GES linelist V4

2013-08-08

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 (Line-list Group, 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 4, released 27.07.2013

Linelist V4
This new release contains the following files

1 ges_atom_nohfs-iso_v4.fits
Line-list for atoms, no hyper-fine splitting (HFS) or isotopic shifts (ISO)
2 ges_atom_hfs-iso_v4.fits
Line-list for atoms, including HFS and ISO
3 ges_molecule_v4.fits
Line-list for molecules, 24 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 2629 (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 files are avialable via the Edinbourgh archive.

1. Overview of changes in V4

- fits-formatted line-lists
- complete revision of the atomic master line-list in HR21
- homogenization of references in the clean and atomic master line-lists
- Updated transition probabilities for Mg I, Si I, Ti I, Ti II, Fe I and some lines of neutron-capture elements
- new flag (EW_FLAG) indicating the usefulness of a line for the EW analysis, based on statistical analysis of 400 UVES iDR1 spectra
- All lines synthesized in Arcturus with central line depth indicated in DEPTH-parameter. Can be used e.g. to discard weak lines in synthesis.
- reported bugs in v3 fixed
- Spectral atlases are provided on the line-list wiki.
- New ABO theory van der Waals values for nine Fe 1 lines in the clean line list (U.Heiter, P. Barklem)

2. Description of the FITS-format

The new 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.

Table 1. FITS format

NAME	STRING (3)	E.g. [Ti, O] or Ca
ION	INT	Ionisation stage of atom or molecule, e.g. 1 for neutral, 2 for singly ionized
ISOTOPE	LONG (3)	Isotope information for NAME, e.g. [46, 0]; 0 if only one isotope present in list
LAMBDA	DOUBLE	Wavelength Å
LAMBDA_REF	STRING	Reference for LAMBDA
LOG_GF	FLOAT	Logarithm of gf-value
LOG_GF_ERR	FLOAT	Experimental error in LOG_GF if applicable
LOG_GF_REF	STRING	Reference for LOG_GF
LOG_GF_FLAG	STRING	Flag indicating relative quality of LOG_GF[a]
LABEL_LOW	STRING	Lower level electron configuration
LABEL_UP	STRING	Upper level electron configuration
E_LOW	FLOAT	Lower level energy [eV]
E_LOW_REF	STRING	Reference for E_LOW
J_LOW	FLOAT	Lower level J-value
E_UP	FLOAT	Upper level energy [eV]
E_UP_REF	FLOAT	Reference for E_UP
J_UP	FLOAT	Upper level J-value
LANDE_LOW	FLOAT	Lower level Lande factor
LANDE_UP	FLOAT	Upper level Lande factor
LANDE_MEAN	FLOAT	Mean Lande factor
LANDE_REF	FLOAT	Reference for Lande factors
RAD_DAMP	FLOAT	Radiation damping : log(FWHM [rad/s])
RAD_DAMP_REF	STRING	Reference for RAD_DAMP
STARK_DAMP	FLOAT	Stark broadening per perturber at 10000K, log(FWHM [rad/s/cm3])
STARK_DAMP_REF	STRING	Reference for STARK_DAMP
VDW_DAMP	FLOAT	Broadening by H I [b]
VDW_DAMP_REF	STRING	Reference for VDW_DAMP
DEPTH	FLOAT	Central line depth in Arcturus[c]
SYN_FLAG	STRING	Blending quality for synthesis [d]
EW_FLAG	FLOAT (4)	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

3. LOG_GF_FLAG and SYN_FLAG

The falgs are either Y (Yes), N (No), or U (undecided). They shall be interpreted as follows:
LOG_GF_FLAG: 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

SYN_FLAG: 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: LOG_-GF_FLAG/SYN_FLAG ABO (indicating presence of ABO data) EW_FLAG

4. Hyperfine splitting and isotopic shifts

HFS and ISO were added 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.

5. Atomic line-lists

An updated extraction of VALD3 data has been used as basis, covering the wavelengths from 4750 to 6850 Åand 8450 to 8950 Å. This includes the Paschen series that previously were missing.

- Mg I gf values updated for 2 lines (Chang & Tang 1990)
- Si I gf-values updated for 6 lines (Nahar 1993)
- Fe I gf-values updated for many Y/ lines. Average values of several sources now account for measurement uncertainties
- Ti I and Ti II gf values updated for 74 and 16 lines, respectively (Lawler et al. 2013, Wood et al. 2013)
- 28 lines of neutron-capture elements (Y, Zr, La, Ce, Nd, Sm, Eu, Gd) have been added.
- Upper cutoff on lower level excitation potential, 50 eV, enforced
- For the lines not in the clean linelist, upper cutoff of 10 eV if log gf < -3.
- The previous VALD3 extraction contained some duplicate transitions for some Sr I lines with Elow 0.5eV and some CrI lines that are not present in the new lists
- Several spurious lines, including the Fe I line at 523.8 nm, have been removed.

6. Molecular line-lists

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

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

The data are given in Tables 2 and 3.

7. Flag for EW analysis

The EW_FLAG is computed on the basis of a statistical analysis of two sample of stars: i) the benchmark sample which includes all stars proposed in the paper by Paula Jofre and Ulrike Heiter, 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 in a homogeneous way with an 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 EW_FLAG 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.

8. Van der Waals damping

We 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

Table 2. Summary of data for molecular transitions

Molecule	Isotope	Dissociation energy (eV)	Reference
C2	12C12C	6.371	T. Masseron (positions: Tanabashi et al. 2007a,b; intensities: Brooke et al. 2013; D00: Luo 2007)
	12C13C		
	13C13C		
CaH		1.700	Weck et al. 2003
CH	12C	3.466	T.Masseron (positions: Zachwieja 1995, 1997; intensities: Luque & Crosley 1999; D00: Kumar et al. 1998)
	13C		
CN	12C14N	7.738	T. Masseron (positions: Ram et al. 2006; intensities: Knowles et al. 1998; D00: Huan et al. 1992)
	13C14N		
FeH		1.590	Dulick et al. 2003
MgH		1.285	T. Masseron (positions: Shayesteh & Bernath 2011; intensities: Saxon et al. 1978; D00: Shayesteh & Bernath 2006)
NH		3.420	T. Masseron (positions: Ram et al. 2010a; intensities: Cantarella et al. 1992; D00: Tarroni et al. 1997)
OH		4.392	T. Masseron (positions: Bernath & Colin 2009; intensities: Goldman et al. 1998a)
SiH		3.060	Kurucz database
TiO	46Ti	6.870	B. Plez (1998)
	47Ti		
	48Ti		
	49Ti		
	50Ti		
VO		6.437	B. Plez (private comm.)
ZrO	90Zr	7.890	B. Plez (private 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

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[1].

[1] http://great.ast.cam.ac.uk/GESwiki/GesWg/GesWg11/Linelists?

9. References codes

Note that **some** references are ordered by **year** and appear in the first part of each list; other references are ordered by **author** and come thereafter.

