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DIVISION B
COMMISSION 14 **ATOMIC AND MOLECULAR DATA**
DONNÉES ATOMIQUES ET MOLÉCULAIRES

WORKING GROUP **ATOMIC DATA**
DONNÉES ATOMIQUES

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TRIENNIAL REPORT 2011-2015

This report summarizes laboratory measurements of atomic wavelengths, energy levels, hyperfine and isotope structure, energy level lifetimes, and oscillator strengths. Theoretical calculations of lifetimes and oscillator strengths are also included. The bibliography is limited to species of astrophysical interest. Compilations of atomic data and internet databases are also included. Papers are listed in the bibliography in alphabetical order, with a reference number in the text.

Comprehensive lists of references for atomic spectra can be found in the NIST Atomic Spectra Bibliographic Databases `http://physics.nist.gov/asbib`.

1. Energy levels, wavelengths, line classifications, and line structure

Major analyses of wavelengths, energy levels and line classifications have been published for **Cr II**[274, 275], **Fe II**[227], and **V II**[311] in the past three years. Laboratory wavelengths and line identifications have been published for coronal lines observed in spectra from the Solar Dynamics Observatory in the region 193 Å to 218 Å and around 131 Å [38, 312, 313]. Wavelengths and identifications of additional coronal lines between 170 Å and 291 Å have been measured using the Hinode EUV Imaging Spectrometer [64].

Additional publications of wavelengths, energy levels, line classifications, hyperfine structure (HFS), and isotope structure (IS) include:

Al II (HFS): [26], **Ar IX**: [277], **B II**: [208], **Br III**: [140], **Cl I**: [300], **Co II** (forbidden): [256], **Dy I**: [292], **Eu I** (HFS,IS): [2, 102, 103, 104], **Fe VIII-IX**:[230], **Fe VIII-XVI**: [37], **Fe XI**: [66], **Fe XIII**: [62], **Fe XVI**: [36], **Fe XVII**: [63], **Fe XVIII**: [54], **Fe XVIII-XXV**: [254], **Gd I** (IS,HFS): [145], **I I**: [124], **K I**: [51], **K III**: [22], **La I**: [106], **Li I**: [50], **Mg VII-VIII**: [177], **Mn I** (HFS): [25, 165], **Mn II** : [46], **N III**: [112], **Na I**: [52], **Nb I**: [72, 235], **Nb I** (HFS): [95], **Nd II** (HFS): [28], **Ne IV** :[170], **Ni I**: [288, 291], **O I**: [204], **O VI**: [341], **P II**: [153], **Pr I** (HFS): [107, 282, 319], **Pr II**: [21], **Pr II** (HFS): [20], **Ru I** (IS,HFS): [101], **S I**: [153], **S VII-XIV**: [180], **S VIII**: [237], **Si IV**: [220], **Se III**: [305], **Sm I**: [174], **Sn II**: [128], **Sn III**: [129], **Ta II**: [318], **Te III**: [306], **Ti X**: [7], **Ti IV**: [220], **Tl I** (IS,HFS): [246], **V I** (HFS): [121, 122, 123], **V II** (forbidden): [256], **V II** (HFS): [1, 29], **Zn I**: [49] **Zn II**: [220].

The references included here for elements heavier than Ni (Z>28) are limited to the first three spectra only, these data being of most interest for astronomical spectroscopy.

Analyses of neutral through doubly-ionized iron-group spectra using Fourier transform spectroscopy (FTS) and grating spectroscopy are underway at the National Institute of Standards and Technology (NIST), USA and Imperial College London, UK. Analysis of moderately ionized species (III-VIII) is being done at NIST, USA; Observatoire de Paris-Meudon, France; the Institute of Spectroscopy in Troitsk, Russia; Centro Investigaciones Opticas, La Plata, Argentina; and Aligarh Muslim University, India. Measurements of HFS and IS using both FTS and laser spectroscopy are in progress at Istanbul University, Turkey; Lund University, Sweden; Graz University of Technology, Austria; Instituut voor Kern- en Stralingsfysica, Leuven, Belgium; Bhabha Atomic Research Centre, India; Poznań University of Technology, Poland; University of Birmingham, UK; ISOLDE (international collaboration including Switzerland, Germany, France, UK, Russia, Belgium, Spain, Portugal, and Japan); and York University, Toronto, Canada.

Studies of more highly-ionized elements are being done using electron beam ion traps (EBIT) at NIST, USA; Lawrence Livermore National Laboratory, USA; Heidelberg, Germany; Shanghai, China; with an accelerator in Beijing, China; and at the National Institute for Fusion Science, Japan.

Theoretical calculations of energy levels, oscillator strengths, HFS, IS, photoionization, and collisional data are currently being performed at NIST, USA; Ohio State University, USA; Queens University Belfast, Northern Ireland; and the University of Lund, Sweden.

2. Wavelength standards

The thorium-argon hollow cathode lamp is an important calibration source for ground-based astronomical spectrographs and new Ritz wavelengths for 19874 thorium lines measured using FTS have been published [248]. In the infrared, uranium-neon hollow cathode lamps have advantages over thorium-argon lamps and an atlas based on FTS for the U/Ne lamp between 850 and 4000 nm has been published [249]. The calibration of these FTS measurements included reference lines in U and Th measured using optogalvanic spectroscopy [61]. Additional Ritz wavelengths based on FTS have been published for Fe II, Mg I-II, Cr II, Ti II, Mn II, Ni II, and Zn II [226]. Wavenumbers and pressure shifts in Ar have been measured using laser spectroscopy [322].

In more highly-charged ions, laser spectroscopy measurements of the $2p\ ^2P_{3/2} -^2 P_{1/2}$ forbidden transition in Ar XIV has been performed in an EBIT [194]. High-accuracy wavelength standards in the 3 keV region have been published for lines of S XIII-XV, Cl XIV-XV, and Ar XV-XVII [281].

3. Oscillator strengths

The transition-probability data in the references in section 9 were obtained by both theoretical and experimental methods. The references included here for elements heavier than Ni (Z>28) are limited to the first three or four spectra only. For Fe II, the set of critically evaluated oscillator strengths has been greatly expanded in the NIST Atomic Spectra Database (`http://physics.nist.gov/asd`) and now contains data for 6700 Fe II lines from 92 nm to 87 μm. Extensive sets of oscillator strengths of fine structure levels (n$\leqslant$10) are being calculated with the Breit-Pauli R-matrix (BPRM) method by S. Nahara, Ohio State Univ, USA (see NORAD database in section 6).

4. Photoionization cross-sections

Many of the theoretical papers in the references also include data on photoionization and collisional cross-sections. Additional references for both experimental and calculated cross-sections are as follows:

Al V: 186
Al X: 187
Ar VI: 178
Ar IX: 108
B II: 208
Be I: 134
C II: 207
C IV: 193
Ca II: 297
Ca XI: 185
Cl I: 300, 339
Cu XX: 184
Fe II: 100
Fe X: 16
Fe XV: 161
Fe XVII: 108
Ga I: 139
Ge I: 27
K III: 22
Kr II: 202, 270
N III: 112
N IV-V: 289
N IV : 162
Ne VII : 162
Ne VIII: 343
Ni I: 288
O II-III: 41
P III-IV: 135
S IX: 317
S V: 163
Se II: 203
Si IX: 317
Sr I: 78
Ti XIX: 188
Ti XX: 189

5. Compilations, Reviews, Conferences

Major compilations of wavelengths, energy levels or oscillator strengths have been published for the following: **Ag II**: [166], **Cr I-II**: [271, 274], **Fe II**:[227], **Fe V**: [169], **In II**: [168], **Mn II**: [171], **Ne IV**: [170], **Sn II**: [128], **Sr II**: [276], **Ti I-II**: [272]. A summary of the methods used for the critical evaluation of atomic data is given in [167].

Papers on atomic spectroscopic data are included in the proceedings of the 11th International Conference on Atomic Spectra and Oscillator Strengths [244] and the 8th International Conference on Atomic and Molecular Data and their Applications [113]. Additional meetings including papers on atomic data include the meetings of the Laboratory Astrophysics Division (LAD) of the American Astronomical Society (AAS), the International Conference on Atomic Processes in Plasmas, the Congress of the European Group on Atomic Systems, the International Conference on Phenomena in Ionized Gases; and the meeting of the Division of Atomic, Molecular and Optical Physics of the American Physical Society.

6. Databases

The following databases of atomic spectra at NIST have received significant updates since the last triennial report:

NIST Atomic Spectra Database, Version 5 (Sept 2014):
`http://physics.nist.gov/asd` contains critically compiled data on wavelengths, energy levels and oscillators strengths.

NIST Atomic Spectra Bibliographic Databases: (Frequently updated)
`http://physics.nist.gov/asbib` consists of three databases of publications on atomic transition probabilities, atomic energy levels and spectra, and atomic spectral line broadening.

Additional on-line databases including significant quantities of atomic data include:

NIST Database of Basic Atomic Spectroscopic Data, Version 1.1.3, (Nov 2013) `http://physics.nist.gov/handbook` Provides a selection of the most important and frequently used atomic spectroscopic data in an easily accessible format.

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The MCHF/MCDHF Collection on the Web, Version 2 (Sept 2010) (C.Froese Fischer *et al.*) at `http://nlte.nist.gov/MCHF/index.html` contains results of multi-configuration Hartree-Fock (MCHF) or Dirac-Hartree-Fock (MCDHF) calculations for hydrogen and Li-like through Ar-like ions, mainly for Z $\leqslant$ 30.

TOPbase, TIPbase, and OPserver(Feb, 2009) `http://cdsweb.u-strasbg.fr/topbase/testop/home.html` provides links to databases of atomic data from the Iron Project and Opacity Projects, with an emphasis on data for astrophysically abundant ions (Z $\leqslant$ 26).

