Calculations with spectroscopic accuracy for energies, transition rates, hyperfine interaction constants, and Landé g_J-factors in nitrogen-like Kr XXX

K. Wang[a,b,c], S. Li[b], P. Jönsson[d], N. Fu[a], W. Dang[a], X.L. Guo[e], C.Y. Chen[c], J. Yan[b], Z. B. Chen[f,*], R. Si[c,*]

[a] *Hebei Key Lab of Optic-electronic Information and Materials, The College of Physics Science and Technology, Hebei University, Baoding 071002, China*
[b] *Institute of Applied Physics and Computational Mathematics, Beijing 100088, China*
[c] *Shanghai EBIT Lab, Institute of Modern Physics, Department of Nuclear Science and Technology, Fudan University, Shanghai 200433, China*
[d] *Group for Materials Science and Applied Mathematics, Malmö University, SE-20506, Malmö, Sweden*
[e] *Department of Radiotherapy, Shanghai Changhai Hospital, Second Military Medical University, Shanghai 200433, Peoples Republic of China*
[f] *College of Science, National University of Defense Technology, Changsha 410073, China*

Abstract

Extensive self-consistent multi-configuration Dirac-Fock (MCDF) calculations and second-order many-body perturbation theory (MBPT) calculations are performed for the lowest 272 states belonging to the $2s^2 2p^3$, $2s2p^4$, $2p^5$, $2s^2 2p^2 3l$, and $2s2p^3 3l$ (l=s,p,d) configurations of N-like Kr XXX. Complete and consistent data sets of level energies, wavelengths, line strengths, oscillator strengths, lifetimes, A_J, B_J hyperfine interaction constants, Landé g_J-factors, and electric dipole (E1), magnetic dipole (M1), electric quadrupole (E2), magnetic quadrupole (M2) transition rates among all these levels are given. The present MCDF and MBPT results are compared with each other and with other available experimental and theoretical results. The mean relative difference between our two sets of level energies is only about 0.003% for these 272 levels. The accuracy of the present calculations are high enough to facilitate identification of many observed spectral lines. These accurate data can be served as benchmark for other calculations and can be useful for fusion plasma research and astrophysical applications.

Keywords: atomic data; N-like Kr, multiconfiguration Dirac-Fock method; Many-body perturbation theory.

*Corresponding Author
Email address: chenzb008@qq.com (Z.B. Chen), rsi13@fudan.edu.cn (R. Si)

1. Introduction

Accurate atomic data of highly-charged ions are important in both astrophysics and fusion plasmas research, such as plasma control and plasma diagnostics [1]. As a rare gas, Krypton can easily be introduced into the plasma and does not pollute the vacuum vessel. For this reason it is widely used as an injected impurity for diagnosing tokamak fusion plasmas [2–6]. Furthermore, Krypton is under consideration as a diagnostic element for the x-ray imaging spectrometer system on the forthcoming ITER project [7–9]. Therefore, in oder to simulate and diagnose plasmas, accurate atomic data for different ionized krypton ions, such as energy levels and transition rates, are required. In view of this, we have performed the calculations for energy levels and transition properties in Mg-like Kr XXV [10, 11], and this work present our efforts at N-like Kr XXX.

On the experimental side, observed levels and wavelengths for the transitions among the $(1s^2)2s^22p^3$ and $2s2p^4$ configurations in Kr XXX were compiled by Saloman [12] based on the measurements of Denne et al. [3]. These data are also available at National Institute of Standards and Technology (NIST) Atomic Spectra Database (ASD) [13]. Lines involving the $2s^22p^23d$ levels were observed by Kink et al. [14]. However their lines were not complied by the NIST ASD, since they are highly blended, due to the relatively low resolution of their measurements, which makes their classification uncertain. Recently, the $2s2p^4 \rightarrow 2s^22p^3$ spectral lines were measured and identified in the NIST electron beam ion trap again [15]. However, the amount of observed values is not enough to meet the application needs of modeling and diagnosing plasmas. Thus one depends heavily on theoretical results.

On the theoretical side, many Kr XXX calculations were performed for the transitions involving the $n = 2$ states [16–21]. Among these calculations, the most accurate and complete one is the multi-configuration Dirac-Fock (MCDF) calculation carried out by Rynkun et al. [18] using the GRASP2K code [22], in which a full set of consistent and highly accurate energy levels and transition rates, including electric dipole (E1), magnetic dipole (M1), electric quadrupole (E2), magnetic quadrupole (M2), was presented. However, accurate results involving higher-lying states are also required for modeling and diagnosing of plasmas. Using the SUPERSTRUCTURE (SS) code [23], Bhatia et al. [24] reported energy levels and transition data for 72 states of both the $n = 2$ and $n = 3$ configurations in Kr XXX. Aggarwal et al. [25] employed the MCDF method in the GRASP package [26], as well as the relativistic configuration interaction (RCI) method in the FAC code [27], to calculate level energies and radiative rates among the 272 levels of the $n = 2, 3$ complexes in Kr XXX. However, the above two mentioned calculations involving the $n = 3$ complex are quite inaccurate due to limited configuration interaction effects included in their works. The deviations from the corresponding observation energies are up to 0.9% for the SS calculations [24] and 0.6% for the values reported by Aggarwal et al. [25], which are far from the spectroscopic accuracy. Therefore, there is a clear need to provide complete and accurate atomic data for Kr XXX.

In the present work, we report on calculated energy levels, wavelengths, line strengths, oscillator strengths, lifetimes, hyperfine interaction constants, Landé g_J-factors, and E1, M1, E2, M2 transition rates among the 272 levels belonging to the $2s^22p^3$, $2s2p^4$, $2p^5$, $2s^22p^23l$, and $2s2p^33l$ (l=s,p,d) configurations in N-like Kr XXX, in an effort to offer complete and consistent data sets of high accuracy. Calculations are performed using the MCDF method [28–33] implemented in the latest version of the GRASP2K code [34], in which higher order relativistic corrections arising from the Breit interaction (BI) and quantum electrodynamics (QED) effects are included within the RCI procedure. To validate the results from the MCDF and RCI calculations and estimate the accuracy, we have performed other independent calculations using the second-order many-body perturbation theory (MBPT) method implemented in the FAC code [27, 35–37]. The present MCDF and MBPT results are compared with each other and previous experimental and theoretical results, where available. Since electron correlation effects are captured to a high degree, our two sets of energies agree very well with each other and with the observed values from the NIST ASD. i.e., the mean relative difference between our MCDF and MBPT energies is only about 0.003% for these 272 levels; the relative difference between our MCDF/MBPT energies and NIST experimental values is around 0.05%. The present results are not only generally more accurate than existing theoretical data, but are also accurate enough to directly confirm/revise experimental identifications.

2. Theoretical methods

2.1. The MCDF method

According to quantum mechanics an electronic state of an N-electron system is determined by a wave function Ψ, which is a solution to the wave equation

$$\hat{H}\Psi = E\Psi. \tag{1}$$

Here $\hat{H}$ is the Hamiltonian operator and E the total energy of the system. In the MCDF method [28–33], the (Dirac-Coulomb) Hamiltonian can be written as

$$\hat{H}_{DC} = \sum_{i=1}^{N}(c\alpha_i \cdot p_i + (\beta_i - 1)c^2 + V^N(r_i)) + \sum_{i<j}^{N}\frac{1}{r_{ij}}. \tag{2}$$

Here, α and β are the 4×4 Dirac matrices, c denotes the speed of light in atomic units. $V^N(r)$ is the monopole part of the electron-nucleus Coulomb interaction. The atomic state functions (ASFs) considered here are obtained as linear combinations of configuration state functions (CSFs)

$$|\Psi_\alpha(PJM)\rangle = \sum_{r=1}^{n_c} c_r(\alpha)|\gamma_r PJM\rangle, \tag{3}$$

where J and M denote the total angular momentum and magnetic quantum number, respectively. P is the parity and γ_r denotes quantum numbers and angular coupling scheme needed to specify the CSF. The CSFs are built from products of one-electron Dirac orbitals. Based on the extended optimal level (EOL) scheme, the radial parts of the Dirac orbitals and the expansion coefficients of the targeted states are all optimized to self-consistency by solving the MCDF equations, which are derived using the variational approach. In a final step relativistic configuration interaction (RCI) calculations are performed in which the BI and QED corrections are added.

2.1.1. Calculation of transition rates

Transition rates for a multipole transition from the state $\Psi_\alpha(PJM)$ to the state $\Psi_\beta(P'J'M')$ can be expressed in terms of the reduced transition matrix element

$$\langle\Psi_\alpha(PJ)||\mathbf{O}^{\lambda,(k)}||\Psi_\beta(P'J')\rangle, \tag{4}$$

where $\mathbf{O}^{\lambda,(k)}$ is the electromagnetic multipole operator of k order in Coulomb/Babushkin gauge (λ= 1/0 for electric/magnetic multipoles). In practical calculations a biorthogonal transformation of the ASFs are carried out before Racah-algebra is applied to express the transition matrix elements into a sum over one-electron matrix elements [38].

2.1.2. Calculation of hyperfine interaction constants and Landé g_J-factors

The hyperfine interaction constants of magnetic dipole A_J and electric quadrupole B_J can be calculated by

$$A_J = \frac{\mu_I}{I}\frac{1}{\sqrt{J(J+1)}}\langle\Psi_\alpha(PJ)||\mathbf{T}^{(1)}||\Psi_\alpha(PJ)\rangle \tag{5}$$

$$B_J = 2Q\sqrt{\frac{J(2J-1)}{(J+1)(2J+3)}}\langle\Psi_\alpha(PJ),)|\mathbf{T}^{(2)}|\Psi_\alpha(PJ)\rangle \tag{6}$$

where μ_I/Q is the nuclear magnetic dipole/electric quadrupole moment. $\mathbf{T}^{(k)}$ are spherical tensor operators of rank k in the electronic-spaces [39]. The hyperfine levels of closely spaced fine-structure levels are also affected by the off-diagonal hyperfine interaction [40]. This effect is small, however, and is neglected in the present study. In our calculations, the nuclear parameters I, μ_I, and Q are all set to 1. To obtain the A_J and B_J values for a specific isotope, the given values can be scaled with the tabulated values.

The Land*é* g_J-factors determine the splitting of magnetic sub-levels in external magnetic fields, given by

$$g_J = \frac{2}{\sqrt{J(J+1)}} \times \langle\Psi_\alpha(PJ)||\sum_{j=1}^{N}\left[-i\frac{\sqrt{2}}{2\alpha}r_j(\alpha_j C^{(1)}(j))^{(1)} + \frac{g_s-2}{2}\beta_j\Sigma_j\right]||\Psi_\alpha(PJ)\rangle, \tag{7}$$

where i is the imaginary unit, g_s is the electron g-factor of the electron spin corrected for QED effects, and Σ_j is the relativistic spin-matrix [41]. The Land*é* g_J-factors can give information about the coupling conditions in the system.

2.2. The MBPT method

The MBPT method was described in detail in Ref.[42–44]. This method has been included in the FAC code, and successfully used in calculating atomic parameters of high accuracy [36, 37, 45–47]. Hence we only repeat the essential features here. The method tries to solve the Dirac equation

$$H_{DCB}\Psi_\alpha(PJM) = E_\alpha\Psi_\alpha(PJM), \tag{8}$$

where $\Psi_\alpha(PJM)$ is an electronic state of an N-electron system. E_α is the total energy of the system. H_{DBC} is the no-pair Dirac-Coulomb-Breit Hamiltonian, given by

$$H_{DCB} = \sum_{i=1}^{N}[h_d(i) - \frac{Z}{r_i}] + \sum_{i<j}(\frac{1}{r_{ij}} + B_{ij}) \tag{9}$$

Here, B_{ij}, $h_d(i)$, and Z is the frequency-independent BI, the Dirac Hamiltonian for one free electron, and the nuclear charge, respectively. The H_{DBC} is split up into a model Hamiltonian H_0 and a perturbation V, a convenient choice is

$$H_0 = \sum_{i=1}^{N}[h_d(i) + U(r_i)] \tag{10}$$

$$V = -\sum_{i=1}^{N}[\frac{Z}{r_i} + U(r_i)] + \sum_{i<j}(\frac{1}{r_{ij}} + B_{ij}) \tag{11}$$

Here, $U(r)$ is a model potential including the screening effects of all electrons, whose appropriate choice makes V as small as possible. In practical calculations self-consistent-field (SCF) iterations are done, from which we can obtain the approximated central potential $U(r)$ and eigenfunctions Φ_k of H_0. The Hilbert space of the Hamiltonian is divided into two subspaces. i.e., a model space M and an orthogonal space N. In the present implementation, the targeted configurations/other's states are contained in the space M/N. The electron correlation effects within the M space are exactly accounted for, while the interaction between M and N is taken into account with the perturbation method. By solving the generalized eigenvalue problem for the first-order effective Hamiltonian, the eigenvalues in second order can be obtained.

3. Results and Discussions

3.1. Details of the calculation

In the present MCDF method, the odd and even states are determined in separate calculations in the EOL scheme. The CSF expansions are obtained with the restricted active space method [48, 49]. For the 140 odd parity states, we start from the $2s^22p^3$, $2p^5$, $2s^22p^23p$, $2s2p^33s$, and $2s2p^33d$ configurations which make up the multireference (MR). For the 132 even parity states, we start from the $2s2p^4$, $2s^22p^23s$, $2s^22p^23d$, and $2s2p^33p$ configurations which make up the MR for this parity. The initial calculations account for the static electron correlation that results from the close degeneracy of the orbitals. Then, the CSF expansions are obtained from configurations generated by single and double (SD) substitutions of the orbitals in the MR with orbitals in an active sets with principal quantum numbers up to $n = 8$ and with orbital quantum numbers up to $l = 6$. In order to obtain/monitor the convergence of the computed properties such as level energies, the orbitals are increased systematically layer by layer in a sequence of calculations. At each stage only the outer orbitals are optimized, while the inside ones are fixed. Moreover, to reduce the number of CSFs during the MCDF calculations, in this work, the $1s^2$ core is closed from $n = 6$, but opened during the subsequent RCI calculations, in which the BI (computed in the low-frequency limit by multiplying the frequency with a scale factor of 10^{-6}), and the QED corrections such as finite nuclear size, self-energy (SE) and vacuum polarization (VP) are included. The number of CSFs in the final even and odd state for the $n = 8$ expansion are about 920000/5300000 and 1100000/6200000 with the $1s^2$ core closed/open, respectively, distributed over the different J symmetries.

On the other hand, in our MBPT calculations, the $2s^22p^3$, $2s2p^4$, $2p^5$, $2s^22p^23l$, and $2s2p^33l$ (l=*s,p,d*) configurations are contained in the model space M and, all the possible configurations that are generated by SD virtual excitations of the M space are contained in the space N. For single/double excitations, we include the configurations with $n \leq 200$ and $l \leq \min(n-1, 25)$/the inner electron promotion up to $n = 65$ and promotion of the outer electron up to $n' = 200$. Moreover, in addition to the Hamiltonian H_{DCB}, several high order corrections (finite nuclear size, nuclear recoil, VP, and SE) to the Hamiltonian are also included.

In the relativistic calculations, the wave functions are given as expansions over *jj*-coupled CSFs. To give a good consistency with the labeling system used by the experimentalists, as well as with the NIST ASD and other sources, in this study, a transformation of ASFs from a *jj*-coupled CSF basis into a LSJ-coupled CSF basis are made and all the quantum states are labeled with the leading term of the LS percentage composition [50].

3.2. Energy levels

In Table 1, as an example, we present the MCDF level energies of the lowest 36 levels in N-like Kr XXX as functions of increasing active sets of orbitals (labeled by the highest principal quantum number n). From the inspection of Table 1, one can see that the present calculations are comparatively well converged with respect to the increasing orbital set. The differences between the adjacent n are decreased by extending the orbital set. For these levels, the main relative difference is about 0.61%, 0.45%, 0.21%, 0.05%, 0.03%, and 0.002% for calculations based on the orbital sets n = 3, 4, 5, 6, 7, and 8, respectively. The greatest difference between the present $n = 8$ and $n = 7$ calculations is less than 55 cm^{-1} whether for the $2s2p^4$ and $2p^5$ configurations or for the $2s^22p^23l$ (l = s, p) configurations, which is highly satisfactory. Table 1 also lists the RCI level energies for the n= 8 expansion. It is can be seen that the BI and QED effects included in the final the RCI calculations can change the energies considerably.

In order to see the BI and QED effects more clearly, their contributions to the MCDF excited energies of the 272 fine-structure levels of Kr XXX in percentage and in cm^{-1} are shown in Figure 1 (a) and (b), respectively. Inspection of Figure 1 shows that the BI corrections are significant, generally lowering the excited levels. For the lowest 15 levels of the $2s^22p^3$, $2s2p^4$, and $2p^5$ configurations, the BI results are lower than the corresponding Coulomb energies by about 900-5000 cm^{-1} (0.42% to 3%) with one exception for the $2s\,2p^4\ ^4P_{1/2}$ level, where the former are higher than the latter by about 1150 cm^{-1} (0.07%). For the remaining levels belonging to the $2s^22p^2nl$ and $2s2p^3nl$ (n= 3, l=s,p,d) configurations, the BI effects on the energies are much lesser, usually less than 0.15%. The reductions over 0.2% occur only for the two states, being 0.22% and 0.21%, for $2s^2\,2p^2(^3P)\,3d\ ^2F_{3/2}$ and $2s^2\,2p^2(^3P)\,3d\ ^2S_{1/2}$, respectively. On the other hand, for the contributions of the QED corrections, there are some differences. The QED effects reduce all the excited energies by up to about 0.08%, except for a few lower states, where they raise the energies. i.e., for the levels $2s^2\,2p^3\ ^2D^o_{3/2}$, $2s^2\,2p^3\ ^2D^o_{5/2}$, $2s^2\,2p^3\ ^2P^o_{1/2}$, and $2s^2\,2p^3\ ^2P^o_{3/2}$, the QED effects increase the energies by about 868 cm^{-1}, 931 cm^{-1}, 728 cm^{-1} and 1616 cm^{-1}, respectively. Moreover, we can see that the QED corrections are naturally grouped according to the number of s-orbital electron of the configurations, i.e., the $2s^22p^3$, $2s2p^4$, $2p^5$, $2s^22p^23l$, $2s2p^33l$, and $2p^43l$ (l=s,p,d) groups. The QED effects on the excitation energies of the configurations $2p^43l$ (l=s,p,d) (without $2s$ electron) are generally larger than the configurations $2s2p^33l$ (l=s,p,d) (with one $2s$ electron) by about 12000 cm^{-1}. Similarly, their effects on the excitation energies of the configurations $2s2p^33l$ (l=s,p,d) (with one $2s$ electron) are generally larger than the configurations $2s^22p^23l$ (l=s,p,d) (with two $2s$ electron) by about 11800 cm^{-1}. Since we are looking at excitation energies, which are the energy differences between excited states and the ground state, and the ground state has two 2s electrons, the QED effects on the real energies of the states without 2s electron are largest.

In Table 2 we list 272 calculated level energies relative to the ground level for the $2s^22p^3$, $2s2p^4$, $2p^5$, $2s^22p^23l$, and $2s2p^33l$ (l=s,p,d) configurations of N-like Kr XXX, obtained from the MCDF and MBPT approaches, respectively. Also listed in the table are the experimental values from the NIST ASD and other theoretical energies. Due to the fact that different calculations have different percentage compositions of the each level, identifications are not the same for all levels. In the present work, we adopt the configuration, total angular number J and energy ordering as the *good* quantum numbers to match the levels from various calculations.

As seen from Table 2, experimental energies are available only for 9 levels of the $2s^22p^3$ and $2s2p^4$ configurations. Our MCDF/MBPT values agree very well with these observations, and the differences are within 0.07%, which is highly satisfactory. Recently, using the MCDF method, Rynkun et al. [18] reported the energies and transition rates (label by MCDF2) for the 15 states of the n = 2 configurations in N-like ions Kr XXX. These results are the most accurate so far and the differences between the calculated energies and the NIST observations are within 0.1%. The present MBPT and MCDF calculations confirm the energies of Rynkun et al. [18]. The average difference between the MCDF/MBPT and MCDF2 values is 0.03% and 0.04% for the n = 2 states. However, for the n = 2 levels, the differences of earlier theoretical energy levels of Bhatia et al. [24] (labeled by SS) relative to the NIST values and our results are large, particularly for the $2s^22p^3$ $^2D_{3/2}$ and $2s2p^4$ $^4P_{1/2}$ levels where the differences are about 0.8%-0.9%. Apart from the n = 2 levels, energies of the remaining levels of the SS calculations are generally higher than our MCDF/MBPT results by about 0.6%-1%. These differences may be due to limited electron correlation effects included in the SS calculations.

In the literature, the most comprehensive theoretical energies for N-like Kr XXX would be the two sets of results for the 272 levels calculated by Aggarwal et al. [25] using the GRASP [26] and FAC codes (labeled by GRASP and FAC). Since limited correlation effects were considered in the calculations, there are some big discrepancies with the experimental results. For the lowest 15 levels, it can be seen that the results from Aggarwal et al. [25] are all higher than the NIST experimental values with one exception for the $2s^2\,2p^3$ $^2D^o_{3/2}$ level, where the former are lower than the latter by about 290 cm^{-1}. The relative deviations from the NIST experimental values for GRASP and FAC are respectively up to 0.6% for the $2s\,2p^4$ $^2P_{3/2}$ level and 0.6% for the $2s\,2p^4$ $^2D_{3/2}$ level, which are larger by over one order of magnitude compared with the present MCDF/MBPT results. For the remaining 257 levels belonging to the $2s^22p^23l$ and $2s2p^33l$ (l=s,p,d) configurations, the discrepancies of the GRASP energies relative to our two sets of results are relatively smaller, usually less than 0.15% , the greatest deviation is 0.19% for level arising from $2p^4(^1D)\,3p$ $^2D^o_{3/2}$.

Relative differences between our two sets of energy levels are plotted in Figure 2. An excellent agreement is found between our two methods. i.e., the differences are within 0.025% for the lowest 15 levels, and are around

0.005% for the remaining 257 levels; the mean (with standard deviation) of the relative differences for all the 272 levels is only about 0.003% ± 0.01%. The present MCDF and MBPT energy data, as well as the calculated transition wavelengths, are not only generally more accurate than existing theoretical data, but are also accurate enough to directly confirm/revise experimental identifications in the x-ray and extreme ultraviolet (EUV) regions. However, for the $n = 0$ transitions with calculated wavelengths in the visible region, the accuracy of our results cannot compare with what experiment can achieve. In this region, further precise measurements are needed.

3.3. Transition rates

In Table 3, our calculated MCDF/MBPT wavelengths, transition rates (A, in s^{-1}), oscillator strengths (gf), and line strengths (S, in a.u.) for the E1, M1, E2, and M2 transitions among the 272 levels of the $n = 2, 3$ configurations in N-like Kr XXX are presented. Here, we present the results in the Babushkin form, since the results in the Babushkin form are less sensitive to electron correlation effects than results in the Coulomb form of the transition operator.

To illustrate the accuracy of the present transition rates, in Table 4 our two sets of the E1, M1, E2, and M2 transition rates among the 15 levels of the $n = 2$ complex are compared with previous theoretical values and the NIST results. it can be seen that our MCDF transition rates are in excellent agreement with the MBPT results. The relative differences are within 4% for all the 185 transitions among the $n = 2$ levels, except for 5 transitions with small transition rates. i.e, $2s^2\,2p^3\ ^2P^o_{3/2}\!\rightarrow\!2s^2\,2p^3\ ^4S^o_{3/2}$, $2p^5\ ^2P^o_{3/2}\!\rightarrow\!2s^2\,2p^3\ ^4S^o_{3/2}$, $2p^5\ ^2P^o_{3/2}\!\rightarrow\!2s^2\,2p^3\ ^2P^o_{3/2}$, $2p^5\ ^2P^o_{1/2}\!\rightarrow\!2s^2\,2p^3\ ^4S^o_{3/2}$, and $2p^5\ ^2P^o_{1/2}\!\rightarrow\!2s^2\,2p^3\ ^2P^o_{1/2}$ transitions. As shown in Table 4, the values given by the NIST ASD are largely missing, i.e., the NIST ASD only lists transition rates for 3 out of the 185 transitions. Our results show excellent agreement with the NIST values to within a few percentage points (0.2% for $2s^2\,2p^3\ ^2D^o_{3/2}\!\rightarrow\!2s^2\,2p^3\ ^4S^o_{3/2}$; 0.6% for $2s^2\,2p^3\ ^2D^o_{5/2}\!\rightarrow\!2s^2\,2p^3\ ^4S^o_{3/2}$, and 2% for $2s^2\,2p^3\ ^2P^o_{1/2}\!\rightarrow\!2s^2\,2p^3\ ^4S^o_{3/2}$), which is highly satisfactory. The most comprehensive and accurate theoretical transition rates among the 185 $n = 2$ transitions of Kr XXX in the literature should be the MCDF2 values reported by Rynkun et al. [18]. They agree with the present MCDF transition rates to within 1% for all the 185 transitions, except for four transitions, i.e. $2s^2\,2p^3\ ^2D^o_{3/2}\!\rightarrow\!2s\,2p^4\ ^4P_{3/2}$, $2s\,2p^4\ ^4P_{3/2}\!\rightarrow\!2s\,2p^4\ ^2D_{5/2}$, $2s^2\,2p^3\ ^4S^o_{3/2}\!\rightarrow\!2p^5\ ^2P^o_{1/2}$, and $2s^2\,2p^3\ ^2P^o_{3/2}\!\rightarrow\!2s\,2p^4\ ^2D_{3/2}$, the largest difference is 6.85% for the last transition. Also, their calculations are generally in good agreement with our MBPT results. i.e., the differences are within 1% for 172 transitions, and are between 2% and 20% for the remaining 13 transitions.

Since E1 transitions are comparatively more important, A broader comparison between the present MCDF and MBPT transition rates for E1 transitions among all the 272 levels of $n = 2, 3$ complexes are made. The agreement between our two sets of transition rates is also satisfactory, being within 10% for 83% out of all the 12156 transitions. There are even better agreement for strong transitions. As shown in Figure 3, their relative differences are within 5% for 94% out of the 3638 transitions with $A_{MCDF}\&A_{MBPT} \geq 10^9\ s^{-1}$. However, for a few strong transitions (22 transitions), the differences are larger than 20%, and even by several orders of magnitude for other weak transitions. Most of them are intercombination or two-electron-one-photon transitions. Such transitions are generally sensitive to the electron correlation effects, and sometimes are even sensitive to the high-order relativistic effects. It is thus necessary to describe the coupling conditions very accurately.

It should be mentioned that for electric multipole transitions, there are two gauges, the Babushkin (length) gauge and the Coulomb (velocity) gauge. To further access the uncertainty of our MCDF transition rates, the quantity dT, defined as $dT = \frac{|A_l - A_v|}{\max(A_l, A_v)}$, in which A_l/A_v are the transition rates in Babushkin/Coulomb gauge, is introduced. In Figure 4, we show the uncertainty estimators dT for E1 transitions among the 272 levels with $A_{MCDF} \geq 10^6$ s^{-1} for N-like Kr XXX. For most strong transitions, the agreement between the two gauges is good, where the uncertainty dT is below 15%. Such a good agreement between the velocity and length forms of the transition rates is an indication of quality for the present calculations [51]. However, for some lines with small transition rates the situation is unclear. For example, for the transition probabilities $A \geq 10^9$ s^{-1}, the uncertainty dT is below 10% for all the transitions, while for the transition probabilities $A < 10^9$ s^{-1}, apart from a few irregularities, the uncertainty dT is from a few percent up to 30%.

3.4. Lifetimes

Lifetime τ for a level j can be determined as

$$\tau = 1/(\sum_i A_{ji}) \tag{12}$$

where the summation includes results from all types of transitions. In Table 5, our MCDF/MBPT lifetimes for the 272 fine-structure levels of N-like Kr XXX, calculated by considering all possible E1, M1, E2, and M2 transitions, are compared with other theoretical calculations. For the lowest 15 levels, the difference between the present MCDF results and the theoretical lifetimes from the MCDF2 calculations [18] is less than 0.15%, except for the 3 levels $2s^2\,2p^3\ ^2D^o_{5/2}$, $2s^2\,2p^3\ ^2P^o_{3/2}$, and $2p^5\ ^2P^o_{3/2}$, where the difference reach 0.38% at most. The agreement between our two sets of lifetimes is also highly satisfactory, being within 2.5% for most levels, while the GRASP calculations [25] differ from the present two sets of values significantly, generally by 10%~20% (up to 50%).

The τ_l/τ_v ratios of our MCDF lifetimes for the 272 levels of Kr XXX are plotted in Figure 5. Generally good agreements are found between the length and velocity forms of our lifetimes. In many cases, the ratio is very near to one. They show relative large difference for only one level, i.e. being 2.7% for $2s\,2p^3(^3D)\,3d\ ^4G^o_{11/2}$.