9.0.1. References to the HFS and ISO data in the clean linelist

by year
Wagner (1955) Fischer et al. (1967) Handrich et al. (1969) Davis et al. (1971) Childs (1971) Childs (1971) Luc & Gerstenkorn (1972) Zeiske et al. (1976) Ertmer & Hofer (1976) Childs et al. (1979a) Childs et al. (1979b) Dembczyński et al. (1979) Johann et al. (1981) Becker et al. (1981b) Becker et al. (1981a) Höhle et al. (1982) Silverans et al. (1986) Brodzinski et al. (1987) Ginibre (1989) Unkel et al. (1989) Bergström et al. (1989) Villemoes et al. (1992b) El-Kashef & Ludwig (1992) Villemoes et al. (1992a) Hermann (1993) Villemoes et al. (1993) Möller et al. (1993) Palmeri et al. (1995) Pickering (1996) Nakhate et al. (1997) Cochrane et al. (1998) Li et al. (2001a) Rivest et al. (2002) Lefèbvre et al. (2003) Masterman et al. (2003) Başar et al. (2003) Ma & Yang (2004) Başar et al. (2004) Blackwell-Whitehead et al. (2005a) Rosner et al. (2005) Öztürk et al. (2007) Kurucz (2013b)

9.0.2. References in the clean linelist

by year
Wolnik et al. (1968) Garz & Kock (1969) Richter & Wulff (1970) Wolnik et al. (1970) Whaling et al. (1977) Kuehne et al. (1978) Biemont & Godefroid (1980) Kerkhoff et al. (1980) Cardon et al. (1982) Blackwell et al. (1982b) Blackwell et al. (1982a) Blackwell et al. (1983) Blackwell et al. (1984) Booth et al. (1984) Kock et al. (1984) Whaling et al. (1985) Doerr & Kock (1985) Duquette et al. (1986) Blackwell et al. (1986) Grevesse et al. (1989) Carlsson et al. (1989) Chang & Tang (1990) Hibbert et al. (1991) Davidson et al. (1992) Hibbert et al. (1993) Butler et al. (1993) Nahar (1993) Mendoza et al. (1995) Volz et al. (1996) Yan et al. (1998) Nitz et al. (1999) Storey & Zeippen (2000) Johansson et al. (2003) Fuhr & Wiese (2006) Zatsarinny & Bartschat (2006) Blackwell-Whitehead & Bergemann (2007) Li et al. (2007) Meléndez & Barbuy (2009) Wiese & Fuhr (2009) Kułaga-Egger & Migdałek (2009) Lawler et al. (2013) Wood et al. (2013)

by author
Aldenius et al. (2007) Barklem & Aspelund-Johansson (2005) Biémont et al. (2011) Biemont et al. (1981a) Bizzarri et al. (1993) Blackwell et al. (1979a) Bard et al. (1991) Bridges & Kornblith (1974) Bard & Kock (1994) O'brian & Lawler (1991) Barklem et al. (2000) O'Brian et al. (1991) Corliss & Bozman (1962a) Cowley & Corliss (1983a) Cocke et al. (1973) Drozdowski et al. (1997) Den Hartog et al. (2006) Den Hartog et al. (2011) Fuhr et al. (1988) Garz (1973) García & Campos (1988) Blackwell et al. (1979b) Blackwell et al. (1982c) Blackwell et al. (1982d) Blackwell et al. (1995) Grevesse (2012) Froese Fischer & Tachiev (2012) Saraph & Storey (2012) Ruffoni & Pickering (2012) Hannaford et al. (1982) Den Hartog et al. (2003) Ivarsson et al. (2001) Kurucz (2006) Kurucz (2007) Kurucz (2008) Kurucz (2009) Kurucz (2010) Kurucz (2011) Kock & Richter (1968) Lawler et al. (2001a) Lawler et al. (2006) Lawler & Dakin (1989) Ljung et al. (2006) Lawler et al. (2009) Lawler et al. (2001c) Lennard et al. (1975) Meggers et al. (1975) Martin et al. (1988) May et al. (1974) Nitz et al. (1998) Pinnington et al. (1993) Pitts & Newsom (1986) Palmeri et al. (2000) Pickering et al. (2001) Raassen & Uylings (1998) Smith & Kuehne (1978) Sobeck et al. (2007) Smith & O'Neill (1975) Smith & Raggett (1981) Smith (1988) Vaeck et al. (1988) Wolnik et al. (1971) Whaling & Brault (1988) Werij et al. (1992) Wickliffe et al. (2000) Wickliffe & Lawler (1997b) Wickliffe et al. (1994)

9.0.3. References in the atomic masterline list

by year
Wolnik et al. (1968) Garz & Kock (1969) Richter & Wulff (1970) Wolnik et al. (1970) Whaling et al. (1977) Kuehne et al. (1978) Biemont & Godefroid (1980) Kerkhoff et al. (1980) Cardon et al. (1982) Blackwell et al. (1982b) Blackwell et al. (1982a) Blackwell et al. (1983) Blackwell et al. (1984) Booth et al. (1984) Kock et al. (1984) Whaling et al. (1985) Doerr & Kock (1985) Duquette et al. (1986) Blackwell et al. (1986) Grevesse et al. (1989) Carlsson et al. (1989) Chang & Tang (1990) Hibbert et al. (1991) Davidson et al. (1992) Hibbert et al. (1993) Butler et al. (1993) Nahar (1993) Mendoza et al. (1995) Volz et al. (1996) Yan et al. (1998) Nitz et al. (1999) Storey & Zeippen (2000) Johansson et al.

(2003) Fuhr & Wiese (2006) Zatsarinny & Bartschat (2006) Blackwell-Whitehead & Bergemann (2007) Li et al. (2007) Meléndez & Barbuy (2009) Wiese & Fuhr (2009) Kułaga-Egger & Migdałek (2009) Gaia-ESO (2013)