NORAD-Atomic-Data (Dec, 2013) `http://www.astronomy.ohio-state.edu/~nahar/nahar_radiativeatomicdata/index.html` includes more recent data from the Opacity and Iron Projects.

CHIANTI, version 7.1.4 (May, 2014), `http://www.chiantidatabase.org/` contains atomic data and programs for computing spectra of astrophysical plasmas, with the emphasis on highly-ionized atoms.

AtomDB, version 3.0.0 (Beta 4, Aug, 2014), `http://www.atomdb.org` is an atomic database for X-ray plasma spectral modeling, with the main emphasis being the modeling of collisional plasmas.

The Vienna Atomic Line Database (VALD3), (Feb, 2014) `http://vald.astro.uu.se` is a database that aims to compile complete lists of spectral line parameters relevant to the interpretation of stellar atmospheric spectra.

The BIBL database, version 1.58.5 (March, 2014) `http://das101.isan.troitsk.ru/bibl.htm` is a comprehensive bibliographic database of experimental and theoretical papers on atomic spectroscopy, with an emphasis on papers published since 1983.

The Virtual Atomic and Molecular Data Centre (VAMDC) `http://www.vamdc.eu` provides a uniform access to a large number of atomic and molecular databases related to astrophysics.

7. Data Needs

Atomic data needs have been summarized in white papers from the AAS Laboratory Astrophysics Working Group (now LAD) [338]. In this section, a few important atomic data needs either for upcoming missions or in support of recent analyses of astrophysical spectra are highlighted.

New ground-based and space-based infrared (IR) spectrographs such as the Stratospheric Observatory for Infrared Astronomy (SOFIA), the Apache Point Observatory Galactic Evolution Experiment (APOGEE), and the Cryogenic High-resolution Infrared Echelle Spectrograph (CRIRES) have increasing demands for atomic data. The wavelength calibration above 2.5 μm is particularly problematic and new wavelength standards in either atomic or molecular species are needed. Measured oscillator strengths in the IR are limited to Fe I, Ti I, and a handful of lines for other species. Additional data are particularly needed in the H-band (around 1.5 μm). The measurement of these oscillator strengths is challenging due to the high excitation of the upper energy level of many of the transitions giving lines in this wavelength region.

Smith & Brickhouse [293] summarize atomic data needs in X-ray astronomy. The interpretation of data from the Chandra X-ray Observatory's Low-Energy Transmission Grating (LETG) has been hampered by the lack of accurate wavelengths and collisional cross sections in the wavelength region from 50 Å to 150 Å. Spectra from the ASTRO-H SXS microcalorimeter, to be launched in 2015, are also likely to be affected. Also required is the improvement of the estimation of uncertainties in atomic data.

The astrophysical models used to measure the chemical abundances, evolution, and physical conditions in many astronomical objects require line identifications, wavelengths, oscillator strengths, collision strengths, photoionization cross sections, and recombination rate coefficients. Although high accuracy experimental wavelengths and oscillator strengths are frequently available for lines from low ionization stages, the measurement of oscillator strengths become more challenging for higher ionization stages of abundant elements. Improved theoretical calculations of moderate accuracy are thus needed, as are calculations of photoionization and collisional cross-sections. The large differences in abundances obtained from the collisional excitation lines of O III and recombination lines of O II observed in planetary nebulae has partially been resolved by improved calculations [238] and similar calculations for other ions are needed.

One notable example of the influence of new atomic data is the composition and opacity of the sun. A new analysis of elemental abundances in the solar spectrum resulted in reductions of 30-50 % in CNO abundances [31], but these revised abundances cannot be reconciled with standard models of the stellar interior using helioseismology. A potential resolution to this conflict would come from an increase in 15 % in the opacity of the solar plasmas. A new laboratory measurement of the iron opacity at conditions similar to those at the solar radiation/convection zone boundary provides an indication of this [35], with an opacity up to 4 times higher than predicted from atomic structure calculations. Since the principal contributors to the opacity are photo-excitation and photoionization, the new measurement indicates that improved calculations are needed for these processes for many abundant elements in the sun. Recent calculations for Fe XVII [217], show an increase of 20 % in opacity for this ion and new calculations for other iron ions are in progress.

8. Notes for References

The references are identified by a running number. This refers to the general reference list at the end of this report, where the literature is ordered alphabetically according to the first author. Each reference contains one or more code letters indicating the method applied by the authors, defined as follows:

THEORETICAL METHODS:

Q: quantum mechanical calculations. **QF:** Calculations of forbidden lines.

EXPERIMENTAL METHODS:

CL: New classifications	**EL:** Energy levels.
WL: Wavelengths.	**HFS:** Hyperfine structure.
IS: Isotope structure.	**L:** Lifetimes.
TE: Experimental oscillator strengths.	**PI:** Photoionization cross-sections.

OTHER:

CP: Data compilations. **R:** Relative values only. **F:** Forbidden lines.

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9. References on lifetimes and oscillator strengths

Ag I : 32

Al II : 26
Al IV : 89
Al X: 10
Al XI : 57
Al XII : 5, 250

Ar II : 39, 97, 219
Ar III : 44, 298
Ar VI : 88
Ar XV : 91
Ar XVI : 213, 223
Ar XVII : 213, 323

Ba II : 114

Be II : 114, 115, 267

C II : 294
C III : 278
C IV : 57, 206

Ca I : 48
Ca II : 19, 114
Ca III : 23
Ca IX : 173
Ca XIV : 79
Ca XVIII : 160, 223
Ca XIX : 4

Cd II : 114

Ce III : 320, 321

Cl I : 232
Cl II-V : 315
Cl III : 295
Cl IV : 120
Cl XIV : 11
Cl XVI : 4

Co XVIII-XXVI : 127
Co II : 256

Cr II : 33, 334
Cr XII : 119
Cr XXIII : 6

Cu I : 32, 192

Eu I : 97, 146, 346
Eu II : 329, 346
F I : 111

Fe I : 133, 200, 255, 257
Fe II : 59, 60, 200, 286
Fe VII : 310
Fe VIII : 231, 309
Fe IX : 70, 231
Fe X : 68
Fe XI : 17, 66, 82
Fe XII : 69
Fe XIII : 65
Fe XIV : 12, 96, 212
Fe XVI : 53, 77
Fe XVII : 40, 53, 109, 217
Fe XVIII : 211
Fe XXII : 86
Fe XXIII : 83, 278
Fe XXIV : 160, 223
Fe XXV : 8

Ga II : 47
Ga III : 80

Gd I-II : 98, 327, 330

He I : 144

Hf II : 42

Hg II : 114

In I : O 264

K I : 51, 222
K XVI : 11
K XVIII : 4

Kr I : 205
Kr II : 219

La I : 99, 132, 283
La II : 283
La III : 158

Li I : 57

Lu I : 156
Lu III : 159

Mg I : 48
Mg II : 114
Mg III-XI : 74
Mg III : 24, 55, 89
Mg V : 308
Mg VIII : 302
Mg XI : 5

Mn I : 25, 131, 154, 210, 285
Mn II : 46, 131, 171
Mn XII : 87
Mn X-XIII : 315
Mn XXIV : 6

Mo I : 143
Mo II : 141
Mo III : 240

N I : 332
N II : 287, 340
N V : 206

Na I : 52
Na VII : 150
Na II-X : 75

Nb II : 251

Nd I : 299

Ne I : 30, 182, 239, 279
Ne II : 219
Ne IV : 214, 215
Ne V: 56
Ne VI : 302
Ne VII : 76, 151, 278

Ni I : 285, 337
Ni II : 45
Ni X : 268
Ni XI : 67
Ni XIV : 326
Ni XV : 71, 85, 117, 172

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References

[1] Abdalmonean, M. H. & Beck, D. R. 2015, *J. Phys. B* 48, 105001, **HFS Q**

[2] Acharyulu, G. V. S. G., Sankari, M., Kumar, P. V. K., & Suryanarayana, M. V. 2014, *J. Quant. Spectrosc. Radiat. Transfer* 133, 251, **IS HFS**

[3] Aggarwal, K. M. & Keenan, F. P. 2012a, *Phys. Scr.* 86, 055301, **Q QF**

[4] Aggarwal, K. M. & Keenan, F. P. 2012b, *Phys. Scr.* 85, 025306, **Q QF**

[5] Aggarwal, K. M. & Keenan, F. P. 2012c, *Phys. Scr.* 85, 025305, **Q QF**

[6] Aggarwal, K. M. & Keenan, F. P. 2012d, *Phys. Scr.* 85, 065301, **Q QF**

[7] Aggarwal, K. M. & Keenan, F. P. 2013a, *Phys. Scr.* 88, 025303, **TE CL Q QF**

[8] Aggarwal, K. M. & Keenan, F. P. 2013b, *Phys. Scr.* 87, 055302, **Q**

[9] Aggarwal, K. M. & Keenan, F. P. 2013c, At. *Data Nucl. Data Tables* 99, 156, **Q QF**

[10] Aggarwal, K. M. & Keenan, F. P. 2014, *Mon. Not. R. Astron. Soc.* 438, 1223, **Q**

[11] Aggarwal, K. M. & Keenan, F. P. 2014, *Phys. Scr.* 89, 125401, **Q QF**

[12] Aggarwal, K. M. & Keenan, F. P. 2014a, *Mon. Not. R. Astron. Soc.* 445 , 2015, **Q**

[13] Aggarwal, K. M. & Keenan, F. P. 2014b, *Mon. Not. R. Astron. Soc.* 442, 388, **Q**

[14] Aggarwal, K. M. & Keenan, F. P. 2015, *Mon. Not. R. Astron. Soc.* 447, 3849, **Q**

