



HAL
open science

Energy levels, transition rates and lifetimes for Li-like ions with $Z \leq 10$ in the $1s2s(3S)3\ell$ states

J P Santos, J P Marques, M C Martins, P Indelicato, E P Benis, T J M Zouros, F Parente

► **To cite this version:**

J P Santos, J P Marques, M C Martins, P Indelicato, E P Benis, et al.. Energy levels, transition rates and lifetimes for Li-like ions with $Z \leq 10$ in the $1s2s(3S)3\ell$ states. *Journal of Physics: Conference Series*, 2015, 635 (5), pp.052060 10.1088/1742-6596/635/5/052060 . hal-01266883

HAL Id: hal-01266883

<https://hal.sorbonne-universite.fr/hal-01266883v1>

Submitted on 3 Feb 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

Energy levels, transition rates and lifetimes for Li-like ions with $Z \leq 10$ in the $1s2s(^3S)3\ell$ states

This content has been downloaded from IOPscience. Please scroll down to see the full text.

2015 J. Phys.: Conf. Ser. 635 052060

(<http://iopscience.iop.org/1742-6596/635/5/052060>)

View [the table of contents for this issue](#), or go to the [journal homepage](#) for more

Download details:

IP Address: 79.131.122.167

This content was downloaded on 28/09/2015 at 08:30

Please note that [terms and conditions apply](#).

Energy levels, transition rates and lifetimes for Li-like ions with $Z \leq 10$ in the $1s2s(^3S)3\ell$ states

J. P. Santos^{†1}, J. P. Marques*, M. C. Martins[†], P. Indelicato[‡], E. P. Benis*,
 T. J. M. Zouros[•], F. Parente[†]

[†] Laboratório de Instrumentação, Engenharia Biomédica e Física da Radiação (LIBPhys-UNL) e Departamento de Física da Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Monte da Caparica, 2892-516 Caparica, Portugal

* BioISI - Biosystems & Integrative Sciences Institute, Faculdade de Ciências da Universidade de Lisboa, Campo Grande, C8, 1749-016 Lisboa, Portugal

[‡] Laboratoire Kastler Brossel, École Normale Supérieure, CNRS, Sorbonne Universités, UPMC Univ. Paris 06, Case 74; 4, place Jussieu, 75252 Paris CEDEX 05, France

* Department of Physics, University of Ioannina, GR 45110 Ioannina, Greece

• Department of Physics, University of Crete, P.O Box 2208, GR 71003 Heraklion, Greece

Synopsis Energy levels, transition rates and lifetimes for Li-like ions with $Z \leq 10$ in the $1s2s(^3S)3\ell$ states were calculated using the Dirac-Fock approach.

In the continuation of the study of the selective enhancement of $1s2sn\ell$ metastable states populated by cascades in single-electron transfer collisions of ions with He and H₂ targets [1], we calculated the energy levels, transition rates and lifetimes for Li-like ions with $Z \leq 10$ in the $1s2s(^3S)3\ell$ states using the multi-configuration Dirac-Fock (MCDF) code of Desclaux and Indelicato [2, 3].

Table 1. Energy levels (EL), Auger and radiative transition rates (ATR, RTR, respectively) and lifetimes for Ne Li-like ions in the $1s2s(^3S)3s\ ^{2,4}S$ states

	$^2S_{1/2}$	$^4S_{3/2}$
EL (eV)	-1750.35	-1760.53
ATR (s ⁻¹)	3.23×10^{13}	3.02×10^{13}
RTR (s ⁻¹)	3.16×10^{10}	6.69×10^{10}
Lifetime (s)	3.10×10^{-14}	3.30×10^{-14}

The radiative and radiationless decay rates were calculated using the code in the single-configuration approach, with the Breit interaction and the vacuum polarization terms included in the self-consistent field calculation, and other QED effects, such as self-energy, included as perturbations [4]. Regarding the radiationless transitions, we have assumed a two-step process, in which the decay is independent from the ionization. Hence, the two electrons do not interact with each other and the core hole state interacts very weakly with the continuum electron, allowing for the transition rates to be calculated from perturbation theory. Initial-state wavefunctions were generated for configurations that contain one initial inner-shell vacancy while

final state wavefunctions were generated for configurations that contain two higher shell vacancies. Continuum-state wavefunctions were obtained by solving the Dirac-Fock equations with the same atomic potential of the initial state, normalized to represent one ejected electron per unit energy. The preliminary results obtained for Ne Li-like ions in the $1s2s(^3S)3s\ ^{2,4}S$ states are listed in Table 1.

This work was supported by FCT Project No. PTDC/FIS/117606/2010, Portugal. We also thank the Allianz Program of the Helmholtz Association, contract No. EMMI HA-216 Extremes of Density and Temperature: Cosmic Matter in the Laboratory. BioISI is supported by the centre grant UID/MULTI/04046/2013 from FCT/MCTES/PIDDAC, Portugal. EPB and TJMZ are co-financed by the European Union (European Social Fund/ESF) and Greek national funds through the Operational Program Education and Lifelong Learning of the National Strategic Reference Framework (NSRF) Research Funding Program: THALES. Investing in knowledge society through the European Social Fund (Grant No. MIS 377289).

References

- [1] T. J. M. Zouros *et al* 2008 *Phys. Rev. A* **77** 050701
- [2] J. Desclaux 1975 *Comput. Phys. Commun.* **9** 31
- [3] P. Indelicato, J. P. Desclaux 1990 *Phys. Rev. A* **42** 5139
- [4] J. P. Santos *J. Phys. B: At. Mol. Opt. Phys.* 1999 **32** 2089

¹E-mail: jps@fct.unl.pt