3.5. Hyperfine interaction constants and Landé g_J-factors

Hyperfine interaction is not only important in astrophysics, but also a sensitive probe of both electron correlation and QED effects. Table 6 displays our calculated total energies, A_J, B_J hyperfine interaction constants and Landé g$_J$-factors for the 272 levels of Kr XXX and the theoretical results for the lowest 15 levels calculated by Rynkun et al. [18]. As can be seen, there is a very good agreement between our values and the ones provided by Rynkun et al. [18]. The agreement is slightly better for the g$_J$-factors than for the A_J,B_J constants. For example, the deviations for A_J, B_J hyperfine interaction constants is about 0.6%, and 0.2%, while the two different calculations give values of g$_J$-factors that are in excellent agreement to within less than 0.02%.

4. Conclusions

Motivated by the necessity of complete, consistent and accurate atomic data, we have performed the calculations of energies and radiative transition properties for highly charged N-like Kr XXX using the MCDF method and with the BI and QED effects added in RCI. Complete and consistent data sets of energies, wavelengths, line strengths, lifetimes, oscillator strengths, A_J, B_J hyperfine interaction constants, Land*é* g$_J$-factors, and E1, M1, E2, M2 transition rates among the 272 levels of the $2s^22p^3$, $2s2p^4$, $2p^5$, $2s^22p^23l$, and $2s2p^33l$ (*l=s,p,d*) configurations are provided. Independent calculations using the MBPT method are also carried out to assess the accuracy of the MCDF calculations. Comparisons with available experimental and other theoretical results, confirm the high accuracy for the present MCDF/MBPT results. For the level energies, the mean difference between our MCDF and MBPT energies is only about 0.003%, and the relative difference between our MCDF/MBPT energies and the NIST experimental values is around 0.05%. For the transition rates, the relative differences between our two sets of results are within 4% for transitions among the lowest 15 levels, and are less than 5% for nearly 94% out of all the E1 strong transitions (A_{MCDF} $\geq 10^9$) among the $n = 2, 3$ levels. The lifetimes also compare well to within 2.5% for most of the 272 excited-levels. For the A_J, B_J hyperfine interaction constants and g$_J$-factors, the greatest deviations between our MCDF results and the data [18] are about 0.6%, 0.2%, and 0.02%, respectively.

Since more electron correlation effects are considered in our methods, our results show not only an improvement in accuracy compared with other calculations, but the results are also accurate enough to directly confirm/revise experimental identifications in the x-ray and EUV regions. The present data sets are believed to be the most comprehensive and accurate ones to date. We expect that these accurate data will be useful for controlled thermonuclear fusion research and astrophysical applications.

Acknowledgments

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[1] K. Słabkowska, J. Rzadkiewicz, Ł. Syrocki, E. Szymańska, A. Shumack, M. Polasik, N. R. Pereira, J. contributors, J. Phys. B: At. Mol. Opt. Phys. 48 (2015) 144028.

[2] J. F. Wyart, TFR Group, Phys. Scr. 31 (1985) 539–544.

[3] B. Denne, E. Hinnov, J. Ramette, B. Saoutic, Phys. Rev. A 40 (1989) 1488–1496.

[4] E. Hinnov, TFTR Operating Team, B. Denne, JET Operating Team, Phys. Rev. A 40 (1989) 4357–4360.

[5] R. Myrnäs, C. Jupén, G. Miecznik, I. Martinson, B. Denne-Hinnov, Phys. Scr. 49 (1994) 429–435.

[6] I. Martinson, C. Jupén, Phys. Scr. 68 (2003) c123.

[7] D. Post, G. Janeschitz, A. Kukushkin, H. Pacher, M. Sugihara, J. Mandrekas, W. Stacey, Physics of Plasmas 4 (1997) 2631–2641.

[8] R. Barnsley, M. O'Mullane, L. C. Ingesson, A. Malaquias, Review of Scientific Instruments 75 (2004) 3743–3746.

[9] A. J. H. Donné, A. E. Costley, R. Barnsley, H. Bindslev, R. Boivin, G. Conway, R. Fisher, R. Giannella, H. Hartfuss, M. G. von Hellermann, E. Hodgson, L. C. Ingesson, K. Itami, D. Johnson, Y. Kawano, T. Kondoh, A. Krasilnikov, Y. Kusama, A. Litnovsky, P. Lotte, P. Nielsen, T. Nishitani, F. Orsitto, B. J. Peterson, G. Razdobarin, J. Sanchez, M. Sasao, T. Sugie, G. Vayakis, V. Voitsenya, K. Vukolov, C. Walker, K. Young, ITPA Topical Group on Diagnostics, Nucl. Fusion 47 (2007) S337–S384.

[10] R. Si, X. L. Guo, J. Yan, C. Y. Li, S. Li, M. Huang, C. Y. Chen, Y. M. Zou, J. Phys. B: At. Mol. Opt. Phys. 48 (2015) 175004.

[11] S. Gustafsson, P. Jönsson, C. F. Fischer, I. Grant, Astronomy and Astrophysics (2016 at press).

[12] E. B. Saloman, J. Phys. Chem. Ref. Data 36 (2007) 215–386.

[13] A. Kramida, Yu. Ralchenko, J. Reader, and NIST ASD Team, NIST Atomic Spectra Database (ver. 5.3), [Online]. Available: `http://physics.nist.gov/asd` [2016, May 10]. National Institute of Standards and Technology, Gaithersburg, MD., 2015.

[14] I. Kink, J. M. Laming, E. Takács, J. V. Porto, J. D. Gillaspy, E. Silver, H. Schnopper, S. R. Bandler, M. Barbera, N. Brickhouse, S. Murray, N. Madden, D. Landis, J. Beeman, E. E. Haller, Phys. Rev. E 63 (2001) 046409.

[15] Y. A. Podpaly, J. D. Gillaspy, J. Reader, Y. Ralchenko, J. Phys. B: At. Mol. Opt. Phys. 47 (2014) 095702.

[16] H. L. Zhang, D. H. Sampson, At. Data Nucl. Data Tables 72 (1999) 153.

[17] M. F. Gu, At. Data Nucl. Data Tables 89 (2005) 267 – 293.

[18] P. Rynkun, P. Jönsson, G. Gaigalas, C. Froese Fischer, At. Data Nucl. Data Tables 100 (2014) 315–402.

[19] S. Verdebout, C. Nazé, P. Jönsson, P. Rynkun, M. Godefroid, G. Gaigalas, At. Data Nucl. Data Tables 100 (2014) 1111–1155.

[20] X. Han, X. Gao, D. Zeng, R. Jin, J. Yan, J. Li, Phys. Rev. A 89 (2014) 042514.

[21] L. Hao, H. Feng, X. Kang, Acta Phys. Pol. A 127 (2015) 693–700.

[22] P. Jönsson, X. He, C. F. Fischer, I. Grant, Comput. Phys. Commun. 177 (2007) 597 – 622.

[23] W. Eissner, M. Jones, H. Nussbaumer, Comput. Phys. Commun. 8 (1974) 270 – 306.

[24] A. K. Bhatia, J. F. Seely, U. Feldman, At. Data Nucl. Data Tables 43 (1989) 99.

[25] K. Aggarwal, F. Keenan, K. Lawson, At. Data Nucl. Data Tables 94 (2008) 323 – 559.

[26] K. Dyall, I. Grant, C. Johnson, F. Parpia, E. Plummer, Comput. Phys. Commun. 55 (1989) 425 – 456.

[27] M. F. Gu, Can. J. Phys. 86 (2008) 675–689.

[28] I. P. Grant, Relativistic Quantum Theory of Atoms and Molecules, Springer New York, 2007.

[29] M. Czarnota, D. Banaś, M. Berset, D. Chmielewska, J.-C. Dousse, J. Hoszowska, Y.-P. Maillard, O. Mauron, M. Pajek, M. Polasik, P. A. Raboud, J. Rzadkiewicz, K. Słabkowska, Z. Sujkowski, Eur. Phys. J. D 57 (2010) 321–324.

[30] M. Czarnota, D. Banaś, M. Berset, D. Chmielewska, J.-C. Dousse, J. Hoszowska, Y.-P. Maillard, O. Mauron, M. Pajek, M. Polasik, P. A. Raboud, J. Rzadkiewicz, K. Słabkowska, Z. Sujkowski, Phys. Rev. A 81 (2010) 064702.

[31] M. Polasik, K. Słabkowska, J. Rzadkiewicz, K. Kozioł, J. Starosta, E. Wiatrowska-Kozioł, J.-C. Dousse, J. Hoszowska, Phys. Rev. Lett. 107 (2011) 073001.

[32] M. Czarnota, D. Banaś, M. Berset, D. Chmielewska, J.-C. Dousse, J. Hoszowska, Y.-P. Maillard, O. Mauron, M. Pajek, M. Polasik, P. A. Raboud, J. Rzadkiewicz, K. Słabkowska, Z. Sujkowski, Phys. Rev. A 88 (2013) 052505.

[33] E. Szymańska, Ł. Syrocki, K. Słabkowska, M. Polasik, J. Rzadkiewicz, High Energy Density Physics 20 (2016) 29–33.

[34] P. Jönsson, G. Gaigalas, J. Bieroń, C. F. Fischer, I. P. Grant, Comput. Phys. Commun. 184 (2013) 2197–2203.

[35] M. F. Gu, Astrophy. J. 582 (2003) 1241–1250.

[36] M. F. Gu, Astrophy. J. Supp. Ser. 156 (2005) 105.

[37] M. F. Gu, Astrophy. J. Supp. Ser. 169 (2007) 154.

[38] J. Olsen, M. R. Godefroid, P. Jönsson, P. Å. Malmqvist, C. F. Fischer, Phys. Rev. E 52 (1995) 4499–4508.

[39] P. Jönsson, F. A. Parpia, C. F. Fischer, Comput. Phys. Commun. 96 (1996) 301–310.

[40] M. Andersson, P. Jönsson, H. Sabel, J. Phys. B: At. Mol. Opt. Phys. 39 (2006) 4239–4247.

[41] M. Andersson, P. Jönsson, Comput. Phys. Commun. 178 (2008) 156–170.

[42] I. Lindgren, J. Phys. B: At. Mol. Opt. Phys. 7 (1974) 2441.

[43] M. S. Safronova, W. R. Johnson, U. I. Safronova, Phys. Rev. A 53 (1996) 4036–4053.

[44] M. J. Vilkas, Y. Ishikawa, K. Koc, Phys. Rev. A 60 (1999) 2808–2821.

[45] K. Wang, D. F. Li, H. T. Liu, X. Y. Han, B. Duan, C. Y. Li, J. G. Li, X. L. Guo, C. Y. Chen, J. Yan, Astrophy. J. Supp. Ser. 215 (2014) 26.

[46] K. Wang, X. L. Guo, H. T. Liu, D. F. Li, F. Y. Long, X. Y. Han, B. Duan, J. G. Li, M. Huang, Y. S. Wang, R. Hutton, Y. M. Zou, J. L. Zeng, C. Y. Chen, J. Yan, Astrophy. J. Supp. Ser. 218 (2015) 16.

[47] K. Wang, R. Si, W. Dang, P. Jönsson, X. L. Guo, S. Li, Z. B. Chen, H. Zhang, F. Y. Long, H. T. Liu, D. F. Li, R. Hutton, C. Y. Chen, J. Yan, Astrophy. J. Supp. Ser. 223 (2016) 3.

[48] L. Sturesson, P. Jönsson, C. Froese Fischer, Comput. Phys. Commun. 177 (2007) 539–550.

[49] J. Olsen, B. O. Roos, P. Jørgensen, H. J. A. Jensen, J. Chem. Phys. 89 (1988) 2185–2192.

[50] G. Gaigalas, T. Zalandauskas, S. Fritzsche, Comput. Phys. Commun. 157 (2004) 239–253.

[51] J. Ekman, M. R. Godefroid, H. Hartman, Atoms 2 (2014) 215–224.

Figures

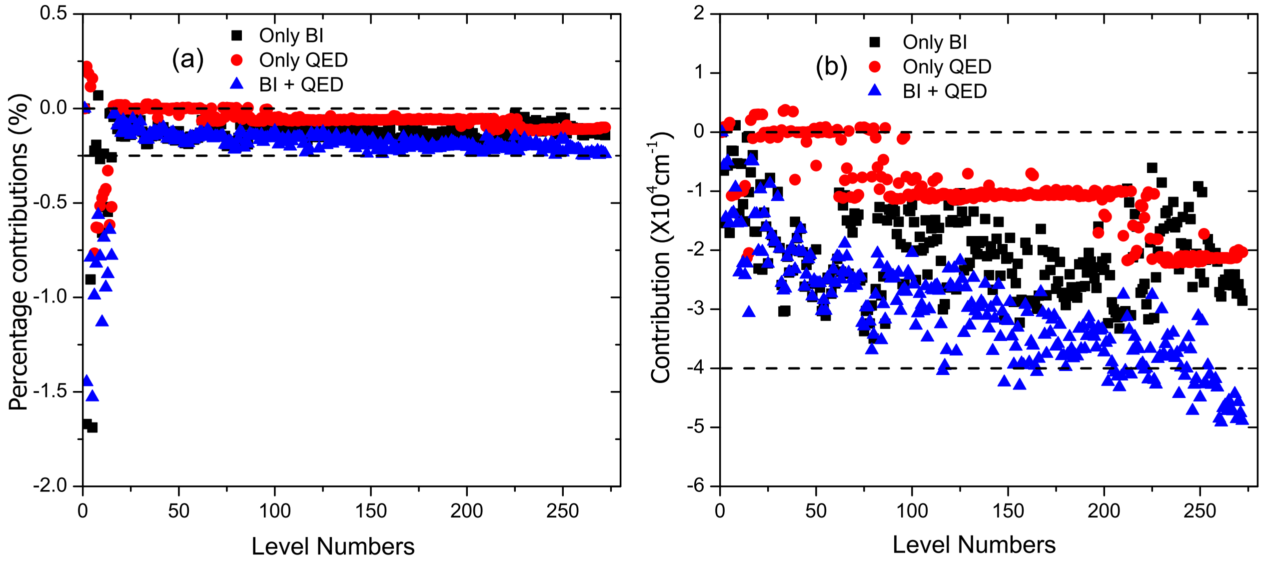

Figure 1. The BI and QED effects on the MCDF level energies for the 272 levels of N-like Kr XXX.

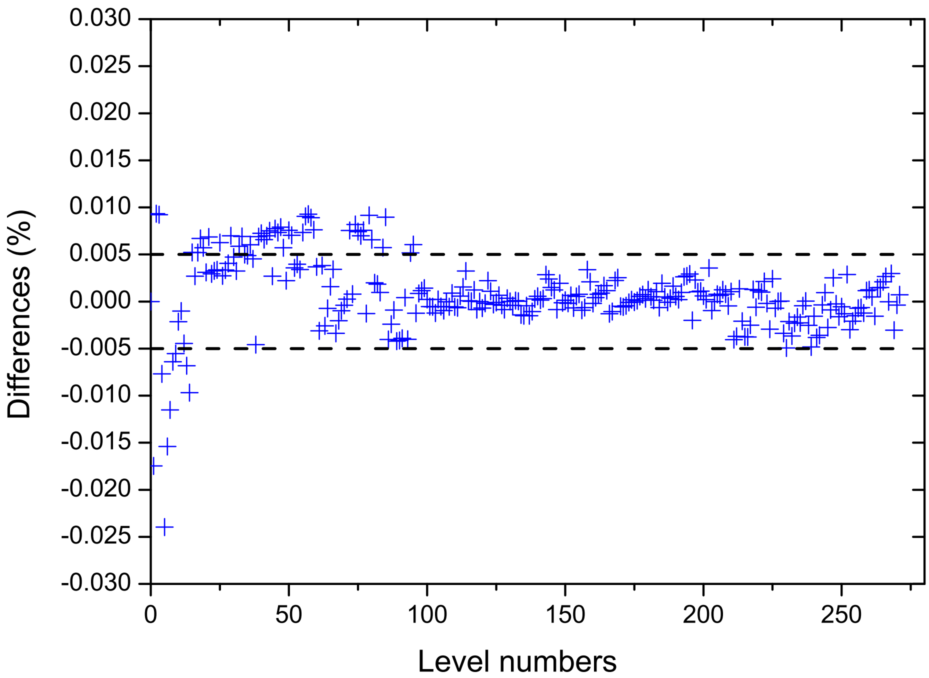

Figure 2. Percentage differences of the MCDF values relative to the MBPT energies for the 272 levels in N-like Kr XXX. Dashed lines indicate the differences of ±0.005%.

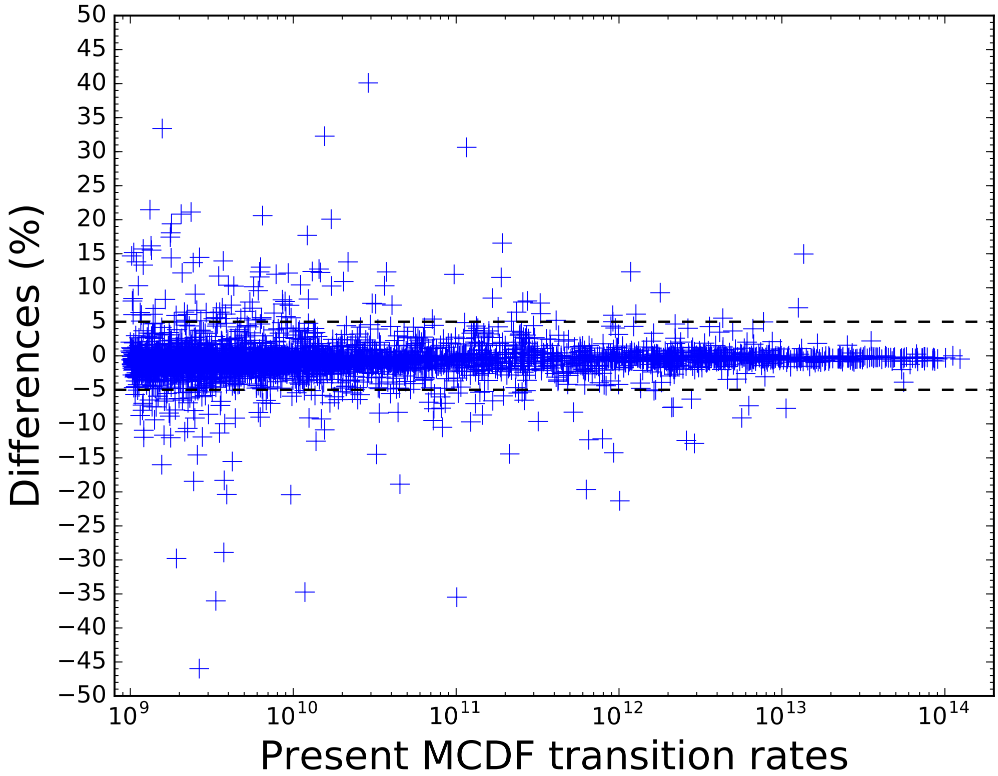

Figure 3. Percentage differences between the present MCDF and MBPT transition rates for the transitions with $A_{MCDF} \geq 10^{-9}$ s^{-1} in N-like Kr XXX. Dashed lines indicate the differences of ±5%.

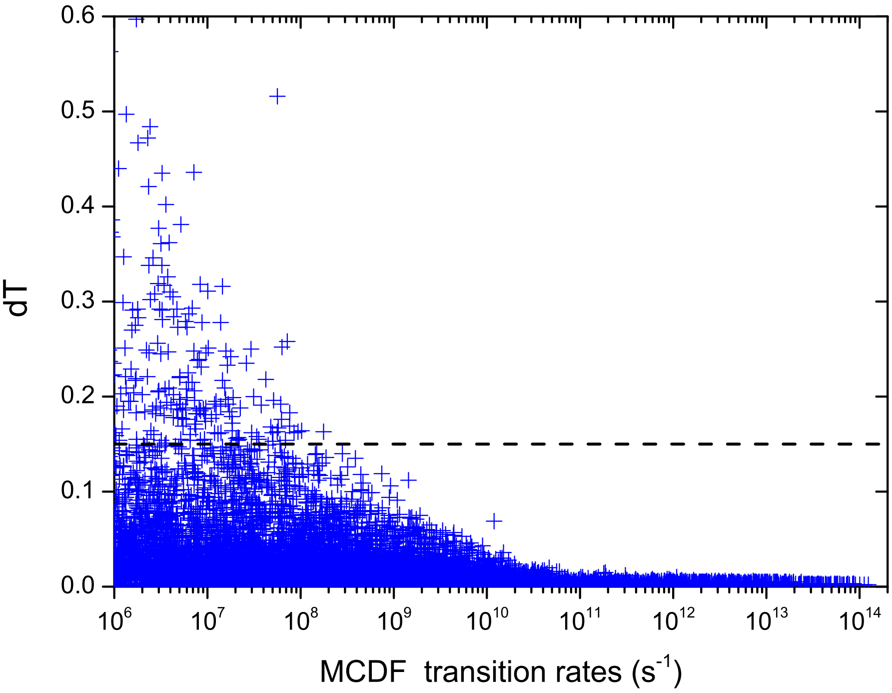

Figure 4. The uncertainty estimators dT for the E1 transitions among the 272 levels with $A_{MCDF} \geq 10^6$ s^{-1} in N-like Kr XXX. Dashed line indicates the difference of 15%.

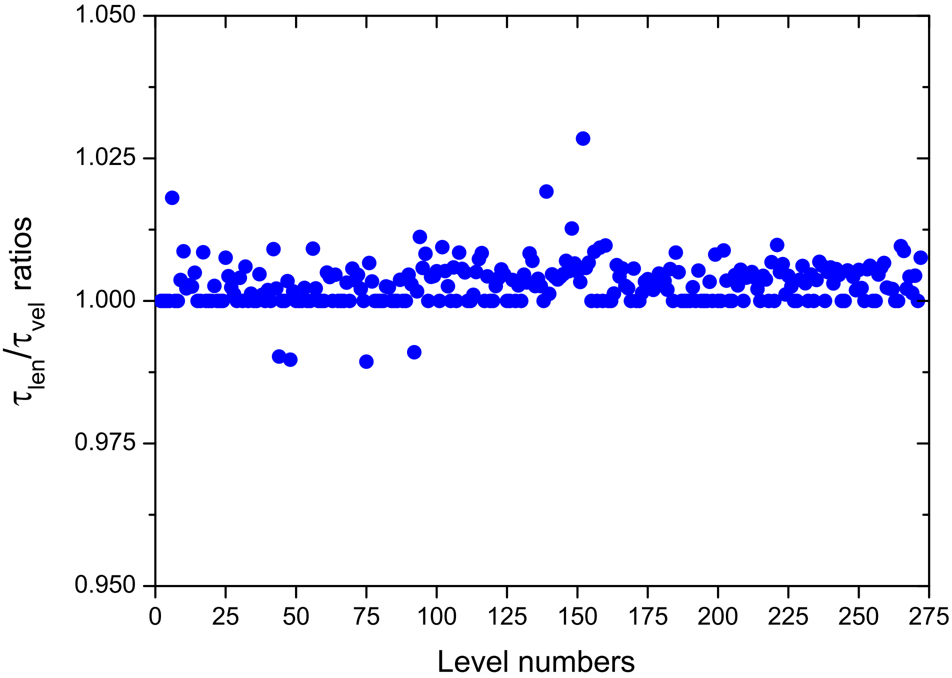

Figure 5. The τ_l/τ_v ratios of the present MCDF lifetimes for the 272 levels in N-like Kr XXX.

Tables

Table 1. Energies (in cm^{-1}) for the 36 levels of Kr XXX as a function of increasing active sets of orbitals.

Level	MR	n= 3	n= 4	n= 5	n= 6	n= 7	n= 8	n= 8 (RCI)
$2s^2\,2p^3\ ^4S^o_{3/2}$	0	0	0	0	0	0	0	0
$2s^2\,2p^3\ ^2D^o_{3/2}$	391684	391031	390372	390649	390717	390756	390766	385107
$2s^2\,2p^3\ ^2D^o_{5/2}$	505195	504258	502962	502206	502125	502067	502051	487566
$2s^2\,2p^3\ ^2P^o_{1/2}$	629474	627783	628538	627252	626943	626766	626719	621778
$2s^2\,2p^3\ ^2P^o_{3/2}$	1014400	1012130	1012264	1011765	1011627	1011546	1011524	996065
$2s\,2p^4\ ^4P_{5/2}$	1409800	1406720	1405800	1404918	1405087	1405141	1405162	1391258
$2s\,2p^4\ ^4P_{3/2}$	1668050	1664417	1662291	1661009	1661038	1661053	1661060	1647428
$2s\,2p^4\ ^4P_{1/2}$	1675470	1671559	1669727	1668051	1667918	1667861	1667847	1658461
$2s\,2p^4\ ^2D_{3/2}$	1983700	1979361	1974859	1972518	1972281	1972203	1972180	1956750
$2s\,2p^4\ ^2D_{5/2}$	2109960	2105335	2100574	2097966	2097684	2097578	2097547	2073821
$2s\,2p^4\ ^2P_{1/2}$	2260750	2255589	2250178	2247353	2246835	2246673	2246623	2231276
$2s\,2p^4\ ^2P_{3/2}$	2356210	2351089	2343386	2340124	2339541	2339384	2339331	2317181
$2s\,2p^4\ ^2S_{1/2}$	2781510	2775255	2768956	2766066	2765442	2765258	2765199	2740986
$2p^5\ ^2P^o_{3/2}$	3506010	3484781	3468993	3464526	3463990	3463683	3463627	3441401
$2p^5\ ^2P^o_{1/2}$	3975740	3954095	3938424	3934462	3933964	3933681	3933632	3903005
$2s^2\,2p^2(^3P)\,3s\ ^4P_{1/2}$	15206100	15172349	15175989	15181456	15181515	15181677	15181681	15176917
$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{1/2}$	15540400	15482333	15485678	15490426	15490398	15490556	15490566	15485623
$2s^2\,2p^2(^3P)\,3s\ ^4P_{3/2}$	15597900	15562568	15565695	15571479	15571649	15571895	15571925	15558050
$2s^2\,2p^2(^3P)\,3s\ ^2P_{1/2}$	15637300	15601163	15603607	15609703	15609786	15610006	15610020	15596139
$2s^2\,2p^2(^3P)\,3s\ ^4P_{5/2}$	15690800	15654413	15657518	15661983	15661991	15662163	15662178	15642075
$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{3/2}$	15713000	15655311	15658063	15663119	15663206	15663376	15663384	15653725
$2s^2\,2p^2(^1D)\,3s\ ^2D_{3/2}$	15721300	15685173	15687388	15692578	15692597	15692741	15692735	15672456
$2s^2\,2p^2(^3P)\,3p\ ^4P^o_{1/2}$	15920900	15869985	15872660	15877878	15877975	15878235	15878273	15864561
$2s^2\,2p^2(^3P)\,3p\ ^2D^o_{3/2}$	15958400	15906999	15909494	15914361	15914401	15914624	15914651	15898559
$2s^2\,2p^2(^1D)\,3p\ ^2F^o_{5/2}$	16024700	15973443	15975751	15980192	15980188	15980361	15980374	15958089
$2s^2\,2p^2(^3P)\,3d\ ^4F_{3/2}$	16026000	15991369	15994198	15997517	15996794	15996917	15996905	15988153
$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{5/2}$	16067700	16016455	16019196	16024375	16024496	16024753	16024792	16007384
$2s^2\,2p^2(^3P)\,3p\ ^2S^o_{1/2}$	16089700	16037419	16040012	16045007	16045098	16045331	16045362	16026824
$2s^2\,2p^2(^3P)\,3p\ ^4S^o_{3/2}$	16103900	16058270	16060720	16065077	16065141	16065331	16065353	16046738
$2s^2\,2p^2(^3P)\,3d\ ^4D_{5/2}$	16109700	16068850	16071130	16074301	16073479	16073599	16073584	16062607
$2s^2\,2p^2(^3P)\,3p\ ^4P^o_{3/2}$	16142800	16089018	16091007	16094642	16094576	16094717	16094719	16074989
$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{7/2}$	16150800	16110572	16112813	16117354	16117385	16117568	16117584	16092044
$2s^2\,2p^2(^1D)\,3s\ ^2D_{5/2}$	16162200	16114259	16116962	16121928	16122043	16122220	16122231	16095429
$2s^2\,2p^2(^3P)\,3s\ ^2P_{3/2}$	16181800	16144604	16146875	16152134	16152100	16152241	16152245	16125770
$2s^2\,2p^2(^3P)\,3p\ ^2P^o_{3/2}$	16200200	16146344	16148421	16152177	16152245	16152413	16152415	16131277
$2s^2\,2p^2(^1D)\,3p\ ^2D^o_{5/2}$	16247400	16193333	16195104	16198595	16198504	16198633	16198632	16174945

Table 2. Energies (in cm^{-1}) relative to the ground state for the lowest 272 levels arising from the $n \le 3$ configurations in Kr XXX. $a-$ the present results; $b-$ the NIST value [13]; $c-$ the MCDF values [18]; $d-$ the SS values [24]; $e-$ the GRASP&FAC values [25].