[15] Aggarwal, K. M., Keenan, F. P., & Msezane, A. Z. 2013a, *Phys. Scr.* 88, 025302, **Q QF**

[16] Aggarwal, S., Singh, J., Jha, A. K. S., & Mohan, M. 2012, *J. Astrophys. Astron.* 33, 291, **PI**

[17] Aggarwal, S., Singh, J., & Mohan, M. 2013b, *At. Data Nucl. Data Tables* 99, 704, **Q**

[18] Aggarwal, S., Verma, N., Singh, A. K., Singh, N., Sharma, R., & Mohan, M. 2014, *Can. J. Phys.* 92, 1285, **Q QF**

[19] Aguilera, J. A., Aragón, C., & Manrique, J. 2015, *J. Quant. Spectrosc. Radiat. Transfer* 160, 10, **L**

[20] Akhtar, N., Anjum, N., Hühnermann, H., & Windholz, L. 2012, *Eur. Phys. J. D* 66, 264, **Hfs**

[21] Akhtar, N. & Windholz, L. 2012, *J. Phys. B* 45, 095001, **EL CL WL**

[22] Alna'washi, G. A., Lu, M., Habibi, M., Esteves-Macaluso, D., Wang, J. C., Phaneuf, R. A., Kilcoyne, A. L. D., Cisneros, C., & McLaughlin, B. M. 2014, *Phys. Rev. A* 90, 023417, **PI**

[23] Alonso-Medina, A. & Colón, C. 2013, *Mon. Not. R. Astron. Soc.* 431 , 2703, **Q**

[24] Alonso-Medina, A., Colón, C., & Moreno-Díaz, C. 2015, *At. Data Nucl. Data Tables* 102, 64, **Q**

[25] Andersson, M., Grumer, J., Ryde, N., Blackwell-Whitehead, R., Hutton, R., Zou, Y., Jönsson, P., & Brage, T. 2015, *Astrophys. J., Suppl. Ser.* 216, 2, **HFS Q TE**

[26] Andersson, M., Lennartsson, T., Nilsson, H., & Chen, C.-Y. 2012, *J. Phys. B* 45, 135001, **HFS Q**

[27] Anin, D., Jänkälä, K., Huttula, S.-M., & Huttula, M. 2012, *Phys. Rev. A* 86, 063410, **PI**

[28] Anjum, N., Akhtar, N., Hühnermann, H., & Windholz, L. 2015, *J. Phys. B* 48, 015003, **HFS**

[29] Armstrong, N. M. R., Rosner, S. D., & Holt, R. A. 2011, *Phys. Scr.* 84, 055301, **HFS**

[30] Asghar, H., Ali, R., & Baig, M. A. 2013, *Phys. Plasmas* 20, 123302, **TE**

[31] Asplund, M., Grevesse, N., Sauval, A. J., & Scott, P. 2009, *Annu. Rev. Astron. Astrophys.* 47, 481

[32] Babich, I. L., Boretskij, V. F., Veklich, A. N., & Semenyshyn, R. V. 2014, *Adv. Space Res.* 54, 1254, **CP**

[33] Bäckström, E., Gurell, J., Royen, P., Mannervik, S., Norlin, L., Blackwell-Whitehead, R., Hartman, H., & Nilsson, H. 2012, *Mon. Not. R. Astron. Soc.* 420, 1636, **LF**

[34] Bäckström, E., Nilsson, H., Engström, L., Hartman, H., & Mannervik, S. 2013, *J. Phys. B* 46, 205001, **TE**

[35] Bailey, J. E., Nagayama, T., Loisel, G. P., Rochau, G. A., Blancard, C., Colgan, J., Cosse, P., Faussurier, G., Fontes, C. J., Gilleron, F., Golovkin, I., Hansen, S. B., Iglesias, C. A., Kilcrease, D. P., MacFarlane, J. J., Mancini, R. C., Nahar, S. N., Orban, C., Pain, J., Pradhan, A. K., Sherrill, M., & Wilson, B. G. 2015, *Nature* 517, 56

[36] Beiersdorfer, P., Diaz, F., & Ishikawa, Y. 2012, Astrophys. J. 745, 167, **TE AT CL**

[37] Beiersdorfer, P. & Lepson, J. K. 2012, *Astrophys. J., Suppl. Ser.* 201, 28, **CL WL**

[38] Beiersdorfer, P., Träbert, E., Lepson, J. K., Brickhouse, N. S., & Golub, L. 2014, *Astrophys. J.* 788, 25, **CL WL**

[39] Belmonte, M. T., Djurović, S., Peláez, R. J., Aparicio, J. A., & Mar, S. 2014, *Mon. Not. R. Astron. Soc.* 445, 3345, **TE**

[40] Bernitt, S., Brown, G. V., Rudolph, J. K., Steinbrügge, R., Graf, A., Leutenegger, M., Epp, S. W., Eberle, S., Kubiček, K., Mäckel, V., Simon, M. C., Träbert, E., Magee, E. W., Beilmann, C., Hell, N., Schippers, S., Müller, A., Kahn, S. M., Surzhykov, A., Harman, Z., Keitel, C. H., Clementson, J., Porter, F. S., Schlotter, W., Turner, J. J., Ullrich, J., Beiersdorfer, P., & López-Urrutia, J. R. C. 2012, *Nature* 492, 225, **TER**

[41] Bizau, J. M., Cubaynes, D., Guilbaud, S., Shorman, M. M. A., Gharaibeh, M. F., Ababneh, I. Q., Blancard, C., & McLaughlin, B. M. 2015, *Phys. Rev. A* 92, 023401, **PI**

[42] Bouazza, S., Quinet, P., & Palmeri, P. 2015, *J. Quant. Spectrosc. Radiat. Transfer* 163, 39, **Q**

[43] Buendía, E., Gálvez, F. J., Maldonado, P., & Sarsa, A. 2012, *Chem. Phys. Lett.* 548, 1, **Q**

[44] Burger, M., Skočić, M., Gavrilov, M., Bukvić, S., & Djeniže, S. 2012, *J. Quant. Spectrosc. Radiat. Transfer* 113, 1662, **TE**

[45] Cassidy, C. M., Ramsbottom, C. A., & Scott, M. P. 2011, *Astrophys. J.* 738, 5, **Q**

[46] Castelli, F., Kurucz, R. L., & Cowley, C. R. 2015, *Astron. Astrophys.* 580, p. A10, **CL W EL**

[47] Chi, H.-C. & Chou, H.-S. 2014, *J. Phys. B* 47, 055002, **Q**

[48] Civiš, S., Ferus, M., Chernov, V. E., & Zanozina, E. M. 2013, *Astron. Astrophys.* 554, p. A24, **Q**

[49] Civiš, S., Ferus, M., Chernov, V. E., Zanozina, E. M., & Juha, L. 2014, *J. Quant. Spectrosc. Radiat. Transfer* 134, 64, **CL WL EL Q**

[50] Civiš, S., Ferus, M., Kubelík, P., Chernov, V. E., & Zanozina, E. M. 2012a, *Astron. Astrophys.* 545, p. A61, **CL WL EL**

[51] Civiš, S., Ferus, M., Kubelík, P., Jelinek, P., & Chernov, V. E. 2012b, *Astron. Astrophys.* 541, p. A125, **CL WL EL Q**

[52] Civiš, S., Ferus, M., Kubelík, P., Jelinek, P., Chernov, V. E., & Zanozina, E. M. 2012c, *Astron. Astrophys.* 542, p. A35, **CL WL EL Q**

[53] Clementson, J. 2011, *Proc. SPIE 8140*, p. 81401C, **Q**

[54] Clementson, J. & Beiersdorfer, P. 2013, *Astrophys. J.* 763, 54, **CL**

[55] Colón, C., Moreno-Díaz, C., & Alonso-Medina, A. 2013, *Mon. Not. R. Astron. Soc.* 435 , 1749, **Q**

[56] Dance, M., Palay, E., Nahar, S. N., & Pradhan, A. K. 2013, *Mon. Not. R. Astron. Soc.* 435, 1576, **Q**

[57] Das, M., Das, M., Chaudhuri, R. K., & Chattopadhyay, S. 2012a, *Phys. Rev. A* 85, 042506, **Q**

[58] Das, R. C., Mandal, P. K., Shah, M. L., Seema, A. U., Rathod, D. R., Dev, V., Manohar, K. G., & Suri, B. M. 2012b, *J. Quant. Spectrosc. Radiat. Transfer* 113, 382, **L**

[59] Deb, N. C. & Hibbert, A. 2011, *Astron. Astrophys.* 536, p. A74, **QF**

[60] Deb, N. C. & Hibbert, A. 2014, *Astron. Astrophys.* 561, p. A32, **Q**

[61] DeGraffenreid, W., Campbell, S. C., & Sansonetti, C. J. 2012, *J. Opt. Soc. Am. B* 29, 1580, **U I; Th I W E**

[62] Del Zanna, G. 2011a, *Astron. Astrophys.* 533, p. A12, **CL WL EL**

[63] Del Zanna, G. 2011b, *Astron. Astrophys.* 536, p. A59, **CL WL**

[64] Del Zanna, G. 2012, *Astron. Astrophys.* 537, p. A38, **WL**

[65] Del Zanna, G. & Storey, P. J. 2012, *Astron. Astrophys.* 543, p. A144, **Q**

[66] Del Zanna, G. & Storey, P. J. 2013, *Astron. Astrophys.* 549, p. A42, **EL TE AT CL Q**

[67] Del Zanna, G., Storey, P. J., & Badnell, N. R. 2014a, *Astron. Astrophys.* 566, p. A123, **Q QF**

