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Dirac–Fock photoionization parameters for HAXPES applications, Part II: Inner atomic shells

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HIGHLIGHTS

- Photoionization parameters are given for inner atomic shells with binding energies $\gtrsim$ 1.5 keV.
- The data are extension of our calculations for use in the HAXPES spectroscopy studies.
- Relativistic calculations were performed by the Dirac–Fock method.
- Photoionization cross sections were calculated including all multipoles.
- The angular distribution parameters were obtained in the quadrupole approximation.

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ABSTRACT

Presented here are the photoionization cross sections and parameters of the photoelectron angular distribution for inner atomic subshells with binding energies beyond 1.5 keV in the photon energy range from 2 keV to 12 keV. The calculations are an extension of our previous paper containing the photoionization parameters for comparatively outer shells with binding energies lower than 1.5 keV (Trzhaskovskaya and Yarzhemsky, 2018). The calculations are intended for use in the experimental HAXPES spectroscopy investigations. The up-to-date HAXPES activity tends to increase the photon energy to investigate the deep core levels resulting in a necessity of theoretical consideration of photoionization parameters for inner atomic shells. Our relativistic calculations have been performed by the Dirac–Fock method. The photoionization cross sections have been found including all multipoles of the radiative field while the photoelectron angular distribution parameters have been obtained in the quadrupole approximation. The effect of the hole resulting in the atomic subshell after photoionization has been taken into account using the frozen orbital model.

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Contents

1. Introduction

Our calculations of the photoionization cross sections and the photoelectron angular distribution parameters [1] have been designed to be used in experimental studies by methods of the hard X-ray photoelectron spectroscopy (HAXPES). The HAXPES spectroscopy enables one to investigate electron states of deep core levels as well as to probe a bulk of electrical and chemical properties of buried layers of various materials non-destructively due to its large analysis depth [2–8].

Nowadays the HAXPES spectroscopy is progressing rapidly. The current trend in the HAXPES experimental studies is toward increase in the photon energy [9–12]. New X-ray sources and powerful analyzers allow the analysis to be carried out in a wide kinetic energy range. Recently a number of experiments has been made which perform the spectra measurements using large probing depth [3,11,12]. For example, HAXPES measurements of the 1*s*-shell spectra of S ($Z = 16$) with the binding energy $E_b \approx 2.8$ keV were performed for various sulfur species [3]. Using the found 1*s* binding energies, behavior of the electric potentials of various S species was studied. In paper [11], a novel laboratory-based HAXPES prototype system is described. The system employs the monochromated microfocused Ga K_α X-ray source which yields a photon energy of 9.25 keV. The feasibility of the HAXPES method for heavier elements using synchrotron radiation up to 35.5 keV at SPring-8 undulator beamlines is demonstrated in paper [12]. As illustration, the 1*s* core-level photoelectron spectra are presented for the Ar, Kr, and Xe atoms at photon energies $k = 6$, 20, and 35.5 keV, respectively. The iodine 1*s* photoelectron spectrum of the CH_3I molecule was measured at $k = 35.46$ keV.

These experimental studies call for the theoretical values of photoionization cross sections and photoelectron angular distribution parameters for more inner shells as compared with those presented in [1] where the comparatively outer atomic shells with binding energies $E_b \leq 1.5$ keV have been considered. Recently we have carried out calculations of the photoionization parameters for inner 3*s*, 3*p*, and 3*d* subshells of heavy elements Ir ($Z = 77$) and Au ($Z = 79$). The data are required for experiments under development at Scienta Omicron Lab [9]. Binding energies of the subshells fall in the range between 2.04 keV and 3.424 keV. In connection with the requirements of HAXPES experiments, we present here calculations for inner atomic shells with 1.5 keV $\lesssim E_b \lesssim$ 10 keV of atoms with $13 \leq Z \leq 100$. The tabulations provide an extension of our calculations [1].

The photoionization parameters have been calculated using the same approximations and formulas. The fundamental approximations are the following. The calculations are based on fully relativistic treatment of photoeffect. The electron wave functions are found by the Dirac–Fock method where the electron exchange is considered properly between atomic electrons as well as between atomic and free electrons [13,14]. The subshell photoionization cross sections $\sigma^{(i)}$ are calculated taking into account all multipoles of the radiative field. Parameters of the photoelectron angular distribution β, γ, and δ are obtained in the quadrupole approximation.

The method of calculations was described in detail [1]. However in order to better appreciate the calculations in hand we present briefly basic formulas. The total photoionization cross section $\sigma^{(i)}$ for the *ith* subshell is written as

$$\sigma^{(i)} = \frac{4\pi^2\alpha}{k}\sum_L\sum_\kappa \Big\{ (2L+1)[Q^{(i)}_{\Lambda=L,L}(\kappa)]^2 + L[Q^{(i)}_{\Lambda=L+1,L}(\kappa)]^2 + (L+1)[Q^{(i)}_{\Lambda=L-1,L}(\kappa)]^2 - 2\sqrt{L(L+1)}\, Q^{(i)}_{\Lambda=L-1,L}(\kappa)Q^{(i)}_{\Lambda=L+1,L}(\kappa) \Big\} . \quad (1)$$

Here α is the fine structure constant, k is the photon energy, L is the multipolarity of the radiative field, $\kappa = (\ell - j)(2j+1)$ is the relativistic quantum number, ℓ and j are quantum numbers of the orbital and total angular momenta of the electron. The reduced matrix element $Q_{\Lambda,L}(\kappa)$ has the form

$$Q_{\Lambda,L}(\kappa) = (-1)^{\bar\ell_\kappa-\ell_i}\left[\bar\ell_\kappa\ell_i j_\kappa j_i \Lambda 1\right]^{1/2} \times \begin{pmatrix} \bar\ell_\kappa & \ell_i & \Lambda \\ 0 & 0 & 0 \end{pmatrix} \begin{Bmatrix} \bar\ell_\kappa & 1/2 & j_\kappa \\ \ell_i & 1/2 & j_i \\ \Lambda & 1 & L \end{Bmatrix} R_{1\Lambda} + (-1)^{\ell_\kappa-\bar\ell_i}\left[\ell_\kappa\bar\ell_i j_\kappa j_i \Lambda 1\right]^{1/2} \times \begin{pmatrix} \ell_\kappa & \bar\ell_i & \Lambda \\ 0 & 0 & 0 \end{pmatrix} \begin{Bmatrix} \ell_\kappa & 1/2 & j_\kappa \\ \bar\ell_i & 1/2 & j_i \\ \Lambda & 1 & L \end{Bmatrix} R_{2\Lambda} , \quad (2)$$

where $\bar\ell = 2j - \ell$ and the notation $[ab] = (2a+1)(2b+1)$. Radial integrals $R_{1\Lambda}$ and $R_{2\Lambda}$ can be written as

$$R_{1\Lambda} = \int_0^\infty G_i(r)F_\kappa(r)j_\Lambda(kr)dr , \qquad R_{2\Lambda} = \int_0^\infty F_i(r)G_\kappa(r)j_\Lambda(kr)dr . \quad (3)$$

Here $j_\Lambda(kr)$ is the spherical Bessel function of order Λ, $G(r) = rg(r)$ and $F(r) = rf(r)$ are the large and small components of the Dirac radial electron wave function. Indices i and κ refer to the initial bound and final continuum electron states, respectively.

It should be noted that the photoionization cross sections calculated in the dipole approximation which is of frequent use in calculations and the cross sections obtained taking into account all significant terms differ in magnitude considerably at a high photon energy. For example, the difference between the two calculations may exceed 10% at $k \geq 10$ keV.

The photoelectron angular distribution at photon energies of interest is adequately described with simple expressions involving three parameters β, γ, and δ [15–17]. The parameter β is the dipole one while γ and δ are non-dipole parameters associated with the terms of the first order $O(kr)$ where r is the radius of the ionized atomic shell. In the case of circular polarized and unpolarized photons, the relevant expression is written as

$$\frac{d\sigma^{(i)}}{d\Omega} = \frac{\sigma^{(i)}}{4\pi}\left[1 - \frac{\beta}{2}P_2(\cos\underline{\theta}) + \left(\frac{\gamma}{2}\sin^2\underline{\theta} + \delta\right)\cos\underline{\theta}\right] , \quad (4)$$

where $P_2(\cos\underline{\theta})$ is the second order Legendre polynomial, $\underline{\theta}$ is the angle between vectors of the photon **k** and photoelectron **p**. Notations of angles and directions are given in Fig. 1 from paper [1].

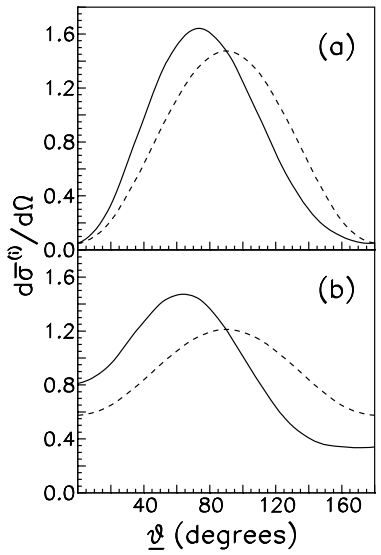

Fig. 1. The photoelectron angular distribution $\frac{d\tilde{\sigma}^{(i)}}{d\Omega}(\underline{\vartheta}) = \frac{d\sigma^{(i)}}{d\Omega}(\underline{\vartheta})/\frac{\sigma^{(i)}}{4\pi}$, in the case of unpolarized and circularly polarized radiation at the photon energy $k = 12$ keV for the 1*s* shell of P, $Z = 15$ (a) and the $3d_{5/2}$ shell of Hf, $Z = 72$ (b). Solid, calculations in the quadrupole approximation; dashed, the dipole approximation. $\underline{\theta}$ is the angle between vectors of the photon **k** and photoelectron **p**.

For linear polarized photons, the angular distribution is represented by the expression involving the same three parameters

$$\frac{d\sigma^{(i)}}{d\Omega} = \frac{\sigma^{(i)}}{4\pi}\left[1 + \beta P_2(\cos\theta) + (\delta + \gamma\cos^2\theta)\sin\theta\cos\varphi\right], \quad (5)$$

where θ is the angle between the vector **p** and the photon polarization direction ε, vector $\boldsymbol{\varepsilon}$ being coincident with the z axis; φ is the angle between the vector **k** and the plane going through the z axis and the vector **p**.

In the photon energy range in question, the magnitude of non-dipole parameters γ and δ may be comparable with the β magnitude. In this situation, the inclusion of quadrupole terms in Eqs. (4) and (5) changes the photoelectron angular distribution significantly. Fig. 1 demonstrates the angular distribution for the case of circular polarized and unpolarized photons [see Eq. (4)] for a photoelectron emitted from the 1*s* state of P, $Z = 15$ (a) and from the $3d_{5/2}$ state of Hf, $Z = 72$ (b) at photon energy $k = 12$ keV. Dashed curves refer to the dipole approximation and solid curves refer to calculations with consideration for quadrupole terms. As is seen, including quadrupole terms changes the photoelectron angular distribution drastically.

Experimental values of the electron binding energies used in the calculations were taken from paper [18]. The binding energy values are listed in Table 1 for all subshells under consideration. As in previous our calculations, the hole in the atomic shell from which an electron was emitted was taken into account in the framework of the frozen orbital approximation [19]. The computational accuracy of our calculations is better than 0.1%. This accuracy does not include possible uncertainties due to the physical approximations mentioned above.

The table contains values of the photoionization cross sections $\sigma^{(i)}$ and of the photoelectron angular distribution parameters β, γ and δ at eleven photon energies in the range 2 keV $\leq k \leq$ 12, keV for atomic subshells with binding energies $E_b \geq$1.5 keV. If binding energies E_b for all listed shells of a specific atom exceed one or more k-values, data for $k \geq E_b$ are given and those for higher values of k from the predetermined set from 14 keV to 30 keV are added. For example, in the case of Ca ($Z = 20$), the 1*s* binding energy is equal 4.038 keV. So eight k-values are selected in the range 5 keV $\leq k \leq$ 12 keV and $k = 14$, 16, and 18 keV are added. Values of photon energies for each Z are presented in the table.

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Explanation of tables

Table 1. **Subshell photoionization cross sections and photoelectron angular distribution parameters**

Z	Atomic number
Shell	Atomic subshell from which an electron is emitted
E_b	Experimental subshell binding energy in eV
k	Photon energy in eV
σ	Subshell photoionization cross section in kb ($=10^{-21}$ cm^2)
β, γ, δ	Parameters of the photoelectron angular distribution

Note: The photoionization cross sections $\sigma^{(i)}$ are given in kb ($=10^{-21}$ cm^2) for completely filled subshells.

Example

In the Table, the first data block gives the parameters for the $1s_{1/2}$ shell of the aluminum atom, $Z = 13$. The experimental binding energy of this shell is equal to 1559.6 eV. At the photon energy $k = 2000$ eV, the photoionization cross section for the completely filled 1s shell is $\sigma^{(1s)} = 8.930 + 1 = 8.930\times10^{1}$ kb $= 8.930 \times 10^{-20}$ cm^2. The angular distribution parameters are $\beta = 1.996$, $\gamma = 2.53-1 = 2.53 \times 10^{-1}$, and $\delta = -5.08-6 = -5.08 \times 10^{-6}$.

Table 1
Subshell photoionization cross sections and photoelectron angular distribution parameters.

Z = 13, Al: [Ne]$3s^2_{1/2}$ $3p^1_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$1s_{1/2}$	σ	8.930+1	3.124+1	1.429+1	7.669+0	4.568+0	2.929+0	1.985+0	1.404+0	1.028+0	7.742−1	5.966−1
E_b=	β	1.996	1.986	1.976	1.966	1.956	1.946	1.935	1.925	1.915	1.905	1.896
1559.6 eV	γ	2.53−1	7.04−1	9.99−1	1.23+0	1.42+0	1.59+0	1.74+0	1.88+0	2.01+0	2.13+0	2.24+0
	δ	−5.08−6	−4.60−6	−3.83−6	−2.82−6	−1.63−6	−1.39−7	1.47−6	3.37−6	5.36−6	7.66−6	1.02−5
Z = 14, Si: [Ne]$3s^2_{1/2}$ $3p^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$1s_{1/2}$	σ	1.108+2	4.022+1	1.866+1	1.010+1	6.051+0	3.901+0	2.655+0	1.884+0	1.383+0	1.044+0	8.062−1
E_b=	β	1.998	1.989	1.979	1.969	1.958	1.948	1.938	1.928	1.918	1.908	1.898
1838.9 eV	γ	5.00−3	5.85−1	9.09−1	1.15+0	1.36+0	1.54+0	1.69+0	1.84+0	1.97+0	2.09+0	2.20+0
	δ	−8.28−6	−5.88−6	−5.15−6	−4.14−6	−2.91−6	−1.50−6	1.76−7	2.06−6	4.23−6	6.71−6	9.40−6
Z = 15, P : [Ne]$3s^2_{1/2}$ $3p^2_{1/2}$ $3p^1_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$1s_{1/2}$	σ	5.058+1	2.380+1	1.299+1	7.836+0	5.075+0	3.467+0	2.469+0	1.818+0	1.376+0	1.065+0	6.736−1
E_b=	β	1.991	1.982	1.971	1.961	1.951	1.941	1.931	1.921	1.911	1.901	1.881
2145.5 eV	γ	4.41−1	8.08−1	1.07+0	1.29+0	1.47+0	1.63+0	1.78+0	1.92+0	2.04+0	2.16+0	2.37+0
	δ	−7.37−6	−6.68−6	−5.74−6	−4.54−6	−3.09−6	−1.41−6	5.07−7	2.68−6	5.12−6	7.85−6	1.43−5
Z = 16, S : [Ne]$3s^2_{1/2}$ $3p^2_{1/2}$ $3p^2_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$1s_{1/2}$	σ	6.194+1	2.967+1	1.635+1	9.926+0	6.460+0	4.431+0	3.166+0	2.337+0	1.773+0	1.375+0	8.733−1
E_b=	β	1.994	1.985	1.975	1.964	1.954	1.944	1.934	1.924	1.914	1.904	1.884
2472.0 eV	γ	2.51−1	6.87−1	9.77−1	1.21+0	1.40+0	1.57+0	1.72+0	1.86+0	1.99+0	2.11+0	2.33+0
	δ	−9.17−6	−8.39−6	−7.51−6	−6.38−6	−4.96−6	−3.28−6	−1.32−6	9.10−7	3.41−6	6.19−6	1.27−5
Z = 17, Cl: [Ne]$3s^2_{1/2}$ $3p^2_{1/2}$ $3p^3_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$1s_{1/2}$	σ	7.333+1	3.626+1	2.018+1	1.234+1	8.074+0	5.560+0	3.986+0	2.951+0	2.243+0	1.744+0	1.111+0
E_b=	β	1.997	1.988	1.978	1.968	1.958	1.948	1.938	1.927	1.917	1.907	1.888
2822.4 eV	γ	−5.06−2	5.42−1	8.65−1	1.11+0	1.32+0	1.50+0	1.66+0	1.80+0	1.94+0	2.06+0	2.28+0
	δ	−1.15−5	−1.04−5	−9.57−6	−8.47−6	−7.13−6	−5.47−6	−3.52−6	−1.30−6	1.27−6	4.12−6	1.07−5
Z = 18, Ar: [Ne]$3s^2_{1/2}$ $3p^2_{1/2}$ $3p^4_{3/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$1s_{1/2}$	σ	4.359+1	2.454+1	1.511+1	9.938+0	6.872+0	4.943+0	3.669+0	2.796+0	2.177+0	1.393+0	9.417−1
E_b=	β	1.991	1.981	1.971	1.961	1.951	1.941	1.931	1.921	1.911	1.891	1.872
3202.9 eV	γ	3.57−1	7.36−1	1.01+0	1.23+0	1.42+0	1.59+0	1.74+0	1.88+0	2.00+0	2.23+0	2.43+0
	δ	−1.25−5	−1.20−5	−1.10−5	−9.66−6	−8.07−6	−6.16−6	−3.97−6	−1.44−6	1.44−6	8.15−6	1.63−5
Z = 19, K : [Ar]$4s^1_{1/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$1s_{1/2}$	σ	5.111+1	2.932+1	1.818+1	1.203+1	8.350+0	6.026+0	4.487+0	3.427+0	2.675+0	1.717+0	1.165+0
E_b=	β	1.994	1.985	1.975	1.965	1.955	1.945	1.935	1.925	1.915	1.895	1.875
3607.4 eV	γ	1.01−1	5.91−1	8.91−1	1.13+0	1.33+0	1.51+0	1.66+0	1.80+0	1.94+0	2.17+0	2.38+0
	δ	−1.45−5	−1.47−5	−1.38−5	−1.25−5	−1.09−5	−9.10−6	−6.82−6	−4.28−6	−1.44−6	5.42−6	1.36−5
Z = 20, Ca: [Ar]$4s^2_{1/2}$												
		k (eV)										
Shell		5000	6000	7000	8000	9000	10000	11000	12000	14000	16000	18000
$1s_{1/2}$	σ	3.450+1	2.160+1	1.437+1	1.002+1	7.257+0	5.419+0	4.150+0	3.246+0	2.091+0	1.422+0	1.009+0
E_b=	β	1.988	1.979	1.969	1.959	1.949	1.939	1.929	1.919	1.899	1.879	1.860
4038.1 eV	γ	4.04−1	7.56−1	1.02+0	1.24+0	1.42+0	1.58+0	1.73+0	1.87+0	2.11+0	2.33+0	2.52+0
	δ	−1.76−5	−1.68−5	−1.57−5	−1.41−5	−1.23−5	−1.02−5	−7.69−6	−4.81−6	1.85−6	1.01−5	2.00−5
Z = 21, Sc: [Ar]$4s^2_{1/2}$ $3d^1_{3/2}$												
		k (eV)										
Shell		5000	6000	7000	8000	9000	10000	11000	12000	14000	16000	18000
$1s_{1/2}$	σ	3.993+1	2.535+1	1.697+1	1.189+1	8.642+0	6.472+0	4.968+0	3.894+0	2.518+0	1.718+0	1.222+0
E_b=	β	1.992	1.983	1.973	1.963	1.953	1.943	1.933	1.923	1.903	1.883	1.864
4492.8 eV	γ	1.41−1	5.94−1	8.95−1	1.13+0	1.32+0	1.50+0	1.65+0	1.80+0	2.05+0	2.27+0	2.47+0
	δ	−2.08−5	−2.04−5	−1.93−5	−1.79−5	−1.61−5	−1.40−5	−1.16−5	−8.82−6	−2.16−6	6.03−6	1.59−5
Z = 22, Ti: [Ar]$4s^2_{1/2}$ $3d^2_{3/2}$												
		k (eV)										
Shell		5000	6000	7000	8000	9000	10000	11000	12000	14000	16000	18000
$1s_{1/2}$	σ	4.298+1	2.935+1	1.980+1	1.394+1	1.017+1	7.639+0	5.879+0	4.619+0	2.997+0	2.050+0	1.462+0
E_b=	β	1.995	1.987	1.977	1.967	1.957	1.947	1.937	1.927	1.907	1.888	1.868
4966.4 eV	γ	−4.32−1	3.94−1	7.48−1	1.01+0	1.22+0	1.40+0	1.57+0	1.71+0	1.98+0	2.21+0	2.41+0

(*continued on next page*)

Table 1 (*continued*)

	δ	−6.57−5	−2.42−5	−2.35−5	−2.19−5	−2.04−5	−1.83−5	−1.60−5	−1.33−5	−6.68−6	1.49−6	1.12−5
Z = 23, V : [Ar]4s$^2_{1/2}$ 3d$^3_{3/2}$												
		k (eV)										
Shell		6000	7000	8000	9000	10000	11000	12000	14000	16000	18000	20000
1s$_{1/2}$	σ	3.346+1	2.286+1	1.618+1	1.185+1	8.929+0	6.890+0	5.425+0	3.533+0	2.424+0	1.733+0	1.280+0
E_b=	β	1.990	1.981	1.971	1.962	1.952	1.942	1.932	1.912	1.892	1.873	1.853
5465.1 eV	γ	1.12−1	5.71−1	8.66−1	1.10+0	1.30+0	1.47+0	1.63+0	1.90+0	2.14+0	2.35+0	2.54+0
	δ	−2.92−5	−2.82−5	−2.67−5	−2.52−5	−2.33−5	−2.10−5	−1.84−5	−1.19−5	−3.79−6	5.97−6	1.76−5
Z = 24, Cr: [Ar]4s$^1_{1/2}$ 3d$^4_{3/2}$ 3d$^1_{5/2}$												
		k (eV)										
Shell		6000	7000	8000	9000	10000	11000	12000	14000	16000	18000	20000
1s$_{1/2}$	σ	3.459+1	2.612+1	1.862+1	1.370+1	1.036+1	8.012+0	6.322+0	4.131+0	2.842+0	2.036+0	1.507+0
E_b=	β	1.992	1.986	1.976	1.966	1.956	1.946	1.936	1.917	1.897	1.877	1.858
5989.2 eV	γ	−4.68−1	3.42−1	6.99−1	9.67−1	1.18+0	1.37+0	1.54+0	1.82+0	2.07+0	2.28+0	2.48+0
	δ	−3.53−4	−3.36−5	−3.25−5	−3.09−5	−2.91−5	−2.69−5	−2.44−5	−1.81−5	−1.01−5	−2.70−7	1.13−5
Z = 25, Mn: [Ar]4s$^2_{1/2}$ 3d$^4_{3/2}$ 3d$^1_{5/2}$												
		k (eV)										
Shell		7000	8000	9000	10000	11000	12000	14000	16000	18000	20000	22000
1s$_{1/2}$	σ	2.930+1	2.120+1	1.567+1	1.189+1	9.222+0	7.294+0	4.785+0	3.303+0	2.372+0	1.759+0	1.339+0
E_b=	β	1.990	1.981	1.971	1.961	1.951	1.941	1.921	1.902	1.882	1.863	1.844
6539.0 eV	γ	3.82−3	5.05−1	8.08−1	1.05+0	1.25+0	1.43+0	1.73+0	1.99+0	2.21+0	2.41+0	2.60+0
	δ	−4.06−5	−3.86−5	−3.71−5	−3.53−5	−3.33−5	−3.10−5	−2.47−5	−1.69−5	−7.32−6	4.27−6	1.77−5
Z = 26, Fe: [Ar]4s$^2_{1/2}$ 3d$^4_{3/2}$ 3d$^2_{5/2}$												
		k (eV)										
Shell		8000	9000	10000	11000	12000	14000	16000	18000	20000	22000	25000
1s$_{1/2}$	σ	2.388+1	1.779+1	1.355+1	1.054+1	8.359+0	5.505+0	3.811+0	2.743+0	2.038+0	1.554+0	1.077+0
E_b=	β	1.985	1.976	1.966	1.956	1.946	1.927	1.907	1.887	1.868	1.849	1.820
7113.0 eV	γ	2.37−1	6.24−1	8.97−1	1.12+0	1.31+0	1.63+0	1.90+0	2.14+0	2.34+0	2.53+0	2.78+0
	δ	−4.60−5	−4.44−5	−4.28−5	−4.08−5	−3.84−5	−3.25−5	−2.48−5	−1.54−5	−3.97−6	9.44−6	3.34−5
Z = 27, Co: [Ar]4s$^2_{1/2}$ 3d$^4_{3/2}$ 3d$^3_{5/2}$												
		k (eV)										
Shell		8000	9000	10000	11000	12000	14000	16000	18000	20000	22000	25000
1s$_{1/2}$	σ	2.629+1	2.001+1	1.532+1	1.196+1	9.507+0	6.286+0	4.365+0	3.149+0	2.345+0	1.791+0	1.244+0
E_b=	β	1.990	1.981	1.971	1.961	1.952	1.932	1.912	1.893	1.873	1.854	1.825
7708.9 eV	γ	−2.14−1	3.95−1	7.23−1	9.77−1	1.19+0	1.53+0	1.81+0	2.06+0	2.27+0	2.46+0	2.72+0
	δ	−5.71−5	−5.30−5	−5.14−5	−4.94−5	−4.68−5	−4.11−5	−3.36−5	−2.44−5	−1.32−5	7.54−9	2.41−5
Z = 28, Ni: [Ar]4s$^2_{1/2}$ 3d$^4_{3/2}$ 3d$^4_{5/2}$												
		k (eV)										
Shell		9000	10000	11000	12000	14000	16000	18000	20000	22000	25000	30000
1s$_{1/2}$	σ	2.224+1	1.719+1	1.348+1	1.074+1	7.134+0	4.968+0	3.594+0	2.681+0	2.052+0	1.428+0	8.461−1
E_b=	β	1.986	1.976	1.967	1.957	1.937	1.918	1.898	1.879	1.859	1.831	1.784
8332.8 eV	γ	6.10−2	5.08−1	8.07−1	1.04+0	1.42+0	1.72+0	1.97+0	2.19+0	2.39+0	2.66+0	3.03+0
	δ	−6.39−5	−6.11−5	−5.92−5	−5.67−5	−5.08−5	−4.36−5	−3.46−5	−2.37−5	−1.07−5	1.31−5	6.43−5
Z = 29, Cu: [Ar]4s$^2_{1/2}$ 3d$^4_{3/2}$ 3d$^5_{5/2}$												
		k (eV)										
Shell		9000	10000	11000	12000	14000	16000	18000	20000	22000	25000	30000
1s$_{1/2}$	σ	2.248+1	1.913+1	1.510+1	1.207+1	8.048+0	5.624+0	4.079+0	3.049+0	2.337+0	1.630+0	9.683−1
E_b=	β	1.992	1.982	1.972	1.963	1.943	1.923	1.904	1.884	1.865	1.836	1.789
8978.9 eV	γ	−6.11−1	2.24−1	6.04−1	8.72−1	1.28+0	1.61+0	1.88+0	2.11+0	2.32+0	2.59+0	2.97+0
	δ	−3.29−5	−7.34−5	−7.06−5	−6.78−5	−6.16−5	−5.45−5	−4.57−5	−3.51−5	−2.26−5	4.31−7	5.16−5
Z = 30, Zn: [Ar]4s$^2_{1/2}$ 3d$^4_{3/2}$ 3d$^6_{5/2}$												
		k (eV)										
Shell		9000	10000	11000	12000	14000	16000	18000	20000	22000	25000	30000
1s$_{1/2}$	σ	0.000+0	2.083+1	1.676+1	1.346+1	9.023+0	6.325+0	4.599+0	3.445+0	2.645+0	1.849+0	1.102+0
E_b=	β	0.000	1.987	1.978	1.968	1.949	1.929	1.910	1.890	1.871	1.842	1.795
9658.6 eV	γ	0.00+0	−2.65−1	3.40−1	6.79−1	1.15+0	1.49+0	1.78+0	2.02+0	2.24+0	2.52+0	2.91+0
	δ	0.00+0	−8.37−5	−8.37−5	−8.13−5	−7.44−5	−6.71−5	−5.86−5	−4.83−5	−3.60−5	−1.33−5	3.71−5
Z = 31, Ga: [Ar]4s$^2_{1/2}$ 3d$^4_{3/2}$ 3d$^6_{5/2}$ 4p$^1_{1/2}$												
		k (eV)										
Shell		9000	10000	11000	12000	14000	16000	18000	20000	22000	25000	30000
1s$_{1/2}$	σ	0.000+0	0.000+0	1.836+1	1.491+1	1.005+1	7.072+0	5.156+0	3.871+0	2.978+0	2.087+0	1.247+0
E_b=	β	0.000	0.000	1.983	1.974	1.955	1.935	1.916	1.896	1.877	1.848	1.801
10367.1 eV	γ	0.00+0	0.00+0	−4.87−2	4.32−1	9.74−1	1.35+0	1.66+0	1.92+0	2.14+0	2.44+0	2.85+0
	δ	0.00+0	0.00+0	−9.92−5	−9.62−5	−8.91−5	−8.20−5	−7.35−5	−6.33−5	−5.11−5	−2.87−5	2.09−5
Z = 32, Ge: [Ar]4s$^2_{1/2}$ 3d$^4_{3/2}$ 3d$^6_{5/2}$ 4p$^2_{1/2}$												
		k (eV)										
Shell		9000	10000	11000	12000	14000	16000	18000	20000	22000	25000	30000
1s$_{1/2}$	σ	0.000+0	0.000+0	0.000+0	1.635+1	1.115+1	7.872+0	5.754+0	4.330+0	3.337+0	2.344+0	1.405+0
E_b=	β	0.000	0.000	0.000	1.980	1.961	1.941	1.922	1.902	1.883	1.854	1.807
11103.1 eV	γ	0.00+0	0.00+0	0.00+0	8.70−2	7.88−1	1.21+0	1.54+0	1.81+0	2.05+0	2.35+0	2.78+0