Key	Level	MCDF^a	MBPT^a	NIST^b	MCDF2^c	SS^d	GRASP^e	FAC^e
1	$2s^2\,2p^3\ ^4S^o_{3/2}$	0	0	0	0	0	0	0
2	$2s^2\,2p^3\ ^2D^o_{3/2}$	385108	385180	384900	384865	381768	384692	384606
3	$2s^2\,2p^3\ ^2D^o_{5/2}$	487566	487527	487220	487310	489988	488962	488567
4	$2s^2\,2p^3\ ^2P^o_{1/2}$	621779	621729	621500	621501	618192	622679	622642
5	$2s^2\,2p^3\ ^2P^o_{3/2}$	996065	996155		995516	979982	995486	995557
6	$2s\,2p^4\ ^4P_{5/2}$	1391259	1391610	1391300	1390850	1383986	1395303	1395965
7	$2s\,2p^4\ ^4P_{3/2}$	1647429	1647704	1646580	1646938	1634526	1653365	1653680
8	$2s\,2p^4\ ^4P_{1/2}$	1658462	1658674	1657500	1658000	1643124	1665060	1665359
9	$2s\,2p^4\ ^2D_{3/2}$	1956750	1956901	1955480	1956188	1944284	1966913	1966335
10	$2s\,2p^4\ ^2D_{5/2}$	2073821	2073963		2073195	2067545	2084094	2083408
11	$2s\,2p^4\ ^2P_{1/2}$	2231277	2231353		2230670	2720255	2243953	2243013
12	$2s\,2p^4\ ^2P_{3/2}$	2317182	2317235	2318860	2316585	2310118	2332797	2331212
13	$2s\,2p^4\ ^2S_{1/2}$	2740986	2741144		2740119	2215707	2754200	2753003
14	$2p^5\ ^2P^o_{3/2}$	3441402	3441681		3441378	3437846	3470510	3468531
15	$2p^5\ ^2P^o_{1/2}$	3903005	3903433		3902701	3894643	3930539	3928608
16	$2s^2\,2p^2(^3P)\,3s\ ^4P_{1/2}$	15176918	15176321			15292566	15168401	15171636
17	$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{1/2}$	15485624	15485407			15601302	15479178	15482262
18	$2s^2\,2p^2(^3P)\,3s\ ^4P_{3/2}$	15558051	15557443			15646297	15549478	15551781
19	$2s^2\,2p^2(^3P)\,3s\ ^2P_{1/2}$	15596139	15595294			15683707	15589022	15592900
20	$2s^2\,2p^2(^3P)\,3s\ ^4P_{5/2}$	15642075	15641383			15737159	15634888	15636759
21	$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{3/2}$	15653725	15653442			15763695	15647785	15651320
22	$2s^2\,2p^2(^1D)\,3s\ ^2D_{3/2}$	15672456	15671582			15766605	15666493	15669447
23	$2s^2\,2p^2(^3P)\,3p\ ^4P^o_{1/2}$	15864562	15864299			15952762	15858350	15860579
24	$2s^2\,2p^2(^3P)\,3p\ ^2D^o_{3/2}$	15898559	15898245			15988244	15893038	15895507
25	$2s^2\,2p^2(^1D)\,3p\ ^2F^o_{5/2}$	15958090	15957757			16094005	15953159	15955174
26	$2s^2\,2p^2(^3P)\,3d\ ^4F_{3/2}$	15988154	15987358			16097164	15983307	15984261
27	$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{5/2}$	16007385	16007155			16052210	16000736	16002938
28	$2s^2\,2p^2(^3P)\,3p\ ^2S^o_{1/2}$	16026825	16026494			16111304	16020994	16023042
29	$2s^2\,2p^2(^3P)\,3p\ ^4S^o_{3/2}$	16046738	16046295			16138703	16042123	16045634
30	$2s^2\,2p^2(^3P)\,3d\ ^4D_{5/2}$	16062607	16061693			16172292	16058669	16060851
31	$2s^2\,2p^2(^3P)\,3p\ ^4P^o_{3/2}$	16074990	16074438			16176716	16071866	16075670
32	$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{7/2}$	16092045	16091731			16178676	16086810	16088779
33	$2s^2\,2p^2(^1D)\,3s\ ^2D_{5/2}$	16095429	16094692			16265525	16087885	16089808
34	$2s^2\,2p^2(^3P)\,3s\ ^2P_{3/2}$	16125770	16124862			16201986	16119133	16122320
35	$2s^2\,2p^2(^3P)\,3p\ ^2P^o_{3/2}$	16131277	16130681			16229237	16128169	16131695
36	$2s^2\,2p^2(^1D)\,3p\ ^2D^o_{5/2}$	16174946	16174365			16265525	16172004	16175396
37	$2s^2\,2p^2(^3P)\,3p\ ^2P^o_{1/2}$	16238178	16237407			16322466	16237336	16240972
38	$2s^2\,2p^2(^1S)\,3s\ ^2S_{1/2}$	16300194	16299666			16402469	16288692	16289212
39	$2s\,2p^3(^5S)\,3s\ ^6S^o_{5/2}$	16346935	16347893				16331091	16339027
40	$2s^2\,2p^2(^3P)\,3d\ ^2P_{3/2}$	16375441	16374524			16457121	16371101	16372318
41	$2s^2\,2p^2(^3P)\,3d\ ^4F_{5/2}$	16387093	16386118			16471033	16383495	16384201
42	$2s^2\,2p^2(^3P)\,3d\ ^4D_{1/2}$	16391252	16390385			16468957	16386263	16387570
43	$2s^2\,2p^2(^3P)\,3d\ ^4F_{7/2}$	16402663	16401728			16487829	16397659	16399001
44	$2s^2\,2p^2(^1D)\,3d\ ^2F_{7/2}$	16449841	16448818			16538502	16446686	16447183
45	$2s\,2p^3(^5S)\,3s\ ^4S^o_{3/2}$	16452985	16452753				16445976	16451632
46	$2s^2\,2p^2(^3P)\,3d\ ^4P_{5/2}$	16456447	16455385			16544170	16453515	16454640
47	$2s^2\,2p^2(^3P)\,3d\ ^4D_{3/2}$	16459489	16458494			16546101	16455498	16456986
48	$2s^2\,2p^2(^3P)\,3d\ ^4F_{9/2}$	16486681	16485591			16577258	16483201	16483800
49	$2s^2\,2p^2(^3P)\,3p\ ^2D^o_{5/2}$	16494576	16493847			16606729	16492539	16496545
50	$2s\,2p^3(^3P)\,3s\ ^2P^o_{3/2}$	16497197	16497044				16494008	16500170
51	$2s^2\,2p^2(^1D)\,3d\ ^2D_{5/2}$	16519648	16518610			16612807	16517038	16517950
52	$2s^2\,2p^2(^3P)\,3d\ ^4P_{3/2}$	16533900	16532950			16626701	16530841	16531830
53	$2s^2\,2p^2(^3P)\,3p\ ^4P^o_{5/2}$	16534007	16533629				16528495	16530354
54	$2s^2\,2p^2(^1D)\,3p\ ^2P^o_{1/2}$	16540565	16540124			16619868	16535573	16537172
55	$2s^2\,2p^2(^1D)\,3p\ ^2F^o_{7/2}$	16544294	16543945			16615605	16538676	16540591

Table 2. (*continued*)

Key	Level	MCDF[a]	MBPT[a]	NIST[b]	MCDF2[c]	SS[d]	GRASP[e]	FAC[e]
56	$2s^2\,2p^2(^3P)\,3d\ ^4P_{1/2}$	16550017	16549017			16640652	16547556	16548421
57	$2s^2\,2p^2(^3P)\,3d\ ^2D_{5/2}$	16579964	16578678			16676533	16580556	16580840
58	$2s^2\,2p^2(^1D)\,3d\ ^2G_{7/2}$	16589308	16587981			16682208	16589486	16589606
59	$2s^2\,2p^2(^3P)\,3d\ ^2D_{3/2}$	16597121	16595857			16689224	16596394	16597042
60	$2s^2\,2p^2(^3P)\,3d\ ^2P_{1/2}$	16602427	16601376			16692711	16599024	16600297
61	$2s^2\,2p^2(^1S)\,3p\ ^2P^o_{1/2}$	16680524	16680125			16780066	16674021	16675819
62	$2s\,2p^3(^5S)\,3p\ ^6P_{3/2}$	16683909	16684642				16669081	16677880
63	$2s^2\,2p^2(^1D)\,3p\ ^2P^o_{3/2}$	16693851	16693427			16882362	16689682	16693945
64	$2s\,2p^3(^5S)\,3p\ ^6P_{5/2}$	16696477	16697124				16682410	16691255
65	$2s\,2p^3(^3D)\,3s\ ^4D^o_{1/2}$	16736107	16736446				16734623	16739781
66	$2s\,2p^3(^3D)\,3s\ ^4D^o_{3/2}$	16764391	16764342				16764588	16769814
67	$2s^2\,2p^2(^1S)\,3p\ ^2P^o_{3/2}$	16781017	16780660				16774548	16776684
68	$2s\,2p^3(^5S)\,3p\ ^6P_{7/2}$	16802491	16803274				16787000	16795532
69	$2s\,2p^3(^3D)\,3s\ ^4D^o_{5/2}$	16842168	16842728				16835411	16840982
70	$2s\,2p^3(^5S)\,3p\ ^4P_{3/2}$	16862522	16862903				16851438	16860003
71	$2s\,2p^3(^5S)\,3p\ ^4P_{5/2}$	16897386	16897670				16886444	16895684
72	$2s\,2p^3(^5S)\,3p\ ^4P_{1/2}$	16909074	16909249				16898698	16907482
73	$2s^2\,2p^2(^3P)\,3d\ ^4D_{7/2}$	16924470	16923412				16920415	16920972
74	$2s\,2p^3(^3D)\,3s\ ^2D^o_{3/2}$	16924629	16924714				16922961	16929159
75	$2s^2\,2p^2(^1D)\,3d\ ^2G_{9/2}$	16942716	16941548			17015716	16938970	16939176
76	$2s^2\,2p^2(^1D)\,3d\ ^2D_{3/2}$	16951949	16950910			17285306	16948639	16950050
77	$2s^2\,2p^2(^1D)\,3d\ ^2P_{1/2}$	16954833	16953867			17027366	16951395	16952568
78	$2s^2\,2p^2(^1D)\,3d\ ^2F_{5/2}$	16955039	16953973			17153230	16952197	16953294
79	$2s\,2p^3(^3D)\,3s\ ^4D^o_{7/2}$	16967714	16968150				16962761	16968106
80	$2^2\,2p^2(^3P)\,3d\ ^2F_{7/2}$	16986128	16984792			16997364	16985973	16986692
81	$2^2\,2p^2(^1D)\,3d\ ^2S_{1/2}$	17024103	17023205				17017614	17023578
82	$2s\,2p^3(^3D)\,3p\ ^4F_{3/2}$	17048501	17048380				17041295	17049926
83	$2s\,2p^3(^3D)\,3p\ ^4D_{1/2}$	17048565	17048469				17051751	17052323
84	$2s\,2p^3(^3D)\,3s\ ^2D^o_{5/2}$	17051648	17051702				17051145	17056946
85	$2s^2\,2p^2(^1D)\,3d\ ^2P_{3/2}$	17062618	17061861				17065175	17062819
86	$2s^2\,2p^2(^3P)\,3d\ ^2F_{5/2}$	17075517	17074206				17074472	17074849
87	$2s\,2p^3(^5S)\,3d\ ^6D^o_{5/2}$	17152355	17153267				17137919	17145667
88	$2s\,2p^3(^3P)\,3s\ ^4P^o_{1/2}$	17152727	17153363				17147462	17151143
89	$2s\,2p^3(^3D)\,3p\ ^4D_{3/2}$	17153250	17153627				17147048	17152987
90	$2s\,2p^3(^5S)\,3d\ ^6D^o_{3/2}$	17154411	17155354				17139410	17147245
91	$2s\,2p^3(^5S)\,3d\ ^6D^o_{1/2}$	17154727	17155659				17139294	17146998
92	$2s\,2p^3(^5S)\,3d\ ^6D^o_{7/2}$	17154880	17155773				17140624	17148480
93	$2s\,2p^3(^3D)\,3p\ ^4F_{5/2}$	17169552	17169701				17163849	17170286
94	$2s\,2p^3(^5S)\,3d\ ^6D^o_{9/2}$	17172509	17173418				17157659	17165882
95	$2s^2\,2p^2(^1S)\,3d\ ^2D_{5/2}$	17186881	17186214			17286228	17183232	17181916
96	$2s^2\,2p^2(^1S)\,3d\ ^2D_{3/2}$	17188233	17187413				17183954	17183474
97	$2s\,2p^3(^3P)\,3s\ ^4P^o_{3/2}$	17204277	17204713				17201550	17205827
98	$2s\,2p^3(^3D)\,3p\ ^4D_{5/2}$	17222964	17223037				17221103	17226947
99	$2s\,2p^3(^3D)\,3p\ ^4S_{3/2}$	17224468	17224489				17225205	17230261
100	$2s\,2p^3(^3D)\,3p\ ^4P_{1/2}$	17247676	17247652				17249356	17254614
101	$2s\,2p^3(^3P)\,3s\ ^2P^o_{1/2}$	17248214	17248398				17249000	17253677
102	$2s\,2p^3(^1D)\,3s\ ^2D^o_{5/2}$	17273522	17273836				17271870	17277862
103	$2s\,2p^3(^3D)\,3p\ ^4F_{7/2}$	17287293	17287613				17281906	17287782
104	$2s\,2p^3(^5S)\,3d\ ^4D^o_{5/2}$	17292098	17292532				17286219	17291626
105	$2s\,2p^3(^1D)\,3s\ ^2D^o_{3/2}$	17294097	17294281				17306506	17300924
106	$2s\,2p^3(^3D)\,3p\ ^2F_{5/2}$	17295465	17295781				17289453	17295937
107	$2s\,2p^3(^5S)\,3d\ ^4D^o_{3/2}$	17310808	17311199				17294548	17311093
108	$2s\,2p^3(^3D)\,3p\ ^2F_{7/2}$	17312910	17313138				17308564	17314863
109	$2s\,2p^3(^5S)\,3d\ ^4D^o_{7/2}$	17340067	17340387				17332738	17339174
110	$2s\,2p^3(^3D)\,3p\ ^2P_{1/2}$	17346213	17346281				17344055	17349707
111	$2s\,2p^3(^3S)\,3s\ ^4S^o_{3/2}$	17348663	17348986				17352864	17356323
112	$2s\,2p^3(^5S)\,3d\ ^4D^o_{1/2}$	17357337	17357676				17348845	17355747

Table 2. (*continued*)

Key	Level	MCDF[a]	MBPT[a]	NIST[b]	MCDF2[c]	SS[d]	GRASP[e]	FAC[e]
113	$2s\,2p^3(^3S)\,3s\ ^2S^o_{1/2}$	17398324	17398448				17404119	17407956
114	$2s\,2p^3(^3D)\,3p\ ^2D_{3/2}$	17407668	17407621				17405746	17411823
115	$2s\,2p^3(^3D)\,3p\ ^4P_{5/2}$	17408606	17408265				17412293	17418798
116	$2s\,2p^3(^3D)\,3p\ ^4F_{9/2}$	17420779	17420990				17416918	17422532
117	$2s\,2p^3(^3D)\,3p\ ^4D_{7/2}$	17426675	17426894				17422527	17428476
118	$2s\,2p^3(^3D)\,3p\ ^2P_{3/2}$	17458182	17458193				17457149	17462397
119	$2s\,2p^3(^3P)\,3p\ ^4D_{1/2}$	17474666	17475040				17471053	17475095
120	$2s\,2p^3(^3P)\,3p\ ^4D_{3/2}$	17528833	17529058				17527984	17532392
121	$2s\,2p^3(^3D)\,3d\ ^4F^o_{3/2}$	17530796	17531145				17530835	17534550
122	$2s\,2p^3(^3D)\,3d\ ^4G^o_{5/2}$	17536181	17536440				17537901	17540455
123	$2s\,2p^3(^3D)\,3p\ ^2D_{5/2}$	17539912	17539750				17540333	17546268
124	$2s\,2p^3(^3S)\,3p\ ^4P_{1/2}$	17553261	17553297				17556498	17560724
125	$2s\,2p^3(^3D)\,3d\ ^4D^o_{1/2}$	17575226	17575507				17576560	17579797
126	$2s\,2p^3(^3D)\,3d\ ^4G^o_{7/2}$	17578415	17578659				17579294	17582790
127	$2s\,2p^3(^1D)\,3p\ ^2F_{5/2}$	17582581	17582691				17585005	17589246
128	$2s\,2p^3(^3D)\,3d\ ^4F^o_{5/2}$	17604056	17604352				17604460	17608646
129	$2s\,2p^3(^3P)\,3s\ ^4P^o_{5/2}$	17620074	17620451				17621567	17625110
130	$2s\,2p^3(^3P)\,3p\ ^4P_{3/2}$	17623607	17623773				17622514	17626658
131	$2s\,2p^3(^3P)\,3p\ ^2P_{3/2}$	17628426	17628650				17629749	17633648
132	$2s\,2p^3(^3D)\,3d\ ^4D^o_{3/2}$	17640120	17640421				17639561	17643910
133	$2s\,2p^3(^3S)\,3p\ ^4P_{5/2}$	17652250	17652459				17652428	17656973
134	$2s\,2p^3(^3P)\,3p\ ^2P_{1/2}$	17658749	17658972				17658607	17663221
135	$2s\,2p^3(^3D)\,3d\ ^4F^o_{7/2}$	17660217	17660693				17656657	17662730
136	$2s\,2p^3(^3D)\,3d\ ^4D^o_{5/2}$	17662269	17662761				17658669	17666810
137	$2s\,2p^3(^3D)\,3d\ ^2P^o_{3/2}$	17662656	17662962				17662366	17661228
138	$2s\,2p^3(^3D)\,3d\ ^2S^o_{1/2}$	17671468	17671962				17667504	17672137
139	$2s\,2p^3(^3D)\,3d\ ^4G^o_{9/2}$	17673844	17674258				17669544	17673688
140	$2s\,2p^3(^3P)\,3s\ ^4P^o_{3/2}$	17675659	17675837				17678227	17681880
141	$2s\,2p^3(^3P)\,3p\ ^2D_{3/2}$	17679984	17680112				17679760	17684552
142	$2s\,2p^3(^1D)\,3p\ ^2F_{7/2}$	17703338	17703539				17714528	17718727
143	$2s\,2p^3(^3D)\,3d\ ^2G^o_{7/2}$	17716076	17716249				17704191	17708589
144	$2s\,2p^3(^3S)\,3p\ ^4P_{3/2}$	17724673	17724394				17734255	17738743
145	$2s\,2p^3(^1P)\,3p\ ^2P_{1/2}$	17731772	17731577				17739132	17742541
146	$2s\,2p^3(^1D)\,3p\ ^2D_{5/2}$	17755972	17755936				17760848	17765075
147	$2s\,2p^3(^1D)\,3p\ ^2P_{1/2}$	17771065	17771075				17775274	17779241
148	$2s\,2p^3(^3D)\,3d\ ^4F^o_{9/2}$	17771890	17772269				17768982	17773230
149	$2s\,2p^3(^1D)\,3p\ ^2D_{3/2}$	17784294	17784180				17789219	17793806
150	$2s\,2p^3(^3D)\,3d\ ^4P^o_{5/2}$	17785390	17785644				17782839	17787144
151	$2s\,2p^3(^3D)\,3d\ ^2P^o_{1/2}$	17791584	17791789				17790673	17794722
152	$2s\,2p^3(^3D)\,3d\ ^4G^o_{11/2}$	17794127	17794389				17791962	17795473
153	$2s\,2p^3(^1P)\,3p\ ^2D_{5/2}$	17798574	17798689				17804420	17807413
154	$2s\,2p^3(^3D)\,3d\ ^4D^o_{7/2}$	17809080	17809430				17808303	17812257
155	$2s\,2p^3(^3D)\,3d\ ^2D^o_{3/2}$	17816133	17816267				17815919	17819934
156	$2s\,2p^3(^3D)\,3d\ ^2G^o_{9/2}$	17826393	17826484				17826151	17829953
157	$2s\,2p^3(^3D)\,3d\ ^2D^o_{5/2}$	17833835	17834230				17831916	17836217
158	$2s\,2p^3(^3D)\,3d\ ^4P^o_{3/2}$	17855855	17856200				17854303	17858819
159	$2s\,2p^3(^3S)\,3p\ ^2P_{1/2}$	17867536	17867161				17879275	17882370
160	$2s\,2p^3(^3S)\,3p\ ^2P_{3/2}$	17870347	17870202				17879252	17882388
161	$2s\,2p^3(^3D)\,3d\ ^4P^o_{1/2}$	17872871	17873138				17872145	17876356
162	$2s\,2p^3(^1P)\,3s\ ^2P^o_{3/2}$	17897395	17897550				17902672	17905746
163	$2s\,2p^3(^1P)\,3s\ ^2P^o_{1/2}$	17905201	17905293				17911147	17914027
164	$2s\,2p^3(^3D)\,3d\ ^4S^o_{3/2}$	17924709	17924779				17926071	17929639
165	$2s\,2p^3(^3D)\,3d\ ^2F^o_{7/2}$	17936758	17936685				17939421	17942483
166	$2s\,2p^3(^3D)\,3d\ ^2F^o_{5/2}$	17945516	17945539				17947498	17950619
167	$2s\,2p^3(^3P)\,3d\ ^4F^o_{3/2}$	17968797	17969262				17967372	17969308
168	$2s\,2p^3(^3P)\,3d\ ^4F^o_{5/2}$	17995323	17995747				17994008	17996145

Table 2. (*continued*)

Key	Level	MCDF[a]	MBPT[a]	NIST[b]	MCDF2[c]	SS[d]	GRASP[e]	FAC[e]
169	$2s\,2p^3(^1D)\,3p\ ^2P_{3/2}$	18007315	18007144				18015538	18019546
170	$2s\,2p^3(^3P)\,3p\ ^2D_{5/2}$	18013008	18012782				18018268	18022906
171	$2s\,2p^3(^3S)\,3d\ ^4D^o_{1/2}$	18021092	18021415				18024211	18026705
172	$2s\,2p^3(^3P)\,3d\ ^4F^o_{7/2}$	18025776	18026112				18026412	18028570
173	$2s\,2p^3(^3P)\,3d\ ^4P^o_{5/2}$	18037071	18037384				18038049	18040143
174	$2s\,2p^3(^3P)\,3d\ ^4D^o_{3/2}$	18048181	18048432				18052247	18054260
175	$2s\,2p^3(^3P)\,3p\ ^4D_{7/2}$	18064639	18064838				18067255	18070676
176	$2s\,2p^3(^3P)\,3d\ ^2D^o_{3/2}$	18068033	18068277				18071260	18073489
177	$2s\,2p^3(^3P)\,3d\ ^2F^o_{5/2}$	18076092	18076306				18079526	18081248
178	$2s\,2p^3(^1D)\,3d\ ^2F^o_{7/2}$	18080271	18080406				18086486	18088037
179	$2s\,2p^3(^3D)\,3p\ ^4P_{3/2}$	18092136	18092235				18096781	18100398
180	$2s\,2p^3(^1D)\,3d\ ^2G^o_{9/2}$	18092260	18092439				18095468	18097441
181	$2s\,2p^3(^3P)\,3p\ ^4P_{5/2}$	18101579	18101586				18107159	18110791
182	$2s\,2p^3(^3P)\,3d\ ^4D^o_{5/2}$	18121862	18122004				18126928	18128730
183	$2s\,2p^3(^1D)\,3d\ ^2P^o_{3/2}$	18137255	18137465				18140324	18142963
184	$2s\,2p^3(^1D)\,3d\ ^2G^o_{7/2}$	18138973	18139016				18146947	18147824
185	$2s\,2p^3(^3P)\,3d\ ^4P^o_{1/2}$	18140077	18140428				18141226	18144490
186	$2s\,2p^3(^3P)\,3p\ ^2S_{1/2}$	18156337	18156220				18161982	18165120
187	$2s\,2p^3(^3S)\,3d\ ^4D^o_{5/2}$	18168108	18168255				18178918	18178816
188	$2s\,2p^3(^1D)\,3d\ ^2P^o_{1/2}$	18171074	18171322				18176086	18178133
189	$2s\,2p^3(^3S)\,3d\ ^4D^o_{3/2}$	18184130	18184303				18194550	18194466
190	$2s\,2p^3(^1D)\,3d\ ^2F^o_{5/2}$	18188222	18188160				18198656	18198923
191	$2s\,2p^3(^3S)\,3d\ ^4D^o_{7/2}$	18191206	18191341				18201154	18201034
192	$2s\,2p^3(^3P)\,3d\ ^4D^o_{1/2}$	18203441	18203638				18214042	18213589
193	$2s\,2p^3(^3P)\,3d\ ^2P^o_{3/2}$	18222365	18222425				18230142	18230548
194	$2s\,2p^3(^3S)\,3d\ ^2D^o_{3/2}$	18247865	18247621				18262932	18262439
195	$2s\,2p^3(^1P)\,3p\ ^2S_{1/2}$	18263044	18262782				18274592	18277172
196	$2s\,2p^3(^1P)\,3p\ ^2D_{3/2}$	18271006	18270707				18282443	18285759
197	$2p^4(^3P)\,3s\ ^4P_{5/2}$	18282909	18283511				18291307	18299690
198	$2s\,2p^3(^3S)\,3d\ ^2D^o_{5/2}$	18290148	18289966				18304567	18303560
199	$2s\,2p^3(^3P)\,3p\ ^4D_{5/2}$	18341504	18341551				18351804	18373193
200	$2p^4(^3P)\,3s\ ^2P_{3/2}$	18341567	18341599				18350175	18357211
201	$2s\,2p^3(^1P)\,3p\ ^2P_{3/2}$	18354774	18354903				18369978	18355162
202	$2s\,2p^3(^3P)\,3d\ ^4F^o_{9/2}$	18439511	18439709				18445705	18446001
203	$2s\,2p^3(^1S)\,3p\ ^2S_{1/2}$	18449755	18449335				18464528	18468325
204	$2s\,2p^3(^1D)\,3d\ ^2S^o_{1/2}$	18470799	18471213				18476674	18478759
205	$2s\,2p^3(^1D)\,3d\ ^2D^o_{3/2}$	18474400	18474638				18480900	18482839
206	$2s\,2p^3(^1D)\,3d\ ^2D^o_{5/2}$	18482658	18482754				18491278	18492181
207	$2s\,2p^3(^3P)\,3d\ ^4D^o_{7/2}$	18484795	18484913				18490955	18491488
208	$2s\,2p^3(^3P)\,3d\ ^2F^o_{7/2}$	18493464	18493472				18501055	18502174
209	$2s\,2p^3(^3P)\,3d\ ^2D^o_{5/2}$	18502364	18502456				18510190	18511223
210	$2p^4(^3P)\,3s\ ^4P_{1/2}$	18516512	18516836				18532990	18539156
211	$2s\,2p^3(^1P)\,3d\ ^2D^o_{3/2}$	18553425	18553469				18560746	18561451
212	$2p^4(^3P)\,3p\ ^4P^o_{3/2}$	18590193	18591185				18602124	18611531
213	$2p^4(^3P)\,3p\ ^4D^o_{5/2}$	18604725	18605651				18616985	18626719
214	$2s\,2p^3(^3P)\,3d\ ^2P^o_{1/2}$	18621242	18621229				18629258	18629857
215	$2p^4(^3P)\,3p\ ^4D^o_{7/2}$	18707294	18707925				18715203	18721555
216	$2p^4(^3P)\,3p\ ^2P^o_{1/2}$	18710578	18711520				18722306	18731059
217	$2p^4(^3P)\,3p\ ^4P^o_{5/2}$	18713477	18714423				18723311	18732622
218	$2p^4(^3P)\,3s\ ^4P_{3/2}$	18732876	18733587				18742184	18751010
219	$2s\,2p^3(^1P)\,3d\ ^2P^o_{1/2}$	18737959	18737961				18752600	18751179
220	$2s\,2p^3(^1P)\,3d\ ^2F^o_{7/2}$	18738434	18738788				18753613	18751893
221	$2s\,2p^3(^1P)\,3d\ ^2D^o_{5/2}$	18738900	18738924				18751668	18754803
222	$2s\,2p^3(^1P)\,3d\ ^2P^o_{3/2}$	18743383	18743438				18755651	18755473
223	$2s\,2p^3(^1P)\,3d\ ^2F^o_{5/2}$	18755040	18754883				18770909	18769838

Table 2. (*continued*)