[68] Del Zanna, G., Storey, P. J., Badnell, N. R., & Mason, H. E. 2012a, *Astron. Astrophys.* 541, p. A90, **Q**

[69] Del Zanna, G., Storey, P. J., Badnell, N. R., & Mason, H. E. 2012b, *Astron. Astrophys.* 543, p. A139, **Q**

https://doi.org/10.1017/S1743921316000685 Published online by Cambridge University Press

[70] Del Zanna, G., Storey, P. J., Badnell, N. R., & Mason, H. E. 2014b, *Astron. Astrophys.* 565, p. A77, **Q**

[71] Del Zanna, G., Storey, P. J., & Mason, H. E. 2014c, *Astron. Astrophys.* 567, p. A18, **Q**

[72] Dembczyński, J., Elantkowska, M., Ruczkowski, J., Öztürk, I. K., Er, A., Güzelçimen, F., Başar, G., & Kröger, S. 2015, *J. Phys. B* 48, 015006, **Q HFS E**

[73] Deng, B. L., Jiang, G., & Zhang, C. 2014, *At. Data Nucl. Data Tables* 100, 1337, **Q**

[74] Deng, B. L., Jiang, G., Zhang, L., Wang, X., & Hua, X. 2012a, *Eur. Phys. J. D* 66, 146, **Q**

[75] Deng, B. L., Jiang, G., Zhang, L., Wang, X., & Hua, X. 2012b, *Phys. Scr.* 85, 045303, **Q**

[76] Di, L., Shi, J. R., & Zhao, G. 2012, *At. Data Nucl. Data Tables* 98, 437, **Q**

[77] Díaz, F., Vilkas, M. J., Ishikawa, Y., & Beiersdorfer, P. 2013, *Astrophys. J., Suppl. Ser.* 207, 11, **Q**

[78] Ding, X.-B., Dong, C.-Z., & O'Sullivan, G. 2012, *Chin. Phys. Lett.* 29, 063201, **PI**

[79] Dong, F., Wang, F., Zhong, J., Liang, G., & Zhao, G. 2012, *Publ. Astron. Soc. Jpn.* 64, 131, **Q QF**

[80] Dutta, N. N., Roy, S., Dixit, G., & Majumder, S. 2013, *Phys. Rev. A* 87, 012501, **Q QF**

[81] Ekman, J., Jönsson, P., Gustafsson, S., Hartman, H., Gaigalas, G., Godefroid, M. R., & Fischer, C. F. 2014, *Astron. Astrophys.* 564, p. A24, **Q**

[82] El-Maaref, A. A., Ahmad, M., & Allam, S. H. 2014, *At. Data Nucl. Data Tables* 100, 781, **Q**

[83] El-Maaref, A. A., Schippers, S., & Müller, A. 2015, *Atoms* 3, 2, **Q**

[84] El-Maaref, A. A., Uosif, M. A. M., Allam, S. H., & El-Sherbini, T. M. 2012, *At. Data Nucl. Data Tables* 98, 589, **Q**

[85] El-Maaref, A. A., Uosif, M. A. M., Allam, S. H., & El-Sherbini, T. M. 2013, *Can. J. Phys.* 91, 981, **Q**

[86] El-Sayed, F. 2013, *At. Data Nucl. Data Tables* 99, 545, **Q QF**

[87] El-Sayed, F. 2014, *At. Data Nucl. Data Tables* 100, 1250, **Q QF**

[88] Elabidi, H. 2012, *J. Phys. Conf. Ser.* 397, 012055, **Q**

[89] Elabidi, H. 2014, *Adv. Space Res.* 54, 1203, **Q**

[90] Elabidi, H. & Sahal-Bréchot, S. 2013, *Mon. Not. R. Astron. Soc.* 436, 1452, **Q**

[91] Elabidi, H., Sahal-Bréchot, S., & Dimitrijević, M. S. 2014, *Adv. Space Res.* 54, 1184, **Q**

[92] Elabidi, H., Sahal-Bréchot, S., Dimitrijević, M. S., & Nessib, N. B. 2011a, *Mon. Not. R. Astron. Soc.* 417, 2624, **Q**

[93] Elabidi, H., Sahal-Bréchot, S., & Nessib, N. B. 2011b, *Balt. Astron.* 20(4), 587, **Q**

[94] Elabidi, H., Sahal-Bréchot, S., & Nessib, N. B. 2012, *Phys. Scr.* 85, 065302, **Q**

[95] Er, A., Öztürk, I. K., Başar, G., Kröger, S., Jarmola, A., Ferber, R., & Tamanis, M. 2011, *J. Phys. B* 44, 205001, **Hfs WL CL**

[96] Fan, J.-Z., Wang, Q.-M., Chang, Z.-W., & Dong, C.-Z. 2012, *Chin. Phys. B* 21, 063102, **Q QF**

[97] Fan, S., Wang, Q., Shang, X., Tian, Y.-S., & Dai, Z.-W. 2014, *J. Phys. B* 47, 215004, **TER TE**

[98] Feng, Y.-Y., Jiang, L.-Y., Wang, Q., Zhang, W., Jiang, Z.-K., & Dai, Z.-W. 2011a, *Mon. Not. R. Astron. Soc.* 418, 998, **L**

[99] Feng, Y. Y., Wang, Q., Jiang, L. Y., Jiang, Z. K., & Dai, Z. W. 2011b, *Eur. Phys. J. D* 65, 299, **L**

[100] Fivet, V., Bautista, M. A., & Ballance, C. P. 2012, *J. Phys. B* 45, 035201, **PI**

[101] Forest, D. H., Powis, R. A., Cochrane, E. C. A., Griffith, J. A. R., & Tungate, G. 2014, *J. Phys. G* 41, 025106, **IS HFS**

[102] Furmann, B. & Stefańska, D. 2011, *J. Phys. B* 44, 225005, **IS Hfs**

[103] Furmann, B. & Stefanska, D. 2014a, *J. Phys. B* 47, 085001, **EL HFS IS**

[104] Furmann, B. & Stefanska, D. 2014b, *Phys. Scr.* 89, 095402, **EL CL WL HFS**

[105] Gallardo, M., Raineri, M., Almandos, J. R., Pagan, C. J. B., & ao, R. A. A. 2015, *Astrophys. J., Suppl. Ser.* 216, 11, **Q L**

[106] Gamper, B., Głowacki, P., Siddiqui, I., Dembczyński, J., & Windholz, L. 2014, *J. Phys. B* 47, 165001, **EL HFS CL**

https://doi.org/10.1017/S1743921316000685 Published online by Cambridge University Press

[107] Gamper, B., Khan, S., Siddiqui, I., & Windholz, L. 2013, *Eur. Phys. J. Spec. Top.* 222, 2171, **EL CL HFS**

[108] Gao, L. C., Zhang, D. H., Xie, L. Y., Wang, J. G., Shi, Y. L., & Dong, C. Z. 2013a, *J. Phys. B* 46, 175402, **PI**

[109] Gao, L. C., Zhang, D. H., Xie, L. Y., Wang, J. G., Shi, Y. L., & Dong, C. Z. 2013b, *J. Phys. B* 46, 175402, **Q QR**

[110] Gedeon, V., Gedeon, S., Lazur, V., Nagy, E., Zatsarinny, O., & Bartschat, K. 2012, *Phys. Rev. A* 85, 022711, **Q**

[111] Gedeon, V., Gedeon, S., Lazur, V., Nagy, E., Zatsarinny, O., & Bartschat, K. 2014, *Phys. Rev. A* 89, 052713, **Q**

[112] Gharaibeh, M. F., Hassan, N. E., Shorman, M. M. A., Bizau, J. M., Cubaynes, D., Guilbaud, S., Sakho, I., Blancard, C., & McLaughlin, B. M. 2014, *J. Phys. B* 47, 065201, **EL**

[113] Gillaspy, J. D., .Wiese, W. L., & Podpaly, Y. A. (eds.) 2013, Eighth international conference on atomic and molecular data and their applicationsICAMDATA-2012, Vol. 1545 of AIP conference proceedings

[114] Glukhov, I. L., Nikitina, E. A., & Ovsiannikov, V. D. 2013a, *Opt. Spectrosc.* 115, 9, **L**

[115] Glukhov, I. L., Nikitina, E. A., & Ovsiannikov, V. D. 2013b, *Phys. Scr.* T157, 014014, **L**

[116] Grumer, J., Li, W.-X., Bernhardt, D., Li, J.-G., Schippers, S., Brage, T., Jönsson, P., Hutton, R., & Zou, Y.-M. 2013, *Phys. Rev. A* 88, 022513, **QF**

[117] Gupta, G. P. & Msezane, A. Z. 2012, *Phys. Scr.* 86, 015303, **Q**

[118] Gupta, G. P. & Msezane, A. Z. 2013, *Phys. Scr.* 88, 025301, **Q**

[119] Gupta, G. P. & Msezane, A. Z. 2014, *Indian J. Phys.* 88, 11, **Q**

[120] Gupta, G. P., Tayal, V., & Msezane, A. Z. 2012, *Indian J. Phys.* 86, 1, **Q**

[121] Güzelçimen, F., Başar, G., Öztürk, I. K., Kröger, S., Ferber, R., Jarmola, A., Tamanis, M., & Başar, G. 2011, *J. Phys. B* 44, 215001, **HFS**

[122] Güzelçimen, F., Er, A., Öztürk, I. K., Başar, G., Kröger, S., Tamanis, M., & Ferber, R. 2015, *J. Phys. B* 48, 115005, **HFS**

[123] Güzelçimen, F., Yapıcı, B., Demir, G., Er, A., Öztürk, I. K., Başar, G., Kröger, S., Tamanis, M., Ferber, R., Docenko, D., & Başar, G. 2014, *Astrophys. J., Suppl. Ser.* 214, 9, **HFS CL**

