GES linelist V5

2014-11-12

Line-lists for the Gaia-ESO Survey

Citation policy
The line-lists are intended for use within the Gaia-ESO survey. Until further notice, all publications based on these data shall cite (Heiter et al. in prep.) If you wish to use the line-list for non Gaia-ESO related projects, please contact the line-list group.

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Version 5, released 20.09.2014

Linelist V5
This new release contains the following files

1 `ges_atom_nohfs-iso_v5.fits`
Line-list for atoms, no hyper-fine splitting (HFS) or isotopic shifts (ISO) 139950 entries, 1341 clean lines

2 `ges_atom_hfs-iso_v5.fits`
Line-list for atoms, including HFS and ISO 141240 entries, 2631 clean lines

3 `ges_molecule_v5.fits`
Line-list for molecules, 27 files

The so-called clean line-list forms a subset of the atom_nohfs-iso and atom_hfs-iso line-lists. For these 1341 (nohfs-iso) or 2631 (hfs-iso) lines only, assessments of atomic data quality and blending properties are included through flags. The two atomic lists are complete and mutually exclusive.

The atomic and molecular data are accessible from the Edinburgh archive (`http://ges.roe.ac.uk`, table LineList).

1. Overview of changes in V5

- Wavelength range extended to cover the complete range from 4200 to 9200 Å.
- New extraction from VALD3 Version 820 [1] of atomic lines on 2014-09-02:

  * Extract Stellar mode for two different stellar parameter combinations (Teff,logg) = (6500,4.0) and (4000,1.0)
  * [M/H]=+0.5, vmicro=2, minimum line depth 0.001

- New molecular line-lists: 25MgH, 26MgH, 12C15N
- Revision of MgH, CN and C2 lists using recent publications (see Table 2)
- Updated wavelengths of Mn I, Co I, and EuII ines to VALD3 in hfs-iso line-list.
- The bug with the Eu II 6645 Å line fixed.
- Spectral atlases, lists, and plots are provided on the line-list wiki[2].
- Updated laboratory log(gf) for 228 Fe I lines from Ruffoni et al. (2014) and Den Hartog et al. (2014).
- Updated laboratory log(gf) for 17 Y II lines in the clean list to Biémont et al. (2011)
- Updated laboratory log(gf) for 31 Ni I lines in the clean list to Wood et al. (2014)
- Updated laboratory log(gf) for 3 Ca I to Aldenius et al. (2009).

[1] (http://vald.astro.uu.se/ vald/php/vald.php)
[2] `http://great.ast.cam.ac.uk/GESwiki/GesWg/GesWg11/Linelists`

- Astrophysical log(gf) for atomic lines around Li I 6707 Å line. This concerns 4 lines of Fe I and V I with uncertain literature log(gf).
- Ca II triplet in the HR21 changed to the Theodosiou (1989) values

2. Description of the FITS-format

The FITS format has been implemented for convenient verification of all data and simple addition of flags (see Table 1). The files can e.g. be read into IDL structures with the command MRDFITS of the NASA IDL library. A line-list for a given purpose can then be created by filtering the information, in e.g. wavelength, relative depth, and/or flags. Some of the information, including log gf_flag, syn_flag, ew_flag, and labels are only included for the clean subset of lines.

3. Hyperfine splitting and isotopic shifts

HFS and ISO are included for Sc I, V I Mn I, Co I, Cu I, Ba II, Eu II, La II, Pr II, Nd II, Sm II. The gf-values are NOT scaled to isotopic abundances. Line-lists with scaled gf-values can be also provided upon request.