by author
Arnesen et al. (1977) Alonso-Medina (1997) Andersen et al. (1975) Andersen & Sorensen (1974) Anisimova & Semenov (1974) Andersen & Soerensen (1973) Aldenius et al. (2007) Anderson et al. (1967) Barklem & Aspelund-Johansson (2005) Blanco et al. (1995) Biémont et al. (2011) Biémont et al. (1998) Biémont et al. (2001a) Biemont et al. (1981a) Biemont et al. (1984) Bizzarri et al. (1993) Biémont (1973) Bièmont (1977) Blackwell et al. (1979a) Bard et al. (1991) Biemont et al. (1982) Blagoev et al. (1978) Blagoev et al. (1977) Blagoev & Komarovskii (1977) Bridges & Kornblith (1974) Bard & Kock (1994) Blackwell-Whitehead et al. (2006) Biémont et al. (1999) Biémont et al. (2003) O'brian & Lawler (1991) Bengston & Miller (1970) Barklem et al. (2000) Biémont et al. (2002a) Biémont et al. (2001b) Biémont et al. (2002b) Biemont et al. (1993) Biemont et al. (1981b) Blackwell et al. (1980) O'Brian et al. (1991) Blackwell-Whitehead et al. (2005b) Barach (1970) Corliss & Bozman (1962b) Corliss & Bozman (1962a) Cowley & Corliss (1983b) Cowley & Corliss (1983a) Kurucz (1993a) Clawson & Miller (1973) Cowley (1973) Cocke et al. (1973) den Hartog et al. (1998) Den Hartog et al. (2005) Den Hartog et al. (2002) Drozdowski et al. (1997) Den Hartog et al. (2006) Den Hartog et al. (2011) Duquette & Lawler (1982) Duquette & Lawler (1985) Duquette et al. (1981) Duquette et al. (1982a) Duquette et al. (1982b) Kurucz (1993b) Fedchak et al. (2000) Froese Fischer (1975) Fuhr et al. (1988) Friedrich & Trefftz (1969) Garz (1973) García & Campos (1988) Blackwell et al. (1979b) Blackwell et al. (1982c) Blackwell et al. (1982d) Blackwell et al. (1995) Grevesse (2012) Froese Fischer & Tachiev (2012) Saraph & Storey (2012) Ruffoni & Pickering (2012) Gough et al. (1982) von der Goltz et al. (1984) Kurucz (1993c) Gorshkov et al. (1980) Gorshkov et al. (1981) Gorshkov et al. (1983) Gruzdev & Loginov (1979) Kurucz (1993d) Hannaford et al. (1982) Hannaford et al. (1981) Den Hartog et al. (2003) Ivarsson et al. (2003) Ivarsson et al. (2001) Ryabtsev (2010) Migdalek (1978) Kurucz (2003) Kurucz (2004) Kurucz (2006) Kurucz (2007) Kurucz (2008) Kurucz (2009) Kurucz (2010) Kurucz (2011) Kurucz (2012) Kurucz (2013a) Kurucz (1975a) Kurucz (1999) Kroll & Kock (1987) Kurucz & Peytremann (1975) Kock & Richter (1968) Kwiatkowski et al. (1982) Kwiatkowski et al. (1984) Kurucz (1975b) Lawrence (1967) Lawler et al. (2001a) Laughlin et al. (1978) Lawler et al. (2006) Lawler et al. (2007) Lawler & Dakin (1989) Lotrian & Guern (1982) Ljung et al. (2006) Lundqvist et al. (2006) Lindgård & Nielson (1977) Lawler et al. (2009) Lawler et al. (2008) Lawler et al. (2001b) Lawler et al. (1990) Lawler et al. (2001c) Lennard et al. (1975) Lambert & Warner (1968) Li et al. (2001b) Lilly (1976) McEachran & Cohen (1971) Martin & Campos (1978) Meggers et al. (1975) Matheron et al. (2001) Martin et al. (1988) Migdalek (1976) Migdałek (1976) Miller et al. (1971) May et al. (1974) Kurucz (1993e) Miller et al. (1974) Miles & Wiese (1969) Murphy (1968) Nilsson et al. (2002a) Ralchenko et al. (2010) Nitz et al. (1998) Nilsson et al. (2002b) Obbarius & Kock (1982) Pinnington et al. (1993) Penkin et al. (1984) Penkin & Komarovskii (1976) Pitts & Newsom (1986) Palmeri et al. (2001) Palmeri et al. (2000) Pickering et al. (2001) Plekhotkin & Verolainen (1985) Quinet et al. (1999b) Quinet et al. (1999a) Radziemski et al. (1995) Ryabchikova et al. (1994) Raassen et al. (1998) Ryabchikova et al. (2006) Ryabchikova & Smirnov (1989) Raassen & Uylings (1998) Schulz-Gulde (1969) Sansonetti & Reader (2001) Salih et al. (1983) Schnehage et al. (1983) Smith & Kuehne (1978) Sobeck et al. (2007) Salih & Lawler (1985) Sigut & Landstreet (1990) Smith & O'Neill (1975) Smith & Raggett (1981) Ryabchikova (2012a) Ryabchikova (2012b) Smith (1981) Smith (1988) Seaton et al. (1994) Theodosiou (1989) Uylings & Raassen (1997) Vaeck et al. (1988) Wolnik et al. (1971) Whaling & Brault (1988) Weiss (1974) Werij et al. (1992) Whaling et al. (1984) Wickliffe et al. (2000) Wickliffe & Lawler (1997b) Wickliffe & Lawler (1997a) Wiese & Martin (1980) Wiese et al. (1966) Wickliffe et al. (1994) Wiese et al. (1969) Wyart et al. (2008) Ward et al. (1985) Warner (1968b) Warner (1968a) Warner (1968c) Xu et al. (2003a) Xu et al. (2003b) Xu et al. (2003c) Yan & Drake (1995) Zhiguo et al. (2000) Zhang et al. (2002) Zhiguo et al. (1999)

9.0.4. References in the molecular masterline list

Tanabashi et al. (2007a) Tanabashi et al. (2007b) Weck et al. (2003) Brooke et al. (2013) Shayesteh & Bernath (2011) Ram et al. (2010a) Ram et al. (2010b) Ram et al. (2010b) Ram & Bernath (2010) Bernath & Colin (2009) Ram et al. (2006) Shayesteh

& Bernath (2006) Dulick et al. (2003) Weck et al. (2003) Luque & Crosley (1999) Goldman et al. (1998a) Goldman et al. (1998b) Tarroni et al. (1997) Cantarella et al. (1992) Saxon et al. (1978) Zachwieja (1997) Zachwieja (1995)

References

Aldenius, M., Tanner, J. D., Johansson, S., Lundberg, H., & Ryan, S. G. 2007, Astron. and Astrophys., 461, 767, (ATJL)

Alonso-Medina, A. 1997, Phys. Scr, 55, 49, (AMb)

Andersen, T., Poulsen, O., Ramanujam, P. S., & Petkov, A. P. 1975, Sol. Phys., 44, 257, (APR)

Andersen, T. & Soerensen, G. 1973, J. Quant. Spec. Radiat. Transf., 13, 369, aS

Andersen, T. & Sorensen, G. 1974, Sol. Phys., 38, 343, (ASa)

Anderson, E. M., Zilitis, V. A., & Sorokina, E. S. 1967, Optics and Spectroscopy, 23, 102, (AZS)

Anisimova, G. P. & Semenov, R. I. 1974, Optics and Spectroscopy, 36, 221, (ASb)

Arnesen, A., Bengtsson, A., Hallin, R., et al. 1977, Phys. Scr, 16, 31, aBH

Başar, G., Başar, G., Acar, G., Öztürk, I. K., & Kröger, S. 2003, Phys. Scr, 67, 476

Başar, G., Başar, F., G., Öztürk, İ. K., & Kröger, S. 2004, Phys. Scr, 69, 189

Barach, J. P. 1970, J. Quant. Spec. Radiat. Transf., 10, 519, (Bar)

Bard, A., Kock, A., & Kock, M. 1991, Astron. and Astrophys., 248, 315, (BKK)

Bard, A. & Kock, M. 1994, Astron. and Astrophys., 282, 1014, (BK)

Barklem, P. S. & Aspelund-Johansson, J. 2005, Astron. and Astrophys., 435, 373, (BA-J)

Barklem, P. S., Piskunov, N., & O'Mara, B. J. 2000, Astron. and Astrophys. Suppl. Ser., 142, 467, (BPM)

Becker, W., Blatt, R., & Werth, G. 1981a, in Precision Measurement and Fundamental Constants, ed. B. N. Taylor & W. D. Phillips, 99

Becker, W., Blatt, R., & Werth, G. 1981b, in European Conference on Atomic Physics, ed. J. Kowalski, G. Zu Putlitz, & H. G. Weber, 208

Bengston, R. D. & Miller, M. H. 1970, Journal of the Optical Society of America (1917-1983), 60, 1093, (BM)

Bergström, H., Peng, W. X., & Persson, A. 1989, Zeitschrift fur Physik D Atoms Molecules Clusters, 13, 203