[124] Deng, L. H., Li, X. Y., Zhu, Y. Y, & Chen, Y. Q. 2015, *J. Quant. Spectrosc. Radiat. Transfer* 161, 153, **HFS**

[125] Han, X.-Y., Gao, X., Zeng, D.-L., Jin, R., Yan, J., & Li, J.-M. 2014, *Phys. Rev. A* 89, 042514, **QF**

[126] Han, X.-Y., Gao, X., Zeng, D.-L., Yan, J., & Li, J.-M. 2012, *Phys. Rev. A* 85, 062506, **QF**

[127] Hao, L.-H., Feng, H., & Kang, X.-P. 2014, *Eur. Phys. J. D* 68, 42, **Q**

[128] Haris, K., Kramida, A., & Tauheed, A. 2014, *Phys. Scr.* 89, 115403, **CP EL CL WL**

[129] Haris, K. & Tauheed, A. 2012, *Phys. Scr.* 85, 055301, **CL WL EL Q**

[130] Hartog, E. A. D. & Lawler, J. E. 2013, *J. Phys. B* 46, 185001, **L**

[131] Hartog, E. A. D., Lawler, J. E., Sobeck, J. S., Sneden, C., & Cowan, J. J. 2011, *Astrophys. J., Suppl. Ser.* 194, 35, **TE**

[132] Hartog, E. A. D., Palmer, A. J., & Lawler, J. E. 2015, *J. Phys. B* 48, 155001, **L TE**

[133] Hartog, E. A. D., Ruffoni, M. P., Lawler, J. E., Pickering, J. C., Lind, K., & Brewer, N. R. 2014, *Astrophys. J., Suppl. Ser.* 215, 23, **L TE**

[134] Hasegawa, S., Obara, S., Yoshida, F., Azuma, Y., Koike, F., & Nagata, T. 2014, *Phys. Rev. A* 90, 032503, **PI**

[135] Hernández, L., Covington, A. M., Hernández, E. M., Antillón, A., Morales-Mori, A., Chartkunchand, K., Aguilar, A., & Hinojosa, G. 2015, *J. Quant. Spectrosc. Radiat. Transfer* 159, 80, **PI**

[136] Herrera-Sancho, O. A., Okhapkin, M. V., Zimmermann, K., Tamm, C., Peik, E., Taichenachev, A. V., Yudin, V. I., & Głowacki, P. 2012, *Phys. Rev. A* 85, 033402, **TER**

[137] Hu, F., Mei, M.-F., Han, C., Han, B.-P., Jiang, G., & Yang, J.-M. 2014, *J. Quant. Spectrosc. Radiat. Transfer* 149, 158, **Q**

[138] Hudson, C. E., Norrington, P. H., Ramsbottom, C. A., & Scott, M. P. 2012, *Astron. Astrophys.* 537, p. A12, **Q**

[139] Iablonskyi, D., Jänkälä, K., Urpelainen, S., & Huttula, M. 2013, *J. Phys. B* 46, 175001, **PI**

[140] Jabeen, S. & Tauheed, A. 2015, *J. Quant. Spectrosc. Radiat. Transfer* 154, 9, **CL EL WL**

[141] Jiang, L. Y., Wang, Q., Feng, Y. Y., Quinet, P., Biémont, E., Li, S. B., & Dai, Z. W. 2012a, *Eur. Phys. J. D* 66, 176, **L Q**

[142] Jiang, L.-Y., Wang, Q., Pei, S.-H., Feng, Y.-Y., Zhang, J.-R., Yu, X.-C., & Dai, Z.-W. 2012b, *J. Opt. Soc. Am. B* 29, 1486, **TE**

[143] Jiang, L.-Y., Wang, Q., Shang, X., Tian, Y.-S., Yin, J.-R., Jiang, Z.-K., Pei, S.-H., & Dai, Z.-W. 2013, *J. Opt. Soc. Am. B* 30, 489, **L TE**

[144] Jiang, P.-H. & Kar, S. 2013, Few-Body Systems 54 , 1791, **QF**

[145] Jin, W.-G., Ono, H., & Minowa, T. 2011, *J. Phys. Soc. Jpn.* 80, 124301, **Hfs ND IS**

[146] Jing, H., Ye, S.-W., & Dai, C.-J. 2015, *Chin. Phys. B* 24, 013203, **L**

[147] Jönsson, P., Alkauskas, A., & Gaigalas, G. 2013a, *At. Data Nucl. Data Tables* 99, 431, **Q QF**

[148] Jönsson, P., Bengtsson, P., Ekman, J., Gustafsson, S., Karlsson, L. B., Gaigalas, G., Fischer, C. F., Kato, D., Murakami, I., Sakaue, H. A., Hara, H., Watanabe, T., Nakamura, N., & Yamamoto, N. 2014, *At. Data Nucl. Data Tables* 100, 1, **Q QF**

[149] Jönsson, P., Ekman, J., Gustafsson, S., Hartman, H., Karlsson, L. B., du Rietz, R., Gaigalas, G., Godefroid, M. R., & Fischer, C. F. 2013b, *Astron. Astrophys.* 559, p. A100, **Q**

[150] Jönsson, P., Ekman, J., & Träbert, E. 2015a, *Atoms* 3, 195, **Q**

[151] Jönsson, P., Ekman, J., & Träbert, E. 2015b, *Atoms* 3, 195, **Q**

[152] Jönsson, P., Rynkun, P., & Gaigalas, G. 2011, *At. Data Nucl. Data Tables* 97, 648, **Q QF**

[153] Jordan, C. 2011, *Mon. Not. R. Astron. Soc.* 414, 634, **CL WL EL**

[154] Kabakçi, S., Özdemir, L., & Usta, B. K. 2015, *J. Quant. Spectrosc. Radiat. Transfer* 164, 248, **Q**

[155] Kadrekar, R. & Natarajan, L. 2011, *Phys. Rev. A* 84, 062506, **Q**

[156] Karaçoban, B. & Özdemir, L. 2011a, *Arab. J. Sci. Eng.* 36, 635, **Q**

[157] Karaçoban, B. & Özdemir, L. 2011b, *Acta Phys. Pol. A* 119(3), 342, **QF Q**

[158] Karaçoban, B. & Özdemir, L. 2012, J. At. Mol. Opt. Phys. (Hindawi) 2012, 246105, **Q**

[159] Karaçoban, B. & Özdemir, L. 2013, *Acta Phys. Pol. A* 123, 651, **Q**

[160] Khetselius, O. Y., Florko, T. A., Svinarenko, A. A., & Tkach, T. B. 2013, *Phys. Scr.* T153, 014037, **Q**

[161] Kim, D.-S., Byun, C. W., Lee, M.-H., & Choi, N. N. 2015, *J. Kor. Phys. Soc.* 66, 915, **PI**

[162] Kim, D.-S. & Kwon, D.-H. 2012, *J. Phys. B* 45, 185201, **PI**

[163] Kim, D.-S. & Kwon, D.-H. 2013, *Phys. Rev. A* 88, 033426, **PI**

[164] Kisielius, R., Kulkarni, V. P., Ferland, G. J., Bogdanovich, P., & Lykins, M. L. 2014, *Astrophys. J.* 780, 76, **Q**

[165] Klose, A., Minamisono, K., & Mantica, P. F. 2013, *Phys. Rev. A* 88, 042701, **WL CL HFS**

[166] Kramida, A. 2013a, *J. Res. Natl. Inst. Stand. Technol.* 118, 168, **EL CL WL**

[167] Kramida, A. 2013b, *Fusion Sci. Technol.* 63, 313, **WL EL**

[168] Kramida, A. 2013c, *J. Res. Natl. Inst. Stand. Technol.* 118, 52, **EL CL WL HFS**

[169] Kramida, A. 2014, *Astrophys. J., Suppl. Ser.* 212, 11, **CP EL CL WL**

[170] Kramida, A., Brown, C. M., Feldman, U., & Reader, J. 2012, *Phys. Scr.* 85, 025303, **CP EL CL WL**

[171] Kramida, A. & Sansonetti, J. E. 2013, *Astrophys. J., Suppl. Ser.* 205, 14, **CL WL EL CP CPF**

[172] Landi, E. & Bhatia, A. K. 2012, *At. Data Nucl. Data Tables* 98, 862, **Q QF**

[173] Landi, E. & Bhatia, A. K. 2014, *At. Data Nucl. Data Tables* 100, 1519, **Q**

[174] Lawler, J. E., Fittante, A. J., & Hartog, E. A. D. 2013a, *J. Phys. B* 46, 215004, **CL WL EL TE**

[175] Lawler, J. E., Guzman, A., Wood, M. P., Sneden, C., & Cowan, J. J. 2013b, *Astrophys. J., Suppl. Ser.* 205, 11, **TE**

https://doi.org/10.1017/S1743921316000685 Published online by Cambridge University Press

[176] Lennartsson, T., Nilsson, H., Blackwell-Whitehead, R., Engström, L., & Huldt, S. 2011, *J. Phys. B* 44, 245001, **TER TE**

[177] Lestinsky, M., Badnell, N. R., Bernhardt, D., Bing, D., Grieser, M., Hahn, M., Hoffmann, J., Jordon-Thaden, B., Krantz, C., Novotný, O., Orlov, D. A., Repnow, R., Shornikov, A., Müller, A., Schippers, S., Wolf, A., & Savin, D. W. 2012, *Astrophys. J.* 758, 40, **EL**

[178] Li, C.-Y., Han, X.-Y., Wang, J.-G., & Qu, Y.-Z. 2013a, *Chin. Phys. B* 22, 123201, **PI**