(*continued on next page*)

Table 1 (*continued*)

	δ	0.00+0	0.00+0	0.00+0	−1.15−4	−1.05−4	−9.74−5	−8.89−5	−7.90−5	−6.72−5	−4.52−5	3.09−6
Z = 33, As: $[Ar]4s^2_{1/2}\,3d^4_{3/2}\,3d^6_{5/2}\,4p^2_{1/2}\,4p^1_{3/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	5.537+1	2.767+1	1.596+1	1.014+1	6.889+0	4.916+0	3.642+0	2.780+0	2.173+0	1.734+0	1.406+0
E_b=	β	1.990	1.998	1.998	1.995	1.990	1.984	1.977	1.969	1.961	1.952	1.944
1526.5 eV	γ	1.51−1	−6.43−2	7.25−2	2.63−1	4.58−1	6.43−1	8.18−1	9.81−1	1.13+0	1.28+0	1.41+0
	δ	−4.79−5	−5.60−5	−5.46−5	−5.25−5	−5.01−5	−4.76−5	−4.50−5	−4.23−5	−3.92−5	−3.59−5	−3.22−5
Z = 34, Se: $[Ar]4s^2_{1/2}\,3d^4_{3/2}\,3d^6_{5/2}\,4p^2_{1/2}\,4p^2_{3/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	5.762+1	2.936+1	1.709+1	1.092+1	7.451+0	5.335+0	3.964+0	3.033+0	2.377+0	1.900+0	1.544+0
E_b=	β	1.986	1.997	1.998	1.996	1.992	1.986	1.979	1.971	1.963	1.955	1.947
1653.9 eV	γ	3.03−1	−7.26−2	2.92−2	2.08−1	3.97−1	5.82−1	7.56−1	9.19−1	1.07+0	1.22+0	1.35+0
	δ	−4.94−5	−6.45−5	−6.40−5	−6.18−5	−5.95−5	−5.70−5	−5.43−5	−5.16−5	−4.84−5	−4.50−5	−4.11−5
Z = 35, Br: $[Ar]4s^2_{1/2}\,3d^4_{3/2}\,3d^6_{5/2}\,4p^2_{1/2}\,4p^3_{3/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	5.932+1	3.099+1	1.820+1	1.170+1	8.021+0	5.764+0	4.295+0	3.295+0	2.588+0	2.072+0	1.687+0
E_b=	β	1.983	1.995	1.998	1.997	1.993	1.987	1.981	1.974	1.966	1.958	1.950
1782.0 eV	γ	5.28−1	−6.73−2	−7.89−3	1.55−1	3.39−1	5.20−1	6.93−1	8.56−1	1.01+0	1.15+0	1.29+0
	δ	−4.54−5	−7.35−5	−7.41−5	−7.23−5	−7.00−5	−6.74−5	−6.48−5	−6.20−5	−5.90−5	−5.56−5	−5.17−5
$2p_{1/2}$	σ	1.060+2	3.594+1	1.584+1	8.199+0	4.723+0	2.936+0	1.932+0	1.330+0	9.484−1	6.965−1	5.241−1
E_b=	β	1.330	1.432	1.374	1.294	1.215	1.140	1.070	1.006	0.947	0.893	0.841
1596.0 eV	γ	−8.57−2	3.77−1	6.90−1	9.12−1	1.08+0	1.20+0	1.31+0	1.39+0	1.46+0	1.52+0	1.57+0
	δ	1.27−2	3.32−2	4.89−2	6.48−2	8.07−2	9.69−2	1.13−1	1.30−1	1.46−1	1.62−1	1.77−1
$2p_{3/2}$	σ	2.027+2	6.722+1	2.929+1	1.503+1	8.598+0	5.313+0	3.479+0	2.383+0	1.692+0	1.237+0	9.275−1
E_b=	β	1.372	1.467	1.410	1.332	1.253	1.178	1.109	1.045	0.986	0.932	0.880
1549.9 eV	γ	−6.56−2	4.04−1	7.22−1	9.48−1	1.12+0	1.25+0	1.35+0	1.43+0	1.50+0	1.56+0	1.61+0
	δ	1.51−2	3.40−2	4.84−2	6.31−2	7.81−2	9.34−2	1.09−1	1.25−1	1.40−1	1.56−1	1.71−1
Z = 36, Kr: $[Ar]4s^2_{1/2}\,3d^4_{3/2}\,3d^6_{5/2}\,4p^2_{1/2}\,4p^4_{3/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	5.970+1	3.262+1	1.933+1	1.251+1	8.611+0	6.210+0	4.641+0	3.569+0	2.809+0	2.254+0	1.838+0
E_b=	β	1.979	1.993	1.998	1.997	1.994	1.989	1.983	1.976	1.969	1.961	1.953
1921.0 eV	γ	8.79−1	−4.53−2	−3.90−2	1.05−1	2.80−1	4.58−1	6.30−1	7.93−1	9.46−1	1.09+0	1.23+0
	δ	−1.87−5	−8.28−5	−8.56−5	−8.43−5	−8.16−5	−7.93−5	−7.66−5	−7.38−5	−7.07−5	−6.73−5	−6.37−5
$2p_{1/2}$	σ	1.168+2	4.052+1	1.799+1	9.358+0	5.410+0	3.373+0	2.226+0	1.536+0	1.098+0	8.075−1	6.088−1
E_b=	β	1.239	1.434	1.389	1.317	1.240	1.167	1.099	1.036	0.978	0.924	0.874
1727.2 eV	γ	−1.66−1	3.08−1	6.39−1	8.76−1	1.05+0	1.19+0	1.30+0	1.39+0	1.46+0	1.53+0	1.58+0
	δ	6.55−3	3.07−2	4.60−2	6.16−2	7.71−2	9.26−2	1.08−1	1.24−1	1.40−1	1.56−1	1.71−1
$2p_{3/2}$	σ	2.245+2	7.575+1	3.320+1	1.712+1	9.823+0	6.087+0	3.995+0	2.742+0	1.951+0	1.429+0	1.073+0
E_b=	β	1.296	1.471	1.428	1.356	1.280	1.207	1.140	1.077	1.019	0.966	0.915
1674.9 eV	γ	−1.47−1	3.36−1	6.73−1	9.15−1	1.09+0	1.23+0	1.34+0	1.43+0	1.51+0	1.57+0	1.63+0
	δ	9.70−3	3.19−2	4.58−2	6.01−2	7.45−2	8.91−2	1.04−1	1.19−1	1.34−1	1.49−1	1.64−1
Z = 37, Rb: $[Kr]5s^1_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	3.414+1	2.044+1	1.330+1	9.197+0	6.657+0	4.991+0	3.848+0	3.036+0	2.441+0	1.994+0
E_b=	β	0.000	1.991	1.997	1.998	1.995	1.991	1.985	1.978	1.971	1.964	1.956
2065.1 eV	γ	0.00+0	−4.05−3	−6.16−2	5.94−2	2.24−1	3.95−1	5.64−1	7.27−1	8.81−1	1.03+0	1.17+0
	δ	0.00+0	−9.26−5	−9.83−5	−9.81−5	−9.55−5	−9.29−5	−8.98−5	−8.66−5	−8.33−5	−7.94−5	−7.55−5
$2p_{1/2}$	σ	1.244+2	4.527+1	2.025+1	1.059+1	6.151+0	3.849+0	2.548+0	1.762+0	1.262+0	9.303−1	7.026−1
E_b=	β	1.064	1.431	1.402	1.336	1.265	1.196	1.131	1.069	1.011	0.956	0.905
1863.9 eV	γ	−2.14−1	2.37−1	5.85−1	8.34−1	1.02+0	1.17+0	1.29+0	1.38+0	1.46+0	1.53+0	1.59+0
	δ	−7.98−4	2.82−2	4.31−2	5.77−2	7.29−2	8.86−2	1.04−1	1.20−1	1.36−1	1.51−1	1.66−1
$2p_{3/2}$	σ	2.430+2	8.456+1	3.732+1	1.933+1	1.114+1	6.923+0	4.556+0	3.134+0	2.234+0	1.640+0	1.233+0
E_b=	β	1.167	1.470	1.442	1.377	1.307	1.239	1.174	1.112	1.054	1.000	0.949
1804.4 eV	γ	−2.12−1	2.67−1	6.20−1	8.74−1	1.07+0	1.21+0	1.33+0	1.43+0	1.51+0	1.58+0	1.64+0
	δ	2.02−3	3.00−2	4.32−2	5.64−2	7.04−2	8.51−2	1.00−1	1.15−1	1.30−1	1.44−1	1.59−1
Z = 38, Sr: $[Kr]5s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	3.562+1	2.154+1	1.411+1	9.803+0	7.121+0	5.355+0	4.139+0	3.272+0	2.636+0	2.157+0
E_b=	β	0.000	1.988	1.996	1.998	1.996	1.992	1.987	1.981	1.974	1.966	1.959
2216.3 eV	γ	0.00+0	6.27−2	−7.55−2	1.87−2	1.72−1	3.39−1	5.06−1	6.68−1	8.23−1	9.70−1	1.11+0
	δ	0.00+0	−1.03−4	−1.13−4	−1.13−4	−1.10−4	−1.07−4	−1.04−4	−1.01−4	−9.74−5	−9.34−5	−8.96−5
$2p_{1/2}$	σ	0.000+0	5.036+1	2.270+1	1.194+1	6.963+0	4.371+0	2.901+0	2.011+0	1.443+0	1.066+0	8.065−1
E_b=	β	0.000	1.423	1.412	1.352	1.285	1.218	1.153	1.091	1.033	0.979	0.928
2006.8 eV	γ	0.00+0	1.61−1	5.28−1	7.93−1	9.91−1	1.15+0	1.27+0	1.37+0	1.46+0	1.53+0	1.59+0
	δ	0.00+0	2.58−2	4.06−2	5.52−2	7.00−2	8.49−2	9.99−2	1.15−1	1.30−1	1.44−1	1.59−1
$2p_{3/2}$	σ	2.488+2	9.402+1	4.177+1	2.174+1	1.257+1	7.839+0	5.171+0	3.564+0	2.546+0	1.871+0	1.409+0
E_b=	β	0.854	1.464	1.453	1.396	1.330	1.263	1.198	1.137	1.079	1.025	0.974

(*continued on next page*)

Table 1 (*continued*)

1939.6 eV	γ	−1.93−1	1.93−1	5.65−1	8.36−1	1.04+0	1.19+0	1.32+0	1.42+0	1.51+0	1.58+0	1.64+0
	δ	2.64−5	2.79−2	4.11−2	5.43−2	6.78−2	8.15−2	9.55−2	1.09−1	1.23−1	1.37−1	1.51−1
Z = 39, Y : [Kr]5s$^2_{1/2}$ 4d$^1_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$2s_{1/2}$	σ	3.701+1	2.264+1	1.492+1	1.042+1	7.594+0	5.727+0	4.437+0	3.516+0	2.837+0	2.326+0	1.624+0
E_b=	β	1.985	1.995	1.997	1.996	1.993	1.988	1.983	1.976	1.969	1.961	1.945
2372.5 eV	γ	1.63−1	−7.83−2	−1.73−2	1.21−1	2.82−1	4.45−1	6.05−1	7.59−1	9.05−1	1.04+0	1.30+0
	δ	−1.11−4	−1.28−4	−1.29−4	−1.28−4	−1.24−4	−1.21−4	−1.18−4	−1.14−4	−1.11−4	−1.07−4	−9.78−5
$2p_{1/2}$	σ	5.580+1	2.537+1	1.341+1	7.852+0	4.945+0	3.291+0	2.287+0	1.645+0	1.217+0	9.222−1	5.611−1
E_b=	β	1.406	1.419	1.368	1.305	1.239	1.176	1.116	1.059	1.006	0.956	0.865
2155.5 eV	γ	7.72−2	4.64−1	7.44−1	9.54−1	1.12+0	1.25+0	1.36+0	1.45+0	1.52+0	1.59+0	1.69+0
	δ	2.26−2	3.81−2	5.20−2	6.63−2	8.06−2	9.50−2	1.09−1	1.24−1	1.38−1	1.52−1	1.80−1
$2p_{3/2}$	σ	1.042+2	4.662+1	2.437+1	1.414+1	8.842+0	5.847+0	4.039+0	2.890+0	2.128+0	1.605+0	9.684−1
E_b=	β	1.452	1.463	1.413	1.351	1.287	1.224	1.164	1.107	1.054	1.004	0.913
2080.0 eV	γ	1.11−1	5.04−1	7.89−1	1.00+0	1.17+0	1.30+0	1.41+0	1.50+0	1.58+0	1.65+0	1.75+0
	δ	2.54−2	3.91−2	5.15−2	6.43−2	7.74−2	9.07−2	1.04−1	1.18−1	1.31−1	1.45−1	1.71−1
Z = 40, Zr: [Kr]5s$^2_{1/2}$ 4d$^2_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$2s_{1/2}$	σ	3.826+1	2.371+1	1.573+1	1.103+1	8.071+0	6.105+0	4.742+0	3.765+0	3.044+0	2.500+0	1.751+0
E_b=	β	1.982	1.993	1.997	1.997	1.994	1.990	1.985	1.978	1.972	1.964	1.949
2531.6 eV	γ	3.10−1	−6.81−2	−4.66−2	7.45−2	2.26−1	3.85−1	5.42−1	6.95−1	8.40−1	9.80−1	1.24+0
	δ	−1.19−4	−1.45−4	−1.48−4	−1.47−4	−1.43−4	−1.40−4	−1.37−4	−1.33−4	−1.30−4	−1.26−4	−1.17−4
$2p_{1/2}$	σ	6.140+1	2.820+1	1.499+1	8.812+0	5.568+0	3.716+0	2.588+0	1.865+0	1.383+0	1.049+0	6.404−1
E_b=	β	1.380	1.424	1.382	1.323	1.261	1.200	1.141	1.085	1.033	0.984	0.894
2306.7 eV	γ	−1.12−2	3.98−1	6.92−1	9.13−1	1.09+0	1.22+0	1.34+0	1.43+0	1.52+0	1.59+0	1.70+0
	δ	1.88−2	3.57−2	4.94−2	6.31−2	7.69−2	9.08−2	1.05−1	1.19−1	1.33−1	1.47−1	1.74−1
$2p_{3/2}$	σ	1.148+2	5.176+1	2.719+1	1.583+1	9.928+0	6.580+0	4.555+0	3.265+0	2.408+0	1.819+0	1.101+0
E_b=	β	1.430	1.470	1.429	1.372	1.310	1.249	1.191	1.136	1.084	1.034	0.945
2222.3 eV	γ	2.57−2	4.39−1	7.39−1	9.65−1	1.14+0	1.28+0	1.40+0	1.50+0	1.58+0	1.65+0	1.76+0
	δ	2.24−2	3.72−2	4.92−2	6.13−2	7.38−2	8.65−2	9.94−2	1.12−1	1.26−1	1.39−1	1.65−1
Z = 41, Nb: [Kr]5s$^1_{1/2}$ 4d$^4_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$2s_{1/2}$	σ	3.930+1	2.479+1	1.655+1	1.166+1	8.560+0	6.494+0	5.057+0	4.024+0	3.260+0	2.681+0	1.883+0
E_b=	β	1.977	1.990	1.996	1.997	1.995	1.991	1.986	1.981	1.974	1.967	1.952
2697.7 eV	γ	5.30−1	−4.13−2	−6.81−2	3.09−2	1.71−1	3.24−1	4.79−1	6.31−1	7.77−1	9.17−1	1.18+0
	δ	−1.22−4	−1.64−4	−1.67−4	−1.67−4	−1.64−4	−1.61−4	−1.57−4	−1.53−4	−1.50−4	−1.46−4	−1.37−4
$2p_{1/2}$	σ	6.727+1	3.128+1	1.672+1	9.866+0	6.254+0	4.184+0	2.920+0	2.109+0	1.566+0	1.191+0	7.285−1
E_b=	β	1.337	1.425	1.395	1.342	1.284	1.224	1.166	1.111	1.058	1.009	0.919
2464.7 eV	γ	−1.07−1	3.25−1	6.34−1	8.69−1	1.05+0	1.20+0	1.32+0	1.42+0	1.51+0	1.58+0	1.70+0
	δ	1.35−2	3.34−2	4.70−2	6.04−2	7.41−2	8.78−2	1.01−1	1.15−1	1.28−1	1.41−1	1.68−1
$2p_{3/2}$	σ	1.262+2	5.740+1	3.028+1	1.769+1	1.112+1	7.388+0	5.124+0	3.678+0	2.717+0	2.056+0	1.247+0
E_b=	β	1.395	1.474	1.445	1.393	1.336	1.276	1.219	1.163	1.111	1.062	0.972
2370.5 eV	γ	−6.69−2	3.68−1	6.83−1	9.23−1	1.11+0	1.26+0	1.38+0	1.49+0	1.57+0	1.65+0	1.77+0
	δ	1.85−2	3.55−2	4.72−2	5.91−2	7.12−2	8.35−2	9.59−2	1.08−1	1.21−1	1.33−1	1.58−1
Z = 42, Mo: [Kr]5s$^1_{1/2}$ 4d$^4_{3/2}$ 4d$^1_{5/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$2s_{1/2}$	σ	3.971+1	2.580+1	1.734+1	1.227+1	9.046+0	6.883+0	5.374+0	4.285+0	3.478+0	2.865+0	2.018+0
E_b=	β	1.972	1.988	1.994	1.996	1.995	1.992	1.988	1.983	1.976	1.970	1.955
2865.5 eV	γ	8.62−1	4.61−3	−8.07−2	−6.25−3	1.21−1	2.67−1	4.18−1	5.68−1	7.13−1	8.53−1	1.11+0
	δ	−7.67−5	−1.83−4	−1.90−4	−1.89−4	−1.88−4	−1.84−4	−1.80−4	−1.76−4	−1.72−4	−1.68−4	−1.59−4
$2p_{1/2}$	σ	7.286+1	3.447+1	1.853+1	1.098+1	6.984+0	4.686+0	3.278+0	2.372+0	1.765+0	1.344+0	8.247−1
E_b=	β	1.267	1.422	1.405	1.358	1.303	1.246	1.190	1.135	1.083	1.034	0.945
2625.1 eV	γ	−2.03−1	2.47−1	5.72−1	8.19−1	1.01+0	1.17+0	1.30+0	1.40+0	1.49+0	1.57+0	1.70+0
	δ	6.15−3	3.06−2	4.42−2	5.72−2	7.06−2	8.40−2	9.72−2	1.10−1	1.23−1	1.36−1	1.62−1
$2p_{3/2}$	σ	1.374+2	6.320+1	3.350+1	1.964+1	1.239+1	8.248+0	5.732+0	4.123+0	3.050+0	2.311+0	1.405+0
E_b=	β	1.341	1.473	1.456	1.411	1.357	1.301	1.245	1.190	1.138	1.090	1.001
2520.2 eV	γ	−1.61−1	2.92−1	6.23−1	8.76−1	1.07+0	1.23+0	1.37+0	1.47+0	1.56+0	1.64+0	1.77+0
	δ	1.30−2	3.33−2	4.49−2	5.62−2	6.80−2	8.00−2	9.20−2	1.04−1	1.16−1	1.28−1	1.52−1
Z = 43, Tc: [Kr]5s$^2_{1/2}$ 4d$^4_{3/2}$ 4d$^1_{5/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$2s_{1/2}$	σ	0.000+0	2.676+1	1.814+1	1.290+1	9.540+0	7.280+0	5.698+0	4.553+0	3.702+0	3.055+0	2.158+0
E_b=	β	0.000	1.984	1.993	1.996	1.996	1.993	1.989	1.984	1.979	1.972	1.958
3042.5 eV	γ	0.00+0	7.47−2	−8.34−2	−3.78−2	7.51−2	2.13−1	3.59−1	5.06−1	6.49−1	7.87−1	1.05+0
	δ	0.00+0	−2.02−4	−2.14−4	−2.15−4	−2.13−4	−2.10−4	−2.07−4	−2.03−4	−1.99−4	−1.95−4	−1.86−4
$2p_{1/2}$	σ	7.738+1	3.780+1	2.045+1	1.217+1	7.768+0	5.226+0	3.665+0	2.657+0	1.981+0	1.511+0	9.299−1
E_b=	β	1.133	1.414	1.412	1.371	1.319	1.264	1.210	1.157	1.107	1.059	0.972
2793.2 eV	γ	−2.88−1	1.66−1	5.10−1	7.69−1	9.72−1	1.14+0	1.27+0	1.38+0	1.48+0	1.56+0	1.70+0
	δ	−5.45−3	2.77−2	4.19−2	5.47−2	6.74−2	8.00−2	9.27−2	1.05−1	1.18−1	1.31−1	1.56−1

(*continued on next page*)

Table 1 (*continued*)