Bernath, P. F. & Colin, R. 2009, Journal of Molecular Spectroscopy, 257, 20

Biémont, E. 1973, Bulletin de la Societe Royale des Sciences de Liege, 42, 206, (BIEMa)

Bièmont, E. 1977, A&AS, 27, 489, (BIEMb)

Biémont, É., Blagoev, K., Engström, L., et al. 2011, MNRAS, 414, 3350, (BBEHL)

Biémont, E., Dutrieux, J., Martin, I., & Quinet, P. 1998, Journal of Physics B Atomic Molecular Physics, 31, 3321, (BDMQ)

Biémont, E., Garnir, H. P., Bastin, T., et al. 2001a, Monthly Notices Roy. Astron. Soc., 321, 481, (BGBP)

Biemont, E. & Godefroid, M. 1980, A&A, 84, 361

Biemont, E., Grevesse, N., Hannaford, P., & Lowe, R. M. 1981a, ApJ, 248, 867, (BGHL)

Biemont, E., Grevesse, N., Kwiatkovski, M., & Zimmermann, P. 1984, A&A, 131, 364, (BGKZ)

Biemont, E., Karner, C., Meyer, G., Traeger, F., & Zu Putlitz, G. 1982, A&A, 107, 166, (BKM)

Biémont, E., Lefèbvre, P., Quinet, P., Svanberg, S., & Xu, H. L. 2003, European Physical Journal D, 27, 33, (BLQS)

Biémont, E., Li, Z. S., Palmeri, P., & Quinet, P. 1999, Journal of Physics B Atomic Molecular Physics, 32, 3409, (BLPQ)

Biémont, E., Palmeri, P., Quinet, P., et al. 2001b, Monthly Notices Roy. Astron. Soc., 328, 1085, (BP)

Biémont, E., Palmeri, P., Quinet, P., Zhang, Z. G., & Svanberg, S. 2002a, ApJ, 567, 1276, (BPQZS)

Biémont, E., Quinet, P., & Ryabchikova, T. A. 2002b, Monthly Notices Roy. Astron. Soc., 336, 1155, (BQR)

Biemont, E., Quinet, P., & Zeippen, C. J. 1993, A&AS, 102, 435, (BQZ)

Biemont, E., Roland, G., & Delbouille, L. 1981b, Sol. Phys., 71, 223, (BRD)

Bizzarri, A., Huber, M. C. E., Noels, A., et al. 1993, A&A, 273, 707, (BHN)

Blackwell, D. E., Booth, A. J., Menon, S. L. R., & Petford, A. D. 1986, MNRAS, 220, 289

Blackwell, D. E., Ibbetson, P. A., Petford, A. D., & Shallis, M. J. 1979a, MNRAS, 186, 633, (BIPS)

Blackwell, D. E., Lynas-Gray, A. E., & Smith, G. 1995, A&A, 296, 217

Blackwell, D. E., Menon, S. L. R., & Petford, A. D. 1983, MNRAS, 204, 883

Blackwell, D. E., Menon, S. L. R., & Petford, A. D. 1984, MNRAS, 207, 533

Blackwell, D. E., Menon, S. L. R., Petford, A. D., & Shallis, M. J. 1982a, MNRAS, 201, 611

Blackwell, D. E., Petford, A. D., & Shallis, M. J. 1979b, MNRAS, 186, 657

Blackwell, D. E., Petford, A. D., Shallis, M. J., & Leggett, S. 1982b, MNRAS, 199, 21

Blackwell, D. E., Petford, A. D., Shallis, M. J., & Simmons, G. J. 1982c, MNRAS, 199, 43
Blackwell, D. E., Petford, A. D., & Simmons, G. J. 1982d, MNRAS, 201, 595
Blackwell, D. E., Shallis, M. J., & Simmons, G. J. 1980, Astron. and Astrophys., 81, 340, (BSScor)
Blackwell-Whitehead, R. & Bergemann, M. 2007, A&A, 472, L43
Blackwell-Whitehead, R. J., Lundberg, H., Nave, G., et al. 2006, Monthly Notices Roy. Astron. Soc., 373, 1603, (BLNP)
Blackwell-Whitehead, R. J., Pickering, J. C., Pearse, O., & Nave, G. 2005a, ApJS, 157, 402
Blackwell-Whitehead, R. J., Xu, H. L., Pickering, J. C., Nave, G., & Lundberg, H. 2005b, MNRAS, 361, 1281, (BXPNL)
Blagoev, K. B. & Komarovskii, V. A. 1977, Optics and Spectroscopy, 42, 229, (BKom)
Blagoev, K. B., Komarovskii, V. A., & Penkin, N. P. 1977, Optics and Spectroscopy, 42, 238, (BKP)
Blagoev, K. B., Komarovskii, V. A., & Penkin, N. P. 1978, Optics and Spectroscopy, 44, 131, (BKPb)
Blanco, F., Botho, B., & Campos, J. 1995, Phys. Scr, 52, 628, (BBC)
Booth, A. J., Blackwell, D. E., Petford, A. D., & Shallis, M. J. 1984, MNRAS, 208, 147
Bridges, J. M. & Kornblith, R. L. 1974, ApJ, 192, 793, (BKor)
Brodzinski, T., Kronfeldt, H.-D., Kropp, J.-R., & Winkler, R. 1987, Zeitschrift fur Physik D Atoms Molecules Clusters, 7, 161
Brooke, J. S. A., Bernath, P. F., Schmidt, T. W., & Bacskay, G. B. 2013, J. Quant. Spec. Radiat. Transf., 124, 11
Butler, K., Mendoza, C., & Zeippen, C. J. 1993, Journal of Physics B Atomic Molecular Physics, 26, 4409
Cantarella, E., Culot, F., & Liévin, J. 1992, Phys. Scr, 46, 489
Cardon, B. L., Smith, P. L., Scalo, J. M., Testerman, L., & Whaling, W. 1982, ApJ, 260, 395
Carlsson, J., Sturesson, L., & Svanberg, S. 1989, Zeitschrift fur Physik D Atoms Molecules Clusters, 11, 287
Chang, T. N. & Tang, X. 1990, J. Quant. Spec. Radiat. Transf., 43, 207
Childs, W. J. 1971, Phys. Rev. A, 4, 1767
Childs, W. J., Poulsen, O., & Goodman, L. S. 1979a, Phys. Rev. A, 19, 160
Childs, W. J., Poulsen, O., Goodman, L. S., & Crosswhite, H. 1979b, Phys. Rev. A, 19, 168
Clawson, J. E. & Miller, M. H. 1973, Journal of the Optical Society of America (1917-1983), 63, 1598, cM
Cochrane, E. C. A., Benton, D. M., Forest, D. H., & Griffith, J. A. R. 1998, Journal of Physics B Atomic Molecular Physics, 31, 2203
Cocke, C. L., Stark, A., & Evans, J. C. 1973, ApJ, 184, 653, (CSE)
Corliss, C. H. & Bozman, W. R. 1962a, NBS Monograph, Vol. 53, Experimental transition probabilities for spectral lines of seventy elements; derived from the NBS Tables of spectral-line intensities, ed. Corliss, C. H. & Bozman, W. R. (US Government Printing Office), (CB)
Corliss, C. H. & Bozman, W. R. 1962b, NBS Monograph, Vol. 53, Experimental transition probabilities for spectral lines of seventy elements; derived from the NBS Tables of spectral-line intensities, ed. Corliss, C. H. & Bozman, W. R. (Washington DC: US Government Printing Office), (CBcor)
Cowley, C. R. 1973, Journ. Res. NBS, 77A, 419, (CRC)
Cowley, C. R. & Corliss, C. H. 1983a, MNRAS, 203, 651, (CC)
Cowley, C. R. & Corliss, C. H. 1983b, MNRAS, 203, 651, (CCout)
Davidson, M. D., Snoek, L. C., Volten, H., & Doenszelmann, A. 1992, A&A, 255, 457
Davis, S. J., Wright, J. J., & Balling, L. C. 1971, Phys. Rev. A, 3, 1220
Dembczyński, J., Ertmer, W., Johann, U., Penselin, S., & Stinner, P. 1979, Zeitschrift fur Physik A Hadrons and Nuclei, 291, 207
den Hartog, E. A., Curry, J. J., Wickliffe, M. E., & Lawler, J. E. 1998, Sol. Phys., 178, 239
Den Hartog, E. A., Herd, M. T., Lawler, J. E., et al. 2005, Astrophys. J., 619, 639, (DHL)
Den Hartog, E. A., Lawler, J. E., Sneden, C., & Cowan, J. J. 2003, Astrophys. J. Suppl. Ser., 148, 543, (HLSC)
Den Hartog, E. A., Lawler, J. E., Sneden, C., & Cowan, J. J. 2006, Astrophys. J. Suppl. Ser., 167, 292, (DLSC)
Den Hartog, E. A., Lawler, J. E., Sobeck, J. S., Sneden, C., & Cowan, J. J. 2011, ApJS, 194, 35, (DLSSC)
Den Hartog, E. A., Wickliffe, M. E., & Lawler, J. E. 2002, Astrophys. J. Suppl. Ser., 141, 255, (DHWL)
Doerr, A. & Kock, M. 1985, J. Quant. Spec. Radiat. Transf., 33, 307
Drozdowski, R., Ignaciuk, M., Kwela, J., & Heldt, J. 1997, Zeitschrift fur Physik D Atoms Molecules Clusters, 41, 125, (DIKH)
Dulick, M., Bauschlicher, Jr., C. W., Burrows, A.,