Sc : Childs (1971); Zeiske et al. (1976); Ertmer & Hofer (1976); Başar et al. (2004); Öztürk et al. (2007)
V : Childs et al. (1979b); Unkel et al. (1989); El-Kashef & Ludwig (1992); Palmeri et al. (1995); Cochrane et al. (1998)
Mn : Handrich et al. (1969); Davis et al. (1971); Luc & Gerstenkorn (1972); Dembczyński et al. (1979); Brodzinski et al. (1987); Lefèbvre et al. (2003); Başar et al. (2003); Blackwell-Whitehead et al. (2005a)
Mn,V : Johann et al. (1981)
Cu : Wagner (1955); Fischer et al. (1967); Bergström et al. (1989); Hermann et al. (1993); Kurucz (2013)
Y : Villemoes et al. (1992a)
Ba : Becker et al. (1981b,a); Silverans et al. (1986); Villemoes et al. (1993)
Eu : Villemoes et al. (1992b); Möller et al. (1993)
La : Höhle et al. (1982); Li et al. (2001a)
Pr : Ginibre (1989); Rivest et al. (2002)
Nd : Nakhate et al. (1997); Rosner et al. (2005)
Sm : Childs et al. (1979a); Masterman et al. (2003)
La, Pr, Nd, Eu : Ma & Yang (2004)

4. Molecular line-lists

The recommended partition functions (Q) are given on polynomial form such that:

$$ln(Q) = \sum_{1}^{6} a_i \ln(T)^i$$

The data are given in Tables 2 and 3.

Table 1. FITS format, as extracted from the Edinburgh archive

NAME1	STRING	E.g. 'Ti '
NAME2	STRING	E.g. 'O '
NAME3	STRING	'–'
ION	INT	Ionisation stage of atom or molecule, e.g. 1 for neutral, 2 for singly ionized
ISOTOPE1	LONG	Isotope information for NAME1, e.g. 46; 0 if only one isotope present in list
ISOTOPE2	LONG	Isotope information for NAME2, e.g. 0; 0 if only one isotope present in list
ISOTOPE3	LONG	Isotope information for NAME3; 0 if only one isotope present in list
LAMBDA	DOUBLE	Wavelength Å
LAMBDAREF	STRING	Reference for LAMBDA
LOGGF	FLOAT	Logarithm of gf-value
LOGGFERR	FLOAT	Experimental error in LOGGF if applicable
LOGGFREF	STRING	Reference for LOGGF
LOGGFFLAG	STRING	Flag indicating relative quality of LOGGF[a]
LABELLOW	STRING	Lower level electron configuration
LABELUP	STRING	Upper level electron configuration
ELOW	FLOAT	Lower level energy [eV]
ELOWREF	STRING	Reference for ELOW
JLOW	FLOAT	Lower level J-value
EUP	FLOAT	Upper level energy [eV]
EUPREF	FLOAT	Reference for EUP
JUP	FLOAT	Upper level J-value
LANDELOW	FLOAT	Lower level Lande factor
LANDEUP	FLOAT	Upper level Lande factor
LANDEMEAN	FLOAT	Mean Lande factor
LANDEREF	FLOAT	Reference for Lande factors
RADDAMP	FLOAT	Radiation damping : log(FWHM [rad/s])
RADDAMPREF	STRING	Reference for RADDAMP
STARKDAMP	FLOAT	Stark broadening per perturber at 10000K, log(FWHM [rad/s/cm3])
STARKDAMPREF	STRING	Reference for STARKDAMP
VDWDAMP	FLOAT	Broadening by H I [b]
VDWDAMPREF	STRING	Reference for VDWDAMP
DEPTH	FLOAT	Central line depth in Arcturus[c]
SYNFLAG	STRING	Blending quality for synthesis [d]
EWFLAG1	FLOAT	Usefulness for EW - analysis
EWFLAG2	FLOAT	Usefulness for EW - analysis
EWFLAG3	FLOAT	Usefulness for EW - analysis
EWFLAG4	FLOAT	Usefulness for EW - analysis

[a] log gf: Y: Recommended, U: Un-decided, N: Not recommended
[b] $>$ 0: int(sigma).alpha ABO theory; $<$ 0: Van der Waals broad. per perturber at 10000K, log(FWHM [rad/s/cm3])
[c] Computed assuming 4247/1.59/-0.54 and scaled solar, 0.2 dex alpha-enhanced composition. For all H I lines, depth is set to 0.999
[d] Y: relatively unblended, U: maybe useful in some stars, N: badly blended, not recommended