[179] Li, F., Liang, G. Y., Bari, M. A., & Zhao, G. 2013b, *Astron. Astrophys.* 556, p. A32, **Q**

[180] Li, F., Liang, G. Y., & Zhao, G. 2013c, *Astrophys. J.* 762, 53, **CL WL**

[181] Li, J.-G., Grumer, J., Li, W.-X., Andersson, M., Brage, T., Hutton, R., Jönsson, P., Yang, Y., & Zou, Y.-M. 2013d, *Phys. Rev. A* 88, 013416, **QF**

[182] Li, J.-G., Jönsson, P., Godefroid, M., Dong, C.-Z., & Gaigalas, G. 2012, *Phys. Rev. A* 86, 052523, **Q QF**

[183] Liang, G. Y., Badnell, N. R., Zhao, G., Zhong, J. Y., & Wang, F. L. 2011, *Astron. Astrophys.* 533, p. A87, **Q**

[184] Liang, L., Gao, W.-J., & Zhou, C. 2012, *J. Quant. Spectrosc. Radiat. Transfer* 113 , 2018, **PI**

[185] Liang, L., Gao, W.-J., & Zhou, C. 2013, *Phys. Scr.* 87, 015301, **PI**

[186] Liang, L., Liu, X.-Y., & Zhou, C. 2014a, *J. Quant. Spectrosc. Radiat. Transfer* 137, 51, **PI**

[187] Liang, L., Liu, X.-Y., & Zhou, C. 2014b, *Can. J. Phys.* 92, 241, **PI**

[188] Liang, L., Liu, X.-Y., & Zhou, C. 2014c, *J. Appl. Spectrosc.* 81, 483, **PI**

[189] Liang, L., Lu, X.-Y., Zhou, C., & Qing, P. 2015, *Eur. Phys. J. D* 69, 115, **PI**

[190] Liu, H., Jiang, G., Hu, F., Wang, C., Wang, Z., & Yang, J. 2013, *Chin. Phys. B* 22, 073202, **Q**

[191] Liu, Y. P., Gao, C., Zeng, J. L., & Shi, J. R. 2011, *Astron. Astrophys.* 536, p. A51, **Q**

[192] Liu, Y. P., Gao, C., Zeng, J. L., Yuan, J. M., & Shi, J. R. 2014, *Astrophys. J., Suppl. Ser.* 211, 30, **Q**

[193] Ma, K., Xie, L.-Y., Zhang, D.-H., & Dong, C.-Z. 2015, *Chin. Phys. B* 24, 073402, **PI**

[194] Mäckel, V., Klawitter, R., Brenner, G., Urrutia, J. R. C. L., & Ullrich, J. 2011, *Phys. Rev. Lett.* 107, 143002, **CL WL**

[195] Malcheva, G., Engström, L., Lundberg, H., Nilsson, H., Hartman, H., & Blagoev, K. 2013, *Phys. Scr.* 88, 045304, **L**

[196] Malcheva, G., Engström, L., Lundberg, H., Nilsson, H., Hartman, H., Blagoev, K., Palmeri, P., & Quinet, P. 2015, *Mon. Not. R. Astron. Soc.* 450, 223, **L Q**

[197] Mandal, P. K., Das, R. C., Seema, A. U., Sahoo, A. C., Shah, M. L., Pulhani, A. K., Manohar, K. G., & Dev, V. 2014, *Appl. Phys. B* 116, 407, **TE L TER**

[198] Marques, J. P., Indelicato, P., & Parente, F. 2012a, *Eur. Phys. J. D* 66, 324, **QF**

[199] Marques, J. P., Parente, F., Costa, A. M., Martins, M. C., Indelicato, P., & Santos, J. P. 2012b, *Phys. Rev. A* 86, 052521, **Q QF**

[200] Mashonkina, L., Gehren, T., Shi, J.-R., Korn, A. J., & Grupp, F. 2011, *Astron. Astrophys.* 528, p. A87, **CP**

[201] Massacrier, G. & Artru, M.-C. 2012, *Astron. Astrophys.* 538, p. A52, **Q**

[202] McLaughlin, B. M. & Ballance, C. P. 2012a, *J. Phys. B* 45, 085701, **PI**

[203] McLaughlin, B. M. & Ballance, C. P. 2012b, *J. Phys. B* 45, 095202, **PI**

[204] McLaughlin, B. M., Ballance, C. P., Bowen, K. P., Gardenghi, D. J., & Stolte, W. C. 2013, *Astrophys. J.* 771, p. L8, **EL**

[205] Milosavljević, V., Simić, Z., Daniels, S., & Dimitrijević, M. S. 2012, *Mon. Not. R. Astron. Soc.* 422, 610, **TE**

[206] Mondal, P. K., Dutta, N. N., Dixit, G., & Majumder, S. 2013, *Phys. Rev. A* 87, 062502, **Q QF**

[207] Müller, A., Jr., A. B., Buhr, T., Hellhund, J., Holste, K., Kilcoyne, A. L. D., Klumpp, S., Martins, M., Ricz, S., Viefhaus, J., & Schippers, S. 2015, *Phys. Rev. Lett.* 114, 013002, **PI**

[208] Müller, A., Schippers, S., Phaneuf, R. A., Scully, S. W. J., Aguilar, A., Cisneros, C., Gharaibeh, M. F., Schlachter, A. S., & McLaughlin, B. M. 2014, *J. Phys. B* 47, 135201, **EL**

[209] Musielok, J. 2014, *Phys. Scr.* T161, 014057, **CP CPF**

[210] Nagata, T., Kawajiri, K., Kosugi, S., Suzuki, N., Kemmotsu, M., Nandi, T., Sokell, E., Azuma, Y., & Koike, F. 2014, *J. Phys. B* 47, 185006, **Q**

[211] Nahar, S. N. 2012, *J. Quant. Spectrosc. Radiat. Transfer* 113 , 1762, **Q**

[212] Nahar, S. N. 2013, *New Astron.* 21, 8, **Q**

[213] Nahar, S. N. 2013, *J. Quant. Spectrosc. Radiat. Transfer* 117, 15, **Q**

[214] Nahar, S. N. 2014, *At. Data Nucl. Data Tables* 100, 1322, **Q**

[215] Nahar, S. N. 2014, *New Astronomy* 29, 42, **Q**

[216] Nahar, S. N. 2015, *New Astronomy* 38, 16, **Q**

[217] Nahar, S. N., Pradhan, A. K., Chen, G.-X., & Eissner, W. 2011, *Phys. Rev. A* 83, 053417, **Q**

[218] Nandy, D. K. & Sahoo, B. K. 2014, *Astron. Astrophys.* 563, p. A25, **QF**

[219] Nandy, D. K. & Sahoo, B. K. 2015a, *Mon. Not. R. Astron. Soc.* 450 , 1012, **QF**

[220] Nandy, D. K. & Sahoo, B. K. 2015b, *Mon. Not. R. Astron. Soc.* 447, 3812, **Q**

[221] Nandy, D. K., Singh, Y., Sahoo, B. K., & Li, C. 2011, *J. Phys. B* 44, 225701, **Q QF**

[222] Nandy, D. K., Singh, Y., Shah, B. P., & Sahoo, B. K. 2012, *Phys. Rev. A* 86, 052517, **Q**

[223] Natarajan, L. 2013, *Phys. Rev. A* 88, 052522, **Q**

[224] Natarajan, L. 2015, *Phys. Rev. A* 92, 012507, **Q**

[225] Natarajan, L. & Kadrekar, R. 2013, *Phys. Rev. A* 88, 012501, **Q QF**

[226] Nave, G. 2012, *Mon. Not. R. Astron. Soc.* 420, 1570, **WL CL EL**

[227] Nave, G. & Johansson, S. 2013, *Astrophys. J., Suppl. Ser.* 204, 1, **EL CL WL**

[228] Nessib, N. B., Alonizan, N., Qindeel, R., Sahal-Bréchot, S., & Dimitrijević, M. S. 2014, *Adv. Space Res.* 54, 1190, **Q**

[229] Nguyen, T. V. B., Chantler, C. T., Lowe, J. A., & Grant, I. P. 2014, *Mon. Not. R. Astron. Soc.* 440, 3439, **Q**

[230] O'Dwyer, B., Del Zanna, G., Badnell, N. R., Mason, H. E., & Storey, P. J. 2012a, *Astron. Astrophys.* 537, p. A22, **TE AT CL**

[231] O'Dwyer, B., Del Zanna, G., Badnell, N. R., Mason, H. E., & Storey, P. J. 2012b, *Astron. Astrophys.* 537, p. A22, **Q**

[232] Oliver, P. & Hibbert, A. 2013, *At. Data Nucl. Data Tables* 99, 459, **Q**

[233] Ortiz, M., Aragón, C., Aguilera, J. A., Rodríguez-García, J., & Mayo-García, R. 2013, *J. Phys. B* 46, 185702, **TE**

[234] Ortiz, M. & Mayo-García, R. 2012, *J. Phys. B* 45, 055701, **TE**

[235] Öztürk, I. K., Başar, G., Er, A., Güzelçimen, F., Başar, G., & Kröger, S. 2015, *J. Phys. B* 48, 015005, **EL CL WL HFS**

[236] Öztürk, I. K., Çelik, G., Gökçe, Y., Atalay, B., Güzelçimen, F., Er, A., Başar, G., & Kröger, S. 2014, *Can. J. Phys.* 92, 1425, **Q**

[237] Pagan, C. J. B., Cavalcanti, G. H., Jupén, C., & Trigueiros, A. G. 2011, *Astrophys. J., Suppl. Ser.* 196, 19, **CL WL EL Q**

[238] Palay, E., Nahar, S. N., Pradhan, A. K., & Eissner, W. 2012, *Mon. Not. R. Astron. Soc.* 423, L35, **Q QF**