$2p_{3/2}$	σ	1.481+2	6.931+1	3.693+1	2.173+1	1.374+1	9.171+0	6.386+0	4.602+0	3.410+0	2.587+0	1.577+0
E_b=	β	1.254	1.468	1.465	1.426	1.375	1.321	1.267	1.214	1.164	1.117	1.030
2676.9 eV	γ	−2.53−1	2.15−1	5.64−1	8.29−1	1.04+0	1.20+0	1.34+0	1.46+0	1.55+0	1.64+0	1.77+0
	δ	4.23−3	3.13−2	4.33−2	5.42−2	6.53−2	7.64−2	8.77−2	9.89−2	1.11−1	1.22−1	1.46−1
Z = 44, Ru: [Kr]$5s^1_{1/2}$ $4d^4_{3/2}$ $4d^3_{5/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$2s_{1/2}$	σ	0.000+0	2.770+1	1.892+1	1.352+1	1.004+1	7.683+0	6.028+0	4.827+0	3.933+0	3.251+0	2.303+0
E_b=	β	0.000	1.981	1.991	1.995	1.996	1.994	1.991	1.986	1.981	1.975	1.961
3224.0 eV	γ	0.00+0	1.79−1	−7.34−2	−6.33−2	3.19−2	1.59−1	2.98−1	4.41−1	5.84−1	7.23−1	9.85−1
	δ	0.00+0	−2.13−4	−2.38−4	−2.43−4	−2.42−4	−2.39−4	−2.35−4	−2.31−4	−2.27−4	−2.22−4	−2.13−4
$2p_{1/2}$	σ	7.505+1	4.144+1	2.255+1	1.347+1	8.626+0	5.820+0	4.091+0	2.973+0	2.220+0	1.696+0	1.046+0
E_b=	β	0.710	1.399	1.416	1.382	1.335	1.285	1.233	1.182	1.132	1.083	0.994
2966.9 eV	γ	−1.63−1	7.37−2	4.37−1	7.09−1	9.22−1	1.10+0	1.24+0	1.36+0	1.46+0	1.55+0	1.69+0
	δ	1.63−2	2.41−2	3.88−2	5.12−2	6.35−2	7.63−2	8.92−2	1.02−1	1.14−1	1.27−1	1.50−1
$2p_{3/2}$	σ	1.566+2	7.594+1	4.065+1	2.400+1	1.522+1	1.018+1	7.105+0	5.129+0	3.806+0	2.891+0	1.766+0
E_b=	β	1.073	1.458	1.472	1.440	1.394	1.344	1.293	1.242	1.192	1.144	1.055
2837.9 eV	γ	−3.18−1	1.26−1	4.93−1	7.71−1	9.90−1	1.17+0	1.32+0	1.44+0	1.54+0	1.63+0	1.77+0
	δ	−1.03−2	2.86−2	4.09−2	5.12−2	6.18−2	7.29−2	8.45−2	9.59−2	1.07−1	1.18−1	1.40−1
Z = 45, Rh: [Kr]$5s^1_{1/2}$ $4d^4_{3/2}$ $4d^4_{5/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$2s_{1/2}$	σ	2.855+1	1.969+1	1.415+1	1.054+1	8.089+0	6.362+0	5.105+0	4.167+0	3.451+0	2.452+0	1.809+0
E_b=	β	1.976	1.988	1.993	1.995	1.994	1.992	1.988	1.983	1.977	1.964	1.949
3411.9 eV	γ	3.28−1	−4.83−2	−8.08−2	−6.02−3	1.10−1	2.42−1	3.80−1	5.19−1	6.57−1	9.20−1	1.16+0
	δ	−2.20−4	−2.64−4	−2.74−4	−2.74−4	−2.72−4	−2.68−4	−2.63−4	−2.59−4	−2.54−4	−2.44−4	−2.34−4
$2p_{1/2}$	σ	4.514+1	2.475+1	1.485+1	9.539+0	6.453+0	4.547+0	3.311+0	2.476+0	1.895+0	1.172+0	7.691−1
E_b=	β	1.375	1.418	1.392	1.349	1.301	1.253	1.204	1.155	1.107	1.018	0.939
3146.1 eV	γ	−2.24−2	3.62−1	6.50−1	8.73−1	1.05+0	1.21+0	1.33+0	1.44+0	1.53+0	1.68+0	1.80+0
	δ	1.99−2	3.63−2	4.86−2	6.04−2	7.25−2	8.51−2	9.78−2	1.10−1	1.22−1	1.45−1	1.69−1
$2p_{3/2}$	σ	8.279+1	4.456+1	2.640+1	1.678+1	1.126+1	7.871+0	5.691+0	4.231+0	3.218+0	1.970+0	1.281+0
E_b=	β	1.440	1.476	1.452	1.410	1.363	1.315	1.267	1.218	1.170	1.081	1.002
3003.8 eV	γ	3.46−2	4.22−1	7.14−1	9.43−1	1.13+0	1.29+0	1.42+0	1.53+0	1.62+0	1.77+0	1.88+0
	δ	2.56−2	3.91−2	4.93−2	5.91−2	6.95−2	8.06−2	9.18−2	1.03−1	1.14−1	1.35−1	1.56−1
Z = 46, Pd: [Kr]$4d^4_{3/2}$ $4d^6_{5/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$2s_{1/2}$	σ	2.926+1	2.046+1	1.477+1	1.105+1	8.507+0	6.705+0	5.390+0	4.406+0	3.654+0	2.604+0	1.927+0
E_b=	β	1.971	1.985	1.992	1.994	1.994	1.992	1.989	1.984	1.979	1.967	1.953
3604.3 eV	γ	5.44−1	−3.87−3	−8.78−2	−3.85−2	6.41−2	1.89−1	3.22−1	4.56−1	5.89−1	8.51−1	1.10+0
	δ	−2.04−4	−2.86−4	−3.02−4	−3.06−4	−3.06−4	−3.04−4	−3.01−4	−2.96−4	−2.91−4	−2.78−4	−2.67−4
$2p_{1/2}$	σ	4.899+1	2.712+1	1.635+1	1.053+1	7.140+0	5.040+0	3.677+0	2.755+0	2.112+0	1.311+0	8.616−1
E_b=	β	1.336	1.416	1.401	1.363	1.316	1.268	1.222	1.176	1.132	1.045	0.963
3330.3 eV	γ	−1.28−1	2.79−1	5.82−1	8.22−1	1.01+0	1.17+0	1.30+0	1.41+0	1.51+0	1.67+0	1.79+0
	δ	1.39−2	3.33−2	4.62−2	5.83−2	6.98−2	8.09−2	9.26−2	1.05−1	1.17−1	1.41−1	1.64−1
$2p_{3/2}$	σ	8.997+1	4.877+1	2.900+1	1.848+1	1.242+1	8.695+0	6.297+0	4.689+0	3.572+0	2.193+0	1.428+0
E_b=	β	1.411	1.477	1.463	1.426	1.380	1.333	1.287	1.243	1.198	1.111	1.029
3173.3 eV	γ	−6.42−2	3.42−1	6.51−1	8.96−1	1.09+0	1.25+0	1.39+0	1.50+0	1.61+0	1.77+0	1.89+0
	δ	2.16−2	3.72−2	4.77−2	5.77−2	6.71−2	7.66−2	8.69−2	9.80−2	1.09−1	1.31−1	1.51−1
Z = 47, Ag: [Kr]$5s^1_{1/2}$ $4d^4_{3/2}$ $4d^6_{5/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$2s_{1/2}$	σ	2.961+1	2.116+1	1.538+1	1.155+1	8.914+0	7.044+0	5.675+0	4.648+0	3.861+0	2.759+0	2.046+0
E_b=	β	1.966	1.981	1.989	1.993	1.994	1.993	1.990	1.986	1.981	1.969	1.956
3805.8 eV	γ	8.62−1	6.18−2	−8.56−2	−6.44−2	2.24−2	1.38−1	2.64−1	3.95−1	5.26−1	7.86−1	1.03+0
	δ	−1.55−4	−3.12−4	−3.38−4	−3.44−4	−3.45−4	−3.43−4	−3.39−4	−3.34−4	−3.29−4	−3.17−4	−3.06−4
$2p_{1/2}$	σ	5.267+1	2.954+1	1.789+1	1.157+1	7.864+0	5.565+0	4.068+0	3.054+0	2.345+0	1.459+0	9.613−1
E_b=	β	1.273	1.410	1.407	1.374	1.331	1.286	1.241	1.197	1.153	1.066	0.986
3523.7 eV	γ	−2.39−1	1.94−1	5.16−1	7.64−1	9.62−1	1.13+0	1.27+0	1.39+0	1.49+0	1.66+0	1.79+0
	δ	5.45−3	3.04−2	4.37−2	5.52−2	6.62−2	7.74−2	8.91−2	1.01−1	1.13−1	1.36−1	1.58−1
$2p_{3/2}$	σ	9.715+1	5.309+1	3.169+1	2.025+1	1.364+1	9.571+0	6.944+0	5.178+0	3.950+0	2.430+0	1.585+0
E_b=	β	1.368	1.475	1.471	1.439	1.398	1.354	1.310	1.266	1.222	1.135	1.054
3351.1 eV	γ	−1.68−1	2.62−1	5.87−1	8.41−1	1.04+0	1.21+0	1.36+0	1.48+0	1.59+0	1.76+0	1.89+0
	δ	1.61−2	3.53−2	4.59−2	5.52−2	6.42−2	7.36−2	8.37−2	9.43−2	1.05−1	1.25−1	1.45−1
Z = 48, Cd: [Kr]$5s^2_{1/2}$ $4d^4_{3/2}$ $4d^6_{5/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$2s_{1/2}$	σ	0.000+0	2.186+1	1.597+1	1.204+1	9.325+0	7.388+0	5.966+0	4.896+0	4.074+0	2.919+0	2.170+0
E_b=	β	0.000	1.977	1.987	1.992	1.994	1.993	1.991	1.987	1.983	1.972	1.959
4018.0 eV	γ	0.00+0	1.58−1	−6.90−2	−8.27−2	−1.47−2	8.89−2	2.09−1	3.35−1	4.64−1	7.21−1	9.64−1
	δ	0.00+0	−3.34−4	−3.73−4	−3.85−4	−3.86−4	−3.84−4	−3.81−4	−3.76−4	−3.71−4	−3.60−4	−3.49−4
$2p_{1/2}$	σ	5.584+1	3.211+1	1.954+1	1.267+1	8.643+0	6.131+0	4.491+0	3.377+0	2.596+0	1.620+0	1.070+0
E_b=	β	1.156	1.398	1.411	1.384	1.346	1.304	1.260	1.216	1.172	1.087	1.008

(*continued on next page*)

Table 1 (*continued*)

3727.0 eV	γ	−3.46−1	9.88−2	4.37−1	6.99−1	9.08−1	1.08+0	1.23+0	1.36+0	1.47+0	1.64+0	1.78+0
	δ	−8.72−3	2.65−2	4.05−2	5.20−2	6.30−2	7.44−2	8.60−2	9.76−2	1.09−1	1.31−1	1.52−1
$2p_{3/2}$	σ	1.043+2	5.769+1	3.456+1	2.215+1	1.495+1	1.051+1	7.640+0	5.705+0	4.357+0	2.686+0	1.756+0
E_b=	β	1.298	1.467	1.477	1.452	1.415	1.374	1.331	1.288	1.244	1.159	1.080
3537.5 eV	γ	−2.78−1	1.71−1	5.12−1	7.79−1	9.94−1	1.17+0	1.33+0	1.46+0	1.57+0	1.75+0	1.88+0
	δ	7.21−3	3.27−2	4.37−2	5.27−2	6.17−2	7.11−2	8.09−2	9.11−2	1.01−1	1.20−1	1.39−1
Z = 49, In: [Kr]$5s^2_{1/2}$ $4d^4_{3/2}$ $4d^6_{5/2}$ $5p^1_{1/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$2s_{1/2}$	σ	0.000+0	2.249+1	1.656+1	1.253+1	9.738+0	7.736+0	6.260+0	5.147+0	4.290+0	3.081+0	2.295+0
E_b=	β	0.000	1.972	1.984	1.990	1.993	1.993	1.991	1.988	1.984	1.974	1.962
4237.5 eV	γ	0.00+0	2.92−1	−3.66−2	−9.13−2	−4.57−2	4.47−2	1.57−1	2.79−1	4.05−1	6.56−1	8.95−1
	δ	0.00+0	−3.46−4	−4.08−4	−4.24−4	−4.28−4	−4.28−4	−4.26−4	−4.23−4	−4.18−4	−4.09−4	−3.98−4
$2p_{1/2}$	σ	5.495+1	3.476+1	2.128+1	1.386+1	9.474+0	6.736+0	4.943+0	3.723+0	2.866+0	1.793+0	1.187+0
E_b=	β	0.817	1.378	1.411	1.393	1.359	1.319	1.276	1.233	1.190	1.107	1.031
3938.0 eV	γ	−3.02−1	−1.05−3	3.57−1	6.33−1	8.54−1	1.04+0	1.19+0	1.32+0	1.44+0	1.62+0	1.76+0
	δ	−1.82−2	2.23−2	3.78−2	4.97−2	6.08−2	7.20−2	8.30−2	9.38−2	1.05−1	1.26−1	1.47−1
$2p_{3/2}$	σ	1.104+2	6.249+1	3.760+1	2.416+1	1.635+1	1.152+1	8.381+0	6.266+0	4.791+0	2.960+0	1.939+0
E_b=	β	1.170	1.454	1.481	1.463	1.431	1.392	1.349	1.307	1.264	1.181	1.106
3730.1 eV	γ	−3.79−1	7.82−2	4.36−1	7.17−1	9.45−1	1.13+0	1.29+0	1.43+0	1.54+0	1.73+0	1.88+0
	δ	−8.06−3	3.02−2	4.21−2	5.13−2	6.03−2	6.93−2	7.84−2	8.75−2	9.66−2	1.15−1	1.34−1
Z = 50, Sn: [Kr]$5s^2_{1/2}$ $4d^4_{3/2}$ $4d^6_{5/2}$ $5p^2_{1/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$2s_{1/2}$	σ	0.000+0	2.304+1	1.713+1	1.303+1	1.015+1	8.085+0	6.557+0	5.400+0	4.507+0	3.246+0	2.423+0
E_b=	β	0.000	1.967	1.980	1.987	1.991	1.992	1.992	1.989	1.986	1.976	1.964
4464.7 eV	γ	0.00+0	4.86−1	1.43−2	−9.10−2	−7.09−2	4.92−3	1.08−1	2.24−1	3.45−1	5.89−1	8.25−1
	δ	0.00+0	−3.44−4	−4.47−4	−4.72−4	−4.80−4	−4.81−4	−4.80−4	−4.77−4	−4.72−4	−4.63−4	−4.51−4
$2p_{1/2}$	σ	0.000+0	3.747+1	2.311+1	1.510+1	1.035+1	7.378+0	5.424+0	4.092+0	3.156+0	1.979+0	1.314+0
E_b=	β	0.000	1.347	1.409	1.399	1.369	1.332	1.291	1.249	1.208	1.129	1.055
4156.1 eV	γ	0.00+0	−1.11−1	2.72−1	5.64−1	7.96−1	9.88−1	1.15+0	1.28+0	1.40+0	1.60+0	1.75+0
	δ	0.00+0	1.63−2	3.48−2	4.70−2	5.79−2	6.85−2	7.88−2	8.92−2	9.96−2	1.21−1	1.42−1
$2p_{3/2}$	σ	1.102+2	6.746+1	4.079+1	2.629+1	1.782+1	1.258+1	9.167+0	6.863+0	5.255+0	3.255+0	2.136+0
E_b=	β	0.834	1.432	1.481	1.472	1.443	1.407	1.367	1.326	1.285	1.206	1.132
3928.8 eV	γ	−3.37−1	−2.39−2	3.56−1	6.52−1	8.90−1	1.09+0	1.25+0	1.39+0	1.51+0	1.71+0	1.87+0
	δ	−2.64−2	2.65−2	4.03−2	4.96−2	5.80−2	6.64−2	7.48−2	8.33−2	9.21−2	1.10−1	1.29−1
Z = 51, Sb: [Kr]$5s^2_{1/2}$ $4d^4_{3/2}$ $4d^6_{5/2}$ $5p^2_{1/2}$ $5p^1_{3/2}$												
		k (eV)										
Shell		5000	6000	7000	8000	9000	10000	11000	12000	14000	16000	18000
$2s_{1/2}$	σ	2.339+1	1.768+1	1.350+1	1.056+1	8.430+0	6.851+0	5.653+0	4.726+0	3.413+0	2.554+0	1.966+0
E_b=	β	1.961	1.975	1.984	1.989	1.991	1.991	1.990	1.987	1.978	1.967	1.954
4698.3 eV	γ	7.74−1	8.97−2	−7.78−2	−8.81−2	−3.00−2	6.14−2	1.69−1	2.85−1	5.23−1	7.57−1	9.82−1
	δ	−2.98−4	−4.82−4	−5.21−4	−5.34−4	−5.37−4	−5.36−4	−5.34−4	−5.30−4	−5.19−4	−5.07−4	−4.92−4
$2p_{1/2}$	σ	4.016+1	2.501+1	1.641+1	1.128+1	8.058+0	5.936+0	4.487+0	3.466+0	2.180+0	1.450+0	1.008+0
E_b=	β	1.296	1.401	1.404	1.379	1.345	1.307	1.267	1.228	1.151	1.077	1.008
4380.4 eV	γ	−2.32−1	1.79−1	4.87−1	7.30−1	9.30−1	1.10+0	1.24+0	1.37+0	1.57+0	1.73+0	1.86+0
	δ	8.07−3	3.13−2	4.40−2	5.47−2	6.49−2	7.51−2	8.54−2	9.59−2	1.17−1	1.38−1	1.59−1
$2p_{3/2}$	σ	7.254+1	4.412+1	2.852+1	1.938+1	1.370+1	1.000+1	7.500+0	5.750+0	3.569+0	2.347+0	1.614+0
E_b=	β	1.400	1.478	1.479	1.455	1.422	1.385	1.346	1.308	1.231	1.158	1.089
4132.3 eV	γ	−1.33−1	2.69−1	5.79−1	8.27−1	1.03+0	1.21+0	1.35+0	1.48+0	1.70+0	1.86+0	1.99+0
	δ	2.15−2	3.82−2	4.76−2	5.56−2	6.36−2	7.17−2	8.00−2	8.87−2	1.06−1	1.25−1	1.43−1
Z = 52, Te: [Kr]$5s^2_{1/2}$ $4d^4_{3/2}$ $4d^6_{5/2}$ $5p^2_{1/2}$ $5p^2_{3/2}$												
		k (eV)										
Shell		5000	6000	7000	8000	9000	10000	11000	12000	14000	16000	18000
$2s_{1/2}$	σ	2.301+1	1.819+1	1.397+1	1.096+1	8.776+0	7.147+0	5.908+0	4.948+0	3.583+0	2.688+0	2.073+0
E_b=	β	1.955	1.970	1.981	1.987	1.990	1.991	1.990	1.988	1.980	1.970	1.957
4939.2 eV	γ	1.24+0	1.96−1	−4.97−2	−9.63−2	−5.87−2	1.94−2	1.18−1	2.28−1	4.59−1	6.92−1	9.16−1
	δ	−2.47−5	−5.10−4	−5.69−4	−5.90−4	−5.96−4	−5.95−4	−5.93−4	−5.89−4	−5.79−4	−5.66−4	−5.52−4
$2p_{1/2}$	σ	4.258+1	2.700+1	1.779+1	1.226+1	8.781+0	6.482+0	4.909+0	3.798+0	2.395+0	1.597+0	1.112+0
E_b=	β	1.210	1.389	1.405	1.387	1.357	1.322	1.284	1.246	1.170	1.097	1.028
4612.0 eV	γ	−3.59−1	7.85−2	4.05−1	6.60−1	8.69−1	1.05+0	1.20+0	1.33+0	1.54+0	1.71+0	1.85+0
	δ	−5.65−3	2.72−2	4.10−2	5.17−2	6.19−2	7.21−2	8.24−2	9.28−2	1.13−1	1.34−1	1.54−1
$2p_{3/2}$	σ	7.768+1	4.761+1	3.087+1	2.102+1	1.489+1	1.089+1	8.177+0	6.278+0	3.906+0	2.573+0	1.772+0
E_b=	β	1.349	1.471	1.483	1.466	1.437	1.403	1.366	1.329	1.254	1.181	1.111
4341.4 eV	γ	−2.51−1	1.75−1	5.02−1	7.61−1	9.76−1	1.16+0	1.32+0	1.45+0	1.68+0	1.85+0	1.98+0
	δ	1.43−2	3.59−2	4.59−2	5.38−2	6.15−2	6.94−2	7.77−2	8.61−2	1.03−1	1.21−1	1.38−1
Z = 53, I : [Kr]$5s^2_{1/2}$ $4d^4_{3/2}$ $4d^6_{5/2}$ $5p^2_{1/2}$ $5p^3_{3/2}$												
		k (eV)										
Shell		5000	6000	7000	8000	9000	10000	11000	12000	14000	16000	18000
$2s_{1/2}$	σ	0.000+0	1.866+1	1.443+1	1.137+1	9.121+0	7.445+0	6.167+0	5.173+0	3.757+0	2.825+0	2.183+0
E_b=	β	0.000	1.965	1.977	1.984	1.988	1.990	1.990	1.988	1.982	1.972	1.960
5188.1 eV	γ	0.00+0	3.44−1	−3.60−3	−9.43−2	−8.08−2	−1.76−2	7.12−2	1.74−1	3.98−1	6.27−1	8.51−1
	δ	0.00+0	−5.23−4	−6.18−4	−6.49−4	−6.59−4	−6.59−4	−6.58−4	−6.55−4	−6.45−4	−6.33−4	−6.19−4

(*continued on next page*)

Table 1 (*continued*)

$2p_{1/2}$	σ	4.369+1	2.905+1	1.924+1	1.331+1	9.548+0	7.064+0	5.359+0	4.152+0	2.626+0	1.754+0	1.223+0
E_b=	β	1.005	1.368	1.404	1.393	1.367	1.335	1.299	1.262	1.188	1.116	1.046
4852.1 eV	γ	−4.40−1	−3.14−2	3.18−1	5.87−1	8.06−1	9.91−1	1.15+0	1.29+0	1.52+0	1.69+0	1.83+0
	δ	−2.90−2	2.21−2	3.79−2	4.90−2	5.90−2	6.92−2	7.95−2	8.97−2	1.10−1	1.29−1	1.48−1
$2p_{3/2}$	σ	8.252+1	5.126+1	3.335+1	2.276+1	1.615+1	1.183+1	8.897+0	6.839+0	4.263+0	2.813+0	1.941+0
E_b=	β	1.266	1.458	1.485	1.475	1.450	1.419	1.384	1.348	1.274	1.201	1.132
4557.1 eV	γ	−3.74−1	7.48−2	4.20−1	6.92−1	9.17−1	1.11+0	1.28+0	1.42+0	1.65+0	1.83+0	1.97+0
	δ	2.02−3	3.29−2	4.42−2	5.21−2	5.96−2	6.74−2	7.55−2	8.36−2	1.00−1	1.16−1	1.33−1
Z = 54, Xe: [Kr]$5s^2_{1/2}$ $4d^4_{3/2}$ $4d^6_{5/2}$ $5p^2_{1/2}$ $5p^4_{3/2}$												
		k (eV)										
Shell		5000	6000	7000	8000	9000	10000	11000	12000	14000	16000	18000
$2s_{1/2}$	σ	0.000+0	1.907+1	1.489+1	1.177+1	9.473+0	7.748+0	6.430+0	5.403+0	3.935+0	2.965+0	2.296+0
E_b=	β	0.000	1.959	1.972	1.981	1.986	1.989	1.989	1.988	1.983	1.974	1.963
5452.8 eV	γ	0.00+0	5.61−1	6.65−2	−7.94−2	−9.54−2	−4.97−2	2.76−2	1.23−1	3.38−1	5.63−1	7.83−1
	δ	0.00+0	−5.08−4	−6.62−4	−7.10−4	−7.27−4	−7.30−4	−7.29−4	−7.27−4	−7.20−4	−7.09−4	−6.97−4
$2p_{1/2}$	σ	0.000+0	3.116+1	2.078+1	1.442+1	1.037+1	7.686+0	5.841+0	4.533+0	2.873+0	1.924+0	1.344+0
E_b=	β	0.000	1.334	1.399	1.398	1.376	1.347	1.313	1.278	1.205	1.133	1.065
5103.7 eV	γ	0.00+0	−1.54−1	2.21−1	5.09−1	7.38−1	9.33−1	1.10+0	1.25+0	1.48+0	1.66+0	1.81+0
	δ	0.00+0	1.53−2	3.42−2	4.62−2	5.61−2	6.62−2	7.64−2	8.64−2	1.06−1	1.24−1	1.43−1
$2p_{3/2}$	σ	8.608+1	5.510+1	3.599+1	2.461+1	1.749+1	1.284+1	9.666+0	7.438+0	4.646+0	3.071+0	2.121+0
E_b=	β	1.098	1.437	1.484	1.482	1.461	1.433	1.400	1.365	1.293	1.222	1.154
4782.2 eV	γ	−4.75−1	−3.47−2	3.31−1	6.19−1	8.54−1	1.06+0	1.23+0	1.38+0	1.62+0	1.81+0	1.96+0
	δ	−2.13−2	2.91−2	4.24−2	5.06−2	5.78−2	6.54−2	7.32−2	8.09−2	9.62−2	1.12−1	1.27−1
Z = 55, Cs: [Xe]$6s^1_{1/2}$												
		k (eV)										
Shell		6000	7000	8000	9000	10000	11000	12000	14000	16000	18000	20000
$2s_{1/2}$	σ	1.927+1	1.530+1	1.215+1	9.807+0	8.043+0	6.688+0	5.628+0	4.110+0	3.103+0	2.407+0	1.909+0
E_b=	β	1.952	1.967	1.977	1.984	1.987	1.988	1.988	1.984	1.976	1.965	1.953
5714.3 eV	γ	8.78−1	1.61−1	−4.98−2	−9.95−2	−7.46−2	−1.02−2	7.64−2	2.80−1	4.97−1	7.12−1	9.22−1
	δ	−4.24−4	−7.08−4	−7.67−4	−7.94−4	−8.06−4	−8.11−4	−8.12−4	−8.06−4	−7.95−4	−7.83−4	−7.68−4
$2p_{1/2}$	σ	3.316+1	2.233+1	1.555+1	1.122+1	8.332+0	6.342+0	4.928+0	3.132+0	2.102+0	1.472+0	1.066+0
E_b=	β	1.283	1.389	1.400	1.384	1.357	1.325	1.290	1.221	1.153	1.087	1.025
5359.4 eV	γ	−2.84−1	1.20−1	4.23−1	6.70−1	8.76−1	1.05+0	1.20+0	1.44+0	1.63+0	1.79+0	1.92+0
	δ	5.22−3	3.01−2	4.30−2	5.39−2	6.38−2	7.31−2	8.21−2	1.01−1	1.19−1	1.38−1	1.56−1
$2p_{3/2}$	σ	5.889+1	3.866+1	2.652+1	1.889+1	1.388+1	1.046+1	8.061+0	5.046+0	3.341+0	2.312+0	1.657+0
E_b=	β	1.407	1.480	1.487	1.471	1.445	1.414	1.381	1.312	1.245	1.180	1.118
5011.9 eV	γ	−1.49−1	2.36−1	5.40−1	7.92−1	1.00+0	1.18+0	1.33+0	1.59+0	1.79+0	1.95+0	2.08+0
	δ	2.40−2	4.00−2	4.91−2	5.68−2	6.39−2	7.07−2	7.74−2	9.16−2	1.07−1	1.22−1	1.38−1
Z = 56, Ba: [Xe]$6s^2_{1/2}$												
		k (eV)										
Shell		6000	7000	8000	9000	10000	11000	12000	14000	16000	18000	20000
$2s_{1/2}$	σ	1.800+1	1.569+1	1.252+1	1.014+1	8.335+0	6.943+0	5.852+0	4.286+0	3.244+0	2.521+0	2.003+0
E_b=	β	1.948	1.961	1.973	1.980	1.985	1.987	1.988	1.984	1.977	1.968	1.956
5988.8 eV	γ	1.34+0	2.93−1	−3.95−3	−9.42−2	−9.25−2	−4.32−2	3.24−2	2.22−1	4.32−1	6.44−1	8.53−1
	δ	2.98−4	−7.35−4	−8.32−4	−8.73−4	−8.90−4	−8.94−4	−8.95−4	−8.89−4	−8.79−4	−8.66−4	−8.50−4
$2p_{1/2}$	σ	3.491+1	2.393+1	1.674+1	1.210+1	9.008+0	6.870+0	5.348+0	3.409+0	2.293+0	1.609+0	1.168+0
E_b=	β	1.187	1.373	1.399	1.389	1.366	1.337	1.306	1.239	1.173	1.108	1.046
5623.6 eV	γ	−4.26−1	9.69−3	3.33−1	5.92−1	8.04−1	9.85−1	1.14+0	1.40+0	1.60+0	1.77+0	1.90+0
	δ	−1.17−2	2.52−2	3.96−2	5.04−2	6.00−2	6.94−2	7.87−2	9.77−2	1.16−1	1.35−1	1.53−1
$2p_{3/2}$	σ	6.272+1	4.144+1	2.850+1	2.034+1	1.497+1	1.130+1	8.719+0	5.471+0	3.629+0	2.515+0	1.805+0
E_b=	β	1.359	1.470	1.489	1.479	1.458	1.430	1.399	1.334	1.268	1.203	1.141
5247.0 eV	γ	−2.74−1	1.37−1	4.57−1	7.18−1	9.36−1	1.12+0	1.29+0	1.55+0	1.77+0	1.93+0	2.07+0
	δ	1.65−2	3.74−2	4.72−2	5.46−2	6.13−2	6.81−2	7.50−2	8.95−2	1.04−1	1.19−1	1.34−1
Z = 57, La: [Xe]$5d^1_{3/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		6000	7000	8000	9000	10000	11000	12000	14000	16000	18000	20000
$2s_{1/2}$	σ	0.000+0	1.602+1	1.288+1	1.046+1	8.622+0	7.197+0	6.077+0	4.464+0	3.387+0	2.637+0	2.098+0
E_b=	β	0.000	1.955	1.968	1.977	1.982	1.985	1.987	1.985	1.979	1.970	1.959
6266.3 eV	γ	0.00+0	4.74−1	6.27−2	−7.56−2	−1.01−1	−6.98−2	−6.39−3	1.69−1	3.72−1	5.81−1	7.88−1
	δ	0.00+0	−7.39−4	−8.92−4	−9.48−4	−9.72−4	−9.81−4	−9.84−4	−9.81−4	−9.73−4	−9.60−4	−9.45−4
$2p_{1/2}$	σ	3.511+1	2.555+1	1.796+1	1.303+1	9.719+0	7.426+0	5.791+0	3.702+0	2.496+0	1.754+0	1.275+0
E_b=	β	0.935	1.347	1.394	1.393	1.374	1.349	1.319	1.255	1.189	1.124	1.062
5890.6 eV	γ	−4.87−1	−1.09−1	2.37−1	5.09−1	7.33−1	9.24−1	1.09+0	1.36+0	1.57+0	1.74+0	1.88+0
	δ	−3.92−2	1.91−2	3.60−2	4.73−2	5.72−2	6.67−2	7.61−2	9.47−2	1.13−1	1.30−1	1.48−1
$2p_{3/2}$	σ	6.633+1	4.430+1	3.056+1	2.186+1	1.611+1	1.218+1	9.411+0	5.917+0	3.933+0	2.730+0	1.962+0
E_b=	β	1.283	1.456	1.489	1.486	1.468	1.444	1.415	1.352	1.287	1.223	1.161
5482.7 eV	γ	−4.07−1	3.21−2	3.68−1	6.41−1	8.70−1	1.07+0	1.24+0	1.52+0	1.74+0	1.92+0	2.06+0
	δ	4.30−3	3.44−2	4.55−2	5.30−2	5.98−2	6.65−2	7.33−2	8.72−2	1.01−1	1.15−1	1.29−1
Z = 58, Ce: [Xe]$4f^2_{5/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		6000	7000	8000	9000	10000	11000	12000	14000	16000	18000	20000
$2s_{1/2}$	σ	0.000+0	1.629+1	1.324+1	1.080+1	8.925+0	7.464+0	6.313+0	4.648+0	3.534+0	2.757+0	2.197+0
E_b=	β	0.000	1.947	1.962	1.972	1.979	1.983	1.985	1.984	1.980	1.972	1.962