Table 2. Summary of data for molecular transitions

Molecule	Isotope	E_{diss} (eV)	Diss.E. Reference	Linelist Reference
C2	12C12C	6.371	Luo (2007)	Brooke et al. (2013)
	12C13C			Ram et al. (2014)
	13C13C			Quercy (priv. comm.); only Swan band; Epot normalized to 0.0256 eV
CaH		1.700		Plez (priv. comm.)
CH	12C	3.466	Kumar et al. (1998)	Masseron et al. (2014)
	13C			
CN	12C14N	7.738	Huang et al. (1993)	Sneden et al. (2014)
	13C14N			
	12C15N			
FeH		1.590		Dulick et al. (2003)
MgH	24MgH	1.285	Shayesteh et al. (2007)	A-X Hinkle et al. (2013); B-X Masseron (priv. comm.)
	25MgH			
	26MgH			
NH		3.420	Tarroni et al. (1997)	Masseron (priv. comm.)
OH		4.392		Masseron (priv. comm.)
SiH		3.060		Kurucz (1992)
TiO	46Ti	6.870	Plez (1998)	Plez (priv. comm.)
	47Ti			
	48Ti			
	49Ti			
	50Ti			
VO		6.437		Plez (priv. comm.)
ZrO	90Zr	7.890		Plez (priv. comm.)
	91Zr			
	92Zr			
	94Zr			
	96Zr			

Table 3. Partition functions for molecules

Mol	a_1	a_2	a_3	a_4	a_5	a_6
C2	-1.37611619D+02	7.52473987D+01	-1.60701760D+01	1.72410801D+00	-9.08948951D-02	1.90678635D-03
CaH	1.57677958D+03	-9.82846806D+02	2.44267425D+02	-3.01777064D+01	1.85392515D+00	-4.52292569D-02
CH	-4.91887806D+02	3.09155097D+02	-7.70038741D+01	9.57241011D+00	-5.93380866D-01	1.47420199D-02
CN	6.81165938D+02	-4.46981105D+02	1.17584738D+02	-1.53931948D+01	1.00366669D+00	-2.60084236D-02
FeH	0.1552109D0	0.3983233D0	0.6073527D0	-0.198406D0	2.47056D-02	-9.90570D-04
MgH	6.53454485D+02	-4.13828321D+02	1.04888640D+02	-1.32317730D+01	8.31982710D-01	-2.07967780D-02
NH	-2.70001339D+02	1.77303226D+02	-4.62157841D+01	6.04541228D+00	-3.95886800D-01	1.04339634D-02
OH	-4.56875469D+02	2.87960316D+02	-7.20525364D+01	9.01193168D+00	-5.62538083D-01	1.40661068D-02
SiH	9.01120422D+01	-4.42299680D+01	8.35706604D+00	-6.74290104D-01	1.83429417D-02	1.99216485D-04
TiO	5.92027276D+02	-3.65351492D+02	9.03939514D+01	-1.10869716D+01	6.75722876D-01	-1.63144071D-02
VO	6.62090157D+02	-4.03350494D+02	9.82836218D+01	-1.18526504D+01	7.08429905D-01	
ZrO	4.27195765D+02	-2.51905561D+02	5.85682500D+01	-6.63032743D+00	3.67462428D-01	-7.92597014D-03

5. LOGGFFLAG and SYNFLAG

The flags are either Y (Yes), N (No), or U (undecided). They shall be interpreted as follows:
LOGGFFLAG: Quality of transition probability listed as log gf

- Y - Data come from a trusted source (mainly laboratory measurements with excellent accuracy)
- U - Quality of data is not decided (advanced theoretical calculations and lower accuracy laboratory data)
- N - Data are expected to have low accuracy

SYNFLAG: Blending properties for the Sun and Arcturus

- Y - Line is particularly un-blended or only blended with line of same species in both stars
- U - Line may be inappropriate in at least one of the stars
- N - Line is strongly blended with line(s) of different species in both stars

We have been more selective with Y-flags for elements with more spectral lines, such as Fe, compared to e.g. O, with very few lines. We have not considered whether the strength of the line is appropriate for analysis in a specific star, since this will vary much between the targets. The blending assessment of a line should thus be seen relative to other lines of the same species and line strength. In the spectral atalases available on the wiki, the titles read: LOGGFFLAG/SYNFLAG ABO (indicating presence of ABO data)

