term designation (short format)

```
| ============ job.005494 ============
| # begin request
| # extract element
| # default configuration
| # short format
| # have rad
| # 5700, 5720,
| # Fe 3
| # end request
|                                  Damping parameters Lande
|Elm Ion  WL(A)    Excit(eV) log(gf) Rad.   Stark  Waals factor References
|'Fe 3', 5701.0710, 25.0490,  0.118, 9.296,-4.877,-7.712, 1.280,'   1   1   1   1   1   1   1'
```

```
|'Fe 3', 5705.1470, 25.0320, -0.167, 9.360,-4.633,-7.518, 1.390,'   1   1   1   1   1   1   1'
|'Fe 3', 5706.4560, 25.4410, -2.858, 8.873,-5.844,-7.715, 1.150,'   1   1   1   1   1   1   1'
|'Fe 3', 5711.4150, 25.4410, -1.870, 8.854,-5.976,-7.715, 1.390,'   1   1   1   1   1   1   1'
|'Fe 3', 5712.8900, 25.0640, -0.136, 9.299,-4.968,-7.763, 1.140,'   1   1   1   1   1   1   1'
|'Fe 3', 5712.9330, 22.5440,  0.078, 9.237,-5.959,-7.764, 0.500,'   1   1   1   1   1   1   1'
|'Fe 3', 5713.9810, 25.0350, -0.438, 9.358,-4.633,-7.518, 1.480,'   1   1   1   1   1   1   1'
|'Fe 3', 5719.7350, 23.5300, -1.819, 9.436,-4.911,-7.594, 1.340,'   1   1   1   1   1   1   1'
| References:
|  1. GFIRON obs. energy level: Fe
|==============================================================================
```

11 EXTRACT STELLAR request

This request must have the following format

```
begin request
extract stellar
[long format]
[short format]
< wavelength 1 >,< wavelength 2 >
< detection − limit >,< microturbulence >
< T_eff >,< log g >
[chemical composition]
......................
end request
```

where $< wavelength\ 1 >$,$< wavelength\ 2 >$ are again the limits of the spectral interval in Angstroem. Effective temperature $< T_{eff} >$ and gravity $< log\, g >$ are used to select a solar abundant model atmosphere for estimating the central depth of spectral lines; $< detection - limit >$ contains the user's lower limit to the central depth, ignoring line blending and expressed as a fraction of the continuum (broadening mechanisms not affecting the equivalent width such as stellar rotation or instrumental broadening are not accounted for). Thus, $< detection - limit >$ of 0.05 rejects all the lines with central depths less than 5% of the continuum. VALD has the latest models computed by R.L. Kurucz (Kurucz CDROM 13, June 23, 1993 edition) covering a temperature range from 3500 K to 50000 K and log g from 0.0 to 5.0. The chemical composition is set as a log10 of the ratio of atomic number density to the total number of atoms. The default values are solar. The abundance value must be separated from the element name with a column (for example, Fe: -4.7). Several values can be set on the same line, separated with commas. The request mail can contain as many lines as needed to set the chemical composition.

Example

```
begin request           # Start of the request
extract stellar         # Request type
5700.,5703.             # Specify wavelength range in Angstroems,
0.05, 2.                # Look for lines reaching more than 0.05
                        # central depth and use microturbulence
                        # of 2 km/s
8000, 4.5               # Teff and Log g
Sr: -4.67, Cr: -3.37,   # Setup specific chemical composition
Eu: -5.53
end request             # End of the request
```