(*continued on next page*)

Table 1 (*continued*)

6548.8 eV	γ	0.00+0	7.44−1	1.59−1	−4.21−2	−1.02−1	−9.12−2	−4.13−2	1.17−1	3.10−1	5.12−1	7.15−1
	δ	0.00+0	−6.76−4	−9.46−4	−1.03−3	−1.07−3	−1.09−3	−1.09−3	−1.09−3	−1.08−3	−1.07−3	−1.05−3
$2p_{1/2}$	σ	0.000+0	2.727+1	1.930+1	1.404+1	1.050+1	8.034+0	6.273+0	4.020+0	2.716+0	1.913+0	1.393+0
E_b=	β	0.000	1.305	1.385	1.394	1.381	1.358	1.330	1.269	1.206	1.144	1.084
6164.2 eV	γ	0.00+0	−2.47−1	1.31−1	4.23−1	6.60−1	8.59−1	1.03+0	1.31+0	1.53+0	1.71+0	1.86+0
	δ	0.00+0	9.96−3	3.18−2	4.44−2	5.44−2	6.36−2	7.23−2	9.00−2	1.08−1	1.26−1	1.43−1
$2p_{3/2}$	σ	6.941+1	4.744+1	3.284+1	2.353+1	1.737+1	1.315+1	1.016+1	6.402+0	4.262+0	2.962+0	2.132+0
E_b=	β	1.138	1.432	1.485	1.491	1.477	1.455	1.428	1.369	1.307	1.246	1.186
5723.4 eV	γ	−5.32−1	−8.64−2	2.73−1	5.63−1	8.03−1	1.01+0	1.18+0	1.47+0	1.71+0	1.89+0	2.04+0
	δ	−2.02−2	3.02−2	4.37−2	5.19−2	5.85−2	6.45−2	7.05−2	8.33−2	9.69−2	1.11−1	1.25−1
Z = 59, Pr: [Xe]$4f^3_{5/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.628+1	1.357+1	1.112+1	9.211+0	7.720+0	6.541+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.939	1.955	1.967	1.975	1.980	1.983
6834.8 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.17+0	2.88−1	9.36−3	−9.02−2	−1.04−1	−6.96−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−3.71−4	−9.88−4	−1.11−3	−1.16−3	−1.19−3	−1.20−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.881+1	2.063+1	1.507+1	1.129+1	8.658+0	6.771+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.237	1.370	1.393	1.386	1.366	1.341
6440.4 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−3.91−1	1.89−2	3.30−1	5.81−1	7.90−1	9.68−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−3.86−3	2.67−2	4.10−2	5.16−2	6.08−2	6.95−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	6.631+1	5.050+1	3.511+1	2.521+1	1.864+1	1.413+1	1.094+1
E_b=	β	0.000	0.000	0.000	0.000	0.654	1.398	1.477	1.493	1.485	1.466	1.442
5964.3 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	−3.39−1	−2.10−1	1.73−1	4.78−1	7.30−1	9.44−1	1.13+0
	δ	0.00+0	0.00+0	0.00+0	0.00+0	−3.00−2	2.44−2	4.15−2	5.04−2	5.72−2	6.31−2	6.89−2
$3s_{1/2}$	σ	3.590+1	1.946+1	1.197+1	8.037+0	5.732+0	4.273+0	3.294+0	2.607+0	2.108+0	1.734+0	1.448+0
E_b=	β	1.949	1.959	1.967	1.974	1.978	1.982	1.984	1.984	1.984	1.983	1.980
1511.0 eV	γ	6.16−1	1.64−1	−3.48−2	−1.17−1	−1.33−1	−1.08−1	−5.72−2	1.01−2	8.82−2	1.73−1	2.63−1
	δ	−1.87−4	−5.07−4	−6.41−4	−7.17−4	−7.70−4	−8.08−4	−8.38−4	−8.60−4	−8.79−4	−8.94−4	−9.05−4
Z = 60, Nd: [Xe]$4f^4_{5/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.387+1	1.142+1	9.491+0	7.972+0	6.767+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.948	1.961	1.970	1.977	1.980
7126.0 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	4.67−1	8.22−2	−6.49−2	−1.06−1	−9.10−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−1.00−3	−1.19−3	−1.26−3	−1.29−3	−1.31−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.991+1	2.198+1	1.612+1	1.212+1	9.309+0	7.292+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.101	1.347	1.388	1.388	1.373	1.350
6721.5 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.28−1	−1.03−1	2.30−1	4.96−1	7.16−1	9.03−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.81−2	2.03−2	3.71−2	4.84−2	5.81−2	6.68−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	5.351+1	3.744+1	2.696+1	1.997+1	1.516+1	1.175+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.346	1.465	1.493	1.491	1.476	1.454
6207.9 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−3.44−1	6.59−2	3.88−1	6.53−1	8.77−1	1.07+0
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.55−2	3.87−2	4.89−2	5.59−2	6.19−2	6.76−2
$3s_{1/2}$	σ	3.649+1	2.000+1	1.237+1	8.329+0	5.954+0	4.446+0	3.433+0	2.720+0	2.202+0	1.813+0	1.516+0
E_b=	β	1.945	1.955	1.964	1.971	1.976	1.980	1.982	1.983	1.983	1.982	1.980
1575.3 eV	γ	6.82−1	2.03−1	−1.37−2	−1.09−1	−1.36−1	−1.20−1	−7.61−2	−1.47−2	5.84−2	1.39−1	2.25−1
	δ	−1.54−4	−5.37−4	−6.90−4	−7.76−4	−8.35−4	−8.79−4	−9.13−4	−9.39−4	−9.61−4	−9.78−4	−9.92−4
Z = 61, Pm: [Xe]$4f^5_{5/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.410+1	1.172+1	9.768+0	8.223+0	6.993+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.940	1.955	1.965	1.973	1.978
7427.9 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	7.15−1	1.83−1	−2.36−2	−9.84−2	−1.05−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−9.44−4	−1.25−3	−1.36−3	−1.41−3	−1.43−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.335+1	1.723+1	1.298+1	9.994+0	7.843+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.310	1.378	1.389	1.379	1.359
7012.8 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.38−1	1.22−1	4.04−1	6.36−1	8.34−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.16−2	3.26−2	4.50−2	5.50−2	6.40−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	5.639+1	3.987+1	2.879+1	2.136+1	1.624+1	1.260+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.264	1.446	1.489	1.495	1.484	1.465
6459.3 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.83−1	−4.97−2	2.91−1	5.69−1	8.04−1	1.01+0
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	5.36−4	3.49−2	4.70−2	5.46−2	6.07−2	6.62−2
$3s_{1/2}$	σ	3.702+1	2.056+1	1.278+1	8.630+0	6.182+0	4.625+0	3.576+0	2.837+0	2.299+0	1.895+0	1.585+0
E_b=	β	1.940	1.951	1.960	1.968	1.973	1.977	1.980	1.981	1.982	1.981	1.980
1648.6 eV	γ	7.67−1	2.46−1	1.11−2	−9.84−2	−1.36−1	−1.29−1	−9.35−2	−3.84−2	2.96−2	1.06−1	1.89−1
	δ	−9.15−5	−5.65−4	−7.41−4	−8.37−4	−9.03−4	−9.54−4	−9.93−4	−1.02−3	−1.05−3	−1.07−3	−1.09−3
Z = 62, Sm: [Xe]$4f^6_{5/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.418+1	1.199+1	1.004+1	8.470+0	7.216+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.931	1.947	1.959	1.968	1.974
7736.8 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.10+0	3.18−1	3.68−2	−7.79−2	−1.09−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−6.48−4	−1.30−3	−1.46−3	−1.52−3	−1.55−3

(*continued on next page*)

Table 1 (*continued*)

$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.466+1	1.836+1	1.388+1	1.071+1	8.421+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.251	1.363	1.386	1.382	1.367
7311.8 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−3.89−1	4.17−3	3.05−1	5.50−1	7.58−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−1.82−3	2.72−2	4.12−2	5.18−2	6.10−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	5.855+1	4.236+1	3.069+1	2.282+1	1.737+1	1.350+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.109	1.418	1.482	1.497	1.491	1.476
6716.2 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.99−1	−1.74−1	1.87−1	4.79−1	7.25−1	9.38−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.75−2	2.97−2	4.49−2	5.31−2	5.94−2	6.51−2
$3s_{1/2}$	σ	3.743+1	2.109+1	1.318+1	8.929+0	6.410+0	4.804+0	3.719+0	2.955+0	2.397+0	1.978+0	1.656+0
E_b=	β	1.935	1.947	1.956	1.964	1.970	1.975	1.978	1.979	1.980	1.980	1.979
1722.8 eV	γ	8.65−1	2.94−1	3.87−2	−8.51−2	−1.34−1	−1.37−1	−1.09−1	−6.02−2	2.43−3	7.46−2	1.53−1
	δ	1.53−5	−5.90−4	−7.92−4	−9.01−4	−9.75−4	−1.03−3	−1.08−3	−1.11−3	−1.14−3	−1.17−3	−1.19−3
$3p_{1/2}$	σ	5.554+1	2.975+1	1.740+1	1.102+1	7.417+0	5.228+0	3.821+0	2.876+0	2.217+0	1.744+0	1.396+0
E_b=	β	1.306	1.571	1.603	1.589	1.560	1.525	1.488	1.450	1.412	1.375	1.339
1540.7 eV	γ	3.20−1	−1.13−2	3.55−2	1.86−1	3.59−1	5.31−1	6.93−1	8.42−1	9.78−1	1.10+0	1.22+0
	δ	4.42−2	2.53−3	2.06−3	5.53−3	1.05−2	1.64−2	2.30−2	3.00−2	3.73−2	4.50−2	5.29−2
Z = 63, Eu: [Xe]$4f^6_{5/2}\,4f^1_{7/2}\,6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.222+1	1.028+1	8.698+0	7.427+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.939	1.953	1.963	1.970
8052.0 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	4.95−1	1.17−1	−4.47−2	−1.04−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−1.31−3	−1.55−3	−1.64−3	−1.69−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.567+1	1.946+1	1.477+1	1.143+1	9.001+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.147	1.341	1.380	1.384	1.372
7617.1 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.33−1	−1.19−1	2.01−1	4.63−1	6.80−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.29−2	2.04−2	3.68−2	4.84−2	5.79−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	5.532+1	4.472+1	3.256+1	2.425+1	1.850+1	1.439+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.568	1.379	1.471	1.496	1.496	1.484
6976.9 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.91−1	−3.01−1	8.16−2	3.88−1	6.46−1	8.65−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−1.13−2	2.26−2	4.22−2	5.14−2	5.82−2	6.37−2
$3s_{1/2}$	σ	3.758+1	2.154+1	1.353+1	9.203+0	6.624+0	4.973+0	3.856+0	3.068+0	2.491+0	2.058+0	1.725+0
E_b=	β	1.930	1.943	1.953	1.960	1.967	1.972	1.976	1.978	1.979	1.979	1.978
1800.0 eV	γ	9.53−1	3.40−1	6.66−2	−7.08−2	−1.30−1	−1.41−1	−1.20−1	−7.85−2	−2.19−2	4.50−2	1.19−1
	δ	1.55−4	−6.13−4	−8.38−4	−9.73−4	−1.05−3	−1.11−3	−1.16−3	−1.20−3	−1.23−3	−1.26−3	−1.28−3
$3p_{1/2}$	σ	5.608+1	3.062+1	1.807+1	1.152+1	7.791+0	5.512+0	4.042+0	3.050+0	2.358+0	1.859+0	1.490+0
E_b=	β	1.246	1.561	1.602	1.593	1.567	1.534	1.499	1.463	1.426	1.390	1.355
1613.9 eV	γ	3.64−1	−6.59−4	1.97−2	1.59−1	3.27−1	4.95−1	6.55−1	8.05−1	9.44−1	1.07+0	1.19+0
	δ	5.79−2	3.28−3	1.72−3	4.71−3	9.40−3	1.51−2	2.14−2	2.83−2	3.57−2	4.34−2	5.13−2
Z = 64, Gd: [Xe]$4f^6_{5/2}\,4f^1_{7/2}\,5d^1_{3/2}\,6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.242+1	1.053+1	8.940+0	7.648+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.930	1.945	1.957	1.965
8375.6 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	7.58−1	2.31−1	7.90−3	−8.67−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−1.23−3	−1.62−3	−1.76−3	−1.83−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.512+1	2.063+1	1.575+1	1.221+1	9.638+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.791	1.305	1.370	1.383	1.376
7930.3 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.93−1	−2.61−1	8.84−2	3.65−1	5.94−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.73−2	1.09−2	3.23−2	4.47−2	5.47−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	4.725+1	3.462+1	2.586+1	1.974+1	1.538+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.315	1.452	1.492	1.499	1.492
7242.8 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.47−1	−3.72−2	2.88−1	5.58−1	7.89−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.07−2	3.88−2	4.99−2	5.69−2	6.26−2
$3s_{1/2}$	σ	3.755+1	2.206+1	1.394+1	9.511+0	6.861+0	5.160+0	4.007+0	3.191+0	2.594+0	2.145+0	1.799+0
E_b=	β	1.924	1.938	1.948	1.957	1.963	1.969	1.973	1.975	1.977	1.977	1.977
1880.8 eV	γ	1.09+0	3.97−1	1.02−1	−5.13−2	−1.23−1	−1.45−1	−1.33−1	−9.77−2	−4.64−2	1.60−2	8.61−2
	δ	5.17−4	−6.20−4	−8.93−4	−1.04−3	−1.14−3	−1.21−3	−1.27−3	−1.31−3	−1.35−3	−1.38−3	−1.40−3
$3p_{1/2}$	σ	5.655+1	3.163+1	1.885+1	1.209+1	8.209+0	5.828+0	4.285+0	3.242+0	2.511+0	1.983+0	1.593+0
E_b=	β	1.152	1.545	1.599	1.596	1.573	1.542	1.508	1.473	1.437	1.402	1.368
1688.3 eV	γ	4.09−1	1.75−2	5.29−3	1.30−1	2.93−1	4.60−1	6.20−1	7.69−1	9.08−1	1.04+0	1.15+0
	δ	8.33−2	4.55−3	1.40−3	3.95−3	8.23−3	1.35−2	1.94−2	2.58−2	3.27−2	3.99−2	4.74−2
$3p_{3/2}$	σ	1.277+2	6.421+1	3.629+1	2.245+1	1.484+1	1.031+1	7.443+0	5.542+0	4.232+0	3.300+0	2.620+0
E_b=	β	1.271	1.601	1.667	1.674	1.660	1.636	1.607	1.576	1.543	1.511	1.478
1544.0 eV	γ	2.72−1	−3.63−2	1.06−2	1.67−1	3.51−1	5.35−1	7.11−1	8.74−1	1.02+0	1.16+0	1.29+0
	δ	4.32−2	7.35−3	9.66−3	1.34−2	1.73−2	2.13−2	2.56−2	3.00−2	3.48−2	3.99−2	4.53−2
Z = 65, Tb: [Xe]$4f^6_{5/2}\,4f^3_{7/2}\,6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.249+1	1.076+1	9.174+0	7.865+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.920	1.937	1.950	1.959
8708.0 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.16+0	3.84−1	8.25−2	−5.43−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−8.71−4	−1.66−3	−1.87−3	−1.96−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.176+1	1.675+1	1.303+1	1.030+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.243	1.352	1.379	1.379

(*continued on next page*)

Table 1 (*continued*)

8251.6 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.21−1	−3.76−2	2.57−1	4.99−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−3.50−3	2.61−2	4.04−2	5.09−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	4.954+1	3.674+1	2.752+1	2.104+1	1.641+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.210	1.426	1.484	1.500	1.497
7514.0 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.91−1	−1.65−1	1.79−1	4.61−1	7.03−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−1.04−2	3.38−2	4.76−2	5.53−2	6.12−2
$3s_{1/2}$	σ	3.645+1	2.258+1	1.436+1	9.825+0	7.102+0	5.350+0	4.160+0	3.318+0	2.700+0	2.235+0	1.876+0
E_b=	β	1.917	1.932	1.943	1.952	1.960	1.966	1.970	1.973	1.975	1.976	1.976
1967.5 eV	γ	1.23+0	4.63−1	1.42−1	−2.79−2	−1.13−1	−1.45−1	−1.41−1	−1.14−1	−6.90−2	−1.19−2	5.41−2
	δ	1.38−3	−6.10−4	−9.38−4	−1.11−3	−1.22−3	−1.30−3	−1.36−3	−1.42−3	−1.46−3	−1.50−3	−1.53−3
$3p_{1/2}$	σ	5.672+1	3.265+1	1.965+1	1.267+1	8.643+0	6.157+0	4.541+0	3.444+0	2.673+0	2.115+0	1.702+0
E_b=	β	1.018	1.527	1.596	1.598	1.579	1.551	1.518	1.484	1.449	1.415	1.381
1767.7 eV	γ	4.11−1	4.38−2	−6.24−3	1.02−1	2.56−1	4.21−1	5.81−1	7.33−1	8.74−1	1.00+0	1.12+0
	δ	1.20−1	6.44−3	1.21−3	3.22−3	7.15−3	1.22−2	1.80−2	2.44−2	3.11−2	3.80−2	4.51−2
$3p_{3/2}$	σ	1.310+2	6.686+1	3.802+1	2.361+1	1.566+1	1.090+1	7.888+0	5.885+0	4.501+0	3.515+0	2.794+0
E_b=	β	1.189	1.585	1.663	1.677	1.667	1.646	1.619	1.589	1.558	1.526	1.493
1611.3 eV	γ	3.17−1	−2.61−2	−7.69−3	1.35−1	3.13−1	4.96−1	6.73−1	8.39−1	9.93−1	1.13+0	1.26+0
	δ	5.96−2	7.87−3	9.44−3	1.31−2	1.68−2	2.08−2	2.50−2	2.95−2	3.41−2	3.90−2	4.39−2
Z = 66, Dy: [Xe]$4f^6_{5/2}\,4f^4_{7/2}\,6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.096+1	9.391+0	8.071+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.928	1.942	1.953
9045.8 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	5.87−1	1.81−1	−6.81−3
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−1.65−3	−1.97−3	−2.09−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.265+1	1.774+1	1.386+1	1.098+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.134	1.326	1.371	1.379
8580.6 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.76−1	−1.73−1	1.46−1	4.02−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.73−2	1.82−2	3.57−2	4.72−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	5.066+1	3.883+1	2.920+1	2.237+1	1.746+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.002	1.390	1.472	1.498	1.501
7790.1 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−6.53−1	−2.99−1	6.70−2	3.64−1	6.15−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.78−2	2.67−2	4.49−2	5.38−2	6.00−2
$3s_{1/2}$	σ	0.000+0	2.299+1	1.472+1	1.011+1	7.326+0	5.529+0	4.306+0	3.438+0	2.801+0	2.321+0	1.950+0
E_b=	β	0.000	1.927	1.938	1.948	1.956	1.962	1.967	1.970	1.972	1.974	1.974
2046.8 eV	γ	0.00+0	5.25−1	1.82−1	−3.88−3	−1.01−1	−1.43−1	−1.47−1	−1.27−1	−8.85−2	−3.69−2	2.44−2
	δ	0.00+0	−5.99−4	−9.85−4	−1.18−3	−1.31−3	−1.40−3	−1.47−3	−1.53−3	−1.58−3	−1.62−3	−1.65−3
$3p_{1/2}$	σ	5.625+1	3.349+1	2.036+1	1.321+1	9.052+0	6.473+0	4.789+0	3.642+0	2.833+0	2.246+0	1.811+0
E_b=	β	0.840	1.508	1.591	1.599	1.584	1.558	1.527	1.495	1.461	1.427	1.394
1841.8 eV	γ	3.20−1	7.38−2	−1.29−2	7.86−2	2.25−1	3.85−1	5.44−1	6.96−1	8.37−1	9.69−1	1.09+0
	δ	1.65−1	8.74−3	1.16−3	2.59−3	6.17−3	1.09−2	1.64−2	2.26−2	2.91−2	3.59−2	4.28−2
$3p_{3/2}$	σ	1.335+2	6.924+1	3.963+1	2.472+1	1.644+1	1.148+1	8.326+0	6.224+0	4.768+0	3.730+0	2.969+0
E_b=	β	1.101	1.568	1.659	1.679	1.672	1.654	1.630	1.601	1.571	1.540	1.509
1675.6 eV	γ	3.41−1	−1.23−2	−2.20−2	1.08−1	2.79−1	4.59−1	6.35−1	8.02−1	9.57−1	1.10+0	1.23+0
	δ	7.92−2	8.60−3	9.29−3	1.29−2	1.65−2	2.03−2	2.43−2	2.86−2	3.31−2	3.78−2	4.24−2
Z = 67, Ho: [Xe]$4f^6_{5/2}\,4f^5_{7/2}\,6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.111+1	9.596+0	8.273+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.918	1.933	1.946
9394.2 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	8.77−1	3.15−1	6.05−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−1.50−3	−2.05−3	−2.23−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.219+1	1.872+1	1.471+1	1.168+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.790	1.287	1.357	1.376
8917.8 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.23−1	−3.21−1	2.56−2	2.99−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.16−2	7.25−3	3.02−2	4.31−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	4.091+1	3.092+1	2.374+1	1.856+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.336	1.454	1.493	1.503
8071.1 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.41−1	−5.24−2	2.61−1	5.24−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.59−2	4.16−2	5.20−2	5.87−2
$3s_{1/2}$	σ	0.000+0	2.338+1	1.506+1	1.039+1	7.547+0	5.707+0	4.452+0	3.559+0	2.903+0	2.407+0	2.024+0
E_b=	β	0.000	1.921	1.933	1.943	1.951	1.958	1.963	1.967	1.970	1.971	1.972
2128.3 eV	γ	0.00+0	5.93−1	2.25−1	2.30−2	−8.63−2	−1.38−1	−1.51−1	−1.38−1	−1.06−1	−5.99−2	−3.50−3
	δ	0.00+0	−5.72−4	−1.03−3	−1.25−3	−1.40−3	−1.50−3	−1.58−3	−1.65−3	−1.70−3	−1.75−3	−1.79−3
$3p_{1/2}$	σ	5.476+1	3.430+1	2.107+1	1.376+1	9.474+0	6.799+0	5.045+0	3.847+0	2.999+0	2.383+0	1.924+0
E_b=	β	0.534	1.484	1.584	1.600	1.588	1.564	1.536	1.505	1.473	1.440	1.407
1922.8 eV	γ	1.62−2	1.12−1	−1.58−2	5.68−2	1.94−1	3.49−1	5.06−1	6.57−1	7.99−1	9.33−1	1.06+0
	δ	2.15−1	1.20−2	1.27−3	2.03−3	5.23−3	9.65−3	1.49−2	2.08−2	2.71−2	3.37−2	4.05−2
$3p_{3/2}$	σ	1.356+2	7.160+1	4.126+1	2.585+1	1.725+1	1.208+1	8.776+0	6.572+0	5.044+0	3.952+0	3.150+0
E_b=	β	0.991	1.548	1.653	1.679	1.677	1.662	1.639	1.613	1.585	1.555	1.525
1741.2 eV	γ	3.39−1	5.95−3	−3.36−2	8.17−2	2.46−1	4.23−1	5.97−1	7.64−1	9.21−1	1.07+0	1.20+0
	δ	1.05−1	9.64−3	9.17−3	1.27−2	1.62−2	1.99−2	2.37−2	2.78−2	3.21−2	3.66−2	4.12−2
Z = 68, Er: [Xe]$4f^6_{5/2}\,4f^6_{7/2}\,6s^2_{1/2}$												
		k (eV)										