Key	Level	MCDF[a]	MBPT[a]	NIST[b]	MCDF2[c]	SS[d]	GRASP[e]	FAC[e]
224	$2p^4(^3P)\,3s\ ^2P_{1/2}$	18778068	18778346				18791637	18798991
225	$2p^4(^3P)\,3p\ ^4D^o_{1/2}$	18814140	18814933				18830308	18838387
226	$2s\,2p^3(^3P)\,3d\ ^2D^o_{3/2}$	18832433	18832221				18848612	18848431
227	$2p^4(^1D)\,3s\ ^2D_{5/2}$	18839323	18839698				18854838	18862655
228	$2p^4(^1D)\,3s\ ^2D_{3/2}$	18854638	18854878				18871186	18878508
229	$2p^4(^3P)\,3p\ ^4S^o_{3/2}$	18858879	18859114				18879748	18886258
230	$2p^4(^3P)\,3p\ ^4D^o_{3/2}$	18941761	18942643				18956916	18964998
231	$2p^4(^3P)\,3p\ ^4P^o_{1/2}$	19016399	19017581				19025158	19034304
232	$2p^4(^3P)\,3d\ ^4D_{5/2}$	19053993	19054642				19066630	19073560
233	$2p^4(^3P)\,3p\ ^2P^o_{3/2}$	19056056	19056999				19068097	19076825
234	$2p^4(^3P)\,3d\ ^4D_{3/2}$	19057530	19058212				19070544	19077438
235	$2p^4(^3P)\,3d\ ^4D_{7/2}$	19065664	19066223				19078261	19085192
236	$2p^4(^3P)\,3d\ ^4P_{1/2}$	19073011	19073690				19086493	19093482
237	$2p^4(^3P)\,3d\ ^4F_{9/2}$	19093691	19094022				19107264	19113834
238	$2p^4(^3P)\,3d\ ^2F_{7/2}$	19096148	19096385				19111567	19117524
239	$2p^4(^1D)\,3p\ ^2F^o_{5/2}$	19132495	19133226				19148577	19157013
240	$2p^4(^3P)\,3p\ ^2D^o_{5/2}$	19149800	19150971				19158661	19167792
241	$2p^4(^3P)\,3d\ ^2P_{1/2}$	19153784	19154330				19168187	19174973
242	$2p^4(^3P)\,3p\ ^2S^o_{1/2}$	19177060	19178039				19187753	19196519
243	$2p^4(^1D)\,3p\ ^2D^o_{3/2}$	19182707	19183641				19193411	19202845
244	$2p^4(^3P)\,3d\ ^4P_{3/2}$	19195446	19195762				19213049	19219120
245	$2p^4(^3P)\,3d\ ^2D_{5/2}$	19220211	19220276				19239064	19244304
246	$2p^4(^1D)\,3p\ ^2F^o_{7/2}$	19250954	19251734				19266236	19274398
247	$2p^4(^1D)\,3p\ ^2P^o_{3/2}$	19260143	19260563				19278073	19285840
248	$2p^4(^1D)\,3p\ ^2D^o_{3/2}$	19275183	19274946				19304327	19309774
249	$2p^4(^3P)\,3d\ ^4F_{3/2}$	19293237	19293536				19312196	19316102
250	$2p^4(^1D)\,3p\ ^2D^o_{5/2}$	19294327	19294887				19311364	19319680
251	$2p^4(^3P)\,3d\ ^4F_{5/2}$	19329100	19329455				19347166	19351741
252	$2p^4(^1D)\,3s\ ^2P_{1/2}$	19407462	19407965				19422042	19428421
253	$2p^4(^1D)\,3p\ ^2P^o_{1/2}$	19431789	19431481				19459999	19465061
254	$2p^4(^3P)\,3d\ ^4D_{1/2}$	19471691	19472523				19482218	19489224
255	$2p^4(^3P)\,3d\ ^2P_{3/2}$	19508718	19509377				19520459	19526931
256	$2p^4(^3P)\,3d\ ^4F_{7/2}$	19522175	19522721				19533085	19538878
257	$2p^4(^3P)\,3d\ ^4P_{5/2}$	19551396	19551788				19565666	19571161
258	$2p^4(^3P)\,3d\ ^2F_{5/2}$	19568656	19569034				19581969	19587242
259	$2p^4(^3P)\,3d\ ^2D_{3/2}$	19579391	19579883				19593217	19598789
260	$2p^4(^1D)\,3d\ ^2G_{7/2}$	19593878	19593903				19611736	19616627
261	$2p^4(^1D)\,3d\ ^2G_{9/2}$	19618885	19618893				19635977	19640449
262	$2p^4(^1D)\,3d\ ^2D_{5/2}$	19655145	19655304				19672781	19678868
263	$2p^4(^1D)\,3d\ ^2S_{1/2}$	19658208	19658770				19672395	19677614
264	$2p^4(^1D)\,3d\ ^2F_{7/2}$	19678734	19678700				19697222	19701401
265	$2p^4(^1D)\,3d\ ^2P_{3/2}$	19686722	19686681				19710245	19714249
266	$2p^4(^1D)\,3d\ ^2F_{5/2}$	19690964	19690805				19714925	19717994
267	$2p^4(^1D)\,3d\ ^2D_{3/2}$	19769191	19768921				19794441	19796817
268	$2p^4(^1S)\,3p\ ^2P^o_{1/2}$	19772450	19772708				19795940	19801984
269	$2p^4(^3P)\,3d\ ^4P_{1/2}$	19800122	19799786				19827641	19830152
270	$2p^4(^1S)\,3p\ ^2P^o_{3/2}$	19834488	19835347				19850041	19856777
271	$2p^4(^1S)\,3d\ ^2D_{5/2}$	20216178	20216515				20233893	20236330
272	$2p^4(^1S)\,3d\ ^2D_{3/2}$	20242101	20242217				20265348	20267818

Table 3. Wavelength (λ, in Å), line strength (S, in a.u.), oscillator strength (f, dimensionless) and radiative rate (A, in s^{-1}) from the present MCDF calculations for the E1, M1, E2 and M2 transitions in Kr XXX, together with the present MBPT results.

i	j	λ_{MCDF}	λ_{MBPT}	Type	S_{MCDF}	f_{MCDF}	A_{MCDF}	S_{MBPT}	f_{MBPT}	A_{MBPT}
2	1	2.5962E+02	2.5967E+02	M1	3.134E+00	4.881E-05	1.208E+06	3.137E+00	4.885E-05	1.208E+06
2	1	2.5962E+02	2.5967E+02	E2	2.944E-04	2.825E-09	6.990E+01	2.951E-04	2.830E-09	6.999E+01
3	1	2.0512E+02	2.0510E+02	M1	4.174E-01	8.230E-06	2.175E+05	4.176E-01	8.234E-06	2.176E+05
3	1	2.0512E+02	2.0510E+02	E2	8.495E-04	1.653E-08	4.367E+02	8.503E-04	1.655E-08	4.373E+02
3	2	9.7707E+02	9.7600E+02	M1	1.279E+00	5.292E-06	6.163E+03	1.280E+00	5.305E-06	6.191E+03
3	2	9.7707E+02	9.7600E+02	E2	1.307E-04	2.352E-11	2.739E-02	1.312E-04	2.369E-11	2.765E-02
4	1	1.6084E+02	1.6083E+02	M1	4.612E-01	1.159E-05	1.495E+06	4.615E-01	1.160E-05	1.496E+06
4	1	1.6084E+02	1.6083E+02	E2	1.867E-04	7.535E-09	9.714E+02	1.869E-04	7.542E-09	9.724E+02
4	2	4.2274E+02	4.2253E+02	M1	7.139E-02	6.829E-07	1.275E+04	7.169E-02	6.861E-07	1.282E+04
4	2	4.2274E+02	4.2253E+02	E2	5.801E-04	1.289E-09	2.406E+01	5.814E-04	1.294E-09	2.417E+01
4	3	7.4514E+02	7.4509E+02	E2	7.266E-04	2.949E-10	1.771E+00	7.279E-04	2.955E-10	1.775E+00
5	1	1.0039E+02	1.0040E+02	M1	1.473E-02	5.934E-07	9.819E+04	1.485E-02	5.982E-07	9.897E+04
5	1	1.0039E+02	1.0040E+02	E2	5.664E-10	9.400E-14	1.556E-02	1.562E-10	2.591E-14	4.287E-03
5	2	1.6367E+02	1.6368E+02	M1	1.850E+00	4.571E-05	2.845E+06	1.852E+00	4.575E-05	2.847E+06
5	2	1.6367E+02	1.6368E+02	E2	1.930E-04	7.390E-09	4.600E+02	1.931E-04	7.394E-09	4.602E+02
5	3	1.9661E+02	1.9666E+02	M1	6.959E-01	1.431E-05	6.175E+05	6.971E-01	1.433E-05	6.181E+05
5	3	1.9661E+02	1.9666E+02	E2	1.438E-03	3.177E-08	1.371E+03	1.441E-03	3.182E-08	1.372E+03
5	4	2.6708E+02	2.6718E+02	M1	7.875E-01	1.192E-05	2.788E+05	7.887E-01	1.194E-05	2.789E+05
5	4	2.6708E+02	2.6718E+02	E2	2.935E-04	2.587E-09	6.048E+01	2.941E-04	2.589E-09	6.048E+01
6	1	7.1859E+01	7.1877E+01	E1	2.378E-02	1.005E-01	2.164E+10	2.386E-02	1.008E-01	2.169E+10
6	1	7.1859E+01	7.1877E+01	M2	1.105E+00	6.659E-09	1.434E+03	1.106E+00	6.655E-09	1.432E+03
6	2	9.9361E+01	9.9389E+01	E1	1.779E-02	5.440E-02	6.126E+09	1.782E-02	5.447E-02	6.130E+09
6	2	9.9361E+01	9.9389E+01	M2	1.942E-02	4.425E-11	4.983E+00	1.958E-02	4.458E-11	5.017E+00
6	3	1.1061E+02	1.1066E+02	E1	7.164E-03	1.967E-02	1.788E+09	7.170E-03	1.968E-02	1.787E+09
6	3	1.1061E+02	1.1066E+02	M2	5.495E-02	9.077E-11	8.248E+00	5.515E-02	9.097E-11	8.259E+00
6	4	1.2989E+02	1.2996E+02	M2	2.648E-02	2.701E-11	1.780E+00	2.655E-02	2.704E-11	1.780E+00
6	5	2.5287E+02	2.5304E+02	E1	4.453E-04	5.349E-04	9.299E+06	4.471E-04	5.367E-04	9.318E+06
6	5	2.5287E+02	2.5304E+02	M2	4.426E-02	6.118E-12	1.064E-01	4.433E-02	6.117E-12	1.062E-01
7	1	6.0691E+01	6.0701E+01	E1	3.785E-02	1.894E-01	8.577E+10	3.791E-02	1.897E-01	8.586E+10
7	1	6.0691E+01	6.0701E+01	M2	5.297E-02	5.296E-10	2.398E+02	5.283E-02	5.280E-10	2.390E+02
7	2	7.9206E+01	7.9219E+01	E1	2.699E-05	1.035E-04	2.751E+07	2.575E-05	9.872E-05	2.623E+07
7	2	7.9206E+01	7.9219E+01	M2	3.172E-01	1.427E-09	3.792E+02	3.178E-01	1.429E-09	3.797E+02
7	3	8.6194E+01	8.6217E+01	E1	3.594E-03	1.266E-02	2.843E+09	3.593E-03	1.266E-02	2.840E+09
7	3	8.6194E+01	8.6217E+01	M2	4.382E-02	1.530E-10	3.433E+01	4.407E-02	1.537E-10	3.448E+01
7	4	9.7468E+01	9.7499E+01	E1	2.088E-04	6.506E-04	1.142E+08	2.086E-04	6.499E-04	1.140E+08
7	4	9.7468E+01	9.7499E+01	M2	9.969E-02	2.406E-10	4.224E+01	9.996E-02	2.411E-10	4.229E+01
7	5	1.5348E+02	1.5352E+02	E1	2.932E-03	5.803E-03	4.108E+08	2.942E-03	5.820E-03	4.118E+08
7	5	1.5348E+02	1.5352E+02	M2	3.684E-04	2.278E-13	1.612E-02	3.615E-04	2.233E-13	1.580E-02
7	6	3.9048E+02	3.9037E+02	M1	2.951E+00	3.056E-05	3.342E+05	2.956E+00	3.062E-05	3.351E+05
7	6	3.9048E+02	3.9037E+02	E2	3.292E-04	9.283E-10	1.015E+01	3.308E-04	9.337E-10	1.022E+01
8	1	6.0289E+01	6.0297E+01	E1	1.532E-02	7.717E-02	7.080E+10	1.535E-02	7.735E-02	7.095E+10
8	1	6.0289E+01	6.0297E+01	M2	1.532E-01	1.563E-09	1.434E+03	1.532E-01	1.562E-09	1.433E+03
8	2	7.8524E+01	7.8533E+01	E1	1.082E-03	4.187E-03	2.265E+09	1.085E-03	4.198E-03	2.270E+09
8	2	7.8524E+01	7.8533E+01	M2	5.056E-02	2.334E-10	1.262E+02	5.072E-02	2.341E-10	1.266E+02
8	3	8.5386E+01	8.5405E+01	M2	1.512E-02	5.429E-11	2.484E+01	1.516E-02	5.440E-11	2.488E+01
8	4	9.6437E+01	9.6462E+01	E1	4.781E-03	1.506E-02	5.401E+09	4.784E-03	1.506E-02	5.400E+09
8	5	1.5094E+02	1.5097E+02	E1	2.826E-04	5.687E-04	8.326E+07	2.829E-04	5.693E-04	8.331E+07
8	5	1.5094E+02	1.5097E+02	M2	4.213E-02	2.738E-11	4.009E+00	4.227E-02	2.746E-11	4.018E+00
8	6	3.7444E+02	3.7425E+02	E2	6.462E-04	2.067E-09	4.916E+01	6.476E-04	2.074E-09	4.939E+01
8	7	9.1154E+03	9.0636E+03	M1	1.491E+00	6.614E-07	2.655E+01	1.496E+00	6.675E-07	2.710E+01
8	7	9.1154E+03	9.0636E+03	E2	1.864E-04	4.131E-14	1.658E-06	1.864E-04	4.203E-14	1.706E-06
9	1	5.1101E+01	5.1105E+01	E1	5.620E-03	3.341E-02	2.133E+10	5.641E-03	3.353E-02	2.141E+10
9	1	5.1101E+01	5.1105E+01	M2	1.179E-01	1.975E-09	1.261E+03	1.182E-01	1.980E-09	1.264E+03
9	2	6.3625E+01	6.3628E+01	E1	4.755E-02	2.270E-01	9.352E+10	4.768E-02	2.276E-01	9.376E+10
9	2	6.3625E+01	6.3628E+01	M2	1.035E-01	8.984E-10	3.701E+02	1.031E-01	8.949E-10	3.686E+02
9	3	6.8056E+01	6.8065E+01	E1	2.640E-03	1.178E-02	4.242E+09	2.651E-03	1.183E-02	4.259E+09
9	3	6.8056E+01	6.8065E+01	M2	3.173E-01	2.250E-09	8.102E+02	3.173E-01	2.249E-09	8.097E+02
9	4	7.4897E+01	7.4908E+01	E1	1.882E-03	7.634E-03	2.269E+09	1.887E-03	7.654E-03	2.275E+09
9	4	7.4897E+01	7.4908E+01	M2	1.503E-01	7.999E-10	2.378E+02	1.502E-01	7.989E-10	2.374E+02
9	5	1.0409E+02	1.0409E+02	E1	2.369E-06	6.914E-06	1.064E+06	2.102E-06	6.134E-06	9.441E+05

Table 3. (*continued*)

i	j	λ_{MCDF}	λ_{MBPT}	Type	S_{MCDF}	f_{MCDF}	A_{MCDF}	S_{MBPT}	f_{MBPT}	A_{MBPT}
9	5	1.0409E+02	1.0409E+02	M2	8.551E-03	1.695E-11	2.609E+00	8.586E-03	1.702E-11	2.619E+00
9	6	1.7690E+02	1.7684E+02	M1	2.923E-01	6.682E-06	3.561E+05	2.915E-01	6.665E-06	3.554E+05
9	6	1.7690E+02	1.7684E+02	E2	3.730E-04	1.131E-08	6.029E+02	3.731E-04	1.133E-08	6.041E+02
9	7	3.2342E+02	3.2329E+02	M1	1.775E+00	2.219E-05	3.538E+05	1.773E+00	2.218E-05	3.538E+05
9	7	3.2342E+02	3.2329E+02	E2	3.224E-06	1.600E-11	2.551E-01	3.244E-06	1.612E-11	2.572E-01
9	8	3.3532E+02	3.3525E+02	M1	6.959E-01	8.392E-06	1.245E+05	6.954E-01	8.389E-06	1.245E+05
9	8	3.3532E+02	3.3525E+02	E2	1.171E-04	5.214E-10	7.733E+00	1.173E-04	5.228E-10	7.757E+00
10	1	4.8217E+01	4.8220E+01	E1	1.410E-05	8.884E-05	4.248E+07	1.416E-05	8.918E-05	4.264E+07
10	1	4.8217E+01	4.8220E+01	M2	2.857E-02	5.698E-10	2.725E+02	2.863E-02	5.708E-10	2.729E+02
10	2	5.9214E+01	5.9217E+01	E1	8.613E-04	4.418E-03	1.401E+09	8.622E-04	4.423E-03	1.402E+09
10	2	5.9214E+01	5.9217E+01	M2	2.552E-01	2.748E-09	8.712E+02	2.555E-01	2.750E-09	8.719E+02
10	3	6.3034E+01	6.3042E+01	E1	5.629E-02	2.713E-01	7.590E+10	5.644E-02	2.719E-01	7.607E+10
10	3	6.3034E+01	6.3042E+01	M2	8.179E-01	7.299E-09	2.042E+03	8.181E-01	7.299E-09	2.042E+03
10	4	6.8859E+01	6.8869E+01	M2	3.689E-01	2.525E-09	5.920E+02	3.690E-01	2.525E-09	5.919E+02
10	5	9.2781E+01	9.2785E+01	E1	2.119E-02	6.938E-02	8.960E+09	2.124E-02	6.952E-02	8.977E+09
10	5	9.2781E+01	9.2785E+01	M2	9.357E-05	2.619E-13	3.382E-02	9.253E-05	2.589E-13	3.344E-02
10	6	1.4655E+02	1.4651E+02	M1	8.610E-01	2.376E-05	1.230E+06	8.603E-01	2.374E-05	1.230E+06
10	6	1.4655E+02	1.4651E+02	E2	4.548E-04	2.426E-08	1.256E+03	4.551E-04	2.430E-08	1.259E+03
10	7	2.3460E+02	2.3453E+02	M1	2.474E-03	4.265E-08	8.615E+02	2.430E-03	4.190E-08	8.468E+02
10	7	2.3460E+02	2.3453E+02	E2	2.901E-04	3.773E-09	7.620E+01	2.902E-04	3.778E-09	7.636E+01
10	8	2.4080E+02	2.4076E+02	E2	1.838E-04	2.210E-09	4.238E+01	1.839E-04	2.212E-09	4.243E+01
10	9	8.5425E+02	8.5418E+02	M1	2.069E+00	9.793E-06	1.492E+04	2.071E+00	9.805E-06	1.494E+04
10	9	8.5425E+02	8.5418E+02	E2	1.251E-04	3.368E-11	5.132E-02	1.257E-04	3.386E-11	5.159E-02
11	1	4.4816E+01	4.4817E+01	E1	1.309E-03	8.872E-03	1.473E+10	1.313E-03	8.899E-03	1.478E+10
11	1	4.4816E+01	4.4817E+01	M2	6.508E-02	1.616E-09	2.684E+03	6.528E-02	1.621E-09	2.692E+03
11	2	5.4166E+01	5.4166E+01	E1	2.025E-02	1.136E-01	1.291E+11	2.030E-02	1.138E-01	1.294E+11
11	2	5.4166E+01	5.4166E+01	M2	5.485E-02	7.715E-10	8.770E+02	5.480E-02	7.707E-10	8.761E+02
11	3	5.7345E+01	5.7349E+01	M2	6.715E-02	7.959E-10	8.072E+02	6.720E-02	7.964E-10	8.076E+02
11	4	6.2126E+01	6.2131E+01	E1	1.757E-02	8.593E-02	7.425E+10	1.762E-02	8.613E-02	7.442E+10
11	5	8.0959E+01	8.0958E+01	E1	3.899E-04	1.463E-03	7.445E+08	3.891E-04	1.460E-03	7.430E+08
11	5	8.0959E+01	8.0958E+01	M2	7.078E-02	2.982E-10	1.517E+02	7.083E-02	2.984E-10	1.518E+02
11	6	1.1908E+02	1.1905E+02	E2	5.454E-06	5.422E-10	1.275E+02	5.451E-06	5.425E-10	1.277E+02
11	7	1.7134E+02	1.7128E+02	M1	9.705E-01	2.291E-05	2.602E+06	9.709E-01	2.292E-05	2.606E+06
11	7	1.7134E+02	1.7128E+02	E2	9.638E-05	3.217E-09	3.655E+02	9.634E-05	3.219E-09	3.660E+02
11	8	1.7462E+02	1.7458E+02	M1	1.789E-01	4.142E-06	4.531E+05	1.787E-01	4.140E-06	4.530E+05
11	9	3.6436E+02	3.6426E+02	M1	2.329E-02	2.585E-07	6.495E+03	2.293E-02	2.546E-07	6.399E+03
11	9	3.6436E+02	3.6426E+02	E2	4.629E-04	1.607E-09	4.037E+01	4.646E-04	1.614E-09	4.057E+01
11	10	6.3536E+02	6.3510E+02	E2	6.004E-04	3.931E-10	3.247E+00	6.021E-04	3.946E-10	3.263E+00
12	1	4.3155E+01	4.3156E+01	E1	2.561E-03	1.803E-02	1.614E+10	2.564E-03	1.805E-02	1.616E+10
12	1	4.3155E+01	4.3156E+01	M2	6.467E-02	1.799E-09	1.610E+03	6.486E-02	1.804E-09	1.615E+03
12	2	5.1758E+01	5.1758E+01	E1	3.073E-04	1.803E-03	1.123E+09	3.087E-04	1.812E-03	1.128E+09
12	2	5.1758E+01	5.1758E+01	M2	2.057E-01	3.316E-09	2.064E+03	2.057E-01	3.316E-09	2.064E+03
12	3	5.4654E+01	5.4656E+01	E1	6.745E-02	3.749E-01	2.093E+11	6.762E-02	3.758E-01	2.098E+11
12	3	5.4654E+01	5.4656E+01	M2	1.936E-01	2.651E-09	1.480E+03	1.940E-01	2.656E-09	1.482E+03
12	4	5.8979E+01	5.8983E+01	E1	1.315E-02	6.771E-02	3.246E+10	1.317E-02	6.783E-02	3.251E+10
12	4	5.8979E+01	5.8983E+01	M2	1.190E-02	1.296E-10	6.213E+01	1.190E-02	1.296E-10	6.213E+01
12	5	7.5696E+01	7.5694E+01	E1	1.186E-02	4.758E-02	1.385E+10	1.188E-02	4.766E-02	1.387E+10
12	5	7.5696E+01	7.5694E+01	M2	5.617E-03	2.895E-11	8.425E+00	5.658E-03	2.916E-11	8.487E+00
12	6	1.0804E+02	1.0800E+02	M1	1.902E-01	7.118E-06	1.017E+06	1.902E-01	7.121E-06	1.018E+06
12	6	1.0804E+02	1.0800E+02	E2	1.245E-06	1.658E-10	2.368E+01	1.246E-06	1.661E-10	2.375E+01
12	7	1.4936E+02	1.4931E+02	M1	9.866E-02	2.671E-06	1.997E+05	9.855E-02	2.669E-06	1.997E+05
12	7	1.4936E+02	1.4931E+02	E2	2.585E-04	1.302E-08	9.736E+02	2.584E-04	1.303E-08	9.749E+02
12	8	1.5185E+02	1.5181E+02	M1	5.484E-02	1.460E-06	1.056E+05	5.483E-02	1.461E-06	1.057E+05
12	8	1.5185E+02	1.5181E+02	E2	5.255E-05	2.520E-09	1.822E+02	5.260E-05	2.524E-09	1.826E+02
12	9	2.7752E+02	2.7745E+02	M1	7.565E-01	1.102E-05	2.387E+05	7.579E-01	1.105E-05	2.393E+05
12	9	2.7752E+02	2.7745E+02	E2	4.405E-04	3.461E-09	7.493E+01	4.421E-04	3.475E-09	7.529E+01
12	10	4.1106E+02	4.1091E+02	M1	4.602E-01	4.527E-06	4.468E+04	4.612E-01	4.539E-06	4.483E+04
12	10	4.1106E+02	4.1091E+02	E2	1.214E-04	2.934E-10	2.896E+00	1.216E-04	2.943E-10	2.906E+00
12	11	1.1644E+03	1.1641E+03	M1	3.389E-01	1.177E-06	1.448E+03	3.395E-01	1.179E-06	1.451E+03
12	11	1.1644E+03	1.1641E+03	E2	3.859E-05	4.104E-12	5.048E-03	3.864E-05	4.113E-12	5.061E-03
13	1	3.6481E+01	3.6483E+01	E1	1.399E-06	1.165E-05	2.920E+07	1.387E-06	1.155E-05	2.894E+07