et al. 2003, ApJ, 594, 651
Duquette, D. W., den Hartog, E. A., & Lawler, J. E. 1986, J. Quant. Spec. Radiat. Transf., 35, 281
Duquette, D. W. & Lawler, J. E. 1982, Phys. Rev. A, 26, 330, (DLa)
Duquette, D. W. & Lawler, J. E. 1985, Journal of the Optical Society of America B Optical Physics, 2, 1948, (DLb)
Duquette, D. W., Salih, S., & Lawler, J. E. 1981, Phys. Rev. A, 24, 2847, dSLa
Duquette, D. W., Salih, S., & Lawler, J. E. 1982a, Phys. Rev. A, 26, 2623, dSLb
Duquette, D. W., Salih, S., & Lawler, J. E. 1982b, Journal of Physics B Atomic Molecular Physics, 15, L897, (DSLc)
El-Kashef, H. & Ludwig, N. 1992, Physica B Condensed Matter, 179, 103
Ertmer, W. & Hofer, B. 1976, Zeitschrift fur Physik A Hadrons and Nuclei, 276, 9
Fedchak, J. A., Den Hartog, E. A., Lawler, J. E., et al. 2000, Astrophys. J., 542, 1109, (FDLP)
Fischer, W., Hühnermann, H., & Kollath, K.-J. 1967, Zeitschrift fur Physik, 200, 158
Friedrich, H. & Trefftz, E. 1969, Tech. Rep. 29, Max-Planck-Institut fur Physik und Astrophysik MPI-PAE/ASTRO, (FTa)
Froese Fischer, C. 1975, Canadian Journal of Physics, 53, 338, (FFb)
Froese Fischer, C. & Tachiev, G. 2012, Multiconfiguration Hartree-Fock and Multiconfiguration Dirac-Hartree-Fock Collection, Version 2, available online at http://physics.nist.gov/mchf/
Fuhr, J. R., Martin, G. A., & Wiese, W. L. 1988, Journal of Physical and Chemical Reference Data, Volume 17, Suppl. 4. New York: American Institute of Physics (AIP) and American Chemical Society, 1988, 17, (FMW)
Fuhr, J. R. & Wiese, W. L. 2006, Journal of Physical and Chemical Reference Data, 35, 1669
Gaia-ESO. 2013, A weighted mean of the Bard, O'Brian, Blackwell data
García, G. & Campos, J. 1988, J. Quant. Spec. Radiat. Transf., 39, 477, (GC)
Garz, T. 1973, A&A, 26, 471, (GARZ)
Garz, T. & Kock, M. 1969, A&A, 2, 274
Ginibre, A. 1989, Phys. Scr, 39, 694
Goldman, A., Chance, K. V., Coffey, M. T., et al. 1998a, J. Quant. Spec. Radiat. Transf., 60, 869
Goldman, A., Schoenfeld, W. G., Goorvitch, D., et al. 1998b, J. Quant. Spec. Radiat. Transf., 59, 453
Gorshkov, V. N., Komarovskii, V. A., Oserovich, A. L., Penkin, N. P., & Khefferlin, R. 1980, Optics and Spectroscopy, 48, 362, (GKOPK)
Gorshkov, V. N., Komarovskii, V. A., Osherovich, A. L., & Penkin, N. P. 1981, Astrofizika, 17, 799, (GKOa)
Gorshkov, V. N., Komarovskii, V. A., Osherovich, A. L., & Penkin, N. P. 1983, Optics and Spectroscopy, 54, 122, (GKOb)
Gough, D. S., Hannaford, P., & Lowe, R. M. 1982, Journal of Physics B Atomic Molecular Physics, 15, L431, (GHLa)
Grevesse, N. 2012, private communication
Grevesse, N., Blackwell, D. E., & Petford, A. D. 1989, A&A, 208, 157
Gruzdev, P. F. & Loginov, A. V. 1979, Optics and Spectroscopy, 46, 129, (GL)
Handrich, E., Steudel, A., & Walther, H. 1969, Physics Letters A, 29, 486
Hannaford, P., Larkins, P. L., & Lowe, R. M. 1981, Journal of Physics B Atomic Molecular Physics, 14, 2321, hLL
Hannaford, P., Lowe, R. M., Grevesse, N., Biemont, E., & Whaling, W. 1982, ApJ, 261, 736, (HLGBW)
Hermann, G. 1993, Spectrochimica Acta, 48, 1259
Hibbert, A., Biemont, E., Godefroid, M., & Vaeck, N. 1991, Journal of Physics B Atomic Molecular Physics, 24, 3943
Hibbert, A., Biemont, E., Godefroid, M., & Vaeck, N. 1993, A&AS, 99, 179
Höhle, C., Hühnermann, H., & Wagner, H. 1982, Zeitschrift fur Physik A Hadrons and Nuclei, 304, 279
Ivarsson, S., Andersen, J., Nordström, B., et al. 2003, Astron. and Astrophys., 409, 1141, (IAN)
Ivarsson, S., Litzén, U., & Wahlgren, G. M. 2001, Physica Scripta, 64, 455, (ILW)
Johann, U., Dembczyński, J., & Ertmer, W. 1981, Zeitschrift fur Physik A Hadrons and Nuclei, 303, 7
Johansson, S., Litzén, U., Lundberg, H., & Zhang, Z. 2003, ApJ, 584, L107
Kerkhoff, H., Schmidt, M., & Zimmermann, P. 1980, Zeitschrift fur Physik A Hadrons and Nuclei, 298, 249
Kock, M., Kroll, S., & Schnehage, S. 1984, Physica Scripta Volume T, 8, 84
Kock, M. & Richter, J. 1968, ZAp, 69, 180, (KR)
Kroll, S. & Kock, M. 1987, Astron. and Astrophys. Suppl. Ser., 67, 225, (KK)
Kuehne, M., Danzmann, K., & Kock, M. 1978, A&A, 64, 111
Kułaga-Egger, D. & Migdałek, J. 2009, Journal of Physics B Atomic Molecular Physics, 42, 185002
Kurucz, R. 1993a, CDROM 18, SAO, Cambridge