(*continued on next page*)

Table 1 (*continued*)

Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.112+1	9.782+0	8.468+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.907	1.924	1.937
9751.3 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.34+0	4.91−1	1.52−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−9.45−4	−2.07−3	−2.35−3
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.965+1	1.557+1	1.241+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.218	1.337	1.369
9264.3 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.85−1	−1.06−1	1.88−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−9.41−3	2.33−2	3.85−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	4.288+1	3.269+1	2.516+1	1.970+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.251	1.428	1.484	1.502
8357.9 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.90−1	−1.81−1	1.52−1	4.28−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.17−3	3.68−2	5.00−2	5.75−2
$3s_{1/2}$	σ	0.000+0	2.374+1	1.541+1	1.067+1	7.772+0	5.888+0	4.600+0	3.682+0	3.006+0	2.495+0	2.100+0
E_b=	β	0.000	1.915	1.927	1.938	1.947	1.954	1.959	1.964	1.967	1.969	1.970
2216.7 eV	γ	0.00+0	6.71−1	2.72−1	5.36−2	−6.88−2	−1.31−1	−1.53−1	−1.47−1	−1.22−1	−8.12−2	−2.99−2
	δ	0.00+0	−5.19−4	−1.07−3	−1.33−3	−1.50−3	−1.62−3	−1.70−3	−1.78−3	−1.84−3	−1.89−3	−1.93−3
$3p_{1/2}$	σ	0.000+0	3.505+1	2.177+1	1.431+1	9.899+0	7.130+0	5.306+0	4.056+0	3.170+0	2.524+0	2.041+0
E_b=	β	0.000	1.457	1.576	1.599	1.591	1.570	1.544	1.514	1.483	1.452	1.420
2005.8 eV	γ	0.00+0	1.58−1	−1.42−2	3.74−2	1.64−1	3.14−1	4.68−1	6.18−1	7.61−1	8.95−1	1.02+0
	δ	0.00+0	1.64−2	1.56−3	1.55−3	4.36−3	8.46−3	1.34−2	1.90−2	2.51−2	3.16−2	3.82−2
$3p_{3/2}$	σ	1.368+2	7.401+1	4.293+1	2.701+1	1.808+1	1.269+1	9.243+0	6.935+0	5.331+0	4.183+0	3.339+0
E_b=	β	0.840	1.525	1.646	1.679	1.681	1.668	1.648	1.624	1.597	1.569	1.540
1811.8 eV	γ	2.81−1	2.97−2	−4.25−2	5.70−2	2.13−1	3.86−1	5.59−1	7.26−1	8.83−1	1.03+0	1.17+0
	δ	1.42−1	1.11−2	9.10−3	1.25−2	1.60−2	1.95−2	2.32−2	2.71−2	3.12−2	3.55−2	3.99−2

Z = 69, Tm: [Xe]$4f^6_{5/2}\,4f^7_{7/2}\,6s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	2.033+1	1.644+1	1.316+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.090	1.305	1.358
9616.9 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−6.37−1	−2.50−1	7.01−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−3.78−2	1.40−2	3.32−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	4.435+1	3.447+1	2.661+1	2.087+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.101	1.392	1.471	1.499
8648.0 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−7.00−1	−3.17−1	3.71−2	3.28−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−3.33−2	2.98−2	4.73−2	5.61−2
$3s_{1/2}$	σ	0.000+0	2.406+1	1.574+1	1.094+1	7.993+0	6.068+0	4.747+0	3.805+0	3.110+0	2.584+0	2.177+0
E_b=	β	0.000	1.908	1.921	1.932	1.941	1.949	1.955	1.960	1.964	1.966	1.968
2306.8 eV	γ	0.00+0	7.55−1	3.24−1	8.73−2	−4.83−2	−1.22−1	−1.53−1	−1.54−1	−1.35−1	−1.01−1	−5.44−2
	δ	0.00+0	−4.38−4	−1.10−3	−1.40−3	−1.60−3	−1.73−3	−1.83−3	−1.91−3	−1.98−3	−2.04−3	−2.09−3
$3p_{1/2}$	σ	0.000+0	3.572+1	2.243+1	1.485+1	1.032+1	7.463+0	5.571+0	4.269+0	3.344+0	2.668+0	2.162+0
E_b=	β	0.000	1.424	1.567	1.597	1.594	1.576	1.551	1.523	1.494	1.463	1.432
2089.8 eV	γ	0.00+0	2.10−1	−7.61−3	2.09−2	1.36−1	2.80−1	4.31−1	5.79−1	7.22−1	8.56−1	9.82−1
	δ	0.00+0	2.22−2	2.08−3	1.15−3	3.58−3	7.35−3	1.20−2	1.73−2	2.32−2	2.94−2	3.59−2
$3p_{3/2}$	σ	1.367+2	7.640+1	4.462+1	2.820+1	1.893+1	1.332+1	9.723+0	7.308+0	5.627+0	4.422+0	3.534+0
E_b=	β	0.606	1.499	1.637	1.678	1.684	1.675	1.657	1.634	1.609	1.582	1.554
1884.5 eV	γ	1.11−1	5.88−2	−4.81−2	3.41−2	1.82−1	3.50−1	5.21−1	6.87−1	8.45−1	9.94−1	1.13+0
	δ	1.86−1	1.32−2	9.07−3	1.23−2	1.58−2	1.93−2	2.27−2	2.65−2	3.03−2	3.45−2	3.87−2
$3d_{3/2}$	σ	2.763+2	9.187+1	3.922+1	1.969+1	1.101+1	6.655+0	4.263+0	2.859+0	1.989+0	1.426+0	1.049+0
E_b=	β	0.787	1.178	1.239	1.223	1.182	1.131	1.077	1.023	0.970	0.919	0.870
1514.6 eV	γ	−1.82−1	6.07−2	3.88−1	6.65−1	8.93−1	1.08+0	1.24+0	1.37+0	1.48+0	1.57+0	1.65+0
	δ	−1.89−3	5.39−2	8.12−2	1.02−1	1.21−1	1.40−1	1.58−1	1.76−1	1.94−1	2.11−1	2.28−1

Z = 70, Yb: [Xe]$4f^6_{5/2}\,4f^8_{7/2}\,6s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.940+1	1.728+1	1.392+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.561	1.258	1.341
9978.2 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.57−1	−4.07−1	−5.80−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	4.77−2	5.51−4	2.68−2
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	4.302+1	3.624+1	2.811+1	2.209+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.634	1.342	1.452	1.492
8943.6 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.28−1	−4.60−1	−8.51−2	2.21−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−4.67−2	1.90−2	4.38−2	5.45−2
$3s_{1/2}$	σ	0.000+0	2.432+1	1.605+1	1.120+1	8.210+0	6.246+0	4.894+0	3.928+0	3.214+0	2.673+0	2.254+0
E_b=	β	0.000	1.901	1.915	1.927	1.936	1.944	1.950	1.956	1.960	1.963	1.965
2398.1 eV	γ	0.00+0	8.39−1	3.79−1	1.24−1	−2.50−2	−1.09−1	−1.50−1	−1.59−1	−1.46−1	−1.18−1	−7.68−2
	δ	0.00+0	−3.33−4	−1.12−3	−1.48−3	−1.70−3	−1.86−3	−1.97−3	−2.06−3	−2.13−3	−2.20−3	−2.25−3
$3p_{1/2}$	σ	0.000+0	3.630+1	2.307+1	1.538+1	1.074+1	7.796+0	5.838+0	4.485+0	3.521+0	2.815+0	2.285+0
E_b=	β	0.000	1.386	1.555	1.595	1.595	1.580	1.558	1.532	1.503	1.474	1.444
2173.0 eV	γ	0.00+0	2.67−1	4.01−3	7.63−3	1.10−1	2.48−1	3.95−1	5.41−1	6.83−1	8.17−1	9.44−1
	δ	0.00+0	2.97−2	2.85−3	8.51−4	2.85−3	6.32−3	1.07−2	1.57−2	2.14−2	2.73−2	3.37−2
$3p_{3/2}$	σ	1.349+2	7.858+1	4.622+1	2.934+1	1.977+1	1.395+1	1.020+1	7.681+0	5.924+0	4.662+0	3.731+0
E_b=	β	0.253	1.471	1.627	1.675	1.686	1.680	1.664	1.644	1.620	1.595	1.568
1949.8 eV	γ	−1.98−1	8.97−2	−5.02−2	1.42−2	1.53−1	3.16−1	4.84−1	6.48−1	8.06−1	9.56−1	1.10+0
	δ	1.85−1	1.57−2	9.10−3	1.22−2	1.57−2	1.91−2	2.24−2	2.59−2	2.96−2	3.35−2	3.76−2

(*continued on next page*)

Table 1 (*continued*)

$3d_{3/2}$	σ	2.919+2	9.861+1	4.230+1	2.131+1	1.195+1	7.241+0	4.649+0	3.123+0	2.176+0	1.563+0	1.151+0
E_b=	β	0.718	1.160	1.237	1.229	1.192	1.144	1.092	1.040	0.988	0.938	0.889
1576.3 eV	γ	−1.80−1	2.15−2	3.47−1	6.29−1	8.63−1	1.06+0	1.22+0	1.35+0	1.47+0	1.56+0	1.65+0
	δ	−8.40−3	5.04−2	7.89−2	9.97−2	1.18−1	1.37−1	1.55−1	1.73−1	1.90−1	2.07−1	2.23−1
$3d_{5/2}$	σ	4.194+2	1.376+2	5.831+1	2.910+1	1.620+1	9.746+0	6.219+0	4.154+0	2.880+0	2.058+0	1.509+0
E_b=	β	0.837	1.183	1.217	1.185	1.134	1.079	1.023	0.969	0.917	0.868	0.822
1527.8 eV	γ	−1.85−1	6.82−2	3.97−1	6.69−1	8.89−1	1.07+0	1.22+0	1.34+0	1.44+0	1.53+0	1.61+0
	δ	−5.70−3	4.87−2	7.81−2	1.02−1	1.24−1	1.46−1	1.67−1	1.88−1	2.08−1	2.27−1	2.46−1
Z = 71, Lu: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^1_{3/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	3.788+1	2.961+1	2.332+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.265	1.425	1.482
9244.1 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−6.04−1	−2.13−1	1.12−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	2.56−3	3.91−2	5.25−2
$3s_{1/2}$	σ	0.000+0	2.450+1	1.631+1	1.145+1	8.413+0	6.415+0	5.036+0	4.047+0	3.316+0	2.760+0	2.329+0
E_b=	β	0.000	1.894	1.908	1.920	1.931	1.939	1.946	1.951	1.956	1.959	1.961
2491.2 eV	γ	0.00+0	9.29−1	4.35−1	1.63−1	7.80−4	−9.39−2	−1.43−1	−1.61−1	−1.56−1	−1.33−1	−9.74−2
	δ	0.00+0	−1.92−4	−1.14−3	−1.56−3	−1.81−3	−1.98−3	−2.11−3	−2.21−3	−2.30−3	−2.37−3	−2.43−3
$3p_{1/2}$	σ	0.000+0	3.674+1	2.365+1	1.588+1	1.115+1	8.125+0	6.104+0	4.702+0	3.700+0	2.963+0	2.410+0
E_b=	β	0.000	1.342	1.542	1.591	1.596	1.584	1.564	1.539	1.512	1.484	1.455
2263.5 eV	γ	0.00+0	3.26−1	2.07−2	−2.23−3	8.65−2	2.17−1	3.60−1	5.05−1	6.47−1	7.81−1	9.08−1
	δ	0.00+0	3.96−2	3.95−3	6.60−4	2.24−3	5.47−3	9.62−3	1.45−2	1.98−2	2.55−2	3.15−2
$3p_{3/2}$	σ	0.000+0	8.067+1	4.779+1	3.048+1	2.061+1	1.458+1	1.069+1	8.062+0	6.228+0	4.908+0	3.933+0
E_b=	β	0.000	1.439	1.615	1.672	1.687	1.684	1.671	1.653	1.630	1.606	1.580
2023.6 eV	γ	0.00+0	1.24−1	−4.92−2	−3.52−3	1.25−1	2.83−1	4.49−1	6.13−1	7.71−1	9.21−1	1.06+0
	δ	0.00+0	1.91−2	9.24−3	1.20−2	1.56−2	1.90−2	2.23−2	2.57−2	2.93−2	3.29−2	3.66−2
$3d_{3/2}$	σ	3.046+2	1.050+2	4.532+1	2.293+1	1.290+1	7.838+0	5.043+0	3.395+0	2.370+0	1.705+0	1.258+0
E_b=	β	0.642	1.141	1.234	1.234	1.201	1.155	1.105	1.054	1.003	0.953	0.906
1639.4 eV	γ	−1.70−1	−1.44−2	3.10−1	5.96−1	8.35−1	1.03+0	1.20+0	1.34+0	1.45+0	1.55+0	1.64+0
	δ	−1.36−2	4.69−2	7.71−2	9.83−2	1.17−1	1.35−1	1.52−1	1.69−1	1.86−1	2.02−1	2.18−1
$3d_{5/2}$	σ	4.393+2	1.465+2	6.242+1	3.128+1	1.746+1	1.053+1	6.736+0	4.508+0	3.130+0	2.240+0	1.645+0
E_b=	β	0.780	1.171	1.217	1.191	1.144	1.090	1.034	0.981	0.929	0.880	0.835
1588.5 eV	γ	−1.83−1	3.24−2	3.63−1	6.41−1	8.66−1	1.05+0	1.20+0	1.33+0	1.43+0	1.52+0	1.60+0
	δ	−1.12−2	4.52−2	7.60−2	1.00−1	1.22−1	1.43−1	1.64−1	1.84−1	2.03−1	2.22−1	2.40−1
Z = 72, Hf: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^2_{3/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	3.927+1	3.115+1	2.461+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.133	1.388	1.467
9560.7 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−7.32−1	−3.53−1	−7.98−3
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−2.81−2	3.17−2	4.97−2
$3s_{1/2}$	σ	0.000+0	2.464+1	1.659+1	1.170+1	8.624+0	6.591+0	5.183+0	4.171+0	3.421+0	2.851+0	2.408+0
E_b=	β	0.000	1.885	1.901	1.914	1.924	1.933	1.941	1.947	1.951	1.955	1.958
2600.9 eV	γ	0.00+0	1.05+0	5.01−1	2.08−1	3.10−2	−7.56−2	−1.35−1	−1.61−1	−1.63−1	−1.47−1	−1.17−1
	δ	0.00+0	3.65−5	−1.14−3	−1.63−3	−1.92−3	−2.11−3	−2.26−3	−2.38−3	−2.48−3	−2.56−3	−2.63−3
$3p_{1/2}$	σ	0.000+0	3.711+1	2.422+1	1.640+1	1.157+1	8.465+0	6.379+0	4.928+0	3.886+0	3.118+0	2.540+0
E_b=	β	0.000	1.282	1.526	1.585	1.596	1.588	1.570	1.547	1.521	1.493	1.465
2365.4 eV	γ	0.00+0	3.92−1	4.46−2	−8.85−3	6.43−2	1.86−1	3.26−1	4.69−1	6.09−1	7.43−1	8.70−1
	δ	0.00+0	5.44−2	5.59−3	5.90−4	1.65−3	4.58−3	8.49−3	1.31−2	1.81−2	2.36−2	2.92−2
$3p_{3/2}$	σ	0.000+0	8.285+1	4.945+1	3.168+1	2.149+1	1.524+1	1.120+1	8.461+0	6.547+0	5.166+0	4.145+0
E_b=	β	0.000	1.400	1.601	1.667	1.688	1.688	1.678	1.661	1.640	1.617	1.592
2107.6 eV	γ	0.00+0	1.65−1	−4.42−2	−1.98−2	9.72−2	2.49−1	4.13−1	5.76−1	7.33−1	8.83−1	1.02+0
	δ	0.00+0	2.40−2	9.48−3	1.19−2	1.55−2	1.89−2	2.22−2	2.55−2	2.88−2	3.21−2	3.56−2
$3d_{3/2}$	σ	3.176+2	1.124+2	4.876+1	2.475+1	1.396+1	8.501+0	5.480+0	3.695+0	2.584+0	1.861+0	1.375+0
E_b=	β	0.543	1.116	1.229	1.237	1.209	1.167	1.119	1.068	1.019	0.970	0.924
1716.4 eV	γ	−1.48−1	−5.31−2	2.67−1	5.59−1	8.03−1	1.01+0	1.18+0	1.32+0	1.44+0	1.54+0	1.63+0
	δ	−1.70−2	4.27−2	7.47−2	9.64−2	1.15−1	1.32−1	1.49−1	1.65−1	1.81−1	1.97−1	2.13−1
$3d_{5/2}$	σ	4.612+2	1.568+2	6.708+1	3.371+1	1.887+1	1.140+1	7.305+0	4.897+0	3.405+0	2.440+0	1.794+0
E_b=	β	0.698	1.156	1.217	1.197	1.153	1.100	1.046	0.993	0.942	0.894	0.849
1661.7 eV	γ	−1.71−1	−6.68−3	3.24−1	6.08−1	8.39−1	1.03+0	1.18+0	1.31+0	1.42+0	1.52+0	1.60+0
	δ	−1.63−2	4.12−2	7.32−2	9.76−2	1.20−1	1.41−1	1.61−1	1.80−1	1.99−1	2.17−1	2.36−1
Z = 73, Ta: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^3_{3/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$2p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	3.910+1	3.268+1	2.593+1
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.790	1.334	1.446
9881.1 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−6.28−1	−5.01−1	−1.35−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−7.39−2	2.04−2	4.57−2
$3s_{1/2}$	σ	0.000+0	2.465+1	1.683+1	1.193+1	8.823+0	6.759+0	5.325+0	4.291+0	3.524+0	2.940+0	2.485+0
E_b=	β	0.000	1.876	1.893	1.907	1.918	1.927	1.935	1.941	1.946	1.951	1.954
2708.0 eV	γ	0.00+0	1.17+0	5.68−1	2.55−1	6.39−2	−5.44−2	−1.24−1	−1.58−1	−1.68−1	−1.58−1	−1.33−1
	δ	0.00+0	3.47−4	−1.13−3	−1.70−3	−2.02−3	−2.25−3	−2.42−3	−2.55−3	−2.66−3	−2.75−3	−2.83−3
$3p_{1/2}$	σ	0.000+0	3.731+1	2.476+1	1.689+1	1.198+1	8.802+0	6.655+0	5.154+0	4.074+0	3.276+0	2.673+0
E_b=	β	0.000	1.218	1.507	1.579	1.595	1.590	1.575	1.553	1.529	1.503	1.476

(*continued on next page*)

Table 1 (*continued*)

2468.7 eV	γ	0.00+0	4.53−1	7.50−2	−1.12−2	4.44−2	1.57−1	2.91−1	4.32−1	5.70−1	7.04−1	8.30−1
	δ	0.00+0	7.40−2	7.79−3	6.75−4	1.13−3	3.72−3	7.38−3	1.17−2	1.65−2	2.16−2	2.71−2
$3p_{3/2}$	σ	0.000+0	8.496+1	5.110+1	3.289+1	2.238+1	1.591+1	1.172+1	8.870+0	6.873+0	5.431+0	4.363+0
E_b=	β	0.000	1.355	1.585	1.661	1.687	1.691	1.683	1.669	1.650	1.628	1.605
2194.0 eV	γ	0.00+0	2.10−1	−3.51−2	−3.36−2	7.09−2	2.16−1	3.76−1	5.38−1	6.95−1	8.45−1	9.86−1
	δ	0.00+0	3.05−2	9.87−3	1.18−2	1.54−2	1.88−2	2.21−2	2.53−2	2.84−2	3.15−2	3.48−2
$3d_{3/2}$	σ	3.262+2	1.200+2	5.230+1	2.664+1	1.507+1	9.197+0	5.941+0	4.013+0	2.810+0	2.027+0	1.500+0
E_b=	β	0.446	1.089	1.223	1.240	1.217	1.178	1.132	1.083	1.035	0.988	0.942
1793.2 eV	γ	−1.16−1	−8.96−2	2.23−1	5.19−1	7.69−1	9.78−1	1.15+0	1.30+0	1.42+0	1.53+0	1.63+0
	δ	−1.58−2	3.80−2	7.21−2	9.44−2	1.13−1	1.30−1	1.46−1	1.62−1	1.77−1	1.93−1	2.08−1
$3d_{5/2}$	σ	4.798+2	1.673+2	7.190+1	3.625+1	2.034+1	1.232+1	7.905+0	5.308+0	3.696+0	2.653+0	1.953+0
E_b=	β	0.608	1.139	1.216	1.203	1.161	1.111	1.058	1.006	0.956	0.908	0.864
1735.1 eV	γ	−1.48−1	−4.45−2	2.83−1	5.73−1	8.10−1	1.00+0	1.16+0	1.30+0	1.41+0	1.51+0	1.59+0
	δ	−1.88−2	3.68−2	7.02−2	9.49−2	1.17−1	1.38−1	1.57−1	1.76−1	1.95−1	2.13−1	2.31−1

Z = 74, W : [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $6s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	2.453+1	1.705+1	1.215+1	9.017+0	6.924+0	5.465+0	4.411+0	3.627+0	3.029+0	2.562+0
E_b=	β	0.000	1.865	1.885	1.899	1.911	1.920	1.929	1.936	1.941	1.946	1.949
2819.6 eV	γ	0.00+0	1.32+0	6.41−1	3.06−1	1.00−1	−2.99−2	−1.09−1	−1.53−1	−1.70−1	−1.67−1	−1.48−1
	δ	0.00+0	8.68−4	−1.10−3	−1.76−3	−2.13−3	−2.39−3	−2.58−3	−2.73−3	−2.85−3	−2.96−3	−3.05−3
$3p_{1/2}$	σ	0.000+0	3.736+1	2.524+1	1.736+1	1.239+1	9.137+0	6.931+0	5.383+0	4.264+0	3.436+0	2.809+0
E_b=	β	0.000	1.128	1.486	1.571	1.594	1.592	1.579	1.560	1.537	1.512	1.486
2574.9 eV	γ	0.00+0	4.95−1	1.12−1	−9.08−3	2.74−2	1.29−1	2.58−1	3.95−1	5.32−1	6.64−1	7.90−1
	δ	0.00+0	1.01−1	1.07−2	9.46−4	6.84−4	2.93−3	6.33−3	1.04−2	1.50−2	1.99−2	2.50−2
$3p_{3/2}$	σ	0.000+0	8.695+1	5.272+1	3.409+1	2.328+1	1.659+1	1.224+1	9.285+0	7.206+0	5.701+0	4.585+0
E_b=	β	0.000	1.304	1.567	1.653	1.685	1.693	1.688	1.676	1.659	1.638	1.616
2281.0 eV	γ	0.00+0	2.55−1	−2.20−2	−4.45−2	4.65−2	1.84−1	3.40−1	4.99−1	6.56−1	8.05−1	9.47−1
	δ	0.00+0	3.89−2	1.05−2	1.17−2	1.53−2	1.88−2	2.20−2	2.51−2	2.81−2	3.11−2	3.41−2
$3d_{3/2}$	σ	3.262+2	1.278+2	5.601+1	2.862+1	1.624+1	9.933+0	6.429+0	4.350+0	3.051+0	2.204+0	1.633+0
E_b=	β	0.365	1.059	1.214	1.241	1.224	1.188	1.144	1.098	1.051	1.005	0.960
1871.6 eV	γ	−7.58−2	−1.24−1	1.79−1	4.77−1	7.33−1	9.48−1	1.13+0	1.28+0	1.41+0	1.52+0	1.62+0
	δ	−7.88−3	3.29−2	6.93−2	9.22−2	1.11−1	1.28−1	1.43−1	1.59−1	1.74−1	1.89−1	2.04−1
$3d_{5/2}$	σ	4.928+2	1.781+2	7.690+1	3.889+1	2.188+1	1.328+1	8.538+0	5.742+0	4.004+0	2.878+0	2.121+0
E_b=	β	0.506	1.119	1.213	1.207	1.170	1.122	1.070	1.018	0.969	0.922	0.878
1809.2 eV	γ	−1.13−1	−8.06−2	2.43−1	5.36−1	7.80−1	9.78−1	1.14+0	1.28+0	1.40+0	1.50+0	1.58+0
	δ	−1.64−2	3.21−2	6.71−2	9.22−2	1.14−1	1.35−1	1.54−1	1.73−1	1.91−1	2.09−1	2.27−1

Z = 75, Re: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^1_{5/2}$ $6s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	2.397+1	1.724+1	1.235+1	9.200+0	7.083+0	5.602+0	4.529+0	3.728+0	3.117+0	2.639+0
E_b=	β	0.000	1.853	1.876	1.891	1.903	1.914	1.922	1.930	1.936	1.941	1.945
2931.7 eV	γ	0.00+0	1.48+0	7.19−1	3.61−1	1.40−1	−2.53−3	−9.21−2	−1.45−1	−1.69−1	−1.73−1	−1.60−1
	δ	0.00+0	2.14−3	−1.04−3	−1.82−3	−2.24−3	−2.53−3	−2.74−3	−2.92−3	−3.06−3	−3.17−3	−3.27−3
$3p_{1/2}$	σ	0.000+0	3.718+1	2.567+1	1.781+1	1.278+1	9.466+0	7.205+0	5.611+0	4.456+0	3.598+0	2.947+0
E_b=	β	0.000	1.010	1.461	1.561	1.591	1.593	1.583	1.566	1.544	1.521	1.496
2681.6 eV	γ	0.00+0	4.91−1	1.56−1	−2.13−3	1.37−2	1.04−1	2.25−1	3.58−1	4.93−1	6.25−1	7.50−1
	δ	0.00+0	1.40−1	1.46−2	1.43−3	3.35−4	2.20−3	5.33−3	9.20−3	1.36−2	1.82−2	2.32−2
$3p_{3/2}$	σ	0.000+0	8.878+1	5.429+1	3.527+1	2.417+1	1.727+1	1.277+1	9.704+0	7.543+0	5.976+0	4.812+0
E_b=	β	0.000	1.241	1.547	1.644	1.682	1.694	1.692	1.682	1.667	1.648	1.627
2367.3 eV	γ	0.00+0	2.96−1	−5.19−3	−5.23−2	2.43−2	1.54−1	3.05−1	4.62−1	6.17−1	7.66−1	9.07−1
	δ	0.00+0	4.98−2	1.13−2	1.16−2	1.51−2	1.87−2	2.20−2	2.50−2	2.79−2	3.07−2	3.36−2
$3d_{3/2}$	σ	2.979+2	1.355+2	5.977+1	3.066+1	1.745+1	1.070+1	6.937+0	4.703+0	3.304+0	2.391+0	1.773+0
E_b=	β	0.509	1.025	1.204	1.241	1.230	1.198	1.157	1.112	1.066	1.021	0.977
1948.9 eV	γ	−1.97−2	−1.54−1	1.37−1	4.35−1	6.96−1	9.16−1	1.10+0	1.26+0	1.39+0	1.51+0	1.61+0
	δ	−1.15−3	2.74−2	6.65−2	9.01−2	1.09−1	1.26−1	1.41−1	1.56−1	1.70−1	1.85−1	2.00−1
$3d_{5/2}$	σ	4.930+2	1.890+2	8.202+1	4.162+1	2.348+1	1.428+1	9.199+0	6.197+0	4.328+0	3.115+0	2.298+0
E_b=	β	0.419	1.097	1.209	1.211	1.178	1.132	1.081	1.031	0.982	0.936	0.892
1882.9 eV	γ	−6.97−2	−1.14−1	2.02−1	4.99−1	7.48−1	9.52−1	1.12+0	1.26+0	1.38+0	1.49+0	1.58+0
	δ	−7.85−3	2.71−2	6.40−2	8.94−2	1.12−1	1.32−1	1.51−1	1.69−1	1.87−1	2.05−1	2.23−1