6. EWFLAG

The EWFLAG is computed on the basis of a statistical analysis of two sample of stars: i) the benchmark sample (see paper), whose spectra have been re-sampled at UVES580 resolution; ii) The DR1 sample, which includes the 421 stars with WG11 recommended parameters.
EWs have been measured with the automatic version of Daospec (DOOp, Cantat-Gaudin et al. 2013, A&A submitted), and the abundances have been with FAMA (Magrini et al 2013 arXiv:1307.2367), considering the HFS when necessary, for lines in the Ew range: 15-100 mA (to avoid faint lines affected by noise and saturated lines). The distribution of the deviation from the average (computed with Y/Y lines whenever possible, or including also Y/U, /UY, and U/U for elements without Y/Y lines) has been built. The sigma corresponding to the 68.2% percentile has been computed.

The results of the statistical analysis are reported in the following way:

1. Number of times (in percentage) the line has been detected in the benchmark sample
2. Sigma of the line at the 68.2 percentile for the benchmark sample
3. Number of times (in percentage) the line has been detected in the DR1 sample
4. Sigma of the line at the 68.2 percentile for the DR1 sample

Thus, a "good" line is a line with a small value of 2 and 4, and high values of the detection percentages (1. and 3.). These two percentiles are usually in good agreement when the % of detection is above 20% in the two sample. For poorly detected lines the percentile values should be considered with some warnings.

The EWFLAG should be used to exclude from the analysis some lines which are in most cases very far from the average of the other lines of the same element. For example, the iron line at 6089.59 Å is 2.555 dex above the average in the benchmark sample, and 2.492 dex from the average in the DR1 sample, hence it is highly recommended its exclusion from any EW based analysis. On the other hand, the iron line at 6220.78 Å is 0.361/0.369 dex from the average, and its exclusion is arguable.

7. Van der Waals damping

We strongly recommend all nodes to comply with the Anstee, Barklem & O'Mara theory for collisional broadening by hydrogen (ABO theory). The column for van der Waals damping data contains the cross-sections and temperature dependence of this theory in a compact notation that we encourage all nodes to adapt directly in their codes. For a detailed description, see `http://www.astro.uu.se/~barklem/howto.html`. For transitions lacking ABO data, the column contains the value 0.000. Negative values for Sc II, Ti II, and Y II lines are logarithmic line widths at 10000K (Kurucz data); they shall be scaled to the local temperature (see the GES document). In the absence of ABO data (available, in particular, for Ba II), one shall use the Unsöld approximation with an enhancement factor of 1.5 for the line width.

The dedicated document is available on the GES wiki[3].

[3] `http://great.ast.cam.ac.uk/GESwiki/GesWg/GesWg11/Linelists?action=AttachFile&do=view&target=GES-linelist-Hcollisions-UH-2012-10-05.pdf`

8. Comparison of spectrum synthesis codes

We compared synthetic spectra generated with two different spectrum synthesis codes, SME and Turbospectrum. For the analysis, the stellar parameters were chosen to be that of the Sun and Arcturus. MARCS 2008 solar abundances were used together with the v5 linelist including all atoms and molecules. The agreement is generally good. Some differences were detected, stemming from different treatment of broadening, model atmosphere interpolation, molecular equilibrium computation. The degree of these differences is probably insignificant for the spectroscopic analysis in the survey.

9. Next steps

Autoionisation lines to be included (e.g. 6362Å), missing HFS to be added (e.g. Eu at 4205Å , La at 6262Å). HFS components should have proper F values and radiative broadening listed. Some atomic data for atoms and molecules will be updated, especially TiO.

10. Reference codes

Table 4. References to transition probabilities of atomic lines.