[239] Piracha, N. K., Delanis, D., Kaminsky, J., Duncan-Chamberlin, K. V., Asghar, H., Ali, R., & Baig, M. A. 2015, *Can. J. Phys.* 93, 80, **L TE**

[240] Quinet, P. 2015, *Phys. Scr.* 90, 015404, **Q**

[241] Quinet, P., Biémont, E., Palmeri, P., Engström, L., Hartman, H., Lundberg, H., & Nilsson, H. 2012, *Astron. Astrophys.* 537, p. A74, **L Q**

[242] Quinet, P., Bouazza, S., & Palmeri, P. 2015a, *J. Quant. Spectrosc. Radiat. Transfer* 164, 193, **Q**

[243] Quinet, P., Bouazza, S., & Palmeri, P. 2015b, *J. Quant. Spectrosc. Radiat. Transfer* 164, 193, **Q**

[244] Quinet, P. & Palmeri, P. (eds.) 2014, Eleventh International Colloquium on Atomic Spectra and Oscillator Strengths for Astrophysical and Laboratory Plasmas, Vol. 89 (11) of Physica Scripta

[245] Radžiūtė, L., Gaidamauskas, E., Gaigalas, G., Li, J.-G., Dong, C.-Z., & Jönsson, P. 2015, *Chin. Phys. B* 24, 043103, **QF**

[246] Ranjit, G., Kealhofer, D., Vukasin, G. D., & Majumder, P. K. 2014, *Phys. Rev. A* 89, 012511, **IS HFS**

[247] Rauch, T., Hoyer, D., Quinet, P., Gallardo, M., & Raineri, M. 2015, *Astron. Astrophys.* 577, p. A88, **Q**

[248] Redman, S. L., Nave, G., & Sansonetti, C. J. 2014, *Astrophys. J., Suppl. Ser.* 211, 4, **EL CL WL**

[249] Redman, S. L., Ycas, G. S., Terrien, R., Mahadevan, S., Ramsey, L. W., Bender, C. F., Osterman, S. N., Diddams, S. A., Quinlan, F., Lawler, J. E., & Nave, G. 2012, *Astrophys. J., Suppl. Ser.* 199, 2, **WL**

[250] Rosmej, F. B., Deschaud, B., Bennadji, K., Indelicato, P., & Marques, J. P. 2013, *Phys. Rev. A* 87, 022515, **Q**

[251] Ruczkowski, J., Bouazza, S., Elantkowska, M., & Dembczyński, J. 2015, *J. Quant. Spectrosc. Radiat. Transfer* 155, 1, **Q**

[252] Ruczkowski, J., Elantkowska, M., & Dembczyński, J. 2014a, *J. Quant. Spectrosc. Radiat. Transfer* 145, 20, **Q**

[253] Ruczkowski, J., Elantkowska, M., & Dembczyński, J. 2014b, *J. Quant. Spectrosc. Radiat. Transfer* 149, 168, **Q**

[254] Rudolph, J. K., Bernitt, S., Epp, S. W., Steinbrügge, R., Beilmann, C., Brown, G. V., Eberle, S., Graf, A., Harman, Z., Hell, N., Leutenegger, M., Müller, A., Schlage, K., Wille, H.-C., Yavaş, H., Ullrich, J., & López-Urrutia, J. R. C. 2013, *Phys. Rev. Lett.* 111, 103002, **WL CL TE**

[255] Ruffoni, M. P., Hartog, E. A. D., Lawler, J. E., Brewer, N. R., Lind, K., Nave, G., & Pickering, J. C. 2014, *Mon. Not. R. Astron. Soc.* 441, 3127, **TER TE**

[256] Ruffoni, M. P. & Pickering, J. C. 2013, *Astrophys. J., Suppl. Ser.* 207, 20, **WL CPF**

[257] Ruffoni, M. P., Prieto, C. A., Nave, G., & Pickering, J. C. 2013, *Astrophys. J.* 779, 17, **TE TER**

[258] Rynkun, P., Jönsson, P., Gaigalas, G., & Fischer, C. F. 2012, *At. Data Nucl. Data Tables* 98, 481, **Q QF**

[259] Rynkun, P., Jönsson, P., Gaigalas, G., & Fischer, C. F. 2013, *Astron. Astrophys.* 557, p. A136, **Q QF**

[260] Rynkun, P., Jönsson, P., Gaigalas, G., & Fischer, C. F. 2014, *At. Data Nucl. Data Tables* 100, 315, **Q QF**

[261] Safronova, M. S., Kozlov, M. G., & Safronova, U. I. 2012, *Phys. Rev. A* 85, 012507, **Q**

[262] Safronova, M. S. & Majumder, P. K. 2013, *Phys. Rev. A* 87, 042502, **L**

[263] Safronova, M. S. & Safronova, U. I. 2012, *Phys. Rev. A* 85, 022504, **Q QF**

[264] Safronova, M. S., Safronova, U. I., & Porsev, S. G. 2013, *Phys. Rev. A* 87, 032513, **L Q**

[265] Safronova, U. I., Safronova, A. S., & Beiersdorfer, P. 2014, *Phys. Rev. A* 90, 012519, **QF**

[266] Safronova, U. I. & Safronova, M. S. 2013a, *Phys. Rev. A* 87, 032501, **Q QF**

[267] Safronova, U. I. & Safronova, M. S. 2013b, *Phys. Rev. A* 87, 032502, **Q**

[268] Safronova, U. I., Wilcox, P. G., & Safronova, A. S. 2011, *J. Phys. B* 44, 225002, **Q QF**

[269] Saha, J. K., Mukherjee, T. K., Mukherjee, P. K., & Fricke, B. 2013, *Phys. Plasmas* 20, 042703, **QF**

[270] Sakho, I. 2014, *At. Data Nucl. Data Tables* 100, 297, **PI**

[271] Saloman, E. B. 2012a, *J. Phys. Chem. Ref. Data* 41, 043103, **CP EL CL WL**

[272] Saloman, E. B. 2012b, *J. Phys. Chem. Ref. Data* 41, 013101, **CP EL CL WL**

[273] Sang, C. C., Gou, B. C., & Wang, F. 2013, *J. Quant. Spectrosc. Radiat. Transfer* 116, 17, **Q**

[274] Sansonetti, C. J. & Nave, G. 2014, *Astrophys. J., Suppl. Ser.* 213, 28, **EL CL WL**

[275] Sansonetti, C. J., Nave, G., Reader, J., & Kerber, F. 2012, *Astrophys. J., Suppl. Ser.* 202, 15, **EL CL WL**

[276] Sansonetti, J. E. 2012, *J. Phys. Chem. Ref. Data* 41, 013102, **CP**

[277] Santana, J. A., Lepson, J. K., Träbert, E., & Beiersdorfer, P. 2015, *Phys. Rev. A* 91, 012502, **CL WL EL TE QR**

[278] Santos, J. P., Marques, J. P., Costa, A. M., Martins, M. C., Indelicato, P., & Parente, F. 2013, *Phys. Scr.* T156, 014020, **Q QF**

[279] Savukov, I. M. 2012, *J. Phys. B* 45, 045002, **Q**

https://doi.org/10.1017/S1743921316000685 Published online by Cambridge University Press

[280] Schippers, S., Bernhardt, D., Müller, A., Lestinsky, M., Hahn, M., Novotný, O., Savin, D. W., Grieser, M., Krantz, C., Repnow, R., & Wolf, A. 2012, *Phys. Rev. A* 85, 012513, **TEF**

[281] Schlesser, S., Boucard, S., Covita, D. S., dos Santos, J. M. F., Fuhrmann, H., Gotta, D., Gruber, A., Hennebach, M., Hirtl, A., Indelicato, P., Bigot, E.-O. L., Simons, L. M., Stingelin, L., Trassinelli, M., Veloso, J. F. C. A., Wasser, A., & Zmeskal, J. 2013, *Phys. Rev. A* 88, 022503, **CL EL WL**

[282] Shamim, K., Siddiqui, I., & Windholz, L. 2011, *Eur. Phys. J. D* 64, 209, **EL CL WL Hfs**

[283] Shang, X., Tian, Y.-S., Wang, Q., Fan, S., Bai, W.-S., & Dai, Z.-W. 2014, *Mon. Not. R. Astron. Soc.* 442, 138, **L**

[284] Shang, X., Wang, Q., Tian, Y.-S., Wang, C., & Dai, Z.-W. 2015a, *J. Phys. B* 48, 085001, **L TE**

[285] Shang, X., Wang, Q., Zhang, F., Wang, C., & Dai, Z.-W. 2015b, *J. Quant. Spectrosc. Radiat. Transfer* 163, 34, **L**

[286] Shchukina, N. G. & Vasil'eva, I. E. 2013, *Kinemat. Phys. Celest. Bodies* 29, 53, **TE**

[287] Shen, X.-Z., Li, J.-G., Jönsson, P., & Wang, J.-G. 2015, *Astrophys. J.* 801, 129, **Q**

[288] Shi, X.-Y., Huang, H., Jacobson, B., Chang, Y.-C., Yin, Q.-Z., & Ng, C. Y. 2012, *Astrophys. J.* 747, 20, **EL CL**

[289] Shorman, M. M. A., Gharaibeh, M. F., Bizau, J. M., Cubaynes, D., Guilbaud, S., Hassan, N. E., Miron, C., Nicolas, C., Robert, E., Sakho, I., Blancard, C., & McLaughlin, B. M. 2013, *J. Phys. B* 46, 195701, **PI**

[290] Singh, J., Aggarwal, S., Singh, A. K., & Mohan, M. 2012, *Can. J. Phys.* 90, 833, **Q**