Table 3. (*continued*)

i	j	$\lambda_{\rm MCDF}$	$\lambda_{\rm MBPT}$	Type	$S_{\rm MCDF}$	$f_{\rm MCDF}$	$A_{\rm MCDF}$	$S_{\rm MBPT}$	$f_{\rm MBPT}$	$A_{\rm MBPT}$
13	1	3.6481E+01	3.6483E+01	M2	6.199E-03	2.854E-10	7.151E+02	6.225E-03	2.866E-10	7.180E+02
13	2	4.2445E+01	4.2447E+01	E1	2.140E-03	1.532E-02	2.836E+10	2.146E-03	1.536E-02	2.843E+10
13	2	4.2445E+01	4.2447E+01	M2	4.766E-02	1.393E-09	2.579E+03	4.775E-02	1.396E-09	2.583E+03
13	3	4.4373E+01	4.4377E+01	M2	1.587E-02	4.060E-10	6.877E+02	1.592E-02	4.073E-10	6.898E+02
13	4	4.7183E+01	4.7187E+01	E1	2.374E-04	1.529E-03	2.290E+09	2.371E-04	1.526E-03	2.286E+09
13	5	5.7307E+01	5.7309E+01	E1	4.111E-02	2.179E-01	2.213E+11	4.121E-02	2.184E-01	2.218E+11
13	5	5.7307E+01	5.7309E+01	M2	3.844E-01	4.566E-09	4.636E+03	3.845E-01	4.567E-09	4.637E+03
13	6	7.4100E+01	7.4089E+01	E2	6.099E-07	2.517E-10	1.529E+02	6.074E-07	2.508E-10	1.524E+02
13	7	9.1454E+01	9.1445E+01	M1	4.125E-02	1.824E-06	7.273E+05	4.139E-02	1.830E-06	7.300E+05
13	7	9.1454E+01	9.1445E+01	E2	1.329E-07	2.918E-11	1.164E+01	1.382E-07	3.035E-11	1.210E+01
13	8	9.2381E+01	9.2377E+01	M1	9.153E-03	4.007E-07	1.566E+05	9.175E-03	4.017E-07	1.570E+05
13	9	1.2751E+02	1.2751E+02	M1	4.068E-01	1.290E-05	2.647E+06	4.071E-01	1.291E-05	2.648E+06
13	9	1.2751E+02	1.2751E+02	E2	6.878E-05	5.571E-09	1.143E+03	6.883E-05	5.574E-09	1.143E+03
13	10	1.4988E+02	1.4989E+02	E2	5.352E-04	2.669E-08	3.962E+03	5.363E-04	2.674E-08	3.969E+03
13	11	1.9616E+02	1.9619E+02	M1	8.527E-01	1.758E-05	1.524E+06	8.535E-01	1.759E-05	1.524E+06
13	12	2.3590E+02	2.3596E+02	M1	6.060E-01	1.039E-05	6.226E+05	6.071E-01	1.040E-05	6.233E+05
13	12	2.3590E+02	2.3596E+02	E2	6.348E-04	8.119E-09	4.866E+02	6.364E-04	8.133E-09	4.872E+02
14	1	2.9056E+01	2.9058E+01	M1	6.885E-05	9.582E-09	1.893E+04	6.570E-05	9.143E-09	1.806E+04
14	1	2.9056E+01	2.9058E+01	E2	1.125E-05	7.697E-08	1.520E+05	1.123E-05	7.686E-08	1.518E+05
14	2	3.2717E+01	3.2719E+01	M1	1.468E-03	1.814E-07	2.827E+05	1.473E-03	1.821E-07	2.836E+05
14	2	3.2717E+01	3.2719E+01	E2	1.498E-05	7.181E-08	1.119E+05	1.500E-05	7.188E-08	1.120E+05
14	3	3.3851E+01	3.3854E+01	M1	4.253E-04	5.080E-08	7.393E+04	4.253E-04	5.080E-08	7.391E+04
14	3	3.3851E+01	3.3854E+01	E2	4.609E-05	1.995E-07	2.903E+05	4.613E-05	1.996E-07	2.904E+05
14	4	3.5462E+01	3.5466E+01	M1	4.328E-04	4.935E-08	6.545E+04	4.358E-04	4.969E-08	6.588E+04
14	4	3.5462E+01	3.5466E+01	E2	1.090E-05	4.103E-08	5.441E+04	1.090E-05	4.101E-08	5.437E+04
14	5	4.0891E+01	4.0894E+01	M1	3.197E-05	3.161E-09	3.153E+03	2.946E-05	2.914E-09	2.905E+03
14	5	4.0891E+01	4.0894E+01	E2	9.364E-09	2.299E-11	2.293E+01	9.080E-09	2.229E-11	2.223E+01
14	6	4.8779E+01	4.8777E+01	E1	6.072E-03	3.781E-02	2.650E+10	6.077E-03	3.784E-02	2.653E+10
14	6	4.8779E+01	4.8777E+01	M2	8.574E-01	1.651E-08	1.157E+04	8.581E-01	1.653E-08	1.158E+04
14	7	5.5742E+01	5.5742E+01	E1	1.699E-02	9.259E-02	4.969E+10	1.699E-02	9.259E-02	4.969E+10
14	7	5.5742E+01	5.5742E+01	M2	1.108E-01	1.430E-09	7.677E+02	1.108E-01	1.429E-09	7.671E+02
14	8	5.6085E+01	5.6087E+01	E1	3.903E-03	2.114E-02	1.121E+10	3.904E-03	2.114E-02	1.121E+10
14	8	5.6085E+01	5.6087E+01	M2	2.083E-01	2.640E-09	1.399E+03	2.085E-01	2.641E-09	1.400E+03
14	9	6.7350E+01	6.7356E+01	E1	2.948E-02	1.329E-01	4.887E+10	2.959E-02	1.334E-01	4.904E+10
14	9	6.7350E+01	6.7356E+01	M2	5.773E-02	4.224E-10	1.553E+02	5.790E-02	4.235E-10	1.557E+02
14	10	7.3114E+01	7.3122E+01	E1	4.622E-02	1.920E-01	5.989E+10	4.632E-02	1.924E-01	6.001E+10
14	10	7.3114E+01	7.3122E+01	M2	5.708E-02	3.265E-10	1.018E+02	5.729E-02	3.276E-10	1.022E+02
14	11	8.2622E+01	8.2636E+01	E1	1.864E-02	6.852E-02	1.674E+10	1.869E-02	6.870E-02	1.678E+10
14	11	8.2622E+01	8.2636E+01	M2	7.624E-02	3.021E-10	7.381E+01	7.649E-02	3.030E-10	7.399E+01
14	12	8.8933E+01	8.8951E+01	E1	4.468E-02	1.526E-01	3.218E+10	4.481E-02	1.530E-01	3.225E+10
14	12	8.8933E+01	8.8951E+01	M2	2.016E-02	6.407E-11	1.351E+01	2.017E-02	6.406E-11	1.350E+01
14	13	1.4275E+02	1.4277E+02	E1	2.330E-03	4.958E-03	4.057E+08	2.338E-03	4.974E-03	4.069E+08
14	13	1.4275E+02	1.4277E+02	M2	1.153E-02	8.860E-12	7.251E-01	1.161E-02	8.915E-12	7.293E-01
15	1	2.5618E+01	2.5621E+01	M1	8.065E-06	1.273E-09	6.469E+03	8.329E-06	1.315E-09	6.679E+03
15	1	2.5618E+01	2.5621E+01	E2	1.173E-09	1.172E-11	5.954E+01	1.093E-09	1.091E-11	5.543E+01
15	2	2.8423E+01	2.8426E+01	M1	3.572E-06	5.082E-10	2.098E+03	3.512E-06	4.996E-10	2.062E+03
15	2	2.8423E+01	2.8426E+01	E2	4.699E-06	3.436E-08	1.418E+05	4.702E-06	3.437E-08	1.419E+05
15	3	2.9275E+01	2.9279E+01	E2	1.045E-05	6.992E-08	2.721E+05	1.045E-05	6.994E-08	2.721E+05
15	4	3.0472E+01	3.0476E+01	M1	3.094E-09	4.106E-13	1.475E+00	3.354E-11	4.450E-15	1.598E-02
15	5	3.4396E+01	3.4400E+01	M1	8.279E-04	9.734E-08	2.744E+05	8.245E-04	9.692E-08	2.731E+05
15	5	3.4396E+01	3.4400E+01	E2	2.416E-05	9.970E-08	2.810E+05	2.417E-05	9.969E-08	2.809E+05
15	6	3.9812E+01	3.9813E+01	M2	3.712E-02	1.315E-09	2.767E+03	3.721E-02	1.318E-09	2.773E+03
15	7	4.4332E+01	4.4335E+01	E1	6.775E-04	4.642E-03	7.878E+09	6.761E-04	4.632E-03	7.860E+09
15	7	4.4332E+01	4.4335E+01	M2	1.357E-01	3.482E-09	5.909E+03	1.361E-01	3.492E-09	5.925E+03
15	8	4.4548E+01	4.4552E+01	E1	2.921E-04	1.992E-03	3.347E+09	2.928E-04	1.996E-03	3.354E+09
15	9	5.1373E+01	5.1381E+01	E1	5.866E-03	3.468E-02	4.383E+10	5.880E-03	3.476E-02	4.392E+10
15	9	5.1373E+01	5.1381E+01	M2	2.073E-01	3.418E-09	4.320E+03	2.072E-01	3.414E-09	4.313E+03
15	10	5.4661E+01	5.4669E+01	M2	4.960E-01	6.788E-09	7.578E+03	4.964E-01	6.791E-09	7.578E+03
15	11	5.9806E+01	5.9818E+01	E1	7.927E-03	4.026E-02	3.754E+10	7.946E-03	4.035E-02	3.761E+10
15	12	6.3044E+01	6.3059E+01	E1	3.934E-02	1.896E-01	1.591E+11	3.944E-02	1.900E-01	1.594E+11
15	12	6.3044E+01	6.3059E+01	M2	1.547E-02	1.380E-10	1.158E+02	1.546E-02	1.378E-10	1.156E+02

Table 3. (*continued*)

i	j	λ_{MCDF}	λ_{MBPT}	Type	S_{MCDF}	f_{MCDF}	A_{MCDF}	S_{MBPT}	f_{MBPT}	A_{MBPT}
15	13	8.6037E+01	8.6057E+01	E1	2.918E-02	1.030E-01	4.642E+10	2.926E-02	1.033E-01	4.651E+10
15	14	2.1657E+02	2.1664E+02	M1	1.319E+00	2.462E-05	1.751E+06	1.322E+00	2.467E-05	1.753E+06
15	14	2.1657E+02	2.1664E+02	E2	5.752E-04	9.508E-09	6.761E+02	5.764E-04	9.519E-09	6.765E+02

Only transitions among the $n = 2$ levels are shown here. Table 3 is available online in its entirety in the *JQSRT* website.

Table 4. Comparison between present calculations and available theoretical transition rates, as well as the NIST values (A in s^{-1}) for N-like Kr XXX.

Lower state	Upper state	Tpye	MCDF	MBPT	MCDF2	NIST
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s^2\,2p^3\;^2D^o_{3/2}$	M1	1.208E+06	1.208E+06	1.206E+06	1.21E+06
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s^2\,2p^3\;^2D^o_{3/2}$	E2	6.999E+01	6.990E+01	6.979E+01	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s^2\,2p^3\;^2D^o_{5/2}$	M1	2.176E+05	2.175E+05	2.172E+05	2.19E+05
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s^2\,2p^3\;^2D^o_{5/2}$	E2	4.373E+02	4.367E+02	4.362E+02	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s^2\,2p^3\;^2D^o_{5/2}$	M1	6.191E+03	6.163E+03	6.189E+03	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s^2\,2p^3\;^2D^o_{5/2}$	E2	2.765E-02	2.739E-02		
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s^2\,2p^3\;^2P^o_{1/2}$	M1	1.496E+06	1.495E+06	1.494E+06	1.52E+06
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s^2\,2p^3\;^2P^o_{1/2}$	E2	9.724E+02	9.714E+02	9.703E+02	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s^2\,2p^3\;^2P^o_{1/2}$	M1	1.282E+04	1.275E+04	1.283E+04	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s^2\,2p^3\;^2P^o_{1/2}$	E2	2.417E+01	2.406E+01	2.417E+01	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s^2\,2p^3\;^2P^o_{1/2}$	E2	1.775E+00	1.771E+00	1.774E+00	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s^2\,2p^3\;^2P^o_{3/2}$	M1	9.897E+04	9.819E+04	9.899E+04	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s^2\,2p^3\;^2P^o_{3/2}$	E2	4.287E-03	1.556E-02		
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s^2\,2p^3\;^2P^o_{3/2}$	M1	2.847E+06	2.845E+06	2.843E+06	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s^2\,2p^3\;^2P^o_{3/2}$	E2	4.602E+02	4.600E+02	4.593E+02	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s^2\,2p^3\;^2P^o_{3/2}$	M1	6.181E+05	6.175E+05	6.171E+05	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s^2\,2p^3\;^2P^o_{3/2}$	E2	1.372E+03	1.371E+03	1.369E+03	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s^2\,2p^3\;^2P^o_{3/2}$	M1	2.789E+05	2.788E+05	2.783E+05	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s^2\,2p^3\;^2P^o_{3/2}$	E2	6.048E+01	6.048E+01	6.028E+01	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^4P_{5/2}$	E1	2.169E+10	2.164E+10	2.169E+10	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^4P_{5/2}$	M2	1.432E+03	1.434E+03	1.429E+03	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^4P_{5/2}$	E1	6.130E+09	6.126E+09	6.127E+09	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^4P_{5/2}$	M2	5.017E+00	4.983E+00	5.027E+00	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^4P_{5/2}$	E1	1.787E+09	1.788E+09	1.786E+09	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^4P_{5/2}$	M2	8.259E+00	8.248E+00	8.262E+00	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^4P_{5/2}$	M2	1.780E+00	1.780E+00	1.780E+00	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^4P_{5/2}$	E1	9.318E+06	9.299E+06	9.336E+06	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^4P_{5/2}$	M2	1.062E-01	1.064E-01		
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^4P_{3/2}$	E1	8.586E+10	8.577E+10	8.577E+10	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^4P_{3/2}$	M2	2.390E+02	2.398E+02	2.381E+02	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^4P_{3/2}$	E1	2.623E+07	2.751E+07	2.557E+07	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^4P_{3/2}$	M2	3.797E+02	3.792E+02	3.796E+02	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^4P_{3/2}$	E1	2.840E+09	2.843E+09	2.834E+09	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^4P_{3/2}$	M2	3.448E+01	3.433E+01	3.452E+01	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^4P_{3/2}$	E1	1.140E+08	1.142E+08	1.138E+08	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^4P_{3/2}$	M2	4.229E+01	4.224E+01	4.229E+01	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^4P_{3/2}$	E1	4.118E+08	4.108E+08	4.121E+08	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^4P_{3/2}$	M2	1.580E-02	1.612E-02		
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^4P_{3/2}$	M1	3.351E+05	3.342E+05	3.349E+05	
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^4P_{3/2}$	E2	1.022E+01	1.015E+01	1.022E+01	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^4P_{1/2}$	E1	7.095E+10	7.080E+10	7.090E+10	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^4P_{1/2}$	M2	1.433E+03	1.434E+03	1.430E+03	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^4P_{1/2}$	E1	2.270E+09	2.265E+09	2.270E+09	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^4P_{1/2}$	M2	1.266E+02	1.262E+02	1.266E+02	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^4P_{1/2}$	M2	2.488E+01	2.484E+01	2.488E+01	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^4P_{1/2}$	E1	5.400E+09	5.401E+09	5.393E+09	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^4P_{1/2}$	E1	8.331E+07	8.326E+07	8.337E+00	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^4P_{1/2}$	M2	4.018E+00	4.009E+00	4.025E+00	
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^4P_{1/2}$	E2	4.939E+01	4.916E+01	4.937E+01	
$2s\,2p^4\;^4P_{3/2}$	$2s\,2p^4\;^4P_{1/2}$	M1	2.710E+01	2.655E+01	2.735E+01	
$2s\,2p^4\;^4P_{3/2}$	$2s\,2p^4\;^4P_{1/2}$	E2	1.706E-06	1.658E-06		
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^2D_{3/2}$	E1	2.141E+10	2.133E+10	2.142E+10	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^2D_{3/2}$	M2	1.264E+03	1.261E+03	1.263E+03	

Table 4. (*continued*)

Lower state	Upper state	Tpye	MCDF	MBPT	MCDF2	NIST
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^2D_{3/2}$	E1	9.376E+10	9.352E+10	9.374E+10	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^2D_{3/2}$	M2	3.686E+02	3.701E+02	3.672E+02	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^2D_{3/2}$	E1	4.259E+09	4.242E+09	4.255E+09	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^2D_{3/2}$	M2	8.097E+02	8.102E+02	8.086E+02	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^2D_{3/2}$	E1	2.275E+09	2.269E+09	2.276E+09	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^2D_{3/2}$	M2	2.374E+02	2.378E+02	2.370E+02	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^2D_{3/2}$	E1	9.441E+05	1.064E+06	8.835E+05	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^2D_{3/2}$	M2	2.619E+00	2.609E+00	2.620E+00	
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^2D_{3/2}$	M1	3.554E+05	3.561E+05	3.542E+05	
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^2D_{3/2}$	E2	6.041E+02	6.029E+02	6.032E+02	
$2s\,2p^4\;^4P_{3/2}$	$2s\,2p^4\;^2D_{3/2}$	M1	3.538E+05	3.538E+05	3.533E+05	
$2s\,2p^4\;^4P_{3/2}$	$2s\,2p^4\;^2D_{3/2}$	E2	2.572E-01	2.551E-01		
$2s\,2p^4\;^4P_{1/2}$	$2s\,2p^4\;^2D_{3/2}$	M1	1.245E+05	1.245E+05	1.242E+05	
$2s\,2p^4\;^4P_{1/2}$	$2s\,2p^4\;^2D_{3/2}$	E2	7.757E+00	7.733E+00	7.749E+00	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	E1	4.264E+07	4.248E+07	4.248E+07	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	M2	2.729E+02	2.725E+02	2.726E+02	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	E1	1.402E+09	1.401E+09	1.400E+09	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	M2	8.719E+02	8.712E+02	8.709E+02	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^2D_{5/2}$	E1	7.607E+10	7.590E+10	7.604E+10	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^2D_{5/2}$	M2	2.042E+03	2.042E+03	2.039E+03	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^2D_{5/2}$	M2	5.919E+02	5.920E+02	5.911E+02	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	E1	8.977E+09	8.960E+09	8.977E+09	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	M2	3.344E-02	3.382E-02		
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^2D_{5/2}$	M1	1.230E+06	1.230E+06	1.228E+06	
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^2D_{5/2}$	E2	1.259E+03	1.256E+03	1.257E+03	
$2s\,2p^4\;^4P_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	M1	8.468E+02	8.615E+02	8.348E+02	
$2s\,2p^4\;^4P_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	E2	7.636E+01	7.620E+01	7.624E+01	
$2s\,2p^4\;^4P_{1/2}$	$2s\,2p^4\;^2D_{5/2}$	E2	4.243E+01	4.238E+01	4.233E+01	
$2s\,2p^4\;^2D_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	M1	1.494E+04	1.492E+04	1.492E+04	
$2s\,2p^4\;^2D_{3/2}$	$2s\,2p^4\;^2D_{5/2}$	E2	5.159E-02	5.132E-02		
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	E1	1.478E+10	1.473E+10	1.478E+10	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	M2	2.692E+03	2.684E+03	2.690E+03	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	E1	1.294E+11	1.291E+11	1.293E+11	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	M2	8.761E+02	8.770E+02	8.742E+02	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^2P_{1/2}$	M2	8.076E+02	8.072E+02	8.065E+02	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^2P_{1/2}$	E1	7.442E+10	7.425E+10	7.441E+10	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	E1	7.430E+08	7.445E+08	7.402E+08	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	M2	1.518E+02	1.517E+02	1.519E+02	
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^2P_{1/2}$	E2	1.277E+02	1.275E+02	1.272E+02	
$2s\,2p^4\;^4P_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	M1	2.606E+06	2.602E+06	2.603E+06	
$2s\,2p^4\;^4P_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	E2	3.660E+02	3.655E+02	3.653E+02	
$2s\,2p^4\;^4P_{1/2}$	$2s\,2p^4\;^2P_{1/2}$	M1	4.530E+05	4.531E+05	4.523E+05	
$2s\,2p^4\;^2D_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	M1	6.399E+03	6.495E+03	6.355E+03	
$2s\,2p^4\;^2D_{3/2}$	$2s\,2p^4\;^2P_{1/2}$	E2	4.057E+01	4.037E+01	4.059E+01	
$2s\,2p^4\;^2D_{5/2}$	$2s\,2p^4\;^2P_{1/2}$	E2	3.263E+00	3.247E+00	3.269E+00	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^2P_{3/2}$	E1	1.616E+10	1.614E+10	1.617E+10	
$2s^2\,2p^3\;^4S^o_{3/2}$	$2s\,2p^4\;^2P_{3/2}$	M2	1.615E+03	1.610E+03	1.615E+03	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^2P_{3/2}$	E1	1.128E+09	1.123E+09	1.133E+09	
$2s^2\,2p^3\;^2D^o_{3/2}$	$2s\,2p^4\;^2P_{3/2}$	M2	2.064E+03	2.064E+03	2.062E+03	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^2P_{3/2}$	E1	2.098E+11	2.093E+11	2.097E+11	
$2s^2\,2p^3\;^2D^o_{5/2}$	$2s\,2p^4\;^2P_{3/2}$	M2	1.482E+03	1.480E+03	1.481E+03	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^2P_{3/2}$	E1	3.251E+10	3.246E+10	3.250E+10	
$2s^2\,2p^3\;^2P^o_{1/2}$	$2s\,2p^4\;^2P_{3/2}$	M2	6.213E+01	6.213E+01	6.208E+01	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^2P_{3/2}$	E1	1.387E+10	1.385E+10	1.387E+10	
$2s^2\,2p^3\;^2P^o_{3/2}$	$2s\,2p^4\;^2P_{3/2}$	M2	8.487E+00	8.425E+00	8.506E+00	
$2s\,2p^4\;^4P_{5/2}$	$2s\,2p^4\;^2P_{3/2}$	M1	1.018E+06	1.017E+06	1.017E+06	

Table 4. (*continued*)

Lower state	Upper state	Tpye	MCDF	MBPT	MCDF2	NIST
$2s\,2p^4\ ^4P_{5/2}$	$2s\,2p^4\ ^2P_{3/2}$	E2	2.375E+01	2.368E+01	2.363E+01	
$2s\,2p^4\ ^4P_{3/2}$	$2s\,2p^4\ ^2P_{3/2}$	M1	1.997E+05	1.997E+05	1.990E+05	
$2s\,2p^4\ ^4P_{3/2}$	$2s\,2p^4\ ^2P_{3/2}$	E2	9.749E+02	9.736E+02	9.734E+02	
$2s\,2p^4\ ^4P_{1/2}$	$2s\,2p^4\ ^2P_{3/2}$	M1	1.057E+05	1.056E+05	1.056E+05	
$2s\,2p^4\ ^4P_{1/2}$	$2s\,2p^4\ ^2P_{3/2}$	E2	1.826E+02	1.822E+02	1.824E+02	
$2s\,2p^4\ ^2D_{3/2}$	$2s\,2p^4\ ^2P_{3/2}$	M1	2.393E+05	2.387E+05	2.392E+05	
$2s\,2p^4\ ^2D_{3/2}$	$2s\,2p^4\ ^2P_{3/2}$	E2	7.529E+01	7.493E+01	7.534E+01	
$2s\,2p^4\ ^2D_{5/2}$	$2s\,2p^4\ ^2P_{3/2}$	M1	4.483E+04	4.468E+04	4.483E+04	
$2s\,2p^4\ ^2D_{5/2}$	$2s\,2p^4\ ^2P_{3/2}$	E2	2.906E+00	2.896E+00	2.908E+00	
$2s\,2p^4\ ^2P_{1/2}$	$2s\,2p^4\ ^2P_{3/2}$	M1	1.451E+03	1.448E+03	1.452E+03	
$2s\,2p^4\ ^2P_{1/2}$	$2s\,2p^4\ ^2P_{3/2}$	E2	5.061E-03	5.048E-03		
$2s^2\,2p^3\ ^4S^o_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	E1	2.894E+07	2.920E+07	2.874E+07	
$2s^2\,2p^3\ ^4S^o_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	M2	7.180E+02	7.151E+02	7.184E+02	
$2s^2\,2p^3\ ^2D^o_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	E1	2.843E+10	2.836E+10	2.844E+10	
$2s^2\,2p^3\ ^2D^o_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	M2	2.583E+03	2.579E+03	2.581E+03	
$2s^2\,2p^3\ ^2D^o_{5/2}$	$2s\,2p^4\ ^2S_{1/2}$	M2	6.898E+02	6.877E+02	6.897E+02	
$2s^2\,2p^3\ ^2P^o_{1/2}$	$2s\,2p^4\ ^2S_{1/2}$	E1	2.286E+09	2.290E+09	2.290E+09	
$2s^2\,2p^3\ ^2P^o_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	E1	2.218E+11	2.213E+11	2.218E+11	
$2s^2\,2p^3\ ^2P^o_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	M2	4.637E+03	4.636E+03	4.631E+03	
$2s\,2p^4\ ^4P_{5/2}$	$2s\,2p^4\ ^2S_{1/2}$	E2	1.524E+02	1.529E+02	1.518E+02	
$2s\,2p^4\ ^4P_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	M1	7.300E+05	7.273E+05	7.299E+05	
$2s\,2p^4\ ^4P_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	E2	1.210E+01	1.164E+01	1.223E+01	
$2s\,2p^4\ ^4P_{1/2}$	$2s\,2p^4\ ^2S_{1/2}$	M1	1.570E+05	1.566E+05	1.570E+05	
$2s\,2p^4\ ^2D_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	M1	2.648E+06	2.647E+06	2.643E+06	
$2s\,2p^4\ ^2D_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	E2	1.143E+03	1.143E+03	1.142E+03	
$2s\,2p^4\ ^2D_{5/2}$	$2s\,2p^4\ ^2S_{1/2}$	E2	3.969E+03	3.962E+03	3.964E+03	
$2s\,2p^4\ ^2P_{1/2}$	$2s\,2p^4\ ^2S_{1/2}$	M1	1.524E+06	1.524E+06	1.522E+06	
$2s\,2p^4\ ^2P_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	M1	6.233E+05	6.226E+05	6.223E+05	
$2s\,2p^4\ ^2P_{3/2}$	$2s\,2p^4\ ^2S_{1/2}$	E2	4.872E+02	4.866E+02	4.861E+0	
$2s^2\,2p^3\ ^4S^o_{3/2}$	$2p^5\ ^2P^o_{3/2}$	M1	1.806E+04	1.893E+04	1.802E+04	
$2s^2\,2p^3\ ^4S^o_{3/2}$	$2p^5\ ^2P^o_{3/2}$	E2	1.518E+05	1.520E+05	1.516E+05	
$2s^2\,2p^3\ ^2D^o_{3/2}$	$2p^5\ ^2P^o_{3/2}$	M1	2.836E+05	2.827E+05	2.830E+05	
$2s^2\,2p^3\ ^2D^o_{3/2}$	$2p^5\ ^2P^o_{3/2}$	E2	1.120E+05	1.119E+05	1.120E+05	
$2s^2\,2p^3\ ^2D^o_{5/2}$	$2p^5\ ^2P^o_{3/2}$	M1	7.391E+04	7.393E+04	7.378E+04	
$2s^2\,2p^3\ ^2D^o_{5/2}$	$2p^5\ ^2P^o_{3/2}$	E2	2.904E+05	2.903E+05	2.904E+05	
$2s^2\,2p^3\ ^2P^o_{1/2}$	$2p^5\ ^2P^o_{3/2}$	M1	6.588E+04	6.545E+04	6.577E+04	
$2s^2\,2p^3\ ^2P^o_{1/2}$	$2p^5\ ^2P^o_{3/2}$	E2	5.437E+04	5.441E+04	5.437E+04	
$2s^2\,2p^3\ ^2P^o_{3/2}$	$2p^5\ ^2P^o_{3/2}$	M1	2.905E+03	3.153E+03	2.881E+03	
$2s^2\,2p^3\ ^2P^o_{3/2}$	$2p^5\ ^2P^o_{3/2}$	E2	2.223E+01	2.293E+01	2.223E+01	
$2s\,2p^4\ ^4P_{5/2}$	$2p^5\ ^2P^o_{3/2}$	E1	2.653E+10	2.650E+10	2.653E+10	
$2s\,2p^4\ ^4P_{5/2}$	$2p^5\ ^2P^o_{3/2}$	M2	1.158E+04	1.157E+04	1.159E+04	
$2s\,2p^4\ ^4P_{3/2}$	$2p^5\ ^2P^o_{3/2}$	E1	4.969E+10	4.969E+10	4.966E+10	
$2s\,2p^4\ ^4P_{3/2}$	$2p^5\ ^2P^o_{3/2}$	M2	7.671E+02	7.677E+02	7.672E+02	
$2s\,2p^4\ ^4P_{1/2}$	$2p^5\ ^2P^o_{3/2}$	E1	1.121E+10	1.121E+10	1.121E+10	
$2s\,2p^4\ ^4P_{1/2}$	$2p^5\ ^2P^o_{3/2}$	M2	1.400E+03	1.399E+03	1.401E+03	
$2s\,2p^4\ ^2D_{3/2}$	$2p^5\ ^2P^o_{3/2}$	E1	4.904E+10	4.887E+10	4.912E+10	
$2s\,2p^4\ ^2D_{3/2}$	$2p^5\ ^2P^o_{3/2}$	M2	1.557E+02	1.553E+02	1.561E+02	
$2s\,2p^4\ ^2D_{5/2}$	$2p^5\ ^2P^o_{3/2}$	E1	6.001E+10	5.989E+10	6.010E+10	
$2s\,2p^4\ ^2D_{5/2}$	$2p^5\ ^2P^o_{3/2}$	M2	1.022E+02	1.018E+02	1.025E+02	
$2s\,2p^4\ ^2P_{1/2}$	$2p^5\ ^2P^o_{3/2}$	E1	1.678E+10	1.674E+10	1.680E+10	
$2s\,2p^4\ ^2P_{1/2}$	$2p^5\ ^2P^o_{3/2}$	M2	7.399E+01	7.381E+01	7.423E+01	
$2s\,2p^4\ ^2P_{3/2}$	$2p^5\ ^2P^o_{3/2}$	E1	3.225E+10	3.218E+10	3.231E+10	
$2s\,2p^4\ ^2P_{3/2}$	$2p^5\ ^2P^o_{3/2}$	M2	1.350E+01	1.351E+01	1.354E+01	
$2s\,2p^4\ ^2S_{1/2}$	$2p^5\ ^2P^o_{3/2}$	E1	4.069E+08	4.057E+08	4.086E+08	
$2s\,2p^4\ ^2S_{1/2}$	$2p^5\ ^2P^o_{3/2}$	M2	7.293E-01	7.251E-01		
$2s^2\,2p^3\ ^4S^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	M1	6.679E+03	6.469E+03	6.663E+03	

Table 4. (*continued*)

Lower state	Upper state	Tpye	MCDF	MBPT	MCDF2	NIST
$2s^2\,2p^3\ ^4S^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	E2	5.543E+01	5.954E+01	5.649E+01	
$2s^2\,2p^3\ ^2D^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	M1	2.062E+03	2.098E+03	2.059E+03	
$2s^2\,2p^3\ ^2D^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	E2	1.419E+05	1.418E+05	1.417E+05	
$2s^2\,2p^3\ ^2D^o_{5/2}$	$2p^5\ ^2P^o_{1/2}$	E2	2.721E+05	2.721E+05	2.719E+05	
$2s^2\,2p^3\ ^2P^o_{1/2}$	$2p^5\ ^2P^o_{1/2}$	M1	1.598E-02	1.475E+00		
$2s^2\,2p^3\ ^2P^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	M1	2.731E+05	2.744E+05	2.726E+05	
$2s^2\,2p^3\ ^2P^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	E2	2.809E+05	2.810E+05	2.810E+05	
$2s\,2p^4\ ^4P_{5/2}$	$2p^5\ ^2P^o_{1/2}$	M2	2.773E+03	2.767E+03	2.775E+03	
$2s\,2p^4\ ^4P_{3/2}$	$2p^5\ ^2P^o_{1/2}$	E1	7.860E+09	7.878E+09	7.856E+09	
$2s\,2p^4\ ^4P_{3/2}$	$2p^5\ ^2P^o_{1/2}$	M2	5.925E+03	5.909E+03	5.933E+03	
$2s\,2p^4\ ^4P_{1/2}$	$2p^5\ ^2P^o_{1/2}$	E1	3.354E+09	3.347E+09	3.360E+09	
$2s\,2p^4\ ^2D_{3/2}$	$2p^5\ ^2P^o_{1/2}$	E1	4.392E+10	4.383E+10	4.399E+10	
$2s\,2p^4\ ^2D_{3/2}$	$2p^5\ ^2P^o_{1/2}$	M2	4.313E+03	4.320E+03	4.312E+03	
$2s\,2p^4\ ^2D_{5/2}$	$2p^5\ ^2P^o_{1/2}$	M2	7.578E+03	7.578E+03	7.582E+03	
$2s\,2p^4\ ^2P_{1/2}$	$2p^5\ ^2P^o_{1/2}$	E1	3.761E+10	3.754E+10	3.760E+10	
$2s\,2p^4\ ^2P_{3/2}$	$2p^5\ ^2P^o_{1/2}$	E1	1.594E+11	1.591E+11	1.594E+11	
$2s\,2p^4\ ^2P_{3/2}$	$2p^5\ ^2P^o_{1/2}$	M2	1.156E+02	1.158E+02	1.157E+02	
$2s\,2p^4\ ^2S_{1/2}$	$2p^5\ ^2P^o_{1/2}$	E1	4.651E+10	4.642E+10	4.659E+10	
$2p^5\ ^2P^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	M1	1.753E+06	1.751E+06	1.750E+06	
$2p^5\ ^2P^o_{3/2}$	$2p^5\ ^2P^o_{1/2}$	E2	6.765E+02	6.761E+02	6.753E+02	

Table 5. The present MCDF and MBPT lifetimes (τ in s) for N-like Kr XXX. Here, (l) is our results in length gauge, (v) the results in the velocity gauge. $a-$ the present results; $b-$ the MCDF values [18]; $c-$ the GRASP values [25].