Z = 76, Os: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^2_{5/2}$ $6s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.740+1	1.254+1	9.378+0	7.239+0	5.737+0	4.645+0	3.829+0	3.204+0	2.716+0
E_b=	β	0.000	0.000	1.866	1.882	1.895	1.906	1.915	1.923	1.930	1.935	1.939
3048.5 eV	γ	0.00+0	0.00+0	8.05−1	4.20−1	1.83−1	2.82−2	−7.17−2	−1.33−1	−1.65−1	−1.76−1	−1.69−1
	δ	0.00+0	0.00+0	−9.39−4	−1.86−3	−2.35−3	−2.67−3	−2.91−3	−3.10−3	−3.26−3	−3.39−3	−3.50−3
$3p_{1/2}$	σ	0.000+0	3.666+1	2.605+1	1.823+1	1.316+1	9.792+0	7.479+0	5.842+0	4.650+0	3.762+0	3.087+0
E_b=	β	0.000	0.828	1.432	1.550	1.587	1.593	1.586	1.571	1.551	1.529	1.505
2792.2 eV	γ	0.00+0	3.84−1	2.08−1	1.01−2	3.26−3	8.00−2	1.94−1	3.22−1	4.55−1	5.85−1	7.10−1
	δ	0.00+0	1.93−1	1.98−2	2.17−3	8.15−5	1.53−3	4.39−3	8.04−3	1.22−2	1.67−2	2.14−2
$3p_{3/2}$	σ	0.000+0	9.048+1	5.586+1	3.647+1	2.507+1	1.797+1	1.331+1	1.013+1	7.889+0	6.259+0	5.046+0
E_b=	β	0.000	1.171	1.524	1.634	1.679	1.695	1.696	1.688	1.675	1.657	1.638
2457.2 eV	γ	0.00+0	3.35−1	1.61−2	−5.72−2	4.09−3	1.24−1	2.69−1	4.24−1	5.77−1	7.26−1	8.68−1

(*continued on next page*)

Table 1 (*continued*)

	δ	0.00+0	6.52−2	1.25−2	1.15−2	1.50−2	1.86−2	2.19−2	2.50−2	2.78−2	3.06−2	3.33−2
$3d_{3/2}$	σ	0.000+0	1.437+2	6.377+1	3.283+1	1.873+1	1.151+1	7.481+0	5.080+0	3.574+0	2.590+0	1.923+0
E_b=	β	0.000	0.985	1.191	1.240	1.234	1.207	1.168	1.125	1.081	1.037	0.994
2030.8 eV	γ	0.00+0	−1.83−1	9.40−2	3.92−1	6.56−1	8.82−1	1.07+0	1.23+0	1.37+0	1.49+0	1.60+0
	δ	0.00+0	2.12−2	6.35−2	8.78−2	1.07−1	1.24−1	1.39−1	1.53−1	1.67−1	1.82−1	1.96−1
$3d_{5/2}$	σ	4.271+2	2.005+2	8.744+1	4.451+1	2.517+1	1.535+1	9.903+0	6.681+0	4.673+0	3.367+0	2.488+0
E_b=	β	0.613	1.071	1.204	1.213	1.185	1.141	1.093	1.043	0.995	0.949	0.906
1960.1 eV	γ	−2.90−3	−1.46−1	1.62−1	4.60−1	7.14−1	9.25−1	1.10+0	1.24+0	1.37+0	1.47+0	1.57+0
	δ	−2.49−3	2.18−2	6.08−2	8.66−2	1.09−1	1.29−1	1.48−1	1.66−1	1.84−1	2.01−1	2.19−1
Z = 77, Ir: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^3_{5/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	1.754+1	1.273+1	9.553+0	7.394+0	5.871+0	4.762+0	3.931+0	3.293+0	2.794+0	2.076+0
E_b=	β	0.000	1.856	1.873	1.887	1.898	1.908	1.916	1.923	1.929	1.934	1.941
3173.7 eV	γ	0.00+0	9.05−1	4.87−1	2.31−1	6.29−2	−4.76−2	−1.18−1	−1.59−1	−1.77−1	−1.77−1	−1.37−1
	δ	0.00+0	−7.71−4	−1.88−3	−2.45−3	−2.82−3	−3.09−3	−3.30−3	−3.48−3	−3.63−3	−3.75−3	−3.94−3
$3p_{1/2}$	σ	3.536+1	2.639+1	1.864+1	1.354+1	1.012+1	7.755+0	6.075+0	4.848+0	3.931+0	3.231+0	2.262+0
E_b=	β	0.503	1.397	1.535	1.581	1.593	1.588	1.576	1.558	1.537	1.514	1.466
2908.7 eV	γ	−6.27−3	2.67−1	2.83−2	−3.52−3	5.87−2	1.63−1	2.87−1	4.17−1	5.46−1	6.70−1	9.03−1
	δ	2.54−1	2.69−2	3.28−3	−6.67−5	9.20−4	3.48−3	6.92−3	1.09−2	1.52−2	1.98−2	2.97−2
$3p_{3/2}$	σ	9.201+1	5.744+1	3.768+1	2.599+1	1.867+1	1.386+1	1.057+1	8.244+0	6.549+0	5.287+0	3.585+0
E_b=	β	1.082	1.497	1.621	1.673	1.694	1.698	1.693	1.682	1.666	1.648	1.608
2550.7 eV	γ	3.59−1	4.21−2	−5.90−2	−1.41−2	9.57−2	2.35−1	3.86−1	5.38−1	6.86−1	8.28−1	1.09+0
	δ	8.58−2	1.42−2	1.15−2	1.49−2	1.85−2	2.19−2	2.50−2	2.78−2	3.05−2	3.30−2	3.84−2
$3d_{3/2}$	σ	1.521+2	6.799+1	3.512+1	2.009+1	1.238+1	8.058+0	5.481+0	3.862+0	2.802+0	2.084+0	1.223+0
E_b=	β	0.939	1.176	1.237	1.238	1.215	1.179	1.138	1.095	1.052	1.011	0.930
2116.1 eV	γ	−2.07−1	5.14−2	3.48−1	6.15−1	8.46−1	1.04+0	1.21+0	1.35+0	1.47+0	1.58+0	1.76+0
	δ	1.42−2	6.05−2	8.57−2	1.05−1	1.22−1	1.37−1	1.51−1	1.65−1	1.78−1	1.93−1	2.21−1
$3d_{5/2}$	σ	2.124+2	9.315+1	4.756+1	2.696+1	1.647+1	1.065+1	7.195+0	5.040+0	3.636+0	2.689+0	1.563+0
E_b=	β	1.041	1.197	1.215	1.191	1.151	1.104	1.055	1.008	0.962	0.919	0.839
2040.4 eV	γ	−1.76−1	1.21−1	4.21−1	6.78−1	8.95−1	1.07+0	1.22+0	1.35+0	1.46+0	1.56+0	1.72+0
	δ	1.59−2	5.77−2	8.38−2	1.06−1	1.26−1	1.45−1	1.63−1	1.81−1	1.98−1	2.15−1	2.49−1
Z = 78, Pt: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^5_{5/2}$ $6s^1_{1/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	1.764+1	1.290+1	9.721+0	7.543+0	6.001+0	4.874+0	4.029+0	3.380+0	2.871+0	2.137+0
E_b=	β	0.000	1.845	1.862	1.877	1.889	1.900	1.909	1.917	1.923	1.928	1.936
3297.2 eV	γ	0.00+0	1.01+0	5.58−1	2.84−1	1.01−1	−2.11−2	−1.00−1	−1.48−1	−1.74−1	−1.80−1	−1.53−1
	δ	0.00+0	−5.38−4	−1.87−3	−2.55−3	−2.98−3	−3.28−3	−3.50−3	−3.68−3	−3.85−3	−4.00−3	−4.23−3
$3p_{1/2}$	σ	0.000+0	2.666+1	1.904+1	1.391+1	1.044+1	8.028+0	6.307+0	5.047+0	4.101+0	3.379+0	2.372+0
E_b=	β	0.000	1.354	1.518	1.574	1.591	1.590	1.580	1.564	1.544	1.523	1.477
3026.7 eV	γ	0.00+0	3.34−1	5.35−2	−6.30−3	4.06−2	1.35−1	2.51−1	3.77−1	5.05−1	6.30−1	8.64−1
	δ	0.00+0	3.67−2	4.88−3	−1.02−4	3.45−4	2.59−3	5.77−3	9.59−3	1.39−2	1.84−2	2.78−2
$3p_{3/2}$	σ	9.324+1	5.903+1	3.892+1	2.693+1	1.939+1	1.443+1	1.102+1	8.609+0	6.849+0	5.536+0	3.762+0
E_b=	β	0.968	1.464	1.606	1.666	1.692	1.700	1.697	1.688	1.674	1.658	1.619
2645.7 eV	γ	3.59−1	7.32−2	−5.73−2	−3.01−2	6.94−2	2.01−1	3.46−1	4.96−1	6.45−1	7.89−1	1.06+0
	δ	1.14−1	1.66−2	1.16−2	1.48−2	1.85−2	2.18−2	2.49−2	2.78−2	3.06−2	3.32−2	3.82−2
$3d_{3/2}$	σ	1.608+2	7.246+1	3.754+1	2.153+1	1.329+1	8.670+0	5.908+0	4.169+0	3.029+0	2.254+0	1.326+0
E_b=	β	0.887	1.158	1.232	1.241	1.222	1.190	1.152	1.110	1.067	1.025	0.945
2201.7 eV	γ	−2.27−1	8.84−3	3.07−1	5.74−1	8.05−1	1.01+0	1.18+0	1.33+0	1.46+0	1.57+0	1.75+0
	δ	6.36−3	5.72−2	8.42−2	1.03−1	1.19−1	1.34−1	1.49−1	1.63−1	1.76−1	1.89−1	2.16−1
$3d_{5/2}$	σ	2.250+2	9.926+1	5.081+1	2.885+1	1.766+1	1.144+1	7.744+0	5.431+0	3.923+0	2.904+0	1.691+0
E_b=	β	1.006	1.189	1.216	1.196	1.159	1.116	1.069	1.021	0.975	0.931	0.852
2121.4 eV	γ	−2.03−1	8.02−2	3.85−1	6.44−1	8.61−1	1.05+0	1.20+0	1.34+0	1.45+0	1.55+0	1.71+0
	δ	9.29−3	5.44−2	8.17−2	1.03−1	1.23−1	1.42−1	1.61−1	1.78−1	1.95−1	2.11−1	2.44−1
Z = 79, Au: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^6_{5/2}$ $6s^1_{1/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	1.770+1	1.305+1	9.876+0	7.686+0	6.127+0	4.985+0	4.126+0	3.466+0	2.947+0	2.197+0
E_b=	β	0.000	1.832	1.852	1.867	1.880	1.891	1.901	1.909	1.916	1.922	1.930
3424.9 eV	γ	0.00+0	1.12+0	6.32−1	3.39−1	1.43−1	9.02−3	−7.99−2	−1.36−1	−1.68−1	−1.82−1	−1.66−1
	δ	0.00+0	−1.98−4	−1.84−3	−2.63−3	−3.13−3	−3.47−3	−3.72−3	−3.92−3	−4.10−3	−4.26−3	−4.52−3
$3p_{1/2}$	σ	0.000+0	2.686+1	1.939+1	1.426+1	1.075+1	8.298+0	6.538+0	5.245+0	4.272+0	3.526+0	2.484+0
E_b=	β	0.000	1.304	1.500	1.566	1.588	1.591	1.583	1.569	1.551	1.531	1.487
3147.8 eV	γ	0.00+0	4.03−1	8.51−2	−4.36−3	2.51−2	1.10−1	2.19−1	3.40−1	4.65−1	5.89−1	8.24−1
	δ	0.00+0	4.93−2	7.02−3	7.61−5	−1.26−4	1.80−3	4.72−3	8.34−3	1.24−2	1.68−2	2.60−2
$3p_{3/2}$	σ	9.399+1	6.056+1	4.013+1	2.787+1	2.012+1	1.499+1	1.148+1	8.977+0	7.153+0	5.789+0	3.942+0
E_b=	β	0.814	1.430	1.591	1.659	1.689	1.701	1.701	1.693	1.682	1.666	1.630
2743.0 eV	γ	3.02−1	1.08−1	−5.16−2	−4.35−2	4.48−2	1.69−1	3.09−1	4.56−1	6.04−1	7.48−1	1.02+0
	δ	1.52−1	1.98−2	1.18−2	1.47−2	1.85−2	2.18−2	2.49−2	2.78−2	3.06−2	3.32−2	3.80−2
$3d_{3/2}$	σ	1.695+2	7.705+1	4.007+1	2.303+1	1.424+1	9.310+0	6.356+0	4.492+0	3.267+0	2.435+0	1.435+0
E_b=	β	0.825	1.138	1.226	1.242	1.228	1.200	1.164	1.124	1.082	1.041	0.962
2291.1 eV	γ	−2.41−1	−3.40−2	2.62−1	5.33−1	7.67−1	9.72−1	1.15+0	1.31+0	1.44+0	1.55+0	1.74+0
	δ	−2.39−3	5.31−2	8.20−2	1.01−1	1.17−1	1.32−1	1.47−1	1.61−1	1.74−1	1.86−1	2.12−1
$3d_{5/2}$	σ	2.376+2	1.055+2	5.417+1	3.083+1	1.891+1	1.227+1	8.317+0	5.841+0	4.224+0	3.131+0	1.827+0

(*continued on next page*)

Table 1 (*continued*)

E_b=	β	0.965	1.178	1.216	1.201	1.167	1.126	1.080	1.034	0.988	0.944	0.864
2205.7 eV	γ	−2.26−1	3.78−2	3.44−1	6.09−1	8.29−1	1.02+0	1.18+0	1.32+0	1.43+0	1.53+0	1.70+0
	δ	2.14−3	5.04−2	7.91−2	1.01−1	1.20−1	1.39−1	1.58−1	1.75−1	1.92−1	2.08−1	2.39−1
Z = 80, Hg: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^6_{5/2}$ $6s^2_{1/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	1.770+1	1.318+1	1.002+1	7.821+0	6.250+0	5.094+0	4.223+0	3.551+0	3.023+0	2.257+0
E_b=	β	0.000	1.821	1.840	1.856	1.870	1.882	1.892	1.901	1.908	1.914	1.924
3561.6 eV	γ	0.00+0	1.25+0	7.15−1	4.00−1	1.89−1	4.34−2	−5.54−2	−1.21−1	−1.61−1	−1.82−1	−1.77−1
	δ	0.00+0	2.29−4	−1.78−3	−2.70−3	−3.27−3	−3.65−3	−3.93−3	−4.17−3	−4.38−3	−4.56−3	−4.84−3
$3p_{1/2}$	σ	0.000+0	2.697+1	1.971+1	1.459+1	1.106+1	8.567+0	6.772+0	5.446+0	4.445+0	3.676+0	2.598+0
E_b=	β	0.000	1.238	1.477	1.555	1.584	1.591	1.585	1.573	1.557	1.538	1.496
3278.5 eV	γ	0.00+0	4.73−1	1.25−1	2.71−3	1.27−2	8.51−2	1.87−1	3.04−1	4.27−1	5.49−1	7.81−1
	δ	0.00+0	6.81−2	1.00−2	4.60−4	−4.96−4	1.08−3	3.78−3	7.20−3	1.11−2	1.52−2	2.40−2
$3p_{3/2}$	σ	9.377+1	6.204+1	4.134+1	2.880+1	2.085+1	1.558+1	1.194+1	9.356+0	7.464+0	6.047+0	4.126+0
E_b=	β	0.588	1.393	1.572	1.649	1.686	1.700	1.703	1.698	1.688	1.675	1.641
2847.1 eV	γ	1.32−1	1.47−1	−4.23−2	−5.42−2	2.14−2	1.38−1	2.74−1	4.19−1	5.65−1	7.07−1	9.73−1
	δ	2.03−1	2.40−2	1.21−2	1.45−2	1.83−2	2.18−2	2.50−2	2.80−2	3.07−2	3.31−2	3.76−2
$3d_{3/2}$	σ	1.778+2	8.176+1	4.267+1	2.459+1	1.524+1	9.985+0	6.826+0	4.831+0	3.519+0	2.626+0	1.551+0
E_b=	β	0.762	1.114	1.218	1.242	1.233	1.208	1.174	1.136	1.096	1.056	0.980
2384.9 eV	γ	−2.47−1	−7.48−2	2.15−1	4.87−1	7.28−1	9.39−1	1.12+0	1.28+0	1.41+0	1.53+0	1.73+0
	δ	−1.17−2	4.88−2	7.94−2	9.91−2	1.15−1	1.31−1	1.45−1	1.58−1	1.70−1	1.82−1	2.08−1
$3d_{5/2}$	σ	2.501+2	1.120+2	5.765+1	3.289+1	2.021+1	1.314+1	8.918+0	6.271+0	4.540+0	3.369+0	1.970+0
E_b=	β	0.915	1.166	1.215	1.206	1.175	1.135	1.091	1.045	1.000	0.957	0.879
2294.9 eV	γ	−2.44−1	−3.44−3	3.02−1	5.69−1	7.97−1	9.92−1	1.16+0	1.30+0	1.42+0	1.52+0	1.69+0
	δ	−5.89−3	4.64−2	7.60−2	9.78−2	1.17−1	1.37−1	1.55−1	1.72−1	1.88−1	2.03−1	2.35−1
Z = 81, Tl: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^6_{5/2}$ $6s^2_{1/2}$ $6p^1_{1/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	1.763+1	1.329+1	1.015+1	7.950+0	6.369+0	5.202+0	4.319+0	3.636+0	3.097+0	2.316+0
E_b=	β	0.000	1.806	1.829	1.846	1.860	1.873	1.883	1.892	1.900	1.906	1.918
3704.1 eV	γ	0.00+0	1.41+0	7.97−1	4.63−1	2.38−1	8.16−2	−2.77−2	−1.03−1	−1.51−1	−1.78−1	−1.85−1
	δ	0.00+0	9.75−4	−1.68−3	−2.75−3	−3.38−3	−3.82−3	−4.17−3	−4.45−3	−4.68−3	−4.87−3	−5.15−3
$3p_{1/2}$	σ	0.000+0	2.698+1	1.998+1	1.491+1	1.136+1	8.835+0	7.006+0	5.647+0	4.619+0	3.827+0	2.714+0
E_b=	β	0.000	1.156	1.453	1.544	1.579	1.590	1.587	1.577	1.563	1.545	1.506
3415.7 eV	γ	0.00+0	5.32−1	1.72−1	1.56−2	3.90−3	6.33−2	1.58−1	2.71−1	3.89−1	5.08−1	7.37−1
	δ	0.00+0	9.39−2	1.40−2	1.17−3	−7.32−4	4.34−4	2.88−3	6.05−3	9.63−3	1.35−2	2.21−2
$3p_{3/2}$	σ	8.979+1	6.352+1	4.253+1	2.975+1	2.160+1	1.617+1	1.242+1	9.743+0	7.781+0	6.310+0	4.315+0
E_b=	β	0.125	1.349	1.553	1.639	1.681	1.699	1.705	1.702	1.694	1.682	1.651
2956.6 eV	γ	−3.22−1	1.89−1	−2.84−2	−6.17−2	8.16−6	1.09−1	2.40−1	3.82−1	5.24−1	6.64−1	9.30−1
	δ	1.87−1	2.95−2	1.25−2	1.43−2	1.81−2	2.19−2	2.52−2	2.82−2	3.07−2	3.30−2	3.75−2
$3d_{3/2}$	σ	1.861+2	8.670+1	4.542+1	2.626+1	1.631+1	1.070+1	7.324+0	5.191+0	3.786+0	2.829+0	1.675+0
E_b=	β	0.683	1.089	1.209	1.241	1.237	1.215	1.184	1.148	1.110	1.072	0.997
2485.1 eV	γ	−2.42−1	−1.15−1	1.66−1	4.42−1	6.90−1	9.06−1	1.09+0	1.25+0	1.39+0	1.51+0	1.72+0
	δ	−2.18−2	4.34−2	7.61−2	9.73−2	1.14−1	1.29−1	1.42−1	1.55−1	1.67−1	1.80−1	2.05−1
$3d_{5/2}$	σ	2.627+2	1.187+2	6.131+1	3.507+1	2.159+1	1.405+1	9.552+0	6.725+0	4.875+0	3.622+0	2.122+0
E_b=	β	0.860	1.152	1.213	1.210	1.182	1.143	1.100	1.056	1.013	0.972	0.893
2389.3 eV	γ	−2.54−1	−4.57−2	2.56−1	5.30−1	7.66−1	9.65−1	1.13+0	1.27+0	1.40+0	1.51+0	1.69+0
	δ	−1.44−2	4.16−2	7.23−2	9.53−2	1.16−1	1.34−1	1.51−1	1.68−1	1.84−1	2.00−1	2.33−1
Z = 82, Pb: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^6_{5/2}$ $6s^2_{1/2}$ $6p^2_{1/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	1.738+1	1.338+1	1.027+1	8.075+0	6.485+0	5.306+0	4.411+0	3.718+0	3.171+0	2.376+0
E_b=	β	0.000	1.791	1.815	1.834	1.849	1.862	1.873	1.882	1.891	1.898	1.911
3850.7 eV	γ	0.00+0	1.60+0	8.94−1	5.32−1	2.92−1	1.24−1	3.19−3	−8.11−2	−1.37−1	−1.71−1	−1.89−1
	δ	0.00+0	2.19−3	−1.51−3	−2.77−3	−3.51−3	−4.02−3	−4.42−3	−4.73−3	−4.97−3	−5.17−3	−5.48−3
$3p_{1/2}$	σ	0.000+0	2.683+1	2.023+1	1.520+1	1.164+1	9.094+0	7.233+0	5.845+0	4.791+0	3.978+0	2.831+0
E_b=	β	0.000	1.056	1.422	1.530	1.573	1.588	1.588	1.581	1.568	1.552	1.515
3554.2 eV	γ	0.00+0	5.63−1	2.27−1	3.44−2	−4.52−4	4.50−2	1.31−1	2.37−1	3.51−1	4.67−1	6.94−1
	δ	0.00+0	1.30−1	1.92−2	2.17−3	−8.93−4	−2.01−4	1.97−3	4.89−3	8.27−3	1.20−2	2.05−2
$3p_{3/2}$	σ	0.000+0	6.492+1	4.373+1	3.069+1	2.235+1	1.677+1	1.290+1	1.013+1	8.101+0	6.578+0	4.508+0
E_b=	β	0.000	1.295	1.531	1.627	1.674	1.697	1.706	1.705	1.699	1.689	1.661
3066.4 eV	γ	0.00+0	2.33−1	−1.06−2	−6.61−2	−1.86−2	8.14−2	2.07−1	3.44−1	4.82−1	6.21−1	8.88−1
	δ	0.00+0	3.73−2	1.33−2	1.41−2	1.81−2	2.20−2	2.54−2	2.83−2	3.08−2	3.31−2	3.77−2
$3d_{3/2}$	σ	1.934+2	9.176+1	4.827+1	2.798+1	1.741+1	1.144+1	7.845+0	5.568+0	4.067+0	3.042+0	1.805+0
E_b=	β	0.594	1.059	1.197	1.239	1.240	1.222	1.194	1.160	1.125	1.088	1.012
2585.6 eV	γ	−2.24−1	−1.53−1	1.20−1	3.99−1	6.50−1	8.67−1	1.05+0	1.22+0	1.36+0	1.49+0	1.71+0
	δ	−3.07−2	3.79−2	7.33−2	9.58−2	1.13−1	1.27−1	1.40−1	1.52−1	1.65−1	1.77−1	2.03−1
$3d_{5/2}$	σ	2.747+2	1.256+2	6.510+1	3.732+1	2.302+1	1.500+1	1.021+1	7.201+0	5.227+0	3.888+0	2.282+0
E_b=	β	0.798	1.135	1.210	1.213	1.188	1.151	1.110	1.068	1.026	0.986	0.906
2484.0 eV	γ	−2.55−1	−8.61−2	2.13−1	4.92−1	7.33−1	9.34−1	1.10+0	1.25+0	1.38+0	1.49+0	1.68+0
	δ	−2.36−2	3.66−2	6.92−2	9.32−2	1.13−1	1.31−1	1.48−1	1.64−1	1.81−1	1.97−1	2.29−1
Z = 83, Bi: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^6_{5/2}$ $6s^2_{1/2}$ $6p^2_{1/2}$ $6p^1_{3/2}$												
		k (eV)										

(*continued on next page*)

Table 1 (*continued*)

Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	1.644+1	1.345+1	1.038+1	8.188+0	6.592+0	5.404+0	4.499+0	3.797+0	3.242+0	2.434+0
E_b=	β	0.000	1.743	1.800	1.821	1.837	1.850	1.862	1.872	1.882	1.890	1.903
3999.1 eV	γ	0.00+0	2.69−1	1.00+0	6.08−1	3.51−1	1.69−1	3.77−2	−5.54−2	−1.19−1	−1.60−1	−1.91−1
	δ	0.00+0	1.55−2	−1.25−3	−2.77−3	−3.64−3	−4.23−3	−4.66−3	−4.99−3	−5.25−3	−5.47−3	−5.82−3
$3p_{1/2}$	σ	0.000+0	2.649+1	2.042+1	1.547+1	1.191+1	9.342+0	7.453+0	6.040+0	4.964+0	4.130+0	2.950+0
E_b=	β	0.000	0.899	1.385	1.513	1.564	1.584	1.588	1.583	1.573	1.558	1.523
3696.3 eV	γ	0.00+0	5.12−1	2.89−1	5.98−2	−2.29−4	2.97−2	1.06−1	2.04−1	3.13−1	4.26−1	6.53−1
	δ	0.00+0	1.83−1	2.64−2	3.59−3	−9.38−4	−7.80−4	1.10−3	3.81−3	7.05−3	1.07−2	1.91−2
$3p_{3/2}$	σ	0.000+0	6.621+1	4.491+1	3.163+1	2.309+1	1.736+1	1.337+1	1.052+1	8.425+0	6.851+0	4.705+0
E_b=	β	0.000	1.241	1.504	1.612	1.666	1.693	1.705	1.708	1.704	1.695	1.670
3176.9 eV	γ	0.00+0	2.77−1	1.08−2	−6.77−2	−3.49−2	5.53−2	1.73−1	3.05−1	4.41−1	5.78−1	8.48−1
	δ	0.00+0	4.72−2	1.44−2	1.41−2	1.79−2	2.19−2	2.54−2	2.83−2	3.09−2	3.34−2	3.81−2
$3d_{3/2}$	σ	1.993+2	9.692+1	5.121+1	2.975+1	1.855+1	1.221+1	8.389+0	5.964+0	4.362+0	3.267+0	1.942+0
E_b=	β	0.497	1.024	1.183	1.235	1.242	1.228	1.203	1.172	1.138	1.101	1.027
2687.6 eV	γ	−1.90−1	−1.89−1	7.51−2	3.54−1	6.05−1	8.24−1	1.02+0	1.19+0	1.34+0	1.47+0	1.69+0
	δ	−3.59−2	3.18−2	7.05−2	9.41−2	1.11−1	1.25−1	1.38−1	1.51−1	1.63−1	1.76−1	1.99−1
$3d_{5/2}$	σ	2.855+2	1.327+2	6.900+1	3.964+1	2.449+1	1.599+1	1.090+1	7.698+0	5.595+0	4.166+0	2.450+0
E_b=	β	0.722	1.116	1.205	1.215	1.194	1.160	1.121	1.080	1.039	0.998	0.918
2579.6 eV	γ	−2.43−1	−1.25−1	1.71−1	4.54−1	6.95−1	8.99−1	1.07+0	1.23+0	1.36+0	1.48+0	1.67+0
	δ	−3.21−2	3.15−2	6.63−2	9.06−2	1.10−1	1.28−1	1.45−1	1.62−1	1.79−1	1.95−1	2.25−1
Z = 84, Po: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^6_{5/2}$ $6s^2_{1/2}$ $6p^2_{1/2}$ $6p^2_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.348+1	1.048+1	8.293+0	6.693+0	5.498+0	4.585+0	3.875+0	3.313+0	2.493+0
E_b=	β	0.000	0.000	1.786	1.807	1.824	1.838	1.851	1.862	1.872	1.881	1.895
4153.5 eV	γ	0.00+0	0.00+0	1.11+0	6.89−1	4.15−1	2.19−1	7.66−2	−2.55−2	−9.72−2	−1.46−1	−1.91−1
	δ	0.00+0	0.00+0	−9.14−4	−2.73−3	−3.74−3	−4.41−3	−4.88−3	−5.24−3	−5.54−3	−5.79−3	−6.21−3
$3p_{1/2}$	σ	0.000+0	2.572+1	2.056+1	1.572+1	1.217+1	9.583+0	7.672+0	6.236+0	5.137+0	4.283+0	3.070+0
E_b=	β	0.000	0.646	1.342	1.493	1.554	1.580	1.588	1.585	1.576	1.564	1.531
3844.3 eV	γ	0.00+0	2.59−1	3.60−1	9.26−2	5.03−3	1.75−2	8.16−2	1.72−1	2.76−1	3.87−1	6.13−1
	δ	0.00+0	2.63−1	3.62−2	5.60−3	−7.71−4	−1.25−3	3.18−4	2.84−3	5.94−3	9.51−3	1.75−2
$3p_{3/2}$	σ	0.000+0	6.746+1	4.609+1	3.258+1	2.384+1	1.796+1	1.386+1	1.092+1	8.762+0	7.134+0	4.909+0
E_b=	β	0.000	1.174	1.475	1.595	1.657	1.689	1.704	1.709	1.707	1.700	1.678
3293.4 eV	γ	0.00+0	3.19−1	3.70−2	−6.57−2	−4.89−2	3.02−2	1.41−1	2.68−1	4.02−1	5.39−1	8.08−1
	δ	0.00+0	6.03−2	1.60−2	1.40−2	1.77−2	2.18−2	2.54−2	2.85−2	3.13−2	3.38−2	3.84−2
$3d_{3/2}$	σ	2.036+2	1.023+2	5.429+1	3.162+1	1.976+1	1.303+1	8.967+0	6.384+0	4.675+0	3.505+0	2.088+0
E_b=	β	0.394	0.985	1.167	1.229	1.243	1.233	1.211	1.182	1.149	1.114	1.041
2793.6 eV	γ	−1.37−1	−2.21−1	2.90−2	3.06−1	5.57−1	7.81−1	9.80−1	1.16+0	1.31+0	1.45+0	1.67+0
	δ	−2.95−2	2.48−2	6.71−2	9.18−2	1.09−1	1.23−1	1.37−1	1.49−1	1.62−1	1.73−1	1.95−1
$3d_{5/2}$	σ	2.949+2	1.400+2	7.308+1	4.207+1	2.604+1	1.703+1	1.163+1	8.224+0	5.984+0	4.460+0	2.627+0
E_b=	β	0.629	1.094	1.199	1.216	1.199	1.168	1.131	1.091	1.050	1.009	0.929
2679.2 eV	γ	−2.13−1	−1.62−1	1.28−1	4.11−1	6.55−1	8.65−1	1.05+0	1.21+0	1.34+0	1.46+0	1.65+0
	δ	−3.81−2	2.57−2	6.28−2	8.77−2	1.07−1	1.25−1	1.43−1	1.60−1	1.76−1	1.92−1	2.21−1
Z = 85, At: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^6_{5/2}$ $6s^2_{1/2}$ $6p^2_{1/2}$ $6p^3_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.350+1	1.056+1	8.388+0	6.788+0	5.588+0	4.669+0	3.952+0	3.383+0	2.550+0
E_b=	β	0.000	0.000	1.770	1.792	1.810	1.826	1.839	1.852	1.862	1.871	1.885
4311.7 eV	γ	0.00+0	0.00+0	1.23+0	7.75−1	4.83−1	2.73−1	1.19−1	7.91−3	−7.26−2	−1.29−1	−1.89−1
	δ	0.00+0	0.00+0	−4.53−4	−2.64−3	−3.81−3	−4.57−3	−5.11−3	−5.51−3	−5.85−3	−6.14−3	−6.63−3
$3p_{1/2}$	σ	0.000+0	2.513+1	2.065+1	1.593+1	1.241+1	9.814+0	7.885+0	6.429+0	5.310+0	4.437+0	3.191+0
E_b=	β	0.000	0.072	1.289	1.471	1.542	1.574	1.586	1.586	1.579	1.568	1.538
3995.8 eV	γ	0.00+0	−6.72−1	4.35−1	1.33−1	1.58−2	9.17−3	6.07−2	1.43−1	2.43−1	3.51−1	5.73−1
	δ	0.00+0	−4.85−2	4.96−2	8.37−3	−3.58−4	−1.62−3	−4.00−4	1.90−3	4.85−3	8.24−3	1.58−2
$3p_{3/2}$	σ	0.000+0	6.860+1	4.724+1	3.352+1	2.459+1	1.857+1	1.436+1	1.133+1	9.103+0	7.419+0	5.115+0
E_b=	β	0.000	1.086	1.443	1.577	1.646	1.683	1.702	1.710	1.710	1.705	1.685
3410.5 eV	γ	0.00+0	3.49−1	6.70−2	−6.00−2	−6.02−2	7.52−3	1.11−1	2.33−1	3.65−1	5.00−1	7.66−1
	δ	0.00+0	7.91−2	1.81−2	1.41−2	1.75−2	2.16−2	2.54−2	2.87−2	3.16−2	3.42−2	3.87−2
$3d_{3/2}$	σ	2.081+2	1.077+2	5.747+1	3.356+1	2.102+1	1.389+1	9.572+0	6.824+0	5.003+0	3.755+0	2.241+0
E_b=	β	0.369	0.941	1.148	1.222	1.242	1.237	1.218	1.191	1.160	1.126	1.056
2901.8 eV	γ	−6.27−2	−2.50−1	−1.68−2	2.57−1	5.10−1	7.39−1	9.44−1	1.12+0	1.28+0	1.42+0	1.65+0
	δ	−5.13−4	1.68−2	6.33−2	8.95−2	1.07−1	1.22−1	1.36−1	1.48−1	1.60−1	1.71−1	1.91−1
$3d_{5/2}$	σ	3.016+2	1.476+2	7.732+1	4.461+1	2.766+1	1.812+1	1.240+1	8.775+0	6.391+0	4.768+0	2.813+0
E_b=	β	0.521	1.068	1.192	1.216	1.204	1.176	1.140	1.101	1.060	1.019	0.941
2780.7 eV	γ	−1.59−1	−1.98−1	8.33−2	3.68−1	6.16−1	8.31−1	1.02+0	1.18+0	1.32+0	1.44+0	1.64+0
	δ	−3.51−2	1.94−2	5.90−2	8.47−2	1.04−1	1.23−1	1.41−1	1.57−1	1.73−1	1.88−1	2.16−1
Z = 86, Rn: [Xe]$4f^6_{5/2}$ $4f^8_{7/2}$ $5d^4_{3/2}$ $5d^6_{5/2}$ $6s^2_{1/2}$ $6p^2_{1/2}$ $6p^4_{3/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.347+1	1.062+1	8.475+0	6.878+0	5.674+0	4.750+0	4.027+0	3.451+0	2.607+0
E_b=	β	0.000	0.000	1.752	1.777	1.795	1.812	1.827	1.839	1.850	1.859	1.874
4474.3 eV	γ	0.00+0	0.00+0	1.37+0	8.67−1	5.56−1	3.31−1	1.66−1	4.49−2	−4.46−2	−1.10−1	−1.83−1
	δ	0.00+0	0.00+0	2.53−4	−2.49−3	−3.85−3	−4.73−3	−5.33−3	−5.80−3	−6.19−3	−6.53−3	−7.07−3

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Table 1 (*continued*)

$3p_{1/2}$	σ	0.000+0	0.000+0	2.067+1	1.612+1	1.263+1	1.004+1	8.093+0	6.619+0	5.480+0	4.589+0	3.312+0
E_b=	β	0.000	0.000	1.226	1.445	1.529	1.567	1.583	1.586	1.582	1.572	1.545
4151.5 eV	γ	0.00+0	0.00+0	5.10−1	1.81−1	3.28−2	5.18−3	4.31−2	1.17−1	2.11−1	3.14−1	5.31−1
	δ	0.00+0	0.00+0	6.83−2	1.21−2	3.54−4	−1.88−3	−1.08−3	9.77−4	3.74−3	6.95−3	1.41−2
$3p_{3/2}$	σ	0.000+0	6.955+1	4.837+1	3.447+1	2.535+1	1.918+1	1.486+1	1.175+1	9.449+0	7.710+0	5.325+0
E_b=	β	0.000	0.986	1.408	1.557	1.634	1.677	1.699	1.709	1.712	1.709	1.692
3530.5 eV	γ	0.00+0	3.62−1	1.01−1	−5.04−2	−6.85−2	−1.29−2	8.22−2	1.99−1	3.28−1	4.60−1	7.23−1
	δ	0.00+0	1.04−1	2.10−2	1.42−2	1.72−2	2.14−2	2.54−2	2.89−2	3.20−2	3.46−2	3.89−2
$3d_{3/2}$	σ	0.000+0	1.132+2	6.077+1	3.559+1	2.233+1	1.478+1	1.021+1	7.285+0	5.347+0	4.017+0	2.402+0
E_b=	β	0.000	0.891	1.127	1.213	1.241	1.240	1.225	1.200	1.170	1.138	1.071
3012.3 eV	γ	0.00+0	−2.74−1	−6.21−2	2.09−1	4.63−1	6.96−1	9.05−1	1.09+0	1.25+0	1.39+0	1.63+0
	δ	0.00+0	7.70−3	5.88−2	8.71−2	1.05−1	1.21−1	1.34−1	1.46−1	1.57−1	1.68−1	1.88−1
$3d_{5/2}$	σ	3.064+2	1.553+2	8.171+1	4.725+1	2.935+1	1.926+1	1.319+1	9.350+0	6.817+0	5.090+0	3.009+0
E_b=	β	0.423	1.039	1.183	1.216	1.208	1.183	1.149	1.110	1.070	1.030	0.954
2884.2 eV	γ	−7.84−2	−2.32−1	3.85−2	3.24−1	5.76−1	7.97−1	9.89−1	1.15+0	1.30+0	1.42+0	1.62+0
	δ	−9.12−3	1.23−2	5.48−2	8.17−2	1.02−1	1.21−1	1.38−1	1.54−1	1.70−1	1.84−1	2.12−1
Z = 87, Fr: [Xe]$7s^1_{1/2}$												
		k (eV)										
Shell		3000	4000	5000	6000	7000	8000	9000	10000	11000	12000	14000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.337+1	1.067+1	8.549+0	6.962+0	5.758+0	4.829+0	4.099+0	3.517+0	2.661+0
E_b=	β	0.000	0.000	1.733	1.759	1.781	1.798	1.812	1.825	1.836	1.847	1.864
4645.7 eV	γ	0.00+0	0.00+0	1.54+0	9.69−1	6.30−1	3.93−1	2.18−1	8.57−2	−1.36−2	−8.65−2	−1.72−1
	δ	0.00+0	0.00+0	1.29−3	−2.26−3	−3.86−3	−4.85−3	−5.57−3	−6.13−3	−6.57−3	−6.93−3	−7.47−3
$3p_{1/2}$	σ	0.000+0	0.000+0	2.061+1	1.626+1	1.283+1	1.025+1	8.297+0	6.804+0	5.647+0	4.738+0	3.432+0
E_b=	β	0.000	0.000	1.147	1.416	1.514	1.559	1.579	1.585	1.583	1.576	1.551
4316.0 eV	γ	0.00+0	0.00+0	5.76−1	2.38−1	5.64−2	5.91−3	2.92−2	9.36−2	1.80−1	2.78−1	4.86−1
	δ	0.00+0	0.00+0	9.43−2	1.71−2	1.50−3	−1.99−3	−1.74−3	3.23−5	2.56−3	5.56−3	1.25−2
$3p_{3/2}$	σ	0.000+0	7.021+1	4.947+1	3.539+1	2.611+1	1.981+1	1.537+1	1.217+1	9.797+0	8.002+0	5.538+0
E_b=	β	0.000	0.856	1.366	1.538	1.621	1.668	1.694	1.708	1.713	1.712	1.698
3657.3 eV	γ	0.00+0	3.39−1	1.39−1	−3.67−2	−7.36−2	−3.09−2	5.63−2	1.67−1	2.90−1	4.18−1	6.75−1
	δ	0.00+0	1.38−1	2.50−2	1.44−2	1.69−2	2.13−2	2.56−2	2.92−2	3.22−2	3.48−2	3.91−2
$3d_{3/2}$	σ	0.000+0	1.187+2	6.415+1	3.769+1	2.371+1	1.572+1	1.086+1	7.765+0	5.706+0	4.293+0	2.573+0
E_b=	β	0.000	0.836	1.104	1.203	1.238	1.242	1.230	1.208	1.181	1.151	1.087
3129.7 eV	γ	0.00+0	−2.93−1	−1.06−1	1.58−1	4.19−1	6.56−1	8.63−1	1.05+0	1.21+0	1.36+0	1.61+0
	δ	0.00+0	−2.88−3	5.37−2	8.39−2	1.04−1	1.20−1	1.32−1	1.44−1	1.55−1	1.65−1	1.87−1
$3d_{5/2}$	σ	4.405+2	1.632+2	8.624+1	5.000+1	3.113+1	2.046+1	1.402+1	9.949+0	7.262+0	5.429+0	3.216+0
E_b=	β	1.103	1.002	1.172	1.214	1.211	1.188	1.156	1.120	1.082	1.044	0.969
2994.9 eV	γ	2.33−2	−2.63−1	−6.82−3	2.78−1	5.39−1	7.65−1	9.56−1	1.12+0	1.27+0	1.39+0	1.61+0
	δ	6.24−4	4.33−3	5.02−2	7.82−2	1.00−1	1.19−1	1.35−1	1.50−1	1.65−1	1.80−1	2.10−1
Z = 88, Ra: [Rn]$7s^2_{1/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$3s_{1/2}$	σ	0.000+0	1.317+1	1.070+1	8.614+0	7.036+0	5.832+0	4.900+0	4.166+0	3.579+0	2.715+0	2.121+0
E_b=	β	0.000	1.712	1.742	1.763	1.782	1.798	1.812	1.825	1.836	1.854	1.868
4822.0 eV	γ	0.00+0	1.74+0	1.07+0	7.18−1	4.63−1	2.74−1	1.31−1	2.30−2	−5.73−2	−1.57−1	−1.99−1
	δ	0.00+0	3.08−3	−1.94−3	−3.82−3	−4.99−3	−5.79−3	−6.39−3	−6.86−3	−7.25−3	−7.88−3	−8.38−3
$3p_{1/2}$	σ	0.000+0	2.044+1	1.637+1	1.301+1	1.044+1	8.486+0	6.981+0	5.810+0	4.887+0	3.554+0	2.667+0
E_b=	β	0.000	1.042	1.380	1.494	1.548	1.573	1.583	1.584	1.579	1.557	1.527
4485.0 eV	γ	0.00+0	6.15−1	3.04−1	8.73−2	1.20−2	1.88−2	7.14−2	1.49−1	2.42−1	4.45−1	6.53−1
	δ	0.00+0	1.32−1	2.42−2	3.08−3	−1.98−3	−2.30−3	−8.20−4	1.53−3	4.40−3	1.12−2	1.90−2
$3p_{3/2}$	σ	7.035+1	5.054+1	3.632+1	2.688+1	2.042+1	1.588+1	1.259+1	1.015+1	8.300+0	5.757+0	4.153+0
E_b=	β	0.656	1.323	1.510	1.605	1.658	1.689	1.705	1.713	1.714	1.703	1.682
3786.6 eV	γ	2.32−1	1.80−1	−1.98−2	−7.61−2	−4.67−2	3.05−2	1.34−1	2.52−1	3.77−1	6.34−1	8.85−1
	δ	1.89−1	3.03−2	1.51−2	1.67−2	2.11−2	2.54−2	2.91−2	3.23−2	3.51−2	3.98−2	4.38−2
$3d_{3/2}$	σ	1.242+2	6.765+1	3.986+1	2.512+1	1.669+1	1.155+1	8.269+0	6.086+0	4.584+0	2.752+0	1.755+0
E_b=	β	0.769	1.075	1.189	1.233	1.243	1.234	1.216	1.191	1.162	1.099	1.033
3248.4 eV	γ	−3.03−1	−1.48−1	1.10−1	3.68−1	6.04−1	8.16−1	1.01+0	1.18+0	1.33+0	1.58+0	1.79+0
	δ	−1.45−2	4.86−2	8.13−2	1.02−1	1.17−1	1.31−1	1.43−1	1.54−1	1.65−1	1.85−1	2.04−1
$3d_{5/2}$	σ	1.710+2	9.087+1	5.281+1	3.293+1	2.167+1	1.488+1	1.057+1	7.729+0	5.784+0	3.432+0	2.166+0
E_b=	β	0.965	1.159	1.211	1.213	1.194	1.165	1.130	1.093	1.055	0.979	0.907
3104.9 eV	γ	−2.88−1	−4.93−2	2.35−1	4.95−1	7.22−1	9.20−1	1.09+0	1.24+0	1.38+0	1.59+0	1.77+0
	δ	−4.41−3	4.60−2	7.53−2	9.67−2	1.15−1	1.32−1	1.48−1	1.64−1	1.79−1	2.08−1	2.34−1
Z = 89, Ac: [Rn]$6d^1_{3/2}$ $7s^2_{1/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.071+1	8.665+0	7.101+0	5.901+0	4.968+0	4.231+0	3.641+0	2.768+0	2.166+0
E_b=	β	0.000	0.000	1.722	1.746	1.766	1.783	1.798	1.811	1.822	1.841	1.856
5000.6 eV	γ	0.00+0	0.00+0	1.19+0	8.04−1	5.34−1	3.33−1	1.80−1	6.34−2	−2.55−2	−1.41−1	−1.95−1
	δ	0.00+0	0.00+0	−1.46−3	−3.73−3	−5.07−3	−5.97−3	−6.65−3	−7.19−3	−7.65−3	−8.38−3	−8.95−3
$3p_{1/2}$	σ	0.000+0	2.013+1	1.644+1	1.317+1	1.062+1	8.666+0	7.154+0	5.971+0	5.034+0	3.676+0	2.767+0
E_b=	β	0.000	0.899	1.339	1.474	1.536	1.567	1.581	1.584	1.581	1.562	1.535
4656.8 eV	γ	0.00+0	5.84−1	3.78−1	1.26−1	2.39−2	1.25−2	5.25−2	1.22−1	2.09−1	4.07−1	6.11−1
	δ	0.00+0	1.90−1	3.35−2	5.34−3	−1.67−3	−2.73−3	−1.61−3	5.32−4	3.26−3	9.78−3	1.71−2
$3p_{3/2}$	σ	6.894+1	5.158+1	3.723+1	2.763+1	2.104+1	1.639+1	1.302+1	1.051+1	8.606+0	5.981+0	4.321+0
E_b=	β	0.317	1.271	1.485	1.589	1.648	1.682	1.702	1.712	1.715	1.708	1.689

(*continued on next page*)

Table 1 (*continued*)