LOGGFREF	Reference
1968PhFl...11.1002W	Wolnik et al. (1968)
1969A&A.....2..274G	Garz & Kock (1969)
1970A&A.....9...37R	Richter & Wulff (1970)
1970ApJ...162.1037W	Wolnik et al. (1970)
1980A&A....84..361B	Biemont & Godefroid (1980)
1980ZPhyA.298..249K	Kerkhoff et al. (1980)
1982ApJ...260..395C	Cardon et al. (1982)
1982MNRAS.199...21B	Blackwell et al. (1982a)
1983MNRAS.204..883B	Blackwell et al. (1983)
1984MNRAS.207..533B	Blackwell et al. (1984)
1984MNRAS.208..147B	Booth et al. (1984)
1984PhST....8...84K	Kock et al. (1984)
1985A&A...153..109W	Whaling et al. (1985)
1985JQSRT..33..307D	Doerr & Kock (1985)
1986JQSRT..35..281D	Duquette et al. (1986)
1986MNRAS.220..289B	Blackwell et al. (1986)
1989A&A...208..157G	Grevesse et al. (1989)
1989ZPhyD..11..287C	Carlsson et al. (1989)
1990JQSRT..43..207C	Chang & Tang (1990)
1991JPhB...24.3943H	Hibbert et al. (1991)
1992A&A...255..457D	Davidson et al. (1992)
1993A&AS...99..179H	Hibbert et al. (1993)
1993JPhB...26.4409B	Butler et al. (1993)
1993PhyS...48..297N	Nahar (1993)
1995JPhB...28.3485M	Mendoza et al. (1995)
1996PhRvL..76.2862V	Volz et al. (1996)
1998PhRvA..57.1652Y	Yan et al. (1998)
1999ApJS..122..557N	Nitz et al. (1999)
2000MNRAS.312..813S	Storey & Zeippen (2000)
2003ApJ...584L.107J	Johansson et al. (2003)
2006JPCRD..35.1669F	Fuhr & Wiese (2006)
2006JPhB...39.2861Z	Zatsarinny & Bartschat (2006)
2007A&A...472L..43B	Blackwell-Whitehead & Bergemann (2007)
2007PhyS...76..577L	Li et al. (2007)
2009A&A...502..989A	Aldenius et al. (2009)
2009A&A...497..611M	Meléndez & Barbuy (2009)
2009JPCRD..38..565W	Wiese & Fuhr (2009)
2009JPhB...42r5002K	Kułaga-Egger & Migdałek (2009)
2013ApJS..205...11L	Lawler et al. (2013a)
2013ApJS..208...27W	Wood et al. (2013a)
2014ApJS..211...20W	Wood et al. (2014)
2014MNRAS.441.3127R	Ruffoni et al. (2014)
ABH	Arnesen et al. (1977)
AMS	Andersen et al. (1972)
AMb	Alonso-Medina (1997)
APH	Andersen et al. (1976)
APR	Andersen et al. (1975)
AS	Andersen & Soerensen (1973)
ASa	Andersen & Sorensen (1974)
ASb	Anisimova & Semenov (1974)
ATJL	Aldenius et al. (2007)

Table 4. Continued.

LOGGFREF	Reference
BBC	Blanco et al. (1995)
BBEHL	Biémont et al. (2011)
BDMQ	Biémont et al. (1998)
BGBP	Biémont et al. (2001a)
BGF	Biemont et al. (1989)
BGHL	Biemont et al. (1981a)
BGHR	Baschek et al. (1970)
BGKZ	Biemont et al. (1984)
BHN	Bizzarri et al. (1993)
BIEMa	Biémont (1973)
BIEMb	Bièmont (1977)
BIPS	Blackwell et al. (1979a)
BK	Bard & Kock (1994)
BKK	Bard et al. (1991)
BKM	Biemont et al. (1982)
BKP	Blagoev et al. (1977)
BKPb	Blagoev et al. (1978)
BKm	Blagoev & Komarovskii (1977)
BKor	Bridges & Kornblith (1974)
BL	O'brian & Lawler (1991)
BLNP	Blackwell-Whitehead et al. (2006)
BLPQ	Biémont et al. (1999)
BLQS	Biémont et al. (2003)
BP	Biémont et al. (2001b)
BPQZS	Biémont et al. (2002a)
BQR	Biémont et al. (2002b)
BQZ	Biemont et al. (1993)
BRD	Biemont et al. (1981b)
BSB	Berzinsh et al. (1997)
BSScor	Blackwell et al. (1980)
BWL	O'Brian et al. (1991)
BXPNL	Blackwell-Whitehead et al. (2005b)
Bar	Barach (1970)
CB	Corliss & Bozman (1962a)
CBcor	Corliss & Bozman (1962b)
CC	Cowley & Corliss (1983a)
CCout	Cowley & Corliss (1983b)
CDROM18	Kurucz (1993a)
CM	Clawson & Miller (1973)
CRC	Cowley (1973)
CSE	Cocke et al. (1973)
DCWL	den Hartog et al. (1998)
DHL	Den Hartog et al. (2005)
DHWL	Den Hartog et al. (2002)
DIKH	Drozdowski et al. (1997)
DLSC	Den Hartog et al. (2006)
DLSSC	Den Hartog et al. (2011)
DLW	Dolk et al. (2002)
DLa	Duquette & Lawler (1982)
DLb	Duquette & Lawler (1985)
DPC	Druetta et al. (1971)