Kurucz, R. L. 1975a, (K75)
Kurucz, R. L. 1975b, (K)
Kurucz, R. L. 1993b, (ESTM)
Kurucz, R. L. 1993c, (GHcor)
Kurucz, R. L. 1993d, (GUES)
Kurucz, R. L. 1993e, (MULT)
Kurucz, R. L. 1999, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2003, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2004, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2006, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2007, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2008, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2009, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2010, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2011, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2012, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2013a, Robert L. Kurucz on-line database of observed and predicted atomic transitions
Kurucz, R. L. 2013b, Robert L. Kurucz on-line database of observed and predicted atomic transitions: Cu I relative ISO shift
Kurucz, R. L. & Peytremann, E. 1975, SAO Special Report, 362, 1, (KP)
Kwiatkowski, M., Zimmermann, P., Biemont, E., & Grevesse, N. 1982, A&A, 112, 337, kZBa
Kwiatkowski, M., Zimmermann, P., Biemont, E., & Grevesse, N. 1984, Astron. and Astrophys., 135, 59, (KZB)
Lambert, D. L. & Warner, B. 1968, MNRAS, 138, 181, (LWa)
Laughlin, C., Constantinides, E. R., & Victor, G. A. 1978, Journal of Physics B Atomic Molecular Physics, 11, 2243, (LCV)
Lawler, J. E., Bonvallet, G., & Sneden, C. 2001a, Astrophys. J., 556, 452, (LBS)
Lawler, J. E. & Dakin, J. T. 1989, Journal of the Optical Society of America B Optical Physics, 6, 1457, (LD)
Lawler, J. E., den Hartog, E. A., Labby, Z. E., et al. 2007, Astrophys. J. Suppl. Ser., 169, 120, (LDLS)
Lawler, J. E., Den Hartog, E. A., Sneden, C., & Cowan, J. J. 2006, Astrophys. J. Suppl. Ser., 162, 227, (LD-HS)
Lawler, J. E., Guzman, A., Wood, M. P., Sneden, C., & Cowan, J. J. 2013, ApJS, 205, 11
Lawler, J. E., Sneden, C., Cowan, J. J., Ivans, I. I., & Den Hartog, E. A. 2009, Astrophys. J. Suppl. Ser., 182, 51, (LSCI)
Lawler, J. E., Sneden, C., Cowan, J. J., et al. 2008, Astrophys. J. Suppl. Ser., 178, 71, (LSCW)
Lawler, J. E., Whaling, W., & Grevesse, N. 1990, Nature, 346, 635, (LWG)
Lawler, J. E., Wickliffe, M. E., Cowley, C. R., & Sneden, C. 2001b, Astrophys. J. Suppl. Ser., 137, 341, (LWCS)
Lawler, J. E., Wickliffe, M. E., den Hartog, E. A., & Sneden, C. 2001c, Astrophys. J., 563, 1075, (LWHS)
Lawrence, G. M. 1967, ApJ, 148, 261, (LAW)
Lefèbvre, P.-H., Garnir, H.-P., & Biémont, E. 2003, A&A, 404, 1153
Lennard, W. N., Whaling, W., Scalo, J. M., & Testerman, L. 1975, ApJ, 197, 517, (LWST)
Li, G.-W., Zhang, X.-M., Lu, F.-Q., Peng, X.-J., & Yang, F.-J. 2001a, Japanese Journal of Applied Physics, 40, 2508
Li, R., Chatelain, R., Holt, R. A., et al. 2007, Phys. Scr, 76, 577
Li, Z. S., Zhang, Z. G., Lokhnygin, V., et al. 2001b, Journal of Physics B Atomic Molecular Physics, 34, 1349, (LZLS)
Lilly, R. A. 1976, Journal of the Optical Society of America (1917-1983), 66, 971, (La)
Lindgård, A. & Nielson, S. E. 1977, Atomic Data and Nuclear Data Tables, 19, 533, (LN)
Ljung, G., Nilsson, H., Asplund, M., & Johansson, S. 2006, A&A, 456, 1181
Lotrian, J. & Guern, Y. 1982, Journal of Physics B Atomic Molecular Physics, 15, 69, (LGb)
Luc, P. & Gerstenkorn, S. 1972, A&A, 18, 209
Lundqvist, M., Nilsson, H., Wahlgren, G. M., et al. 2006, Astron. and Astrophys., 450, 407, (LNWLX)
Luque, J. & Crosley, D. R. 1999, Appl. Opt., 38, 1423
Ma, H. L. & Yang, F. J. 2004, Atomic Data and Nuclear Data Tables, 86, 3