Lower state	Upper state	MCDF (l)[a]	MCDF (v)[a]	MBPT (l)[a]	MCDF2 (l)[b]	GRASP (l)[c]
1	$2s^2\,2p^3\;^4S^o_{3/2}$					
2	$2s^2\,2p^3\;^2D^o_{3/2}$	8.28E-07	8.28E-07	8.28E-07	8.29E-07	8.34E-07
3	$2s^2\,2p^3\;^2D^o_{5/2}$	4.46E-06	4.46E-06	4.46E-06	4.47E-06	4.50E-06
4	$2s^2\,2p^3\;^2P^o_{1/2}$	6.62E-07	6.62E-07	6.63E-07	6.63E-07	6.65E-07
5	$2s^2\,2p^3\;^2P^o_{3/2}$	2.60E-07	2.60E-07	2.60E-07	2.61E-07	2.61E-07
6	$2s\,2p^4\;^4P_{5/2}$	3.38E-11	3.32E-11	3.38E-11	3.38E-11	3.25E-11
7	$2s\,2p^4\;^4P_{3/2}$	1.12E-11	1.12E-11	1.12E-11	1.12E-11	1.11E-11
8	$2s\,2p^4\;^4P_{1/2}$	1.27E-11	1.27E-11	1.27E-11	1.27E-11	1.23E-11
9	$2s\,2p^4\;^2D_{3/2}$	8.22E-12	8.19E-12	8.24E-12	8.22E-12	7.81E-12
10	$2s\,2p^4\;^2D_{5/2}$	1.16E-11	1.15E-11	1.16E-11	1.16E-11	1.11E-11
11	$2s\,2p^4\;^2P_{1/2}$	4.56E-12	4.55E-12	4.57E-12	4.56E-12	4.39E-12
12	$2s\,2p^4\;^2P_{3/2}$	3.66E-12	3.65E-12	3.67E-12	3.66E-12	3.50E-12
13	$2s\,2p^4\;^2S_{1/2}$	3.96E-12	3.95E-12	3.97E-12	3.96E-12	3.78E-12
14	$2p^5\;^2P^o_{3/2}$	4.07E-12	4.05E-12	4.07E-12	4.06E-12	3.88E-12
15	$2p^5\;^2P^o_{1/2}$	3.35E-12	3.35E-12	3.36E-12	3.35E-12	3.20E-12
16	$2s^2\,2p^2(^3P)\,3s\;^4P_{1/2}$	1.28E-13	1.28E-13	1.29E-13		1.27E-13
17	$2s^2\,2p^2(^3P)\,3p\;^4D^o_{1/2}$	1.18E-11	1.17E-11	1.19E-11		9.37E-12
18	$2s^2\,2p^2(^3P)\,3s\;^4P_{3/2}$	1.66E-13	1.66E-13	1.66E-13		1.64E-13
19	$2s^2\,2p^2(^3P)\,3s\;^2P_{1/2}$	7.75E-14	7.75E-14	7.78E-14		7.60E-14
20	$2s^2\,2p^2(^3P)\,3s\;^4P_{5/2}$	1.30E-13	1.30E-13	1.30E-13		1.28E-13
21	$2s^2\,2p^2(^3P)\,3p\;^4D^o_{3/2}$	7.62E-12	7.60E-12	7.71E-12		5.89E-12
22	$2s^2\,2p^2(^1D)\,3s\;^2D_{3/2}$	8.10E-14	8.10E-14	8.13E-14		7.94E-14
23	$2s^2\,2p^2(^3P)\,3p\;^4P^o_{1/2}$	1.27E-11	1.27E-11	1.28E-11		9.45E-12
24	$2s^2\,2p^2(^3P)\,3p\;^2D^o_{3/2}$	1.38E-11	1.38E-11	1.39E-11		1.09E-11
25	$2s^2\,2p^2(^1D)\,3p\;^2F^o_{5/2}$	1.33E-11	1.32E-11	1.34E-11		1.09E-11
26	$2s^2\,2p^2(^3P)\,3d\;^4F_{3/2}$	9.26E-14	9.22E-14	9.28E-14		9.07E-14
27	$2s^2\,2p^2(^3P)\,3p\;^4D^o_{5/2}$	8.42E-12	8.40E-12	8.51E-12		6.64E-12
28	$2s^2\,2p^2(^3P)\,3p\;^2S^o_{1/2}$	8.44E-12	8.43E-12	8.52E-12		6.02E-12
29	$2s^2\,2p^2(^3P)\,3p\;^4S^o_{3/2}$	2.25E-12	2.25E-12	2.28E-12		1.82E-12
30	$2s^2\,2p^2(^3P)\,3d\;^4D_{5/2}$	2.47E-14	2.46E-14	2.47E-14		2.43E-14
31	$2s^2\,2p^2(^3P)\,3p\;^4P^o_{3/2}$	2.29E-12	2.29E-12	2.34E-12		1.58E-12
32	$2s^2\,2p^2(^3P)\,3p\;^4D^o_{7/2}$	1.67E-11	1.66E-11	1.67E-11		1.42E-11
33	$2s^2\,2p^2(^1D)\,3s\;^2D_{5/2}$	1.13E-13	1.13E-13	1.13E-13		1.11E-13
34	$2s^2\,2p^2(^3P)\,3s\;^2P_{3/2}$	7.92E-14	7.91E-14	7.94E-14		7.78E-14
35	$2s^2\,2p^2(^3P)\,3p\;^2P^o_{3/2}$	2.03E-12	2.03E-12	2.05E-12		1.69E-12
36	$2s^2\,2p^2(^1D)\,3p\;^2D^o_{5/2}$	3.97E-12	3.97E-12	4.01E-12		3.22E-12
37	$2s^2\,2p^2(^3P)\,3p\;^2P^o_{1/2}$	2.14E-12	2.13E-12	2.16E-12		1.74E-12
38	$2s^2\,2p^2(^1S)\,3s\;^2S_{1/2}$	9.38E-14	9.37E-14	9.40E-14		9.27E-14
39	$2s\,2p^3(^5S)\,3s\;^6S^o_{5/2}$	7.60E-13	7.60E-13	7.60E-13		7.99E-13
40	$2s^2\,2p^2(^3P)\,3d\;^2P_{3/2}$	5.26E-14	5.25E-14	5.27E-14		5.15E-14
41	$2s^2\,2p^2(^3P)\,3d\;^4F_{5/2}$	1.01E-13	1.01E-13	1.02E-13		9.56E-14
42	$2s^2\,2p^2(^3P)\,3d\;^4D_{1/2}$	1.11E-13	1.10E-13	1.11E-13		1.09E-13
43	$2s^2\,2p^2(^3P)\,3d\;^4F_{7/2}$	4.63E-13	4.62E-13	4.62E-13		4.65E-13
44	$2s^2\,2p^2(^1D)\,3d\;^2F_{7/2}$	5.08E-12	5.13E-12	5.20E-12		4.52E-12
45	$2s\,2p^3(^5S)\,3s\;^4S^o_{3/2}$	2.60E-13	2.60E-13	2.67E-13		2.67E-13
46	$2s^2\,2p^2(^3P)\,3d\;^4P_{5/2}$	1.81E-14	1.81E-14	1.82E-14		1.78E-14
47	$2s^2\,2p^2(^3P)\,3d\;^4D_{3/2}$	2.89E-14	2.88E-14	2.89E-14		2.84E-14
48	$2s^2\,2p^2(^3P)\,3d\;^4F_{9/2}$	1.92E-10	1.94E-10	1.93E-10		1.84E-10
49	$2s^2\,2p^2(^3P)\,3p\;^2D^o_{5/2}$	5.98E-12	5.97E-12	6.07E-12		4.57E-12
50	$2s\,2p^3(^3P)\,3s\;^2P^o_{3/2}$	1.29E-13	1.29E-13	1.27E-13		1.20E-13
51	$2s^2\,2p^2(^1D)\,3d\;^2D_{5/2}$	1.47E-14	1.47E-14	1.48E-14		1.45E-14
52	$2s^2\,2p^2(^3P)\,3d\;^4P_{3/2}$	1.09E-14	1.09E-14	1.09E-14		1.07E-14
53	$2s^2\,2p^2(^3P)\,3p\;^4P^o_{5/2}$	8.77E-12	8.75E-12	8.84E-12		7.03E-12
54	$2s^2\,2p^2(^1D)\,3p\;^2P^o_{1/2}$	1.83E-12	1.83E-12	1.86E-12		1.48E-12
55	$2s^2\,2p^2(^1D)\,3p\;^2F^o_{7/2}$	1.02E-11	1.02E-11	1.02E-11		8.44E-12

Table 5. (*continued*)

Lower state	Upper state	MCDF (*l*)[a]	MCDF (*v*)[a]	MBPT (*l*)[a]	MCDF2 (*l*)[b]	GRASP (*l*)[c]
56	$2s^2\,2p^2(^3P)\,3d\;^4P_{1/2}$	1.10E-14	1.09E-14	1.10E-14		1.07E-14
57	$2s^2\,2p^2(^3P)\,3d\;^2D_{5/2}$	9.17E-15	9.15E-15	9.21E-15		8.75E-15
58	$2s^2\,2p^2(^1D)\,3d\;^2G_{7/2}$	1.28E-14	1.28E-14	1.29E-14		1.26E-14
59	$2s^2\,2p^2(^3P)\,3d\;^2D_{3/2}$	1.62E-14	1.62E-14	1.63E-14		1.56E-14
60	$2s^2\,2p^2(^3P)\,3d\;^2P_{1/2}$	1.43E-14	1.43E-14	1.44E-14		1.38E-14
61	$2s^2\,2p^2(^1S)\,3p\;^2P^o_{1/2}$	4.03E-12	4.01E-12	4.07E-12		3.27E-12
62	$2s\,2p^3(^5S)\,3p\;^6P_{3/2}$	7.16E-13	7.13E-13	7.11E-13		7.46E-13
63	$2s^2\,2p^2(^1D)\,3p\;^2P^o_{3/2}$	5.48E-13	5.48E-13	5.61E-13		5.60E-13
64	$2s\,2p^3(^5S)\,3p\;^6P_{5/2}$	2.18E-13	2.17E-13	2.18E-13		2.17E-13
65	$2s\,2p^3(^3D)\,3s\;^4D^o_{1/2}$	1.23E-13	1.23E-13	1.23E-13		1.20E-13
66	$2s\,2p^3(^3D)\,3s\;^4D^o_{3/2}$	2.14E-13	2.14E-13	2.15E-13		2.18E-13
67	$2s^2\,2p^2(^1S)\,3p\;^2P^o_{3/2}$	1.70E-12	1.70E-12	1.66E-12		8.81E-13
68	$2s\,2p^3(^5S)\,3p\;^6P_{7/2}$	3.12E-12	3.11E-12	3.13E-12		2.84E-12
69	$2s\,2p^3(^3D)\,3s\;^4D^o_{5/2}$	1.60E-13	1.60E-13	1.61E-13		1.55E-13
70	$2s\,2p^3(^5S)\,3p\;^4P_{3/2}$	5.32E-14	5.29E-14	5.34E-14		5.02E-14
71	$2s\,2p^3(^5S)\,3p\;^4P_{5/2}$	5.56E-14	5.54E-14	5.59E-14		5.33E-14
72	$2s\,2p^3(^5S)\,3p\;^4P_{1/2}$	4.40E-14	4.38E-14	4.40E-14		4.09E-14
73	$2s^2\,2p^2(^3P)\,3d\;^4D_{7/2}$	4.75E-13	4.74E-13	4.83E-13		4.50E-13
74	$2s\,2p^3(^3D)\,3s\;^2D^o_{3/2}$	1.13E-13	1.13E-13	1.13E-13		1.09E-13
75	$2s^2\,2p^2(^1D)\,3d\;^2G_{9/2}$	1.86E-10	1.88E-10	1.87E-10		1.77E-10
76	$2s^2\,2p^2(^1D)\,3d\;^2D_{3/2}$	1.51E-14	1.50E-14	1.51E-14		1.48E-14
77	$2s^2\,2p^2(^1D)\,3d\;^2P_{1/2}$	2.94E-14	2.93E-14	2.96E-14		2.92E-14
78	$2s^2\,2p^2(^1D)\,3d\;^2F_{5/2}$	1.41E-14	1.41E-14	1.42E-14		1.37E-14
79	$2s\,2p^3(^3D)\,3s\;^4D^o_{7/2}$	1.23E-13	1.23E-13	1.24E-13		1.18E-13
80	$2s^2\,2p^2(^3P)\,3d\;^2F_{7/2}$	1.18E-14	1.18E-14	1.19E-14		1.12E-14
81	$2s^2\,2p^2(^1D)\,3d\;^2S_{1/2}$	1.59E-14	1.59E-14	1.57E-14		1.43E-14
82	$2s\,2p^3(^3D)\,3p\;^4F_{3/2}$	3.95E-14	3.94E-14	3.63E-14		1.55E-14
83	$2s\,2p^3(^3D)\,3p\;^4D_{1/2}$	4.24E-14	4.23E-14	4.45E-14		5.59E-14
84	$2s\,2p^3(^3D)\,3s\;^2D^o_{5/2}$	9.82E-14	9.82E-14	9.87E-14		9.45E-14
85	$2s^2\,2p^2(^1D)\,3d\;^2P_{3/2}$	1.58E-14	1.58E-14	1.64E-14		3.59E-14
86	$2s^2\,2p^2(^3P)\,3d\;^2F_{5/2}$	1.38E-14	1.38E-14	1.38E-14		1.42E-14
87	$2s\,2p^3(^5S)\,3d\;^6D^o_{5/2}$	2.71E-13	2.70E-13	2.72E-13		2.75E-13
88	$2s\,2p^3(^3P)\,3s\;^4P^o_{1/2}$	1.67E-13	1.67E-13	1.59E-13		1.23E-13
89	$2s\,2p^3(^3D)\,3p\;^4D_{3/2}$	1.59E-13	1.59E-13	1.60E-13		1.47E-13
90	$2s\,2p^3(^5S)\,3d\;^6D^o_{3/2}$	2.19E-13	2.18E-13	2.19E-13		2.28E-13
91	$2s\,2p^3(^5S)\,3d\;^6D^o_{1/2}$	3.44E-13	3.43E-13	3.88E-13		1.09E-12
92	$2s\,2p^3(^5S)\,3d\;^6D^o_{7/2}$	1.10E-12	1.11E-12	1.10E-12		1.22E-12
93	$2s\,2p^3(^3D)\,3p\;^4F_{5/2}$	5.96E-14	5.95E-14	5.67E-14		2.18E-14
94	$2s\,2p^3(^5S)\,3d\;^6D^o_{9/2}$	1.80E-10	1.78E-10	1.81E-10		1.74E-10
95	$2s^2\,2p^2(^1S)\,3d\;^2D_{5/2}$	1.74E-14	1.73E-14	1.77E-14		2.74E-14
96	$2s^2\,2p^2(^1S)\,3d\;^2D_{3/2}$	1.22E-14	1.21E-14	1.22E-14		1.16E-14
97	$2s\,2p^3(^3P)\,3s\;^4P^o_{3/2}$	1.39E-13	1.39E-13	1.40E-13		1.31E-13
98	$2s\,2p^3(^3D)\,3p\;^4D_{5/2}$	7.13E-14	7.10E-14	7.17E-14		7.43E-14
99	$2s\,2p^3(^3D)\,3p\;^4S_{3/2}$	9.17E-14	9.13E-14	9.28E-14		9.54E-14
100	$2s\,2p^3(^3D)\,3p\;^4P_{1/2}$	1.93E-13	1.92E-13	1.94E-13		1.64E-13
101	$2s\,2p^3(^3P)\,3s\;^2P^o_{1/2}$	8.21E-14	8.21E-14	8.26E-14		7.93E-14
102	$2s\,2p^3(^1D)\,3s\;^2D^o_{5/2}$	1.07E-13	1.06E-13	1.07E-13		8.03E-14
103	$2s\,2p^3(^3D)\,3p\;^4F_{7/2}$	3.84E-12	3.82E-12	3.68E-12		6.40E-12
104	$2s\,2p^3(^5S)\,3d\;^4D^o_{5/2}$	3.88E-14	3.87E-14	3.88E-14		4.08E-14
105	$2s\,2p^3(^1D)\,3s\;^2D^o_{3/2}$	7.10E-14	7.10E-14	7.15E-14		3.94E-14
106	$2s\,2p^3(^3D)\,3p\;^2F_{5/2}$	8.55E-14	8.50E-14	8.60E-14		8.20E-14
107	$2s\,2p^3(^5S)\,3d\;^4D^o_{3/2}$	3.90E-14	3.90E-14	3.92E-14		6.00E-14
108	$2s\,2p^3(^3D)\,3p\;^2F_{7/2}$	1.19E-13	1.18E-13	1.19E-13		1.18E-13
109	$2s\,2p^3(^5S)\,3d\;^4D^o_{7/2}$	1.79E-14	1.78E-14	1.79E-14		1.73E-14
110	$2s\,2p^3(^3D)\,3p\;^2P_{1/2}$	6.02E-14	5.99E-14	6.04E-14		5.95E-14
111	$2s\,2p^3(^3S)\,3s\;^4S^o_{3/2}$	1.43E-13	1.43E-13	1.44E-13		1.41E-13
112	$2s\,2p^3(^5S)\,3d\;^4D^o_{1/2}$	2.19E-14	2.19E-14	2.20E-14		2.08E-14

Table 5. (*continued*)

Lower state	Upper state	MCDF (*l*)[a]	MCDF (*v*)[a]	MBPT (*l*)[a]	MCDF2 (*l*)[b]	GRASP (*l*)[c]
113	$2s\,2p^3(^3S)\,3s\;^2S^o_{1/2}$	9.24E-14	9.23E-14	9.29E-14		8.69E-14
114	$2s\,2p^3(^3D)\,3p\;^2D_{3/2}$	5.96E-14	5.93E-14	5.99E-14		5.86E-14
115	$2s\,2p^3(^3D)\,3p\;^4P_{5/2}$	1.37E-13	1.36E-13	1.38E-13		1.35E-13
116	$2s\,2p^3(^3D)\,3p\;^4F_{9/2}$	2.40E-11	2.38E-11	2.41E-11		2.28E-11
117	$2s\,2p^3(^3D)\,3p\;^4D_{7/2}$	1.02E-13	1.02E-13	1.02E-13		9.89E-14
118	$2s\,2p^3(^3D)\,3p\;^2P_{3/2}$	4.65E-14	4.63E-14	4.67E-14		4.42E-14
119	$2s\,2p^3(^3P)\,3p\;^4D_{1/2}$	1.51E-13	1.51E-13	1.52E-13		1.45E-13
120	$2s\,2p^3(^3P)\,3p\;^4D_{3/2}$	1.25E-13	1.25E-13	1.26E-13		1.24E-13
121	$2s\,2p^3(^3D)\,3d\;^4F^o_{3/2}$	3.87E-14	3.86E-14	3.89E-14		3.80E-14
122	$2s\,2p^3(^3D)\,3d\;^4G^o_{5/2}$	7.53E-13	7.50E-13	7.52E-13		8.04E-13
123	$2s\,2p^3(^3D)\,3p\;^2D_{5/2}$	5.46E-14	5.43E-14	5.47E-14		5.46E-14
124	$2s\,2p^3(^3S)\,3p\;^4P_{1/2}$	6.49E-14	6.46E-14	6.52E-14		6.27E-14
125	$2s\,2p^3(^3D)\,3d\;^4D^o_{1/2}$	1.02E-13	1.02E-13	1.02E-13		9.99E-14
126	$2s\,2p^3(^3D)\,3d\;^4G^o_{7/2}$	1.75E-13	1.75E-13	1.75E-13		1.90E-13
127	$2s\,2p^3(^1D)\,3p\;^2F_{5/2}$	8.21E-14	8.18E-14	8.29E-14		7.94E-14
128	$2s\,2p^3(^3D)\,3d\;^4F^o_{5/2}$	2.12E-14	2.12E-14	2.12E-14		2.17E-14
129	$2s\,2p^3(^3P)\,3s\;^4P^o_{5/2}$	7.37E-14	7.35E-14	7.40E-14		7.00E-14
130	$2s\,2p^3(^3P)\,3p\;^4P_{3/2}$	1.29E-13	1.29E-13	1.28E-13		1.40E-13
131	$2s\,2p^3(^3P)\,3p\;^2P_{3/2}$	8.71E-14	8.67E-14	8.80E-14		7.83E-14
132	$2s\,2p^3(^3D)\,3d\;^4D^o_{3/2}$	3.09E-14	3.08E-14	3.08E-14		3.33E-14
133	$2s\,2p^3(^3S)\,3p\;^4P_{5/2}$	1.21E-13	1.20E-13	1.21E-13		1.16E-13
134	$2s\,2p^3(^3P)\,3p\;^2P_{1/2}$	1.43E-13	1.42E-13	1.44E-13		1.25E-13
135	$2s\,2p^3(^3D)\,3d\;^4F^o_{7/2}$	3.85E-14	3.84E-14	3.86E-14		3.67E-14
136	$2s\,2p^3(^3D)\,3d\;^4D^o_{5/2}$	2.59E-14	2.58E-14	2.60E-14		2.31E-14
137	$2s\,2p^3(^3D)\,3d\;^2P^o_{3/2}$	3.83E-14	3.82E-14	3.86E-14		3.46E-14
138	$2s\,2p^3(^3D)\,3d\;^2S^o_{1/2}$	1.39E-13	1.39E-13	1.40E-13		1.32E-13
139	$2s\,2p^3(^3D)\,3d\;^4G^o_{9/2}$	4.25E-11	4.17E-11	4.29E-11		3.75E-11
140	$2s\,2p^3(^3P)\,3s\;^4P^o_{3/2}$	8.02E-14	8.01E-14	8.03E-14		6.75E-14
141	$2s\,2p^3(^3P)\,3p\;^2D_{3/2}$	6.45E-14	6.42E-14	6.46E-14		6.33E-14
142	$2s\,2p^3(^1D)\,3p\;^2F_{7/2}$	9.57E-14	9.53E-14	9.59E-14		2.66E-13
143	$2s\,2p^3(^3D)\,3d\;^2G^o_{7/2}$	2.66E-13	2.65E-13	2.66E-13		9.69E-14
144	$2s\,2p^3(^3S)\,3p\;^4P_{3/2}$	2.37E-13	2.36E-13	2.38E-13		2.37E-13
145	$2s\,2p^3(^1P)\,3p\;^2P_{1/2}$	8.56E-14	8.52E-14	8.59E-14		8.23E-14
146	$2s\,2p^3(^1D)\,3p\;^2D_{5/2}$	2.87E-13	2.85E-13	2.87E-13		2.76E-13
147	$2s\,2p^3(^1D)\,3p\;^2P_{1/2}$	7.71E-14	7.67E-14	7.72E-14		8.03E-14
148	$2s\,2p^3(^3D)\,3d\;^4F^o_{9/2}$	3.99E-11	3.94E-11	4.01E-11		3.72E-11
149	$2s\,2p^3(^1D)\,3p\;^2D_{3/2}$	1.53E-13	1.52E-13	1.53E-13		1.41E-13
150	$2s\,2p^3(^3D)\,3d\;^4P^o_{5/2}$	1.95E-14	1.94E-14	1.95E-14		1.90E-14
151	$2s\,2p^3(^3D)\,3d\;^2P^o_{1/2}$	3.02E-14	3.01E-14	3.03E-14		2.88E-14
152	$2s\,2p^3(^3D)\,3d\;^4G^o_{11/2}$	6.14E-11	5.97E-11	6.19E-11		5.39E-11
153	$2s\,2p^3(^1P)\,3p\;^2D_{5/2}$	1.74E-13	1.73E-13	1.74E-13		1.66E-13
154	$2s\,2p^3(^3D)\,3d\;^4D^o_{7/2}$	1.50E-14	1.49E-14	1.50E-14		1.40E-14
155	$2s\,2p^3(^3D)\,3d\;^2D^o_{3/2}$	1.58E-14	1.58E-14	1.58E-14		1.51E-14
156	$2s\,2p^3(^3D)\,3d\;^2G^o_{9/2}$	1.17E-11	1.16E-11	1.17E-11		1.11E-11
157	$2s\,2p^3(^3D)\,3d\;^2D^o_{5/2}$	1.21E-14	1.21E-14	1.22E-14		1.18E-14
158	$2s\,2p^3(^3D)\,3d\;^4P^o_{3/2}$	1.08E-14	1.07E-14	1.08E-14		1.03E-14
159	$2s\,2p^3(^3S)\,3p\;^2P_{1/2}$	1.30E-13	1.30E-13	1.31E-13		1.27E-13
160	$2s\,2p^3(^3S)\,3p\;^2P_{3/2}$	1.04E-13	1.03E-13	1.04E-13		1.06E-13
161	$2s\,2p^3(^3D)\,3d\;^4P^o_{1/2}$	2.40E-14	2.40E-14	2.41E-14		2.31E-14
162	$2s\,2p^3(^1P)\,3s\;^2P^o_{3/2}$	1.04E-13	1.04E-13	1.04E-13		1.00E-13
163	$2s\,2p^3(^1P)\,3s\;^2P^o_{1/2}$	7.70E-14	7.69E-14	7.74E-14		7.41E-14
164	$2s\,2p^3(^3D)\,3d\;^4S^o_{3/2}$	1.60E-14	1.59E-14	1.60E-14		1.53E-14
165	$2s\,2p^3(^3D)\,3d\;^2F^o_{7/2}$	2.34E-14	2.33E-14	2.35E-14		2.24E-14
166	$2s\,2p^3(^3D)\,3d\;^2F^o_{5/2}$	1.76E-14	1.75E-14	1.76E-14		1.66E-14
167	$2s\,2p^3(^3P)\,3d\;^4F^o_{3/2}$	7.59E-14	7.57E-14	7.61E-14		7.39E-14
168	$2s\,2p^3(^3P)\,3d\;^4F^o_{5/2}$	4.52E-14	4.51E-14	4.54E-14		4.29E-14

Table 5. (*continued*)