[291] Smirnov, Y. M. 2012, *Opt. Spectrosc.* 112, 836, **CL**

[292] Smirnov, Y. M. 2015, *Eur. Phys. J. D* 69, 15, **CL**

[293] Smith, R. K. & Brickhouse, N. S. 2014, *Adv. Atomic Molecular Optical Physics* 64, 271

[294] Sochi, T. & Storey, P. J. 2013, *At. Data Nucl. Data Tables* 99, 633, **Q**

[295] Sossah, A. M. & Tayal, S. S. 2012, *Astrophys. J., Suppl. Ser.* 202, 12, **Q**

[296] Sossah, A. M. & Tayal, S. S. 2014, *Astrophys. J.* 787, 2, **Q**

[297] Sossah, A. M., Zhou, H.-L., & Manson, S. T. 2012, *Phys. Rev. A* 86, 023403, **PI**

[298] Stancalie, V., Pais, V. F., Mihailescu, A., & to the EFDA-TF-ITM, C. 2012, *Eur. Phys. J. D* 66, 84, **Q**

[299] Stockett, M. H., Wood, M. P., Hartog, E. A. D., & Lawler, J. E. 2011, *J. Phys. B* 44, 235003, **TE**

[300] Stolte, W. C., Felfli, Z., Guillemin, R., Öhrwall, G., Yu, S.-W., Young, J. A., Lindle, D. W., Gorczyca, T. W., Deb, N. C., Manson, S. T., Hibbert, A., & Msezane, A. Z. 2013, *Phys. Rev. A* 88, 053425, **PI**

[301] Storey, P. J., Sochi, T., & Badnell, N. R. 2014, *Mon. Not. R. Astron. Soc.* 441, 3028, **Q**

[302] Sun, Y., Chen, F., Chen, C., & Gou, B. C. 2013a, *Eur. Phys. J. D* 67, 88, **Q**

[303] Sun, Y., Chen, F., Chen, C., & Gou, B. C. 2014, *At. Data Nucl. Data Tables* 100, 286, **Q**

[304] Sun, Y., Gou, B. C., & Chen, C. 2013b, *Phys. Rev. A* 87, 032509, **Q**

[305] Tauheed, A. & Hala 2012, *Phys. Scr.* 85, 025304, **EL CL WL**

[306] Tauheed, A. & Naz, A. 2011, *J. Kor. Phys. Soc.* 59 , 2910, **CL WL**

[307] Tayal, S. S. 2012, *Astron. Astrophys.* 541, p. A61, **Q**

[308] Tayal, S. S. & Sossah, A. M. 2015, *Astron. Astrophys.* 574, p. A87, **Q**

[309] Tayal, S. S. & Zatsarinny, O. 2011, *Astrophys. J.* 743, 206, **Q**

[310] Tayal, S. S. & Zatsarinny, O. 2014, *Astrophys. J.* 788, 24, **Q**

[311] Thorne, A. P., Pickering, J. C., & Semeniuk, J. I. 2013, *Astrophys. J., Suppl. Ser.* 207, 13, **EL CL WL**

[312] Träbert, E., Beiersdorfer, P., Brickhouse, N. S., & Golub, L. 2014a, *Astrophys. J., Suppl. Ser.* 215, 6, **WL**

[313] Träbert, E., Beiersdorfer, P., Brickhouse, N. S., & Golub, L. 2014b, *Astrophys. J., Suppl. Ser.* 211, 14, **WL CL**

[314] Träbert, E., Grieser, M., Hoffmann, J., Krantz, C., Repnow, R., & Wolf, A. 2012a, *Phys. Rev. A* 85, 042508, **LF**

[315] Träbert, E., Grieser, M., Krantz, C., Repnow, R., Wolf, A., Diaz, F. J., Ishikawa, Y., & Santana, J. A. 2012b, *J. Phys. B* 45, 215003, **LF LF L L**

https://doi.org/10.1017/S1743921316000685 Published online by Cambridge University Press

[316] Träbert, E., Grieser, M., von Hahn, R., Krantz, C., Repnow, R., & Wolf, A. 2012c, *New J. Phys.* 14, 023061, **LF**
[317] Tyndall, N. B., Ramsbottom, C. A., Hibbert, A., & Ferland, G. 2015, *J. Phys. B* 48, 155204, **PI**
[318] Uddin, Z. & Windholz, L. 2014, *J. Quant. Spectrosc. Radiat. Transfer* 149, 204, **EL CL WL HFS**
[319] Uddin, Z., Zafar, R., Sikander, R., Siddiqui, I., Shamim, K., & Windholz, L. 2012, *J. Phys. B* 45, 205001, **CL WL EL Hfs**
[320] Usta, B. K. 2015a, *Chin. J. Phys.* 53, 40, **Q**
[321] Usta, B. K. 2015b, *Acta Phys. Pol. A* 127, 1605, **Q**
[322] Veza, D., Sansonetti, C. J., Salit, M. L., & Travis, J. C. 2012, *J. Phys. B* 45, 115001, **CL WL**
[323] Wan, J. & Dong, C.-Z. 2011, *Phys. Scr.* 84, 045301, **Q**
[324] Wang, K., Guo, X. L., Liu, H. T., Li, D. F., Long, F. Y., Han, X. Y., Duan, B., Li, J. G., Huang, M., Wang, Y. S., Hutton, R., Zou, Y. M., Zeng, J. L., Chen, C. Y., & Yan, J. 2015, *Astrophys. J., Suppl. Ser.* 218, 16, **Q**
[325] Wang, K., Li, D. F., Liu, H. T., Han, X. Y., Duan, B., Li, C. Y., Li, J. G., Guo, X. L., Chen, C. Y., & Yan, J. 2014a, *Astrophys. J., Suppl. Ser.* 215, 26, **Q QF**
[326] Wang, K., Yan, J., Huang, M., Li, C. Y., Zeng, J. L., Chen, C. Y., Wang, Y. S., & Zou, Y. M. 2012, *At. Data Nucl. Data Tables* 98, 779, **Q QF**
[327] Wang, Q., Jiang, L.-Y., Jiang, H.-M., Shang, X., Tian, Y.-S., & Dai, Z.-W. 2013a, *J. Phys. B* 46, 045003, **L**
[328] Wang, Q., Jiang, L. Y., Quinet, P., Palmeri, P., Zhang, W., Shang, X., Tian, Y. S., & Dai, Z. W. 2014b, *Astrophys. J., Suppl. Ser.* 211, 31, **L Q**
[329] Wang, Q., Shang, X., Tian, Y.-S., Fan, S., & Dai, Z.-W. 2013b, *Mon. Not. R. Astron. Soc.* 435 , 2060, **L TER TE**
[330] Wang, Q., Yin, J.-R., Jiang, L.-Y., Shang, X., Tian, Y.-S., & Dai, Z.-W. 2014c, *J. Phys. B* 47, 035003, **TER TE**
[331] Wang, X., Jiang, G., Hao, L. H., Zhang, L., & Deng, B. 2011, *Eur. Phys. J. D* 65, 505, **Q**
[332] Wang, Y., Zatsarinny, O., & Bartschat, K. 2014d, *Phys. Rev. A* 89, 062714, **Q**
[333] Wang, Z. & Guo, Y. 2012, *Frontiers Phys.* 7, 252, **Q**
[334] Wasson, I. R., Ramsbottom, C. A., & Scott, M. P. 2011, *Astrophys. J., Suppl. Ser.* 196, 24, **Q**
[335] Wei, H. G., Shi, J. R., Wang, F. L., Zhong, J. Y., Liang, G. Y., & Zhao, G. 2014, *Astron. Astrophys.* 566, p. A105, **Q**
[336] Wood, M. P., Lawler, J. E., Sneden, C., & Cowan, J. J. 2013, *Astrophys. J., Suppl. Ser.* 208, 27, **TE TER**
[337] Wood, M. P., Lawler, J. E., Sneden, C., & Cowan, J. J. 2014, *Astrophys. J., Suppl. Ser.* 211, 20, **TER TE**
[338] Working Group on Laboratory Astrophysics 2010, http//www.aas.org/labastro/lawg_charter.php
[339] Yang, L., Gao, H., Zhou, J.-G., & Ng, C. Y. 2015, *Astrophys. J.* 810, 132, **PI**
[340] Yildiz, M. & Gökçe, Y. 2014, *Can. J. Phys.* 92, 82, **Q L**
[341] Young, P. R. 2012, *Astrophys. J.* 749, 1, **CL WL**
[342] Yu, X., Sun, Z., Xu, H., Zhang, J., Jiang, Z., Svanberg, S., & Dai, Z.-W. 2011, *J. Phys. B* 44, 215002, **L TE**
[343] Zabaydullin, O. & Dubau, J. 2013, *J. Phys. B* 46, 075005, **PI**
[344] Zanna, G. D., Fernández-Menchero, L., & Badnell, N. R. 2015, *Astron. Astrophys.* 574, p. A99, **Q**
[345] Zhang, H. L. & Fontes, C. J. 2015, *At. Data Nucl. Data Tables* 101, 41, **Q**
[346] Zhang, W., Feng, Y.-Y., Jiang, L.-Y., Du, S., Wang, L., Jiang, Z.-K., & Dai, Z.-W. 2011a, *J. Phys. B* 44, 175002, **L**
[347] Zhang, W., Feng, Y.-Y., Li, P.-F., Du, S., Ma, X.-W., Yang, X.-B., Jiang, Z.-K., & Dai, Z.-W. 2011b, *Mon. Not. R. Astron. Soc.* 416, 547, **L**
[348] Zhang, W., Palmeri, P., Quinet, P., & Biémont, E. 2013, *Astron. Astrophys.* 551, p. A136, **Q**