Table 4. Continued.

LOGGFREF	Reference
DSJ	Dworetsky et al. (1984)
DSLa	Duquette et al. (1981)
DSLb	Duquette et al. (1982a)
DSLc	Duquette et al. (1982b)
ESTM	Kurucz (1993b)
FDLP	Fedchak et al. (2000)
FMW	Fuhr et al. (1988)
FTa	Friedrich & Trefftz (1969)
GARZ	Garz (1973)
GC	García & Campos (1988)
GESB79b	Blackwell et al. (1979b)
GESB79b	Blackwell et al. (1979b)
GESB82c	Blackwell et al. (1982b)
GESB82d	Blackwell et al. (1982c)
GESB86	Blackwell et al. (1986)
GESG12	Grevesse (2012)
GESHRL14	Den Hartog et al. (2014)
GESMCHF	Froese Fischer & Tachiev (2012)
GESOP	Saraph & Storey (2012)
GHLa	Gough et al. (1982)
GHR	von der Goltz et al. (1984)
GHcor	Kurucz (1993c)
GKOPK	Gorshkov et al. (1980)
GKOa	Gorshkov et al. (1981)
GKOb	Gorshkov et al. (1983)
GL	Gruzdev & Loginov (1979)
GNEL	Gurell et al. (2010)
GUES	Kurucz (1993d)
HLB	Hannaford et al. (1985)
HLGBW	Hannaford et al. (1982)
HLGN	Hannaford et al. (1992)
HLL	Hannaford et al. (1981)
HLSC	Den Hartog et al. (2003)
IAN	Ivarsson et al. (2003)
ILW	Ivarsson et al. (2001)
ISAN	Ryabtsev (2010)
JMG	Migdalek (1978)
K	Kurucz (1975a)
K03	Kurucz (2003)
K04	Kurucz (2004)
K06	Kurucz (2006)
K07	Kurucz (2007)
K08	Kurucz (2008)
K09	Kurucz (2009)
K10	Kurucz (2010)
K11	Kurucz (2011)
K12	Kurucz (2012)
K13	Kurucz (2013)
K14	Kurucz (2014)
K75	Kurucz (1975b)
K99	Kurucz (1999)

Table 4. Continued.