Lower state	Upper state	MCDF (l)[a]	MCDF (v)[a]	MBPT (l)[a]	MCDF2 (l)[b]	GRASP (l)[c]
169	$2s\,2p^3(^1D)\,3p\;^2P_{3/2}$	1.59E-13	1.59E-13	1.60E-13		1.56E-13
170	$2s\,2p^3(^3P)\,3p\;^2D_{5/2}$	5.32E-14	5.29E-14	5.35E-14		5.10E-14
171	$2s\,2p^3(^3S)\,3d\;^4D^o_{1/2}$	2.15E-14	2.15E-14	2.16E-14		2.00E-14
172	$2s\,2p^3(^3P)\,3d\;^4F^o_{7/2}$	2.15E-13	2.15E-13	2.15E-13		2.01E-13
173	$2s\,2p^3(^3P)\,3d\;^4P^o_{5/2}$	7.06E-14	7.05E-14	7.08E-14		6.99E-14
174	$2s\,2p^3(^3P)\,3d\;^4D^o_{3/2}$	2.96E-14	2.95E-14	2.98E-14		2.26E-14
175	$2s\,2p^3(^3P)\,3p\;^4D_{7/2}$	5.25E-13	5.23E-13	5.27E-13		4.90E-13
176	$2s\,2p^3(^3P)\,3d\;^2D^o_{3/2}$	2.99E-14	2.98E-14	2.99E-14		3.65E-14
177	$2s\,2p^3(^3P)\,3d\;^2F^o_{5/2}$	5.14E-14	5.13E-14	5.17E-14		4.77E-14
178	$2s\,2p^3(^1D)\,3d\;^2F^o_{7/2}$	7.92E-14	7.90E-14	7.93E-14		7.60E-14
179	$2s\,2p^3(^3D)\,3p\;^4P_{3/2}$	6.29E-14	6.26E-14	6.31E-14		6.18E-14
180	$2s\,2p^3(^1D)\,3d\;^2G^o_{9/2}$	6.87E-12	6.85E-12	6.90E-12		6.59E-12
181	$2s\,2p^3(^3P)\,3p\;^4P_{5/2}$	2.86E-13	2.85E-13	2.83E-13		3.43E-13
182	$2s\,2p^3(^3P)\,3d\;^4D^o_{5/2}$	5.12E-14	5.11E-14	5.14E-14		4.90E-14
183	$2s\,2p^3(^1D)\,3d\;^2P^o_{3/2}$	1.80E-14	1.79E-14	1.80E-14		1.75E-14
184	$2s\,2p^3(^1D)\,3d\;^2G^o_{7/2}$	2.96E-14	2.96E-14	2.97E-14		2.81E-14
185	$2s\,2p^3(^3P)\,3d\;^4P^o_{1/2}$	1.19E-14	1.18E-14	1.19E-14		1.14E-14
186	$2s\,2p^3(^3P)\,3p\;^2S_{1/2}$	4.00E-14	3.98E-14	4.01E-14		4.04E-14
187	$2s\,2p^3(^3S)\,3d\;^4D^o_{5/2}$	2.15E-14	2.15E-14	2.16E-14		2.32E-14
188	$2s\,2p^3(^1D)\,3d\;^2P^o_{1/2}$	1.23E-14	1.23E-14	1.24E-14		1.19E-14
189	$2s\,2p^3(^3S)\,3d\;^4D^o_{3/2}$	1.56E-14	1.56E-14	1.57E-14		1.53E-14
190	$2s\,2p^3(^1D)\,3d\;^2F^o_{5/2}$	1.28E-14	1.28E-14	1.29E-14		1.15E-14
191	$2s\,2p^3(^3S)\,3d\;^4D^o_{7/2}$	4.18E-14	4.17E-14	4.20E-14		4.00E-14
192	$2s\,2p^3(^3P)\,3d\;^4D^o_{1/2}$	1.30E-14	1.30E-14	1.31E-14		1.26E-14
193	$2s\,2p^3(^3P)\,3d\;^2P^o_{3/2}$	1.89E-14	1.88E-14	1.88E-14		1.72E-14
194	$2s\,2p^3(^3S)\,3d\;^2D^o_{3/2}$	1.11E-14	1.11E-14	1.12E-14		1.07E-14
195	$2s\,2p^3(^1P)\,3p\;^2S_{1/2}$	1.82E-13	1.82E-13	1.83E-13		1.73E-13
196	$2s\,2p^3(^1P)\,3p\;^2D_{3/2}$	1.01E-13	1.01E-13	1.02E-13		9.85E-14
197	$2p^4(^3P)\,3s\;^4P_{5/2}$	2.99E-13	2.98E-13	2.99E-13		2.45E-13
198	$2s\,2p^3(^3S)\,3d\;^2D^o_{5/2}$	1.28E-14	1.28E-14	1.28E-14		1.25E-14
199	$2s\,2p^3(^3P)\,3p\;^4D_{5/2}$	1.24E-13	1.23E-13	1.24E-13		1.34E-13
200	$2p^4(^3P)\,3s\;^2P_{3/2}$	1.40E-13	1.40E-13	1.41E-13		2.29E-13
201	$2s\,2p^3(^1P)\,3p\;^2P_{3/2}$	1.43E-13	1.43E-13	1.43E-13		1.02E-13
202	$2s\,2p^3(^3P)\,3d\;^4F^o_{9/2}$	9.13E-12	9.05E-12	9.20E-12		7.96E-12
203	$2s\,2p^3(^1S)\,3p\;^2S_{1/2}$	2.82E-13	2.81E-13	2.84E-13		2.78E-13
204	$2s\,2p^3(^1D)\,3d\;^2S^o_{1/2}$	1.33E-14	1.33E-14	1.34E-14		1.27E-14
205	$2s\,2p^3(^1D)\,3d\;^2D^o_{3/2}$	1.37E-14	1.37E-14	1.37E-14		1.31E-14
206	$2s\,2p^3(^1D)\,3d\;^2D^o_{5/2}$	2.22E-14	2.21E-14	2.23E-14		2.10E-14
207	$2s\,2p^3(^3P)\,3d\;^4D^o_{7/2}$	3.67E-14	3.66E-14	3.66E-14		8.17E-14
208	$2s\,2p^3(^3P)\,3d\;^2F^o_{7/2}$	1.84E-14	1.83E-14	1.85E-14		1.33E-14
209	$2s\,2p^3(^3P)\,3d\;^2D^o_{5/2\;b}$	1.71E-14	1.71E-14	1.72E-14		1.53E-14
210	$2p^4(^3P)\,3s\;^4P_{1/2}$	2.46E-13	2.45E-13	2.46E-13		2.37E-13
211	$2s\,2p^3(^1P)\,3d\;^2D^o_{3/2}$	2.15E-14	2.14E-14	2.15E-14		2.02E-14
212	$2p^4(^3P)\,3p\;^4P^o_{3/2}$	7.96E-14	7.92E-14	7.98E-14		7.77E-14
213	$2p^4(^3P)\,3p\;^4D^o_{5/2}$	7.36E-14	7.33E-14	7.38E-14		7.00E-14
214	$2s\,2p^3(^3P)\,3d\;^2P^o_{1/2}$	9.64E-15	9.62E-15	9.68E-15		9.16E-15
215	$2p^4(^3P)\,3p\;^4D^o_{7/2}$	1.11E-13	1.11E-13	1.14E-13		1.31E-13
216	$2p^4(^3P)\,3p\;^2P^o_{1/2}$	4.57E-14	4.55E-14	4.52E-14		3.59E-14
217	$2p^4(^3P)\,3p\;^4P^o_{5/2}$	5.32E-14	5.30E-14	5.31E-14		5.01E-14
218	$2p^4(^3P)\,3s\;^4P_{3/2}$	2.94E-13	2.94E-13	2.97E-13		2.64E-13
219	$2s\,2p^3(^1P)\,3d\;^2P^o_{1/2}$	1.48E-14	1.47E-14	1.49E-14		1.50E-14
220	$2s\,2p^3(^1P)\,3d\;^2F^o_{7/2}$	1.35E-13	1.35E-13	1.33E-13		1.10E-13
221	$2s\,2p^3(^1P)\,3d\;^2D^o_{5/2}$	1.03E-13	1.02E-13	9.99E-14		1.34E-13
222	$2s\,2p^3(^1P)\,3d\;^2P^o_{3/2}$	1.98E-14	1.97E-14	1.99E-14		1.87E-14
223	$2s\,2p^3(^1P)\,3d\;^2F^o_{5/2}$	1.56E-14	1.55E-14	1.58E-14		1.40E-14

Table 5. (*continued*)

Lower state	Upper state	MCDF (l)[a]	MCDF (v)[a]	MBPT (l)[a]	MCDF2 (l)[b]	GRASP (l)[c]
224	$2p^4(^3P)\,3s\ ^2P_{1/2}$	8.98E-14	8.97E-14	9.04E-14		8.34E-14
225	$2p^4(^3P)\,3p\ ^4D^o_{1/2}$	6.84E-14	6.81E-14	6.85E-14		6.73E-14
226	$2s\,2p^3(^3P)\,3d\ ^2D^o_{3/2}$	7.86E-15	7.84E-15	7.87E-15		7.29E-15
227	$2p^4(^1D)\,3s\ ^2D_{5/2}$	1.50E-13	1.50E-13	1.51E-13		1.37E-13
228	$2p^4(^1D)\,3s\ ^2D_{3/2}$	1.19E-13	1.19E-13	1.20E-13		1.11E-13
229	$2p^4(^3P)\,3p\ ^4S^o_{3/2}$	5.42E-14	5.40E-14	5.55E-14		6.07E-14
230	$2p^4(^3P)\,3p\ ^4D^o_{3/2}$	6.57E-14	6.53E-14	6.59E-14		6.54E-14
231	$2p^4(^3P)\,3p\ ^4P^o_{1/2}$	6.51E-14	6.49E-14	6.53E-14		6.24E-14
232	$2p^4(^3P)\,3d\ ^4D_{5/2}$	1.86E-12	1.86E-12	1.85E-12		1.93E-12
233	$2p^4(^3P)\,3p\ ^2P^o_{3/2}$	6.52E-14	6.49E-14	6.55E-14		6.27E-14
234	$2p^4(^3P)\,3d\ ^4D_{3/2}$	1.18E-12	1.18E-12	1.18E-12		1.16E-12
235	$2p^4(^3P)\,3d\ ^4D_{7/2}$	2.73E-12	2.72E-12	2.72E-12		2.77E-12
236	$2p^4(^3P)\,3d\ ^4P_{1/2}$	5.87E-13	5.83E-13	5.90E-13		5.51E-13
237	$2p^4(^3P)\,3d\ ^4F_{9/2}$	4.89E-12	4.86E-12	4.94E-12		4.52E-12
238	$2p^4(^3P)\,3d\ ^2F_{7/2}$	2.01E-12	2.01E-12	2.02E-12		1.95E-12
239	$2p^4(^1D)\,3p\ ^2F^o_{5/2}$	7.95E-14	7.91E-14	7.96E-14		7.90E-14
240	$2p^4(^3P)\,3p\ ^2D^o_{5/2}$	6.84E-14	6.80E-14	6.86E-14		6.75E-14
241	$2p^4(^3P)\,3d\ ^2P_{1/2}$	3.26E-14	3.25E-14	3.27E-14		3.20E-14
242	$2p^4(^3P)\,3p\ ^2S^o_{1/2}$	5.39E-14	5.36E-14	5.41E-14		5.09E-14
243	$2p^4(^1D)\,3p\ ^2D^o_{3/2}$	6.61E-14	6.58E-14	6.62E-14		6.57E-14
244	$2p^4(^3P)\,3d\ ^4P_{3/2}$	2.71E-14	2.71E-14	2.72E-14		2.68E-14
245	$2p^4(^3P)\,3d\ ^2D_{5/2}$	2.03E-14	2.03E-14	2.04E-14		2.02E-14
246	$2p^4(^1D)\,3p\ ^2F^o_{7/2}$	7.52E-14	7.48E-14	7.54E-14		7.54E-14
247	$2p^4(^1D)\,3p\ ^2P^o_{3/2}$	6.00E-14	5.97E-14	5.97E-14		6.26E-14
248	$2p^4(^1D)\,3p\ ^2D^o_{3/2}$	4.76E-14	4.74E-14	4.85E-14		4.47E-14
249	$2p^4(^3P)\,3d\ ^4F_{3/2}$	5.31E-14	5.30E-14	5.35E-14		5.10E-14
250	$2p^4(^1D)\,3p\ ^2D^o_{5/2}$	7.40E-14	7.36E-14	7.41E-14		7.41E-14
251	$2p^4(^3P)\,3d\ ^4F_{5/2}$	4.44E-14	4.43E-14	4.46E-14		4.38E-14
252	$2p^4(^1D)\,3s\ ^2P_{1/2}$	1.01E-13	1.01E-13	1.02E-13		9.36E-14
253	$2p^4(^1D)\,3p\ ^2P^o_{1/2}$	5.43E-14	5.40E-14	5.48E-14		5.58E-14
254	$2p^4(^3P)\,3d\ ^4D_{1/2}$	1.63E-12	1.62E-12	1.64E-12		1.55E-12
255	$2p^4(^3P)\,3d\ ^2P_{3/2}$	3.99E-13	3.99E-13	4.02E-13		1.49E-13
256	$2p^4(^3P)\,3d\ ^4F_{7/2}$	3.40E-12	3.40E-12	3.42E-12		3.16E-12
257	$2p^4(^3P)\,3d\ ^4P_{5/2}$	4.34E-14	4.32E-14	4.34E-14		4.52E-14
258	$2p^4(^3P)\,3d\ ^2F_{5/2}$	1.71E-13	1.70E-13	1.76E-13		1.10E-13
259	$2p^4(^3P)\,3d\ ^2D_{3/2}$	1.51E-13	1.50E-13	1.51E-13		3.48E-13
260	$2p^4(^1D)\,3d\ ^2G_{7/2}$	4.30E-12	4.29E-12	4.33E-12		3.99E-12
261	$2p^4(^1D)\,3d\ ^2G_{9/2}$	4.60E-12	4.59E-12	4.65E-12		4.24E-12
262	$2p^4(^1D)\,3d\ ^2D_{5/2}$	4.78E-13	4.77E-13	4.85E-13		4.71E-13
263	$2p^4(^1D)\,3d\ ^2S_{1/2}$	1.28E-14	1.28E-14	1.28E-14		1.23E-14
264	$2p^4(^1D)\,3d\ ^2F_{7/2}$	1.53E-12	1.53E-12	1.51E-12		1.63E-12
265	$2p^4(^1D)\,3d\ ^2P_{3/2}$	1.05E-14	1.04E-14	1.06E-14		9.56E-15
266	$2p^4(^1D)\,3d\ ^2F_{5/2}$	1.15E-14	1.14E-14	1.15E-14		1.03E-14
267	$2p^4(^1D)\,3d\ ^2D_{3/2}$	9.35E-15	9.33E-15	9.40E-15		8.87E-15
268	$2p^4(^1S)\,3p\ ^2P^o_{1/2}$	4.71E-14	4.69E-14	4.76E-14		4.59E-14
269	$2p^4(^3P)\,3d\ ^4P_{1/2}$	7.16E-15	7.15E-15	7.21E-15		6.67E-15
270	$2p^4(^1S)\,3p\ ^2P^o_{3/2}$	6.82E-14	6.79E-14	6.85E-14		6.77E-14
271	$2p^4(^1S)\,3d\ ^2D_{5/2}$	5.69E-13	5.69E-13	5.66E-13		5.48E-13
272	$2p^4(^1S)\,3d\ ^2D_{3/2}$	1.33E-14	1.32E-14	1.34E-14		1.21E-14

Table 6. The present MCDF hyperfine magnetic dipole constants $A_J(I/\mu_I)$ (MHz per unit of μ_N), electric quadrupole constants B_J/Q(MHz/barn), Land$\acute{e}$ g_J-factors, and the total energies E_h (a.u.) for the 272 levels in N-like Kr XXX. $a-$ the present results; $b-$ the MCDF values [18].

Key	Level	$E_h{}^a$	$A_J{}^a$	A_J (MCDF2)^b	$B_J{}^a$	B_J (MCDF2)^b	$g_J{}^a$	g_J (MCDF2)^b
1	$2s^2\,2p^3\ ^4S^o_{3/2}$	-1985.83	5.953E+04	5.948E+04	9.717E+04	9.700E+04	1.548E+00	1.549E+00
2	$2s^2\,2p^3\ ^2D^o_{3/2}$	-1984.07	2.044E+04	2.036E+04	7.033E+04	7.028E+04	1.320E+00	1.320E+00
3	$2s^2\,2p^3\ ^2D^o_{5/2}$	-1983.60	1.549E+05	1.549E+05	-7.734E+02	-7.717E+02	1.192E+00	1.192E+00
4	$2s^2\,2p^3\ ^2P^o_{1/2}$	-1982.99	4.537E+05	4.540E+05	0.000E+00	0.000E+00	6.561E-01	6.561E-01
5	$2s^2\,2p^3\ ^2P^o_{3/2}$	-1981.29	8.572E+04	8.569E+04	-1.687E+05	-1.685E+05	1.244E+00	1.244E+00
6	$2s\,2p^4\ ^4P_{5/2}$	-1979.49	3.532E+05	3.536E+05	1.013E+05	1.011E+05	1.546E+00	1.546E+00
7	$2s\,2p^4\ ^4P_{3/2}$	-1978.32	5.607E+04	5.633E+04	-1.070E+05	-1.069E+05	1.520E+00	1.520E+00
8	$2s\,2p^4\ ^4P_{1/2}$	-1978.27	1.118E+06	1.119E+06	0.000E+00	0.000E+00	2.429E+00	2.429E+00
9	$2s\,2p^4\ ^2D_{3/2}$	-1976.91	9.911E+04	9.884E+04	-1.304E+05	-1.302E+05	1.136E+00	1.136E+00
10	$2s\,2p^4\ ^2D_{5/2}$	-1976.38	4.346E+05	4.350E+05	-2.503E+05	-2.499E+05	1.239E+00	1.239E+00
11	$2s\,2p^4\ ^2P_{1/2}$	-1975.66	1.395E+05	1.403E+05	0.000E+00	0.000E+00	1.543E+00	1.543E+00
12	$2s\,2p^4\ ^2P_{3/2}$	-1975.27	3.249E+04	3.228E+04	5.775E+04	5.770E+04	1.189E+00	1.190E+00
13	$2s\,2p^4\ ^2S_{1/2}$	-1973.34	1.173E+06	1.175E+06	0.000E+00	0.000E+00	1.340E+00	1.340E+00
14	$2p^5\ ^2P^o_{3/2}$	-1970.15	7.362E+04	7.361E+04	-1.464E+05	-1.462E+05	1.326E+00	1.326E+00
15	$2p^5\ ^2P^o_{1/2}$	-1968.04	4.555E+05	4.556E+05	0.000E+00	0.000E+00	6.561E-01	6.562E-01
16	$2s^2\,2p^2(^3P)\,3s\ ^4P_{1/2}$	-1916.67	3.874E+05		0.000E+00		2.107E+00	
17	$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{1/2}$	-1915.27	1.243E+05		0.000E+00		6.728E-01	
18	$2s^2\,2p^2(^3P)\,3s\ ^4P_{3/2}$	-1914.94	1.100E+05		9.904E+04		1.687E+00	
19	$2s^2\,2p^2(^3P)\,3s\ ^2P_{1/2}$	-1914.76	-1.385E+05		0.000E+00		1.234E+00	
20	$2s^2\,2p^2(^3P)\,3s\ ^4P_{5/2}$	-1914.56	2.133E+05		6.507E+04		1.399E+00	
21	$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{3/2}$	-1914.50	2.303E+04		3.399E+04		1.344E+00	
22	$2s^2\,2p^2(^1D)\,3s\ ^2D_{3/2}$	-1914.42	1.407E+05		4.817E+04		1.044E+00	
23	$2s^2\,2p^2(^3P)\,3p\ ^4P^o_{1/2}$	-1913.54	-5.607E+04		0.000E+00		1.623E+00	
24	$2s^2\,2p^2(^3P)\,3p\ ^2D^o_{3/2}$	-1913.39	1.066E+05		6.374E+03		1.161E+00	
25	$2s^2\,2p^2(^1D)\,3p\ ^2F^o_{5/2}$	-1913.12	1.580E+05		5.913E+04		1.163E+00	
26	$2s^2\,2p^2(^3P)\,3d\ ^4F_{3/2}$	-1912.98	1.516E+04		3.244E+03		7.610E-01	
27	$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{5/2}$	-1912.89	4.068E+03		1.562E+05		1.429E+00	
28	$2s^2\,2p^2(^3P)\,3p\ ^2S^o_{1/2}$	-1912.80	-1.076E+05		0.000E+00		1.861E+00	
29	$2s^2\,2p^2(^3P)\,3p\ ^4S^o_{3/2}$	-1912.71	1.025E+05		-2.663E+04		1.314E+00	
30	$2s^2\,2p^2(^3P)\,3d\ ^4D_{5/2}$	-1912.64	4.202E+03		-3.084E+03		1.199E+00	
31	$2s^2\,2p^2(^3P)\,3p\ ^4P^o_{3/2}$	-1912.58	1.346E+05		2.945E+04		1.451E+00	
32	$2s^2\,2p^2(^3P)\,3p\ ^4D^o_{7/2}$	-1912.51	1.051E+05		9.950E+04		1.289E+00	
33	$2s^2\,2p^2(^1D)\,3s\ ^2D_{5/2}$	-1912.49	1.527E+05		8.568E+04		1.388E+00	
34	$2s^2\,2p^2(^3P)\,3s\ ^2P_{3/2}$	-1912.35	2.654E+04		3.420E+04		1.113E+00	
35	$2s^2\,2p^2(^3P)\,3p\ ^2P^o_{3/2}$	-1912.33	4.503E+04		4.597E+04		1.285E+00	
36	$2s^2\,2p^2(^1D)\,3p\ ^2D^o_{5/2}$	-1912.13	1.338E+05		1.903E+04		1.182E+00	
37	$2s^2\,2p^2(^3P)\,3p\ ^2P^o_{1/2}$	-1911.84	4.347E+05		0.000E+00		7.365E-01	
38	$2s^2\,2p^2(^1S)\,3s\ ^2S_{1/2}$	-1911.56	3.959E+05		0.000E+00		1.977E+00	
39	$2s\,2p^3(^5S)\,3s\ ^6S^o_{5/2}$	-1911.34	3.812E+05		4.487E+04		1.871E+00	
40	$2s^2\,2p^2(^3P)\,3d\ ^2P_{3/2}$	-1911.21	2.851E+04		-7.351E+04		9.514E-01	
41	$2s^2\,2p^2(^3P)\,3d\ ^4F_{5/2}$	-1911.16	7.337E+04		-3.497E+04		9.945E-01	
42	$2s^2\,2p^2(^3P)\,3d\ ^4D_{1/2}$	-1911.14	1.012E+05		0.000E+00		2.094E-01	
43	$2s^2\,2p^2(^3P)\,3d\ ^4F_{7/2}$	-1911.09	-2.513E+03		1.074E+05		1.284E+00	
44	$2s^2\,2p^2(^1D)\,3d\ ^2F_{7/2}$	-1910.88	8.997E+04		7.304E+04		1.153E+00	
45	$2s\,2p^3(^5S)\,3s\ ^4S^o_{3/2}$	-1910.86	1.841E+05		5.377E+04		1.484E+00	
46	$2s^2\,2p^2(^3P)\,3d\ ^4P_{5/2}$	-1910.84	3.282E+04		-5.439E+04		1.204E+00	
47	$2s^2\,2p^2(^3P)\,3d\ ^4D_{3/2}$	-1910.83	-3.772E+04		-3.649E+04		1.221E+00	
48	$2s^2\,2p^2(^3P)\,3d\ ^4F_{9/2}$	-1910.71	7.617E+04		6.043E+04		1.228E+00	
49	$2s^2\,2p^2(^3P)\,3p\ ^2D^o_{5/2}$	-1910.67	9.924E+04		4.579E+04		1.184E+00	
50	$2s\,2p^3(^3P)\,3s\ ^2P^o_{3/2}$	-1910.66	2.924E+05		3.897E+04		1.634E+00	
51	$2s^2\,2p^2(^1D)\,3d\ ^2D_{5/2}$	-1910.56	7.290E+04		1.312E+04		1.259E+00	
52	$2s^2\,2p^2(^3P)\,3d\ ^4P_{3/2}$	-1910.49	7.577E+04		7.123E+03		1.408E+00	
53	$2s^2\,2p^2(^3P)\,3p\ ^4P^o_{5/2}$	-1910.49	6.912E+04		2.812E+04		1.252E+00	
54	$2s^2\,2p^2(^1D)\,3p\ ^2P^o_{1/2}$	-1910.46	1.609E+05		0.000E+00		1.044E+00	
55	$2s^2\,2p^2(^1D)\,3p\ ^2F^o_{7/2}$	-1910.44	6.699E+04		1.359E+05		1.272E+00	

Table 6. (*continued*)

Key	Level	$E_h{}^a$	$A_J{}^a$	A_J (MCDF2)^b	$B_J{}^a$	B_J (MCDF2)^b	$g_J{}^a$	g_J (MCDF2)^b
56	$2s^2\,2p^2(^3P)\,3d\ ^4P_{1/2}$	-1910.42	2.170E+05		0.000E+00		2.113E+00	
57	$2s^2\,2p^2(^3P)\,3d\ ^2D_{5/2}$	-1910.28	9.265E+03		7.789E+04		1.129E+00	
58	$2s^2\,2p^2(^1D)\,3d\ ^2G_{7/2}$	-1910.24	8.953E+04		2.749E+04		1.084E+00	
59	$2s^2\,2p^2(^3P)\,3d\ ^2D_{3/2}$	-1910.20	1.165E+05		2.099E+04		8.899E-01	
60	$2s^2\,2p^2(^3P)\,3d\ ^2P_{1/2}$	-1910.18	-1.704E+05		0.000E+00		8.275E-01	
61	$2s^2\,2p^2(^1S)\,3p\ ^2P^o_{1/2}$	-1909.82	1.267E+05		0.000E+00		6.827E-01	
62	$2s\,2p^3(^5S)\,3p\ ^6P_{3/2}$	-1909.81	4.314E+05		3.523E+04		2.131E+00	
63	$2s^2\,2p^2(^1D)\,3p\ ^2P^o_{3/2}$	-1909.76	7.794E+04		9.654E+04		1.306E+00	
64	$2s\,2p^3(^5S)\,3p\ ^6P_{5/2}$	-1909.75	3.243E+05		2.827E+04		1.676E+00	
65	$2s\,2p^3(^3D)\,3s\ ^4D^o_{1/2}$	-1909.57	-3.951E+05		0.000E+00		4.982E-01	
66	$2s\,2p^3(^3D)\,3s\ ^4D^o_{3/2}$	-1909.44	3.527E+04		1.003E+05		1.331E+00	
67	$2s^2\,2p^2(^1S)\,3p\ ^2P^o_{3/2}$	-1909.37	4.053E+04		-4.036E+04		1.301E+00	
68	$2s\,2p^3(^5S)\,3p\ ^6P_{7/2}$	-1909.27	2.286E+05		8.109E+04		1.624E+00	
69	$2s\,2p^3(^3D)\,3s\ ^4D^o_{5/2}$	-1909.09	3.382E+05		1.976E+05		1.496E+00	
70	$2s\,2p^3(^5S)\,3p\ ^4P_{3/2}$	-1908.99	3.769E+05		-2.443E+04		1.679E+00	
71	$2s\,2p^3(^5S)\,3p\ ^4P_{5/2}$	-1908.84	2.443E+05		4.226E+04		1.562E+00	
72	$2s\,2p^3(^5S)\,3p\ ^4P_{1/2}$	-1908.78	4.778E+05		0.000E+00		2.119E+00	
73	$2s^2\,2p^2(^3P)\,3d\ ^4D_{7/2}$	-1908.71	4.116E+04		2.395E+04		1.227E+00	
74	$2s\,2p^3(^3D)\,3s\ ^2D^o_{3/2}$	-1908.71	2.254E+05		1.051E+05		1.201E+00	
75	$2s^2\,2p^2(^1D)\,3d\ ^2G_{9/2}$	-1908.63	4.543E+04		1.109E+05		1.208E+00	
76	$2s^2\,2p^2(^1D)\,3d\ ^2D_{3/2}$	-1908.59	7.251E+04		-5.786E+04		1.064E+00	
77	$2s^2\,2p^2(^1D)\,3d\ ^2P_{1/2}$	-1908.57	5.086E+04		0.000E+00		8.657E-01	
78	$2s^2\,2p^2(^1D)\,3d\ ^2F_{5/2}$	-1908.57	5.729E+04		-1.037E+04		1.210E+00	
79	$2s\,2p^3(^3D)\,3s\ ^4D^o_{7/2}$	-1908.52	3.738E+05		-3.460E+02		1.421E+00	
80	$2^2\,2p^2(^3P)\,3d\ ^2F_{7/2}$	-1908.43	5.905E+04		5.571E+04		1.071E+00	
81	$2^2\,2p^2(^1D)\,3d\ ^2S_{1/2}$	-1908.26	-4.862E+04		0.000E+00		1.825E+00	
82	$2s\,2p^3(^3D)\,3p\ ^4F_{3/2}$	-1908.15	-5.452E+04		9.117E+04		9.260E-01	
83	$2s\,2p^3(^3D)\,3p\ ^4D_{1/2}$	-1908.15	-2.137E+05		0.000E+00		1.058E+00	
84	$2s\,2p^3(^3D)\,3s\ ^2D^o_{5/2}$	-1908.13	3.884E+05		-3.882E+04		1.238E+00	
85	$2s^2\,2p^2(^1D)\,3d\ ^2P_{3/2}$	-1908.08	-9.041E+03		1.914E+04		1.159E+00	
86	$2s^2\,2p^2(^3P)\,3d\ ^2F_{5/2}$	-1908.02	3.592E+04		8.502E+04		1.123E+00	
87	$2s\,2p^3(^5S)\,3d\ ^6D^o_{5/2}$	-1907.67	2.249E+05		1.205E+04		1.542E+00	
88	$2s\,2p^3(^3P)\,3s\ ^4P^o_{1/2}$	-1907.67	7.372E+05		0.000E+00		2.396E+00	
89	$2s\,2p^3(^3D)\,3p\ ^4D_{3/2}$	-1907.67	3.330E+05		1.083E+05		1.471E+00	
90	$2s\,2p^3(^5S)\,3d\ ^6D^o_{3/2}$	-1907.66	2.828E+05		-3.940E+03		1.741E+00	
91	$2s\,2p^3(^5S)\,3d\ ^6D^o_{1/2}$	-1907.66	7.244E+05		0.000E+00		3.033E+00	
92	$2s\,2p^3(^5S)\,3d\ ^6D^o_{7/2}$	-1907.66	2.002E+05		3.241E+04		1.496E+00	
93	$2s\,2p^3(^3D)\,3p\ ^4F_{5/2}$	-1907.60	7.043E+04		1.281E+05		1.179E+00	
94	$2s\,2p^3(^5S)\,3d\ ^6D^o_{9/2}$	-1907.58	1.746E+05		4.518E+04		1.488E+00	
95	$2s^2\,2p^2(^1S)\,3d\ ^2D_{5/2}$	-1907.52	4.788E+04		-2.081E+04		1.181E+00	
96	$2s^2\,2p^2(^1S)\,3d\ ^2D_{3/2}$	-1907.51	1.819E+04		4.616E+04		8.302E-01	
97	$2s\,2p^3(^3P)\,3s\ ^4P^o_{3/2}$	-1907.44	2.818E+05		-1.229E+05		1.524E+00	
98	$2s\,2p^3(^3D)\,3p\ ^4D_{5/2}$	-1907.35	1.360E+05		9.446E+04		1.230E+00	
99	$2s\,2p^3(^3D)\,3p\ ^4S_{3/2}$	-1907.35	-4.513E+04		-6.486E+04		1.206E+00	
100	$2s\,2p^3(^3D)\,3p\ ^4P_{1/2}$	-1907.24	1.748E+05		0.000E+00		1.629E+00	
101	$2s\,2p^3(^3P)\,3s\ ^2P^o_{1/2}$	-1907.24	-2.392E+05		0.000E+00		8.389E-01	
102	$2s\,2p^3(^1D)\,3s\ ^2D^o_{5/2}$	-1907.12	1.336E+05		-1.148E+05		1.352E+00	
103	$2s\,2p^3(^3D)\,3p\ ^4F_{7/2}$	-1907.06	2.491E+05		1.104E+05		1.307E+00	
104	$2s\,2p^3(^5S)\,3d\ ^4D^o_{5/2}$	-1907.04	2.063E+05		-2.276E+04		1.330E+00	
105	$2s\,2p^3(^1D)\,3s\ ^2D^o_{3/2}$	-1907.03	3.225E+04		-8.224E+04		1.011E+00	
106	$2s\,2p^3(^3D)\,3p\ ^2F_{5/2}$	-1907.02	2.045E+05		9.392E+04		1.291E+00	
107	$2s\,2p^3(^5S)\,3d\ ^4D^o_{3/2}$	-1906.95	1.197E+04		-2.729E+04		1.116E+00	
108	$2s\,2p^3(^3D)\,3p\ ^2F_{7/2}$	-1906.94	2.805E+05		9.607E+04		1.308E+00	
109	$2s\,2p^3(^5S)\,3d\ ^4D^o_{7/2}$	-1906.82	1.866E+05		4.889E+04		1.346E+00	
110	$2s\,2p^3(^3D)\,3p\ ^2P_{1/2}$	-1906.79	7.889E+05		0.000E+00		1.630E+00	
111	$2s\,2p^3(^3S)\,3s\ ^4S^o_{3/2}$	-1906.78	2.521E+05		9.859E+03		1.693E+00	
112	$2s\,2p^3(^5S)\,3d\ ^4D^o_{1/2}$	-1906.74	-4.662E+05		0.000E+00		1.883E-01	