The return mail will contain the following table

```
|============= job.005495 =============
|# begin request
|# extract stellar
|# default configuration
|# short format
|# 5700, 5703,
|# .05, 2,
|# 8000, 4.5,
|#  Sr: -4.67, Cr: -3.37,        #  Setup specific chemical composition
|#  Eu: -5.53
|#
|# end request
| 5700.0000, 5703.0000,  8,   76, 2.0, Wavelength region, lines selected, lines processed, Vmicro
|                                       Damping parameters  Lande  Central
|Elm Ion  WL(A)    Excit(eV) Vmic log(gf) Rad.   Stark  Waals factor  depth   Reference
|'Cr 1', 5700.5180,  3.5510, 2.0, -1.440, 7.538,-5.991,-7.845, 1.330, 0.555, ' 1 1 1 1 1 1 1'
|'Cr 1', 5700.5500,  3.4490, 2.0, -2.574, 7.812,-6.185,-7.822, 1.120, 0.204, ' 1 1 1 1 1 1 1'
|'S  1', 5700.5800,  7.8680, 2.0, -1.040, 0.000, 0.000, 0.000,99.000, 0.094, ' 2 2 2 2 2 2 2'
|'Si 1', 5701.1040,  4.9300, 2.0, -2.050, 8.310,-4.410, 0.000,99.000, 0.088, ' 3 3 3 3 3 3 3'
|'Cr 2', 5701.4640,  3.8270, 2.0, -3.845, 8.677,-6.611,-7.929, 0.960, 0.635, ' 1 1 1 1 1 1 1'
|'Fe 1', 5701.5450,  2.5590, 2.0, -2.216, 8.167,-6.052,-7.840, 1.100, 0.241, ' 4 4 4 5 5 5 5'
|'Cr 1', 5702.3230,  3.4490, 2.0, -0.970, 7.797,-6.171,-7.822, 1.100, 0.624, ' 1 1 1 1 1 1 1'
|'Cr 1', 5702.7060,  4.6130, 2.0, -2.089, 8.114,-6.171,-7.840, 1.040, 0.114, ' 1 1 1 1 1 1 1'
|'08000G45.KRZ',
|'H :  0.91','He: -1.05',
|'Li:-10.88','Be:-10.89','B : -9.44','C : -3.48','N : -3.99','O : -3.11',
|'F : -7.48','Ne: -3.95','Na: -5.71','Mg: -4.46','Al: -5.57','Si: -4.49',
|'P : -6.59','S : -4.83','Cl: -6.54','Ar: -5.48','K : -6.82','Ca: -5.68',
|'Sc: -8.94','Ti: -7.05','V : -8.04','Cr: -3.37','Mn: -6.65','Fe: -4.37',
|'Co: -7.12','Ni: -5.79','Cu: -7.83','Zn: -7.44','Ga: -9.16','Ge: -8.63',
|'As: -9.67','Se: -8.69','Br: -9.41','Kr: -8.81','Rb: -9.44','Sr: -4.67',
```

```
|'Y : -9.80','Zr: -9.54','Nb:-10.62','Mo:-10.12','Tc:-20.00','Ru:-10.20',
|'Rh:-10.92','Pd:-10.35','Ag:-11.10','Cd:-10.18','In:-10.58','Sn:-10.04',
|'Sb:-11.04','Te: -9.80','I :-10.53','Xe: -9.81','Cs:-10.92','Ba: -9.91',
|'La:-10.82','Ce:-10.49','Pr:-11.33','Nd:-10.54','Pm:-20.00','Sm:-11.04',
|'Eu: -5.53','Gd:-10.92','Tb:-11.94','Dy:-10.94','Ho:-11.78','Er:-11.11',
|'Tm:-12.04','Yb:-10.96','Lu:-11.28','Hf:-11.16','Ta:-11.91','W :-10.93',
|'Re:-11.77','Os:-10.59','Ir:-10.69','Pt:-10.24','Au:-11.03','Hg:-10.95',
|'Tl:-11.14','Pb:-10.19','Bi:-11.33','Po:-20.00','At:-20.00','Rn:-20.00',
|'Fr:-20.00','Ra:-20.00','Ac:-20.00','Th:-11.92','Pa:-20.00','U :-12.51',
|'Np:-20.00','Pu:-20.00','Am:-20.00','Cm:-20.00','Bk:-20.00','Cf:-20.00',
|'Es:-20.00','END'
| References:
|  1. GFIRON obs. energy level: Cr
|  2. Bell light: Si to K
|  3. NLTE lines: Si
|  4. FeI NMT Whaling and Bard & Kock
|  5. GFIRON obs. energy level: Fe
|==============================================================================
```

Note that for this request type the output table includes also the microturbulence (Vmic) in km/s and the estimated central line depth relative to continuum. We also provide the name of model atmosphere file in the format '$< T_{eff} > g < 10 * logg > . < source >$' and the abundances of the first 99 elements. The abundances of three elements have been substituted from the request data. However the model atmosphere used is **not** affected by the change in composition.

12 Errors in VALD

VALD does not guarantee in any way the absence of errors in the original data, but we are very interested in reducing their number. Therefore we encourage VALD users to send us error reports, so that we can notify other users and attempt to correct the data. Please send your messages to the VALD administrator by e-mail via our contact page (http://ams.astro.univie.ac.at/cgi-bin/vald/) or with a regular mail to the address given below. If data is used for spectroscopic analysis one needs to know about the reliability of the source. The gf-values have to be used with special care. Some of the sources contain data compilations which are updated from time to time without prior warning by their authors (e.g. the BELL lists). Thus there is no way to maintain a quality estimate for EACH individual line in these lists. In addition, some lists (e.g. GFIRON) consist of semiempirically calculated gf-values with a primary focus on completeness of the list rather than the highest possible accuracy. The VALD team will compile a special list for known "wrong" lines. We will enable this compilation to be taken into account for data extraction, too.

13 Using VALD data

If the VALD data was used in your research work, we would appreciate the acknowledgment of VALD and of the VALD tools that you find most useful.

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Piskunov N.E., Kupka F., Ryabchikova T.A., Weiss W.W., Jeffery C.S., 1995, A&AS 112, 525–535

We would also appreciate receiving a preprint or reprint of the relevant papers at the following address

VALD project
Institut für Astronomie
Türkenschanzstraße 17
A-1180 Wien, Austria
c/o W.W.Weiss

When using data from the DREAM database, users are requested to acknowledge the usage of the DREAM database via VALD by:

> Atomic data compiled in the DREAM data base (E. Biemont, P. Palmeri & P. Quinet, Astrophys. Space Sci. 269-270, 635 (1999)) were extracted via VALD (Kupka et al., 1999, A&AS 138, 119, and references therein).

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