Martin, G., Fuhr, J., & Wiese, W. 1988, J. Phys. Chem. Ref. Data Suppl., 17
Martin, P. & Campos, J. 1978, J. Quant. Spec. Radiat. Transf., 19, 109, (MCb)
Masterman, D., Rosner, S. D., Scholl, T. J., Sharikova, A., & Holt, R. . 2003, Canadian Journal of Physics, 81, 1389
Matheron, P., Escarguel, A., Redon, R., Lesage, A., & Richou, J. 2001, J. Quant. Spec. Radiat. Transf., 69, 535, (MER)
May, M., Richter, J., & Wichelmann, J. 1974, A&AS, 18, 405, (MRW)
McEachran, R. P. & Cohen, M. 1971, J. Quant. Spec. Radiat. Transf., 11, 1819, (MCa)
Meggers, W. F., Corliss, C. H., & Scribner, B. F. 1975, Tables of spectral-line intensities. Part I, II_- arranged by elements., ed. Meggers, W. F., Corliss, C. H., & Scribner, B. F., (MC)
Meléndez, J. & Barbuy, B. 2009, A&A, 497, 611
Mendoza, C., Eissner, W., LeDourneuf, M., & Zeippen, C. J. 1995, Journal of Physics B Atomic Molecular Physics, 28, 3485
Migdalek, J. 1976, J. Quant. Spec. Radiat. Transf., 16, 265, mIGa
Migdałek, J. 1976, Canadian Journal of Physics, 54, 2272, (MIGb)
Migdalek, J. 1978, J. Quant. Spec. Radiat. Transf., 20, 81, jMG
Miles, B. M. & Wiese, W. L. 1969, Atomic Data, 1, 1, (MW)
Miller, M. H., Roig, R. A., & Bengtson, R. D. 1971, Phys. Rev. A, 4, 1709, (MRB)
Miller, M. H., Wilkerson, T. D., Roig, R. A., & Bengtson, R. D. 1974, Phys. Rev. A, 9, 2312, (MWRB)
Möller, W., Hühnermann, H., Alkhazov, G., & Panteleev, V. 1993, Physical Review Letters, 70, 541
Murphy, P. W. 1968, Journal of the Optical Society of America (1917-1983), 58, 1200, (M)
Nahar, S. N. 1993, Phys. Scr, 48, 297
Nakhate, S. G., Afzal, S. M., & Ahmad, S. A. 1997, Zeitschrift fur Physik D Atoms Molecules Clusters, 42, 71
Nilsson, H., Ivarsson, S., Johansson, S., & Lundberg, H. 2002a, Astron. and Astrophys., 381, 1090, (NIJL)
Nilsson, H., Zhang, Z. G., Lundberg, H., Johansson, S., & Nordström, B. 2002b, Astron. and Astrophys., 382, 368, (NZL)
Nitz, D. E., Kunau, A. E., Wilson, K. L., & Lentz, L. R. 1999, ApJS, 122, 557
Nitz, D. E., Wickliffe, M. E., & Lawler, J. E. 1998, Astrophys. J. Suppl. Ser., 117, 313, (NWL)
Obbarius, H. U. & Kock, M. 1982, Journal of Physics B Atomic Molecular Physics, 15, 527, oK
O'brian, T. R. & Lawler, J. E. 1991, Phys. Rev. A, 44, 7134, (BL)
O'Brian, T. R., Wickliffe, M. E., Lawler, J. E., Whaling, W., & Brault, J. W. 1991, Journal of the Optical Society of America B Optical Physics, 8, 1185, (BWL)
Öztürk, I. K., Gülay Acar, F., Basar, G., Basar, G., & Kröger, S. 2007, Phys. Scr, 75, 624
Palmeri, P., Biemont, E., Aboussaid, A., & Godefroid, M. 1995, Journal of Physics B Atomic Molecular Physics, 28, 3741
Palmeri, P., Quinet, P., & Biémont, E. 2001, Physica Scripta, 63, 468, (PQB)
Palmeri, P., Quinet, P., Wyart, J., & Biémont, E. 2000, Physica Scripta, 61, 323, (PQWB)
Penkin, N. P., Gorshkov, V. N., & Komarovskii, V. A. 1984, Optics and Spectroscopy, 57, 488, (PGK)
Penkin, N. P. & Komarovskii, V. A. 1976, J. Quant. Spec. Radiat. Transf., 16, 217, (PK)
Pickering, J. C. 1996, ApJS, 107, 811
Pickering, J. C., Thorne, A. P., & Perez, R. 2001, Astrophys. J. Suppl. Ser., 132, 403, (PTP)
Pinnington, E. H., Ji, Q., Guo, B., et al. 1993, Canadian Journal of Physics, 71, 470, (PGBH)
Pitts, R. E. & Newsom, G. H. 1986, J. Quant. Spec. Radiat. Transf., 35, 383, (PN)
Plekhotkin, G. A. & Verolainen, Y. F. 1985, Optics and Spectroscopy, 58, 447, pV
Quinet, P., Palmeri, P., & Biemont, E. 1999a, J. Quant. Spectrosc. Radiat. Transfer, 62, 625, (QPB)
Quinet, P., Palmeri, P., Biémont, E., et al. 1999b, Monthly Notices Roy. Astron. Soc., 307, 934, (QPBM)
Raassen, A. J. J., Pickering, J. C., & Uylings, P. H. M. 1998, A&AS, 130, 541, (RPU)
Raassen, A. J. J. & Uylings, P. H. M. 1998, A&A, 340, 300, (RU)
Radziemski, L. J., Engleman, Jr., R., & Brault, J. W. 1995, Phys. Rev. A, 52, 4462, (REB)
Ralchenko, Y., Kramida, A., Reader, J., & NIST ASD Team. 2010, NIST Atomic Spectra Database (ver. 4.0.0), [Online].
Ram, R. S. & Bernath, P. F. 2010, Journal of Molecular Spectroscopy, 260, 115
Ram, R. S., Davis, S. P., Wallace, L., et al. 2006, Journal of Molecular Spectroscopy, 237, 225
Ram, R. S., Wallace, L., & Bernath, P. F. 2010a, Journal of Molecular Spectroscopy, 263, 82
Ram, R. S., Wallace, L., Hinkle, K., & Bernath, P. F.