Table 6. (*continued*)

Key	Level	E_h[a]	A_J[a]	A_J (MCDF2)[b]	B_J[a]	B_J (MCDF2)[b]	g_J[a]	g_J (MCDF2)[b]
113	$2s\,2p^3(^3S)\,3s\ ^2S^o_{1/2}$	-1906.55	2.703E+05		0.000E+00		1.217E+00	
114	$2s\,2p^3(^3D)\,3p\ ^2D_{3/2}$	-1906.51	2.424E+05		-1.200E+04		1.393E+00	
115	$2s\,2p^3(^3D)\,3p\ ^4P_{5/2}$	-1906.51	3.885E+05		5.782E+04		1.501E+00	
116	$2s\,2p^3(^3D)\,3p\ ^4F_{9/2}$	-1906.45	2.575E+05		4.061E+04		1.327E+00	
117	$2s\,2p^3(^3D)\,3p\ ^4D_{7/2}$	-1906.42	3.028E+05		-2.274E+04		1.294E+00	
118	$2s\,2p^3(^3D)\,3p\ ^2P_{3/2}$	-1906.28	5.761E+05		-2.111E+04		1.302E+00	
119	$2s\,2p^3(^3P)\,3p\ ^4D_{1/2}$	-1906.21	-1.299E+05		0.000E+00		3.179E-01	
120	$2s\,2p^3(^3P)\,3p\ ^4D_{3/2}$	-1905.96	2.276E+05		-1.290E+05		1.049E+00	
121	$2s\,2p^3(^3D)\,3d\ ^4F^o_{3/2}$	-1905.95	-3.151E+04		-9.614E+04		7.155E-01	
122	$2s\,2p^3(^3D)\,3d\ ^4G^o_{5/2}$	-1905.93	-8.876E+04		1.289E+05		7.976E-01	
123	$2s\,2p^3(^3D)\,3p\ ^2D_{5/2}$	-1905.91	2.675E+05		-1.050E+04		1.224E+00	
124	$2s\,2p^3(^3S)\,3p\ ^4P_{1/2}$	-1905.85	-1.912E+05		0.000E+00		1.937E+00	
125	$2s\,2p^3(^3D)\,3d\ ^4D^o_{1/2}$	-1905.75	3.777E+04		0.000E+00		5.428E-01	
126	$2s\,2p^3(^3D)\,3d\ ^4G^o_{7/2}$	-1905.73	-2.025E+04		1.348E+05		1.117E+00	
127	$2s\,2p^3(^1D)\,3p\ ^2F_{5/2}$	-1905.71	9.245E+04		-1.154E+05		1.129E+00	
128	$2s\,2p^3(^3D)\,3d\ ^4F^o_{5/2}$	-1905.62	-2.219E+04		-1.085E+05		1.120E+00	
129	$2s\,2p^3(^3P)\,3s\ ^4P^o_{5/2}$	-1905.54	3.674E+05		-7.982E+04		1.370E+00	
130	$2s\,2p^3(^3P)\,3p\ ^4P_{3/2}$	-1905.53	1.172E+05		1.423E+04		1.367E+00	
131	$2s\,2p^3(^3P)\,3p\ ^2P_{3/2}$	-1905.50	2.380E+05		4.844E+04		1.536E+00	
132	$2s\,2p^3(^3D)\,3d\ ^4D^o_{3/2}$	-1905.45	1.425E+05		1.432E+04		1.296E+00	
133	$2s\,2p^3(^3S)\,3p\ ^4P_{5/2}$	-1905.40	2.995E+04		-8.252E+04		1.341E+00	
134	$2s\,2p^3(^3P)\,3p\ ^2P_{1/2}$	-1905.37	1.513E+05		0.000E+00		6.983E-01	
135	$2s\,2p^3(^3D)\,3d\ ^4F^o_{7/2}$	-1905.36	1.740E+05		2.195E+04		1.297E+00	
136	$2s\,2p^3(^3D)\,3d\ ^4D^o_{5/2}$	-1905.35	2.070E+05		-4.431E+04		1.298E+00	
137	$2s\,2p^3(^3D)\,3d\ ^2P^o_{3/2}$	-1905.35	3.061E+05		-3.642E+04		1.330E+00	
138	$2s\,2p^3(^3D)\,3d\ ^2S^o_{1/2}$	-1905.31	7.667E+05		0.000E+00		1.864E+00	
139	$2s\,2p^3(^3D)\,3d\ ^4G^o_{9/2}$	-1905.30	1.503E+05		1.748E+05		1.259E+00	
140	$2s\,2p^3(^3P)\,3s\ ^4P^o_{3/2}$	-1905.29	3.893E+05		-4.081E+04		1.208E+00	
141	$2s\,2p^3(^3P)\,3p\ ^2D_{3/2}$	-1905.27	3.302E+04		9.768E+04		1.221E+00	
142	$2s\,2p^3(^1D)\,3p\ ^2F_{7/2}$	-1905.16	5.091E+04		-8.404E+04		1.258E+00	
143	$2s\,2p^3(^3D)\,3d\ ^2G^o_{7/2}$	-1905.11	1.355E+05		8.919E+04		1.075E+00	
144	$2s\,2p^3(^3S)\,3p\ ^4P_{3/2}$	-1905.07	3.639E+02		-6.156E+04		1.365E+00	
145	$2s\,2p^3(^1P)\,3p\ ^2P_{1/2}$	-1905.03	8.659E+05		0.000E+00		1.615E+00	
146	$2s\,2p^3(^1D)\,3p\ ^2D_{5/2}$	-1904.92	1.531E+05		-7.190E+04		1.243E+00	
147	$2s\,2p^3(^1D)\,3p\ ^2P_{1/2}$	-1904.86	-1.557E+05		0.000E+00		1.648E+00	
148	$2s\,2p^3(^3D)\,3d\ ^4F^o_{9/2}$	-1904.85	2.363E+05		1.276E+04		1.296E+00	
149	$2s\,2p^3(^1D)\,3p\ ^2D_{3/2}$	-1904.79	6.585E+04		-6.360E+04		1.102E+00	
150	$2s\,2p^3(^3D)\,3d\ ^4P^o_{5/2}$	-1904.79	1.069E+05		6.534E+03		1.222E+00	
151	$2s\,2p^3(^3D)\,3d\ ^2P^o_{1/2}$	-1904.76	-2.818E+05		0.000E+00		1.335E+00	
152	$2s\,2p^3(^3D)\,3d\ ^4G^o_{11/2}$	-1904.75	2.086E+05		9.641E+03		1.267E+00	
153	$2s\,2p^3(^1P)\,3p\ ^2D_{5/2}$	-1904.73	1.563E+05		2.538E+04		1.394E+00	
154	$2s\,2p^3(^3D)\,3d\ ^4D^o_{7/2}$	-1904.68	2.531E+05		4.459E+04		1.345E+00	
155	$2s\,2p^3(^3D)\,3d\ ^2D^o_{3/2}$	-1904.65	7.963E+04		-7.104E+04		1.288E+00	
156	$2s\,2p^3(^3D)\,3d\ ^2G^o_{9/2}$	-1904.60	2.476E+05		-3.268E+04		1.144E+00	
157	$2s\,2p^3(^3D)\,3d\ ^2D^o_{5/2}$	-1904.57	3.276E+05		2.848E+04		1.400E+00	
158	$2s\,2p^3(^3D)\,3d\ ^4P^o_{3/2}$	-1904.47	5.548E+05		2.557E+04		1.617E+00	
159	$2s\,2p^3(^3S)\,3p\ ^2P_{1/2}$	-1904.42	1.117E+04		0.000E+00		1.402E+00	
160	$2s\,2p^3(^3S)\,3p\ ^2P_{3/2}$	-1904.40	1.119E+05		1.588E+04		1.320E+00	
161	$2s\,2p^3(^3D)\,3d\ ^4P^o_{1/2}$	-1904.39	8.591E+05		0.000E+00		1.448E+00	
162	$2s\,2p^3(^1P)\,3s\ ^2P^o_{3/2}$	-1904.28	-3.079E+04		-4.140E+04		1.467E+00	
163	$2s\,2p^3(^1P)\,3s\ ^2P^o_{1/2}$	-1904.24	-2.306E+05		0.000E+00		1.095E+00	
164	$2s\,2p^3(^3D)\,3d\ ^4S^o_{3/2}$	-1904.16	3.694E+05		-1.718E+04		1.319E+00	
165	$2s\,2p^3(^3D)\,3d\ ^2F^o_{7/2}$	-1904.10	2.047E+05		4.835E+04		1.137E+00	
166	$2s\,2p^3(^3D)\,3d\ ^2F^o_{5/2}$	-1904.06	2.412E+05		-5.667E+04		1.131E+00	
167	$2s\,2p^3(^3P)\,3d\ ^4F^o_{3/2}$	-1903.95	-1.144E+05		3.686E+04		5.862E-01	
168	$2s\,2p^3(^3P)\,3d\ ^4F^o_{5/2}$	-1903.83	1.002E+05		-3.109E+04		1.117E+00	

Table 6. (*continued*)

Key	Level	$E_h{}^a$	$A_J{}^a$	A_J (MCDF2)[b]	$B_J{}^a$	B_J (MCDF2)[b]	$g_J{}^a$	g_J (MCDF2)[b]
169	$2s\,2p^3(^1D)\,3p\ \ ^2P_{3/2}$	-1903.78	3.576E+05		-7.234E+04		1.346E+00	
170	$2s\,2p^3(^3P)\,3p\ \ ^2D_{5/2}$	-1903.75	3.314E+05		-9.663E+04		1.096E+00	
171	$2s\,2p^3(^3S)\,3d\ \ ^4D^o_{1/2}$	-1903.72	-5.606E+03		0.000E+00		5.439E-01	
172	$2s\,2p^3(^3P)\,3d\ \ ^4F^o_{7/2}$	-1903.69	6.062E+04		-1.006E+05		1.188E+00	
173	$2s\,2p^3(^3P)\,3d\ \ ^4P^o_{5/2}$	-1903.64	1.102E+05		1.012E+04		1.213E+00	
174	$2s\,2p^3(^3P)\,3d\ \ ^4D^o_{3/2}$	-1903.59	7.943E+04		4.821E+04		1.095E+00	
175	$2s\,2p^3(^3P)\,3p\ \ ^4D_{7/2}$	-1903.52	2.214E+05		-3.343E+04		1.265E+00	
176	$2s\,2p^3(^3P)\,3d\ \ ^2D^o_{3/2}$	-1903.50	4.805E+03		1.409E+04		9.829E-01	
177	$2s\,2p^3(^3P)\,3d\ \ ^2F^o_{5/2}$	-1903.47	-7.974E+03		7.958E+04		1.173E+00	
178	$2s\,2p^3(^1D)\,3d\ \ ^2F^o_{7/2}$	-1903.45	3.853E+03		-9.962E+04		1.151E+00	
179	$2s\,2p^3(^3D)\,3p\ \ ^4P_{3/2}$	-1903.39	3.346E+05		2.765E+03		1.182E+00	
180	$2s\,2p^3(^1D)\,3d\ \ ^2G^o_{9/2}$	-1903.39	3.123E+04		-9.975E+04		1.198E+00	
181	$2s\,2p^3(^3P)\,3p\ \ ^4P_{5/2}$	-1903.35	2.648E+05		-5.908E+04		1.315E+00	
182	$2s\,2p^3(^3P)\,3d\ \ ^4D^o_{5/2}$	-1903.26	8.915E+04		6.899E+04		1.120E+00	
183	$2s\,2p^3(^1D)\,3d\ \ ^2P^o_{3/2}$	-1903.19	4.108E+04		6.156E+04		1.326E+00	
184	$2s\,2p^3(^1D)\,3d\ \ ^2G^o_{7/2}$	-1903.18	8.522E+04		-3.681E+04		1.136E+00	
185	$2s\,2p^3(^3P)\,3d\ \ ^4P^o_{1/2}$	-1903.17	2.559E+05		0.000E+00		1.817E+00	
186	$2s\,2p^3(^3P)\,3p\ \ ^2S_{1/2}$	-1903.10	7.773E+04		0.000E+00		1.179E+00	
187	$2s\,2p^3(^3S)\,3d\ \ ^4D^o_{5/2}$	-1903.05	-1.222E+04		-2.109E+04		1.204E+00	
188	$2s\,2p^3(^1D)\,3d\ \ ^2P^o_{1/2}$	-1903.03	-2.084E+05		0.000E+00		8.633E-01	
189	$2s\,2p^3(^3S)\,3d\ \ ^4D^o_{3/2}$	-1902.97	5.874E+04		-3.833E+04		1.026E+00	
190	$2s\,2p^3(^1D)\,3d\ \ ^2F^o_{5/2}$	-1902.95	5.829E+04		-3.155E+04		1.042E+00	
191	$2s\,2p^3(^3S)\,3d\ \ ^4D^o_{7/2}$	-1902.94	1.010E+05		-8.607E+03		1.267E+00	
192	$2s\,2p^3(^3P)\,3d\ \ ^4D^o_{1/2}$	-1902.89	-2.361E+05		0.000E+00		3.384E-01	
193	$2s\,2p^3(^3P)\,3d\ \ ^2P^o_{3/2}$	-1902.80	-8.023E+04		-2.801E+03		1.077E+00	
194	$2s\,2p^3(^3S)\,3d\ \ ^2D^o_{3/2}$	-1902.68	8.878E+04		5.347E+04		1.127E+00	
195	$2s\,2p^3(^1P)\,3p\ \ ^2S_{1/2}$	-1902.61	-1.362E+05		0.000E+00		1.479E+00	
196	$2s\,2p^3(^1P)\,3p\ \ ^2D_{3/2}$	-1902.58	-9.674E+04		-2.152E+04		1.113E+00	
197	$2p^4(^3P)\,3s\ \ ^4P_{5/2}$	-1902.52	9.721E+04		4.864E+04		1.465E+00	
198	$2s\,2p^3(^3S)\,3d\ \ ^2D^o_{5/2}$	-1902.49	6.697E+04		2.359E+04		1.126E+00	
199	$2s\,2p^3(^3P)\,3p\ \ ^4D_{5/2}$	-1902.26	-1.073E+04		5.692E+04		1.337E+00	
200	$2p^4(^3P)\,3s\ \ ^2P_{3/2}$	-1902.26	-2.609E+04		8.125E+03		1.245E+00	
201	$2s\,2p^3(^1P)\,3p\ \ ^2P_{3/2}$	-1902.20	-4.098E+04		7.009E+03		1.286E+00	
202	$2s\,2p^3(^3P)\,3d\ \ ^4F^o_{9/2}$	-1901.81	1.635E+05		-5.435E+04		1.200E+00	
203	$2s\,2p^3(^1S)\,3p\ \ ^2S_{1/2}$	-1901.76	7.192E+05		0.000E+00		1.435E+00	
204	$2s\,2p^3(^1D)\,3d\ \ ^2S^o_{1/2}$	-1901.67	6.245E+05		0.000E+00		1.815E+00	
205	$2s\,2p^3(^1D)\,3d\ \ ^2D^o_{3/2}$	-1901.65	2.632E+05		-7.958E+03		1.345E+00	
206	$2s\,2p^3(^1D)\,3d\ \ ^2D^o_{5/2}$	-1901.61	1.936E+05		2.986E+04		1.282E+00	
207	$2s\,2p^3(^3P)\,3d\ \ ^4D^o_{7/2}$	-1901.60	1.638E+05		-2.705E+04		1.230E+00	
208	$2s\,2p^3(^3P)\,3d\ \ ^2F^o_{7/2}$	-1901.56	2.311E+05		-9.989E+04		1.050E+00	
209	$2s\,2p^3(^3P)\,3d\ \ ^2D^o_{5/2}$	-1901.52	2.012E+05		-4.934E+04		1.006E+00	
210	$2p^4(^3P)\,3s\ \ ^4P_{1/2}$	-1901.46	3.603E+05		0.000E+00		2.076E+00	
211	$2s\,2p^3(^1P)\,3d\ \ ^2D^o_{3/2}$	-1901.29	-4.795E+04		4.359E+04		1.020E+00	
212	$2p^4(^3P)\,3p\ \ ^4P^o_{3/2}$	-1901.12	5.799E+04		3.509E+04		1.536E+00	
213	$2p^4(^3P)\,3p\ \ ^4D^o_{5/2}$	-1901.06	7.514E+04		3.528E+04		1.288E+00	
214	$2s\,2p^3(^3P)\,3d\ \ ^2P^o_{1/2}$	-1900.98	-3.641E+05		0.000E+00		9.237E-01	
215	$2p^4(^3P)\,3p\ \ ^4D^o_{7/2}$	-1900.59	1.313E+04		6.311E+04		1.294E+00	
216	$2p^4(^3P)\,3p\ \ ^2P^o_{1/2}$	-1900.57	9.803E+04		0.000E+00		1.256E+00	
217	$2p^4(^3P)\,3p\ \ ^4P^o_{5/2}$	-1900.56	4.057E+04		1.298E+04		1.309E+00	
218	$2p^4(^3P)\,3s\ \ ^4P_{3/2}$	-1900.47	9.697E+04		-7.710E+04		1.642E+00	
219	$2s\,2p^3(^1P)\,3d\ \ ^2P^o_{1/2}$	-1900.45	-1.939E+04		0.000E+00		5.579E-01	
220	$2s\,2p^3(^1P)\,3d\ \ ^2F^o_{7/2}$	-1900.45	-4.940E+03		6.197E+04		1.273E+00	
221	$2s\,2p^3(^1P)\,3d\ \ ^2D^o_{5/2}$	-1900.45	-4.999E+04		8.206E+03		1.154E+00	
222	$2s\,2p^3(^1P)\,3d\ \ ^2P^o_{3/2}$	-1900.42	-3.540E+04		-4.138E+03		1.142E+00	
223	$2s\,2p^3(^1P)\,3d\ \ ^2F^o_{5/2}$	-1900.37	-5.264E+04		2.085E+04		1.060E+00	

Table 6. (*continued*)

Key	Level	E_h[a]	A_J[a]	A_J (MCDF2)[b]	B_J[a]	B_J (MCDF2)[b]	g_J[a]	g_J (MCDF2)[b]
224	$2p^4(^3P)\,3s\ ^2P_{1/2}$	-1900.27	-1.116E+05		0.000E+00		1.218E+00	
225	$2p^4(^3P)\,3p\ ^4D^o_{1/2}$	-1900.10	1.211E+05		0.000E+00		6.769E-01	
226	$2s\,2p^3(^3P)\,3d\ ^2D^o_{3/2}$	-1900.02	1.920E+05		1.347E+04		9.970E-01	
227	$2p^4(^1D)\,3s\ ^2D_{5/2}$	-1899.99	2.120E+05		-2.116E+05		1.274E+00	
228	$2p^4(^1D)\,3s\ ^2D_{3/2}$	-1899.92	1.455E+05		-1.171E+05		9.361E-01	
229	$2p^4(^3P)\,3p\ ^4S^o_{3/2}$	-1899.90	6.602E+04		9.815E+03		1.328E+00	
230	$2p^4(^3P)\,3p\ ^4D^o_{3/2}$	-1899.52	1.769E+04		1.110E+04		1.324E+00	
231	$2p^4(^3P)\,3p\ ^4P^o_{1/2}$	-1899.18	-7.324E+04		0.000E+00		1.982E+00	
232	$2p^4(^3P)\,3d\ ^4D_{5/2}$	-1899.01	4.509E+04		6.021E+02		1.278E+00	
233	$2p^4(^3P)\,3p\ ^2P^o_{3/2}$	-1899.00	1.067E+05		-5.392E+04		1.234E+00	
234	$2p^4(^3P)\,3d\ ^4D_{3/2}$	-1898.99	6.056E+04		-2.897E+04		1.213E+00	
235	$2p^4(^3P)\,3d\ ^4D_{7/2}$	-1898.96	3.722E+04		2.661E+04		1.298E+00	
236	$2p^4(^3P)\,3d\ ^4P_{1/2}$	-1898.92	9.931E+04		0.000E+00		1.101E+00	
237	$2p^4(^3P)\,3d\ ^4F_{9/2}$	-1898.83	3.468E+04		5.811E+04		1.278E+00	
238	$2p^4(^3P)\,3d\ ^2F_{7/2}$	-1898.82	3.928E+04		1.961E+04		1.122E+00	
239	$2p^4(^1D)\,3p\ ^2F^o_{5/2}$	-1898.65	1.631E+05		-1.977E+05		9.993E-01	
240	$2p^4(^3P)\,3p\ ^2D^o_{5/2}$	-1898.57	-3.428E+03		-3.722E+04		1.393E+00	
241	$2p^4(^3P)\,3d\ ^2P_{1/2}$	-1898.55	-4.601E+04		0.000E+00		1.808E+00	
242	$2p^4(^3P)\,3p\ ^2S^o_{1/2}$	-1898.45	-9.267E+04		0.000E+00		1.305E+00	
243	$2p^4(^1D)\,3p\ ^2D^o_{3/2}$	-1898.42	4.109E+04		6.973E+04		1.279E+00	
244	$2p^4(^3P)\,3d\ ^4P_{3/2}$	-1898.37	1.204E+04		-1.704E+04		1.224E+00	
245	$2p^4(^3P)\,3d\ ^2D_{5/2}$	-1898.25	2.991E+04		3.535E+04		1.159E+00	
246	$2p^4(^1D)\,3p\ ^2F^o_{7/2}$	-1898.11	1.081E+05		-1.632E+05		1.200E+00	
247	$2p^4(^1D)\,3p\ ^2P^o_{3/2}$	-1898.07	9.193E+04		-6.946E+04		1.331E+00	
248	$2p^4(^1D)\,3p\ ^2D^o_{3/2}$	-1898.00	1.257E+05		-1.343E+05		1.095E+00	
249	$2p^4(^3P)\,3d\ ^4F_{3/2}$	-1897.92	2.248E+04		2.815E+04		7.523E-01	
250	$2p^4(^1D)\,3p\ ^2D^o_{5/2}$	-1897.91	1.256E+05		-7.151E+04		1.184E+00	
251	$2p^4(^3P)\,3d\ ^4F_{5/2}$	-1897.76	6.091E+03		-2.206E+04		1.181E+00	
252	$2p^4(^1D)\,3s\ ^2P_{1/2}$	-1897.40	3.770E+05		0.000E+00		1.944E+00	
253	$2p^4(^1D)\,3p\ ^2P^o_{1/2}$	-1897.29	4.473E+05		0.000E+00		6.774E-01	
254	$2p^4(^3P)\,3d\ ^4D_{1/2}$	-1897.11	1.347E+05		0.000E+00		2.757E-01	
255	$2p^4(^3P)\,3d\ ^2P_{3/2}$	-1896.94	7.396E+04		4.854E+04		1.080E+00	
256	$2p^4(^3P)\,3d\ ^4F_{7/2}$	-1896.88	-8.834E+03		-6.614E+04		1.278E+00	
257	$2p^4(^3P)\,3d\ ^4P_{5/2}$	-1896.74	4.733E+04		-1.277E+04		1.139E+00	
258	$2p^4(^3P)\,3d\ ^2F_{5/2}$	-1896.66	2.007E+04		7.249E+04		1.112E+00	
259	$2p^4(^3P)\,3d\ ^2D_{3/2}$	-1896.62	-6.505E+04		6.513E+04		1.201E+00	
260	$2p^4(^1D)\,3d\ ^2G_{7/2}$	-1896.55	1.057E+05		-1.857E+05		9.692E-01	
261	$2p^4(^1D)\,3d\ ^2G_{9/2}$	-1896.44	8.127E+04		-1.896E+05		1.157E+00	
262	$2p^4(^1D)\,3d\ ^2D_{5/2}$	-1896.27	4.962E+04		5.301E+04		1.136E+00	
263	$2p^4(^1D)\,3d\ ^2S_{1/2}$	-1896.26	1.747E+05		0.000E+00		1.971E+00	
264	$2p^4(^1D)\,3d\ ^2F_{7/2}$	-1896.16	8.410E+04		-1.284E+04		1.150E+00	
265	$2p^4(^1D)\,3d\ ^2P_{3/2}$	-1896.13	4.409E+04		-1.268E+04		1.263E+00	
266	$2p^4(^1D)\,3d\ ^2F_{5/2}$	-1896.11	6.299E+04		-1.255E+05		1.084E+00	
267	$2p^4(^1D)\,3d\ ^2D_{3/2}$	-1895.75	1.249E+05		3.846E+04		8.185E-01	
268	$2p^4(^1S)\,3p\ ^2P^o_{1/2}$	-1895.74	1.408E+05		0.000E+00		6.637E-01	
269	$2p^4(^3P)\,3d\ ^4P_{1/2}$	-1895.61	-1.549E+05		0.000E+00		8.297E-01	
270	$2p^4(^1S)\,3p\ ^2P^o_{3/2}$	-1895.45	2.157E+04		5.535E+04		1.324E+00	
271	$2p^4(^1S)\,3d\ ^2D_{5/2}$	-1893.71	5.429E+03		4.022E+04		1.193E+00	
272	$2p^4(^1S)\,3d\ ^2D_{3/2}$	-1893.60	1.247E+04		9.464E+03		8.171E-01	