LOGGFREF	Reference
KG	Kling & Griesmann (2000)
KK	Kroll & Kock (1987)
KP	Kurucz & Peytremann (1975)
KR	Kock & Richter (1968)
KSG	Kling et al. (2001)
KZB	Kwiatkowski et al. (1984)
KZBa	Kwiatkowski et al. (1982)
LAW	Lawrence (1967)
LBS	Lawler et al. (2001a)
LCG	Lotrian et al. (1978)
LCV	Laughlin et al. (1978)
LD	Lawler & Dakin (1989)
LD-HS	Lawler et al. (2006)
LDLS	Lawler et al. (2007)
LGWSC	Lawler et al. (2013b)
LGa	Loginov & Gruzdev (1978)
LGb	Lotrian & Guern (1982)
LMW	Lambert et al. (1969)
LN	Lindgård & Nielson (1977)
LNAJ	Ljung et al. (2006)
LNWLX	Lundqvist et al. (2006)
LSC	Lawler et al. (2004)
LSCI	Lawler et al. (2009)
LSCW	Lawler et al. (2008)
LV	Laughlin & Victor (1974)
LWCS	Lawler et al. (2001b)
LWG	Lawler et al. (1990)
LWHS	Lawler et al. (2001c)
LWST	Lennard et al. (1975)
LWa	Lambert & Warner (1968)
LZLS	Li et al. (2001b)
La	Lilly (1976)
M	Murphy (1968)
MC	Meggers et al. (1975)
MCa	McEachran & Cohen (1971)
MER	Matheron et al. (2001)
MFW	Martin et al. (1988)
MIGa	Migdalek (1976)
MIGb	Migdałek (1976)
MRB	Miller et al. (1971)
MRW	May et al. (1974)
MULT	Kurucz (1993e)
MW	Miles & Wiese (1969)
MWRB	Miller et al. (1974)
NG	Grevesse (1969)
NHEL	Nilsson et al. (2010)
NI	Nilsson & Ivarsson (2008)
NIJL	Nilsson et al. (2002a)
NIST10	Ralchenko et al. (2010)
NWL	Nitz et al. (1998)
NZL	Nilsson et al. (2002b)

Table 4. Continued.

LOGGFREF	Reference
OK	Obbarius & Kock (1982)
PGBH	Pinnington et al. (1993)
PGHcor	Pauls et al. (1990)
PGK	Penkin et al. (1984)
PK	Penkin & Komarovskii (1976)
PN	Pitts & Newsom (1986)
PQB	Palmeri et al. (2001)
PQWB	Palmeri et al. (2000)
PRT	Parkinson et al. (1976)
PST	Pfennig et al. (1965)
PSa	Penkin & Shabanova (1963)
PTP	Pickering et al. (2001)
PV	Plekhotkin & Verolainen (1985)
QPB	Quinet et al. (1999a)
QPBM	Quinet et al. (1999b)
RHL	Ryabchikova et al. (1994)
RPU	Raassen et al. (1998)
RRKB	Ryabchikova et al. (2006)
RSa	Ryabchikova & Smirnov (1989)
RU	Raassen & Uylings (1998)
RW	Rosberg & Wyart (1997)
S	Smith (1988)
S-G	Schulz-Gulde (1969)
SCRJ	Sansonetti & Reader (2001)
SDL	Salih et al. (1983)
SDcor	Schnehage et al. (1983)
SEN	Sengupta (1975)
SG	Smith & Gallagher (1966)
SK	Smith & Kuehne (1978)
SLS	Sobeck et al. (2007)
SLb	Salih & Lawler (1985)
SLd	Sigut & Landstreet (1990)
SN	Smith & O'Neill (1975)
SPN	Sikström et al. (2001)
SR	Smith & Raggett (1981)
Sm	Smith (1981)
Si2-av1	Ryabchikova (2012a)
Si2-av2	Ryabchikova (2012b)
T	Theodosiou (1989)
T83av	Ryabchikova et al. (1999)
TB	Seaton et al. (1994)
TZ	Trefftz & Zare (1969)
UR	Uylings & Raassen (1997)
VGH	Vaeck et al. (1988)
WBW	Wolnik et al. (1971)
WBb	Whaling & Brault (1988)
WEI	Weiss (1974)
WGTG	Werij et al. (1992)
WL	Wickliffe & Lawler (1997a)
WLN	Wickliffe et al. (2000)
WLSC	Wood et al. (2013b)

Table 4. Continued.

LOGGFREF	Reference
WLa	Wickliffe & Lawler (1997b)
WM	Wiese & Martin (1980)
WSG	Wiese et al. (1966)
WSL	Wickliffe et al. (1994)
WSM	Wiese et al. (1969)
WTCR	Wyart et al. (2008)
WV	Ward et al. (1985)
Wa	Warner (1968b)
Wc	Warner (1968a)
Wd	Warner (1968c)
XJZD	Xu et al. (2003a)
XSCL	Xu et al. (2003b)
XSQG	Xu et al. (2003c)
ZLLZ	Zhiguo et al. (2000)
ZS	Zhang et al. (2002)
ZZZ	Zhiguo et al. (1999)

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