2010b, ApJS, 188, 500
Richter, J. & Wulff, P. 1970, A&A, 9, 37
Rivest, R. C., Izawa, M. R., Rosner, S. D., et al. 2002, Canadian Journal of Physics, 80, 557
Rosner, S. D., Masterman, D., Scholl, T. U., & Holt, R. A. 2005, Canadian Journal of Physics, 83, 841
Ruffoni, M. & Pickering, J. 2012, private communication
Ryabchikova, T., Ryabtsev, A., Kochukhov, O., & Bagnulo, S. 2006, Astron. and Astrophys., 456, 329, (RRKB)
Ryabchikova, T. A. 2012a, (Si2-av1)
Ryabchikova, T. A. 2012b, (Si2-av2)
Ryabchikova, T. A., Hill, G. M., Landstreet, J. D., Piskunov, N., & Sigut, T. A. A. 1994, MNRAS, 267, 697, (RHL)
Ryabchikova, T. A. & Smirnov, Y. M. 1989, Astron. Tsirk., 21, (RSa)
Ryabtsev, A. N. 2010, private communication, (ISAN)
Salih, S., Duquette, D. W., & Lawler, J. E. 1983, Phys. Rev. A, 27, 1193, (SDL)
Salih, S. & Lawler, J. E. 1985, Journal of the Optical Society of America B Optical Physics, 2, 422, (SLb)
Sansonetti, C. J. & Reader, J. 2001, Physica Scripta, 63, 219, (SCRJ)
Saraph, H. & Storey, P. 2012, publication in preparation, available online at http://cdsweb.u-strasbg.fr/topbase/topbase.html
Saxon, R. P., Kirby, K., & Liu, B. 1978, J. Chem. Phys., 69, 5301
Schnehage, S. E., Danzmann, K., Kuennemeyer, R., & Kock, M. 1983, J. Quant. Spec. Radiat. Transf., 29, 507, (SDcor)
Schulz-Gulde, E. 1969, J. Quant. Spec. Radiat. Transf., 9, 13, (S-G)
Seaton, M. J., Yan, Y., Mihalas, D., & Pradhan, A. K. 1994, Monthly Notices Roy. Astron. Soc., 266, 805, (TB)
Shayesteh, A. & Bernath, P. F. 2006, J. Chem. Phys., 124, 156101
Shayesteh, A. & Bernath, P. F. 2011, J. Chem. Phys., 135, 094308
Sigut, T. A. A. & Landstreet, J. D. 1990, MNRAS, 247, 611, (SLd)
Silverans, R. E., Borghs, G., de Bisschop, P., & van Hove, M. 1986, Phys. Rev. A, 33, 2117
Smith, G. 1981, Astron. and Astrophys., 103, 351, (Sm)
Smith, G. 1988, Journal of Physics B Atomic Molecular Physics, 21, 2827, (S)
Smith, G. & O'Neill, J. A. 1975, Astron. and Astrophys., 38, 1, (SN)
Smith, G. & Raggett, D. S. J. 1981, Journal of Physics B Atomic Molecular Physics, 14, 4015, (SR)
Smith, P. L. & Kuehne, M. 1978, Royal Society of London Proceedings Series A, 362, 263, (SK)
Sobeck, J. S., Lawler, J. E., & Sneden, C. 2007, Astrophys. J., 667, 1267, (SLS)
Storey, P. J. & Zeippen, C. J. 2000, MNRAS, 312, 813
Tanabashi, A., Hirao, T., Amano, T., & Bernath, P. F. 2007a, ApJS, 170, 261
Tanabashi, A., Hirao, T., Amano, T., & Bernath, P. F. 2007b, ApJS, 169, 472
Tarroni, R., Palmieri, P., Mitrushenkov, A., Tosi, P., & Bassi, D. 1997, J. Chem. Phys., 106, 10265
Theodosiou, C. E. 1989, Physical Review A, 39, 4880, (T)
Unkel, P., Buch, P., Dembczyński, J., Ertmer, W., & Johann, U. 1989, Zeitschrift fur Physik D Atoms Molecules Clusters, 11, 259
Uylings, P. H. M. & Raassen, A. J. J. 1997, A&AS, 125, 539, (UR)
Vaeck, N., Godefroid, M., & Hansen, J. E. 1988, Phys. Rev. A, 38, 2830, (VGH)
Villemoes, P., Arnesen, A., Heijkenskjöld, F., Kastberg, A., & Larsson, M. O. 1992a, Phys. Scr, 46, 45
Villemoes, P., Arnesen, A., Heijkenskjöld, F., Kastberg, A., & Wännström, A. 1992b, Physics Letters A, 162, 178
Villemoes, P., Arnesen, A., Heijkenskjold, F., & Wannstrom, A. 1993, Journal of Physics B Atomic Molecular Physics, 26, 4289
Volz, U., Majerus, M., Liebel, H., Schmitt, A., & Schmoranzer, H. 1996, Physical Review Letters, 76, 2862
von der Goltz, D., Hansen, W., & Richter, J. 1984, Phys. Scr, 30, 244, (GHR)
Wagner, S. 1955, Zeitschrift fur Physik, 141, 122
Ward, L., Vogel, O., Arnesen, A., Hallin, R., & Wännström, A. 1985, Phys. Scr, 31, 161, (WV)
Warner, B. 1968a, MNRAS, 139, 115, (Wc)
Warner, B. 1968b, MNRAS, 140, 53, wa
Warner, B. 1968c, MNRAS, 141, 273, (Wd)
Weck, P. F., Stancil, P. C., & Kirby, K. 2003, J. Chem. Phys., 118, 9997
Weiss, A. W. 1974, Phys. Rev. A, 9, 1524, (WEI)
Werij, H. G. C., Greene, C. H., Theodosiou, C. E., & Gallagher, A. 1992, Phys. Rev. A, 46, 1248, (WGTG)
Whaling, W. & Brault, J. W. 1988, Phys. Scr, 38, 707, (WBb)
Whaling, W., Hannaford, P., Lowe, R. M.,

Biemont, E., & Grevesse, N. 1984, J. Quant. Spec. Radiat. Transf., 32, 69, (WHLBG)
Whaling, W., Hannaford, P., Lowe, R. M., Biemont, E., & Grevesse, N. 1985, A&A, 153, 109
Whaling, W., Scalo, J. M., & Testerman, L. 1977, ApJ, 212, 581
Wickliffe, M. E. & Lawler, J. E. 1997a, Journal of the Optical Society of America B Optical Physics, 14, 737, (WL)
Wickliffe, M. E. & Lawler, J. E. 1997b, ApJS, 110, 163, (WLa)
Wickliffe, M. E., Lawler, J. E., & Nave, G. 2000, J. Quant. Spectrosc. Radiat. Transfer, 66, 363, (WLN)
Wickliffe, M. E., Salih, S., & Lawler, J. E. 1994, J. Quant. Spec. Radiat. Transf., 51, 545, (WSL)
Wiese, W. L. & Fuhr, J. R. 2009, Journal of Physical and Chemical Reference Data, 38, 565
Wiese, W. L. & Martin, G. A. 1980, Wavelengths and transition probabilities for atoms and atomic ions: Part 2. Transition probabilities, ed. Reader, J., Corliss, C. H., Wiese, W. L., & Martin, G. A., (WM)
Wiese, W. L., Smith, M. W., & Glennon, B. M. 1966, Atomic transition probabilities. Vol.: Hydrogen through Neon. A critical data compilation, ed. Wiese, W. L., Smith, M. W., & Glennon, B. M. (US Government Printing Office), (WSG)
Wiese, W. L., Smith, M. W., & Miles, B. M. 1969, Atomic transition probabilities. Vol. 2: Sodium through Calcium. A critical data compilation, ed. Wiese, W. L., Smith, M. W., & Miles, B. M. (US Government Printing Office), (WSM)
Wolnik, S. J., Berthel, R. O., Larson, G. S., Carnevale, E. H., & Wares, G. W. 1968, Physics of Fluids, 11, 1002
Wolnik, S. J., Berthel, R. O., & Wares, G. W. 1970, ApJ, 162, 1037
Wolnik, S. J., Berthel, R. O., & Wares, G. W. 1971, ApJ, 166, L31+, (WBW)
Wood, M. P., Lawler, J. E., Sneden, C., & Cowan, J. J. 2013, in American Astronomical Society Meeting Abstracts, Vol. 221, 348.04
Wyart, J., Tchang-Brillet, W., Churilov, S. S., & Ryabtsev, A. N. 2008, Astron. and Astrophys., 483, 339, (WTCR)
Xu, H., Jiang, Z., Zhang, Z., et al. 2003a, Journal of Physics B Atomic Molecular Physics, 36, 1771, (XJZD)
Xu, H. L., Svanberg, S., Cowan, R. D., et al. 2003b, Monthly Notices Roy. Astron. Soc., 346, 433, (XSCL)
Xu, H. L., Svanberg, S., Quinet, P., Garnir, H. P., & Biémont, E. 2003c, Journal of Physics B Atomic Molecular Physics, 36, 4773, (XSQG)
Yan, Z.-C. & Drake, G. W. F. 1995, Phys. Rev. A, 52, 4316, (YD)
Yan, Z.-C., Tambasco, M., & Drake, G. W. F. 1998, Phys. Rev. A, 57, 1652
Zachwieja, M. 1995, Journal of Molecular Spectroscopy, 170, 285
Zachwieja, M. 1997, Journal of Molecular Spectroscopy, 182, 18
Zatsarinny, O. & Bartschat, K. 2006, Journal of Physics B Atomic Molecular Physics, 39, 2861
Zeiske, W., Meisel, G., Gebauer, H., Hofer, B., & Ertmer, W. 1976, Physics Letters A, 55, 405
Zhang, Z. G., Somesfalean, G., Svanberg, S., et al. 2002, Astron. and Astrophys., 384, 364, (ZS)
Zhiguo, Z., Li, Z. S., Lundberg, H., et al. 2000, Journal of Physics B Atomic Molecular Physics, 33, 521, (ZLLZ)
Zhiguo, Z., Zhongshan, L., & Zhankui, J. 1999, European Physical Journal D, 7, 499, (ZZZ)