3916.7 eV	γ	−6.89−2	2.22−1	1.67−3	−7.46−2	−5.97−2	7.14−3	1.04−1	2.18−1	3.41−1	5.94−1	8.42−1
	δ	2.51−1	3.75−2	1.59−2	1.64−2	2.07−2	2.52−2	2.92−2	3.27−2	3.57−2	4.05−2	4.43−2
$3d_{3/2}$	σ	1.296+2	7.128+1	4.213+1	2.661+1	1.771+1	1.228+1	8.802+0	6.485+0	4.889+0	2.941+0	1.878+0
E_b=	β	0.695	1.045	1.175	1.227	1.242	1.238	1.222	1.199	1.172	1.111	1.048
3370.1 eV	γ	−3.04−1	−1.88−1	6.02−2	3.16−1	5.56−1	7.75−1	9.70−1	1.14+0	1.30+0	1.56+0	1.77+0
	δ	−2.78−2	4.23−2	7.77−2	9.97−2	1.16−1	1.30−1	1.42−1	1.53−1	1.63−1	1.82−1	2.00−1
$3d_{5/2}$	σ	1.791+2	9.577+1	5.578+1	3.485+1	2.297+1	1.580+1	1.124+1	8.222+0	6.158+0	3.660+0	2.313+0
E_b=	β	0.917	1.144	1.207	1.215	1.199	1.172	1.139	1.102	1.064	0.990	0.918
3219.7 eV	γ	−3.09−1	−9.37−2	1.88−1	4.50−1	6.83−1	8.88−1	1.07+0	1.22+0	1.35+0	1.57+0	1.75+0
	δ	−1.46−2	4.06−2	7.15−2	9.37−2	1.13−1	1.30−1	1.46−1	1.62−1	1.76−1	2.03−1	2.29−1
Z = 90, Th: [Rn]$6d^2_{3/2}$ $7s^2_{1/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.070+1	8.706+0	7.159+0	5.965+0	5.032+0	4.293+0	3.700+0	2.818+0	2.209+0
E_b=	β	0.000	0.000	1.700	1.727	1.748	1.766	1.782	1.795	1.807	1.827	1.843
5182.3 eV	γ	0.00+0	0.00+0	1.32+0	9.00−1	6.11−1	3.97−1	2.34−1	1.08−1	9.95−3	−1.21−1	−1.87−1
	δ	0.00+0	0.00+0	−8.01−4	−3.56−3	−5.11−3	−6.15−3	−6.93−3	−7.55−3	−8.08−3	−8.90−3	−9.51−3
$3p_{1/2}$	σ	0.000+0	1.950+1	1.647+1	1.329+1	1.078+1	8.836+0	7.319+0	6.127+0	5.178+0	3.795+0	2.865+0
E_b=	β	0.000	0.641	1.289	1.449	1.522	1.559	1.576	1.583	1.582	1.567	1.542
4830.4 eV	γ	0.00+0	3.36−1	4.57−1	1.73−1	4.20−2	1.09−2	3.76−2	9.84−2	1.79−1	3.69−1	5.67−1
	δ	0.00+0	2.80−1	4.64−2	8.43−3	−1.11−3	−3.08−3	−2.38−3	−4.80−4	2.08−3	8.25−3	1.52−2
$3p_{3/2}$	σ	0.000+0	5.256+1	3.813+1	2.838+1	2.166+1	1.691+1	1.345+1	1.087+1	8.913+0	6.205+0	4.490+0
E_b=	β	0.000	1.213	1.454	1.570	1.636	1.674	1.697	1.710	1.715	1.711	1.696
4046.1 eV	γ	0.00+0	2.64−1	2.65−2	−7.01−2	−6.99−2	−1.36−2	7.58−2	1.85−1	3.04−1	5.52−1	7.96−1
	δ	0.00+0	4.69−2	1.72−2	1.63−2	2.03−2	2.50−2	2.93−2	3.30−2	3.61−2	4.10−2	4.47−2
$3d_{3/2}$	σ	1.344+2	7.495+1	4.445+1	2.814+1	1.876+1	1.303+1	9.351+0	6.897+0	5.206+0	3.137+0	2.007+0
E_b=	β	0.616	1.010	1.158	1.219	1.240	1.240	1.227	1.207	1.182	1.124	1.064
3490.8 eV	γ	−2.92−1	−2.26−1	1.23−2	2.67−1	5.09−1	7.31−1	9.29−1	1.10+0	1.26+0	1.52+0	1.74+0
	δ	−4.16−2	3.54−2	7.41−2	9.76−2	1.15−1	1.29−1	1.41−1	1.51−1	1.61−1	1.79−1	1.97−1
$3d_{5/2}$	σ	1.867+2	1.007+2	5.880+1	3.680+1	2.430+1	1.673+1	1.192+1	8.728+0	6.543+0	3.896+0	2.465+0
E_b=	β	0.862	1.127	1.202	1.216	1.204	1.179	1.146	1.111	1.074	1.001	0.932
3332.0 eV	γ	−3.21−1	−1.36−1	1.42−1	4.07−1	6.45−1	8.54−1	1.03+0	1.19+0	1.33+0	1.55+0	1.74+0
	δ	−2.58−2	3.52−2	6.78−2	9.09−2	1.10−1	1.28−1	1.44−1	1.58−1	1.72−1	1.99−1	2.25−1
Z = 91, Pa: [Rn]$5f^2_{5/2}$ $6d^1_{3/2}$ $7s^2_{1/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.066+1	8.738+0	7.213+0	6.025+0	5.093+0	4.352+0	3.756+0	2.868+0	2.252+0
E_b=	β	0.000	0.000	1.676	1.705	1.727	1.747	1.764	1.779	1.792	1.814	1.831
5366.9 eV	γ	0.00+0	0.00+0	1.48+0	1.01+0	7.00−1	4.70−1	2.94−1	1.57−1	5.07−2	−9.43−2	−1.74−1
	δ	0.00+0	0.00+0	2.49−4	−3.27−3	−5.11−3	−6.33−3	−7.21−3	−7.88−3	−8.44−3	−9.34−3	−1.00−2
$3p_{1/2}$	σ	0.000+0	0.000+0	1.645+1	1.340+1	1.093+1	8.997+0	7.477+0	6.276+0	5.318+0	3.915+0	2.966+0
E_b=	β	0.000	0.000	1.228	1.418	1.504	1.549	1.571	1.581	1.582	1.571	1.548
5002.7 eV	γ	0.00+0	0.00+0	5.40−1	2.29−1	6.74−2	1.46−2	2.65−2	7.62−2	1.49−1	3.28−1	5.24−1
	δ	0.00+0	0.00+0	6.42−2	1.28−2	−2.23−4	−3.36−3	−3.13−3	−1.48−3	9.02−4	6.89−3	1.38−2
$3p_{3/2}$	σ	0.000+0	5.354+1	3.906+1	2.916+1	2.230+1	1.744+1	1.389+1	1.124+1	9.226+0	6.438+0	4.667+0
E_b=	β	0.000	1.141	1.418	1.547	1.620	1.665	1.691	1.707	1.714	1.714	1.701
4173.8 eV	γ	0.00+0	3.05−1	5.62−2	−6.21−2	−7.78−2	−3.26−2	4.81−2	1.50−1	2.64−1	5.09−1	7.53−1
	δ	0.00+0	5.99−2	1.92−2	1.62−2	2.00−2	2.48−2	2.91−2	3.29−2	3.63−2	4.16−2	4.56−2
$3d_{3/2}$	σ	1.388+2	7.875+1	4.689+1	2.975+1	1.986+1	1.381+1	9.928+0	7.333+0	5.542+0	3.346+0	2.144+0
E_b=	β	0.522	0.970	1.138	1.210	1.237	1.241	1.232	1.214	1.191	1.136	1.077
3606.4 eV	γ	−2.62−1	−2.61−1	−3.46−2	2.18−1	4.58−1	6.79−1	8.81−1	1.06+0	1.23+0	1.50+0	1.72+0
	δ	−5.38−2	2.75−2	7.06−2	9.57−2	1.13−1	1.27−1	1.39−1	1.51−1	1.61−1	1.79−1	1.95−1
$3d_{5/2}$	σ	1.945+2	1.059+2	6.202+1	3.888+1	2.570+1	1.772+1	1.264+1	9.265+0	6.954+0	4.147+0	2.628+0
E_b=	β	0.796	1.107	1.196	1.216	1.208	1.185	1.155	1.122	1.086	1.013	0.943
3439.4 eV	γ	−3.23−1	−1.78−1	9.75−2	3.64−1	6.02−1	8.12−1	9.98−1	1.16+0	1.30+0	1.54+0	1.72+0
	δ	−3.82−2	2.92−2	6.44−2	8.81−2	1.07−1	1.24−1	1.41−1	1.56−1	1.71−1	1.97−1	2.22−1
Z = 92, U : [Rn]$5f^3_{5/2}$ $6d^1_{3/2}$ $7s^2_{1/2}$												
		k (eV)										
Shell		4000	5000	6000	7000	8000	9000	10000	11000	12000	14000	16000
$3s_{1/2}$	σ	0.000+0	0.000+0	1.059+1	8.751+0	7.252+0	6.075+0	5.146+0	4.405+0	3.807+0	2.914+0	2.293+0
E_b=	β	0.000	0.000	1.651	1.683	1.707	1.727	1.745	1.761	1.776	1.799	1.817
5548.0 eV	γ	0.00+0	0.00+0	1.65+0	1.12+0	7.88−1	5.45−1	3.57−1	2.09−1	9.44−2	−6.54−2	−1.58−1
	δ	0.00+0	0.00+0	1.62−3	−2.88−3	−5.04−3	−6.46−3	−7.47−3	−8.23−3	−8.85−3	−9.82−3	−1.06−2
$3p_{1/2}$	σ	0.000+0	0.000+0	1.636+1	1.347+1	1.106+1	9.144+0	7.626+0	6.420+0	5.453+0	4.032+0	3.065+0
E_b=	β	0.000	0.000	1.151	1.383	1.484	1.536	1.564	1.577	1.581	1.574	1.554
5182.2 eV	γ	0.00+0	0.00+0	6.16−1	2.95−1	1.01−1	2.40−2	1.95−2	5.79−2	1.22−1	2.91−1	4.81−1
	δ	0.00+0	0.00+0	8.93−2	1.87−2	1.19−3	−3.44−3	−3.81−3	−2.45−3	−2.62−4	5.46−3	1.22−2
$3p_{3/2}$	σ	0.000+0	5.442+1	3.994+1	2.991+1	2.293+1	1.796+1	1.433+1	1.161+1	9.540+0	6.670+0	4.843+0
E_b=	β	0.000	1.057	1.380	1.523	1.604	1.653	1.684	1.702	1.712	1.716	1.706
4303.4 eV	γ	0.00+0	3.35−1	8.88−2	−5.03−2	−8.24−2	−4.89−2	2.33−2	1.18−1	2.27−1	4.66−1	7.09−1
	δ	0.00+0	7.72−2	2.18−2	1.63−2	1.96−2	2.45−2	2.90−2	3.30−2	3.65−2	4.21−2	4.63−2
$3d_{3/2}$	σ	1.423+2	8.261+1	4.940+1	3.141+1	2.101+1	1.463+1	1.053+1	7.787+0	5.891+0	3.565+0	2.288+0
E_b=	β	0.418	0.926	1.115	1.198	1.233	1.241	1.235	1.220	1.199	1.148	1.090
3727.6 eV	γ	−2.09−1	−2.92−1	−8.15−2	1.68−1	4.09−1	6.31−1	8.34−1	1.02+0	1.19+0	1.47+0	1.70+0

(*continued on next page*)

Table 1 (*continued*)

	δ	−5.81−2	1.85−2	6.61−2	9.35−2	1.12−1	1.26−1	1.38−1	1.49−1	1.60−1	1.77−1	1.94−1
$3d_{5/2}$	σ	2.015+2	1.112+2	6.531+1	4.102+1	2.715+1	1.874+1	1.338+1	9.822+0	7.379+0	4.409+0	2.798+0
E_b=	β	0.718	1.084	1.188	1.216	1.211	1.191	1.163	1.131	1.096	1.025	0.955
3551.7 eV	γ	−3.07−1	−2.18−1	5.13−2	3.20−1	5.61−1	7.74−1	9.62−1	1.13+0	1.28+0	1.52+0	1.71+0
	δ	−5.04−2	2.24−2	6.04−2	8.53−2	1.05−1	1.21−1	1.38−1	1.53−1	1.68−1	1.95−1	2.19−1

Z = 93, Np: [Rn]$5f^4_{5/2}$ $6d^1_{3/2}$ $7s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	1.045+1	8.751+0	7.284+0	6.120+0	5.196+0	4.456+0	3.856+0
E_b=	β	0.000	0.000	0.000	0.000	1.624	1.659	1.684	1.706	1.725	1.742	1.757
5739.6 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	1.84+0	1.24+0	8.84−1	6.26−1	4.26−1	2.68−1	1.43−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	3.84−3	−2.32−3	−4.89−3	−6.53−3	−7.70−3	−8.58−3	−9.27−3
$3p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	1.621+1	1.351+1	1.117+1	9.276+0	7.766+0	6.558+0	5.585+0
E_b=	β	0.000	0.000	0.000	0.000	1.047	1.343	1.461	1.522	1.555	1.572	1.580
5366.7 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	6.69−1	3.69−1	1.42−1	3.98−2	1.72−2	4.30−2	9.79−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	1.27−1	2.68−2	3.28−3	−3.27−3	−4.40−3	−3.40−3	−1.41−3
$3p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	5.518+1	4.080+1	3.066+1	2.356+1	1.849+1	1.477+1	1.198+1	9.856+0
E_b=	β	0.000	0.000	0.000	0.964	1.338	1.497	1.586	1.640	1.675	1.697	1.710
4433.4 eV	γ	0.00+0	0.00+0	0.00+0	3.54−1	1.24−1	−3.48−2	−8.38−2	−6.27−2	5.84−4	8.90−2	1.93−1
	δ	0.00+0	0.00+0	0.00+0	1.01−1	2.54−2	1.65−2	1.93−2	2.41−2	2.89−2	3.31−2	3.67−2
$3d_{3/2}$	σ	0.000+0	0.000+0	1.446+2	8.648+1	5.197+1	3.313+1	2.220+1	1.548+1	1.116+1	8.259+0	6.256+0
E_b=	β	0.000	0.000	0.340	0.877	1.090	1.185	1.226	1.240	1.238	1.226	1.207
3849.8 eV	γ	0.00+0	0.00+0	−1.30−1	−3.19−1	−1.27−1	1.18−1	3.59−1	5.82−1	7.86−1	9.73−1	1.14+0
	δ	0.00+0	0.00+0	−3.17−2	8.08−3	6.10−2	9.08−2	1.10−1	1.25−1	1.37−1	1.48−1	1.58−1
$3d_{5/2}$	σ	0.000+0	0.000+0	2.077+2	1.166+2	6.871+1	4.323+1	2.866+1	1.981+1	1.415+1	1.040+1	7.822+0
E_b=	β	0.000	0.000	0.627	1.057	1.179	1.214	1.213	1.196	1.170	1.140	1.106
3665.2 eV	γ	0.00+0	0.00+0	−2.70−1	−2.56−1	4.64−3	2.75−1	5.20−1	7.35−1	9.26−1	1.10+0	1.25+0
	δ	0.00+0	0.00+0	−6.06−2	1.49−2	5.59−2	8.23−2	1.02−1	1.19−1	1.35−1	1.50−1	1.65−1
$4s_{1/2}$	σ	1.862+1	1.121+1	7.409+0	5.247+0	3.907+0	3.019+0	2.400+0	1.952+0	1.618+0	1.361+0	1.160+0
E_b=	β	1.532	1.640	1.685	1.713	1.733	1.749	1.764	1.776	1.787	1.796	1.804
1500.1 eV	γ	9.89−1	8.40−1	6.56−1	4.87−1	3.40−1	2.16−1	1.12−1	2.79−2	−4.04−2	−9.49−2	−1.37−1
	δ	4.67−3	−4.22−4	−2.91−3	−4.54−3	−5.74−3	−6.67−3	−7.42−3	−8.04−3	−8.59−3	−9.09−3	−9.54−3

Z = 94, Pu: [Rn]$5f^6_{5/2}$ $7s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	1.008+1	8.738+0	7.307+0	6.158+0	5.241+0	4.504+0	3.904+0
E_b=	β	0.000	0.000	0.000	0.000	1.590	1.632	1.661	1.685	1.704	1.721	1.736
5932.9 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	2.05+0	1.37+0	9.84−1	7.10−1	5.00−1	3.33−1	1.98−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	1.06−2	−1.54−3	−4.64−3	−6.53−3	−7.87−3	−8.90−3	−9.72−3
$3p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	1.596+1	1.351+1	1.124+1	9.386+0	7.891+0	6.686+0	5.709+0
E_b=	β	0.000	0.000	0.000	0.000	0.920	1.297	1.437	1.507	1.545	1.566	1.577
5541.2 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	6.66−1	4.47−1	1.90−1	6.18−2	2.00−2	3.22−2	7.79−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	1.79−1	3.72−2	6.04−3	−2.77−3	−4.86−3	−4.32−3	−2.57−3
$3p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	5.580+1	4.163+1	3.138+1	2.417+1	1.901+1	1.521+1	1.236+1	1.018+1
E_b=	β	0.000	0.000	0.000	0.847	1.292	1.471	1.568	1.627	1.665	1.690	1.705
4556.6 eV	γ	0.00+0	0.00+0	0.00+0	3.43−1	1.61−1	−1.57−2	−8.16−2	−7.37−2	−1.98−2	6.23−2	1.61−1
	δ	0.00+0	0.00+0	0.00+0	1.31−1	2.99−2	1.69−2	1.88−2	2.37−2	2.88−2	3.33−2	3.71−2
$3d_{3/2}$	σ	0.000+0	0.000+0	1.357+2	9.045+1	5.467+1	3.494+1	2.346+1	1.639+1	1.182+1	8.759+0	6.639+0
E_b=	β	0.000	0.000	0.733	0.822	1.063	1.170	1.219	1.238	1.239	1.230	1.213
3972.6 eV	γ	0.00+0	0.00+0	3.30−3	−3.39−1	−1.72−1	6.55−2	3.09−1	5.36−1	7.42−1	9.28−1	1.10+0
	δ	0.00+0	0.00+0	4.84−3	−4.01−3	5.48−2	8.71−2	1.09−1	1.24−1	1.36−1	1.47−1	1.56−1
$3d_{5/2}$	σ	0.000+0	0.000+0	2.129+2	1.223+2	7.228+1	4.557+1	3.026+1	2.094+1	1.498+1	1.101+1	8.288+0
E_b=	β	0.000	0.000	0.514	1.027	1.168	1.211	1.215	1.201	1.176	1.147	1.115
3778.1 eV	γ	0.00+0	0.00+0	−1.97−1	−2.91−1	−4.30−2	2.27−1	4.77−1	7.00−1	8.93−1	1.06+0	1.21+0
	δ	0.00+0	0.00+0	−5.80−2	6.41−3	5.08−2	7.85−2	9.98−2	1.17−1	1.33−1	1.47−1	1.61−1
$4s_{1/2}$	σ	1.853+1	1.126+1	7.478+0	5.313+0	3.966+0	3.070+0	2.445+0	1.991+0	1.651+0	1.390+0	1.186+0
E_b=	β	1.488	1.610	1.663	1.693	1.714	1.730	1.745	1.758	1.770	1.781	1.790
1559.3 eV	γ	1.02+0	8.79−1	6.96−1	5.28−1	3.81−1	2.54−1	1.46−1	5.69−2	−1.60−2	−7.43−2	−1.20−1
	δ	5.87−3	−2.90−5	−2.83−3	−4.60−3	−5.91−3	−6.95−3	−7.80−3	−8.50−3	−9.09−3	−9.59−3	−1.01−2

Z = 95, Am: [Rn]$5f^6_{5/2}$ $5f^1_{7/2}$ $7s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	8.704+0	7.317+0	6.186+0	5.278+0	4.545+0	3.946+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.605	1.635	1.661	1.682	1.700	1.716
6132.6 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.50+0	1.09+0	8.00−1	5.78−1	4.01−1	2.58−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	−5.01−4	−4.26−3	−6.48−3	−8.00−3	−9.16−3	−1.01−2
$3p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	1.552+1	1.348+1	1.130+1	9.490+0	8.012+0	6.813+0	5.834+0
E_b=	β	0.000	0.000	0.000	0.000	0.698	1.238	1.406	1.488	1.533	1.559	1.572
5747.0 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	4.96−1	5.40−1	2.52−1	9.34−2	2.92−2	2.52−2	5.93−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	2.71−1	5.36−2	1.03−2	−1.81−3	−5.14−3	−5.17−3	−3.72−3
$3p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	5.618+1	4.253+1	3.217+1	2.484+1	1.956+1	1.568+1	1.276+1	1.052+1
E_b=	β	0.000	0.000	0.000	0.673	1.237	1.439	1.546	1.611	1.654	1.682	1.700
4706.0 eV	γ	0.00+0	0.00+0	0.00+0	2.72−1	2.05−1	9.13−3	−7.58−2	−8.25−2	−3.95−2	3.48−2	1.28−1
	δ	0.00+0	0.00+0	0.00+0	1.79−1	3.70−2	1.78−2	1.84−2	2.31−2	2.84−2	3.32−2	3.73−2
$3d_{3/2}$	σ	0.000+0	0.000+0	0.000+0	9.413+1	5.728+1	3.671+1	2.470+1	1.728+1	1.249+1	9.263+0	7.029+0

(*continued on next page*)

Table 1 (*continued*)

E_b=	β	0.000	0.000	0.000	0.765	1.034	1.153	1.210	1.234	1.239	1.233	1.219
4092.1 eV	γ	0.00+0	0.00+0	0.00+0	−3.52−1	−2.12−1	1.67−2	2.57−1	4.86−1	6.96−1	8.84−1	1.06+0
	δ	0.00+0	0.00+0	0.00+0	−1.69−2	4.85−2	8.35−2	1.06−1	1.23−1	1.36−1	1.46−1	1.55−1
$3d_{5/2}$	σ	0.000+0	0.000+0	2.159+2	1.275+2	7.568+1	4.782+1	3.181+1	2.204+1	1.579+1	1.162+1	8.755+0
E_b=	β	0.000	0.000	0.420	0.994	1.156	1.207	1.216	1.205	1.183	1.154	1.124
3886.9 eV	γ	0.00+0	0.00+0	−7.72−2	−3.21−1	−8.64−2	1.80−1	4.33−1	6.60−1	8.58−1	1.03+0	1.18+0
	δ	0.00+0	0.00+0	−5.59−3	−2.49−3	4.58−2	7.48−2	9.68−2	1.15−1	1.31−1	1.45−1	1.58−1
$4s_{1/2}$	σ	1.840+1	1.129+1	7.532+0	5.369+0	4.017+0	3.116+0	2.485+0	2.027+0	1.683+0	1.418+0	1.211+0
E_b=	β	1.439	1.579	1.638	1.671	1.694	1.711	1.726	1.740	1.753	1.764	1.774
1619.2 eV	γ	1.04+0	9.16−1	7.37−1	5.70−1	4.21−1	2.92−1	1.82−1	8.84−2	1.13−2	−5.13−2	−1.01−1
	δ	7.21−3	4.18−4	−2.71−3	−4.66−3	−6.08−3	−7.22−3	−8.15−3	−8.92−3	−9.57−3	−1.01−2	−1.06−2

Z = 96, Cm: [Rn]$5f^6_{5/2}\,5f^1_{7/2}\,6d^1_{3/2}\,7s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	8.649+0	7.315+0	6.206+0	5.309+0	4.580+0	3.984+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.571	1.606	1.634	1.657	1.677	1.694
6342.5 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.67+0	1.21+0	8.99−1	6.63−1	4.75−1	3.22−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.14−3	−3.69−3	−6.32−3	−8.09−3	−9.42−3	−1.05−2
$3p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	1.463+1	1.339+1	1.133+1	9.564+0	8.110+0	6.920+0	5.943+0
E_b=	β	0.000	0.000	0.000	0.000	0.215	1.172	1.370	1.466	1.519	1.550	1.567
5943.3 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	−2.42−1	6.25−1	3.20−1	1.32−1	4.44−2	2.37−2	4.55−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	3.56−1	7.48−2	1.59−2	−4.48−4	−5.29−3	−5.96−3	−4.80−3
$3p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	5.589+1	4.329+1	3.287+1	2.545+1	2.008+1	1.612+1	1.313+1	1.084+1
E_b=	β	0.000	0.000	0.000	0.424	1.180	1.403	1.521	1.593	1.641	1.673	1.694
4841.5 eV	γ	0.00+0	0.00+0	0.00+0	8.34−2	2.44−1	3.48−2	−6.74−2	−8.79−2	−5.53−2	1.08−2	9.73−2
	δ	0.00+0	0.00+0	0.00+0	2.40−1	4.53−2	1.92−2	1.81−2	2.26−2	2.80−2	3.30−2	3.73−2
$3d_{3/2}$	σ	0.000+0	0.000+0	0.000+0	9.800+1	6.014+1	3.866+1	2.605+1	1.825+1	1.320+1	9.806+0	7.449+0
E_b=	β	0.000	0.000	0.000	0.695	0.997	1.133	1.199	1.229	1.238	1.235	1.224
4229.4 eV	γ	0.00+0	0.00+0	0.00+0	−3.56−1	−2.53−1	−3.34−2	2.04−1	4.33−1	6.43−1	8.34−1	1.01+0
	δ	0.00+0	0.00+0	0.00+0	−3.27−2	4.11−2	7.97−2	1.04−1	1.22−1	1.34−1	1.45−1	1.55−1
$3d_{5/2}$	σ	0.000+0	0.000+0	0.000+0	1.333+2	7.952+1	5.033+1	3.353+1	2.326+1	1.667+1	1.229+1	9.264+0
E_b=	β	0.000	0.000	0.000	0.952	1.140	1.202	1.217	1.209	1.189	1.162	1.133
4014.9 eV	γ	0.00+0	0.00+0	0.00+0	−3.49−1	−1.33−1	1.33−1	3.88−1	6.17−1	8.17−1	9.93−1	1.15+0
	δ	0.00+0	0.00+0	0.00+0	−1.36−2	4.01−2	7.12−2	9.39−2	1.12−1	1.28−1	1.42−1	1.55−1
$4s_{1/2}$	σ	1.823+1	1.131+1	7.583+0	5.423+0	4.067+0	3.161+0	2.525+0	2.061+0	1.714+0	1.446+0	1.235+0
E_b=	β	1.388	1.544	1.609	1.646	1.671	1.691	1.707	1.722	1.735	1.747	1.758
1688.6 eV	γ	1.06+0	9.55−1	7.82−1	6.15−1	4.65−1	3.33−1	2.19−1	1.22−1	4.15−2	−2.49−2	−7.91−2
	δ	8.80−3	9.71−4	−2.51−3	−4.67−3	−6.25−3	−7.49−3	−8.50−3	−9.33−3	−1.00−2	−1.06−2	−1.12−2

Z = 97, Bk: [Rn]$5f^6_{5/2}\,5f^2_{7/2}\,6d^1_{3/2}\,7s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	8.559+0	7.300+0	6.216+0	5.331+0	4.610+0	4.017+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.538	1.576	1.607	1.632	1.652	1.671
6547.6 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.85+0	1.33+0	1.00+0	7.51−1	5.52−1	3.90−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	3.42−3	−2.93−3	−6.07−3	−8.11−3	−9.61−3	−1.08−2
$3p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.325+1	1.132+1	9.618+0	8.193+0	7.017+0	6.045+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.093	1.330	1.441	1.503	1.539	1.560
6139.9 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	7.02−1	3.97−1	1.78−1	6.65−2	2.75−2	3.58−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.04−1	2.35−2	1.62−3	−5.14−3	−6.61−3	−5.88−3
$3p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	5.419+1	4.403+1	3.357+1	2.605+1	2.059+1	1.656+1	1.351+1	1.116+1
E_b=	β	0.000	0.000	0.000	−.053	1.117	1.367	1.497	1.575	1.627	1.662	1.686
4975.3 eV	γ	0.00+0	0.00+0	0.00+0	−2.82−1	2.82−1	6.39−2	−5.53−2	−9.00−2	−6.87−2	−1.11−2	6.92−2
	δ	0.00+0	0.00+0	0.00+0	1.58−1	5.62−2	2.10−2	1.79−2	2.19−2	2.74−2	3.27−2	3.74−2
$3d_{3/2}$	σ	0.000+0	0.000+0	0.000+0	1.014+2	6.287+1	4.055+1	2.738+1	1.922+1	1.392+1	1.035+1	7.873+0
E_b=	β	0.000	0.000	0.000	0.619	0.960	1.112	1.186	1.222	1.236	1.236	1.227
4353.4 eV	γ	0.00+0	0.00+0	0.00+0	−3.46−1	−2.87−1	−8.05−2	1.53−1	3.82−1	5.95−1	7.88−1	9.64−1
	δ	0.00+0	0.00+0	0.00+0	−4.84−2	3.29−2	7.52−2	1.02−1	1.20−1	1.34−1	1.45−1	1.54−1
$3d_{5/2}$	σ	0.000+0	0.000+0	0.000+0	1.386+2	8.316+1	5.276+1	3.520+1	2.446+1	1.755+1	1.295+1	9.773+0
E_b=	β	0.000	0.000	0.000	0.908	1.124	1.196	1.216	1.212	1.194	1.169	1.141
4128.8 eV	γ	0.00+0	0.00+0	0.00+0	−3.69−1	−1.75−1	8.65−2	3.42−1	5.75−1	7.80−1	9.59−1	1.12+0
	δ	0.00+0	0.00+0	0.00+0	−2.52−2	3.42−2	6.71−2	9.07−2	1.10−1	1.25−1	1.39−1	1.53−1
$4s_{1/2}$	σ	1.803+1	1.131+1	7.618+0	5.466+0	4.109+0	3.200+0	2.561+0	2.094+0	1.742+0	1.472+0	1.259+0
E_b=	β	1.330	1.507	1.580	1.621	1.648	1.669	1.686	1.702	1.716	1.728	1.740
1748.3 eV	γ	1.07+0	9.89−1	8.24−1	6.59−1	5.08−1	3.75−1	2.58−1	1.58−1	7.34−2	2.79−3	−5.51−2
	δ	1.06−2	1.60−3	−2.28−3	−4.67−3	−6.39−3	−7.74−3	−8.85−3	−9.76−3	−1.05−2	−1.12−2	−1.18−2
$4p_{1/2}$	σ	1.704+1	1.289+1	9.452+0	7.078+0	5.439+0	4.279+0	3.435+0	2.806+0	2.325+0	1.952+0	1.657+0
E_b=	β	0.619	1.308	1.508	1.593	1.635	1.657	1.667	1.670	1.668	1.662	1.653
1554.5 eV	γ	5.53−1	7.29−1	4.24−1	2.04−1	7.79−2	2.14−2	1.28−2	3.64−2	8.13−2	1.40−1	2.09−1
	δ	1.31−1	4.59−3	−1.38−2	−1.66−2	−1.63−2	−1.54−2	−1.41−2	−1.27−2	−1.11−2	−9.29−3	−7.34−3

Z = 98, Cf: [Rn]$5f^6_{5/2}\,5f^4_{7/2}\,7s^2_{1/2}$

		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	8.417+0	7.277+0	6.220+0	5.349+0	4.636+0	4.047+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.504	1.543	1.578	1.605	1.628	1.647
6764.0 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	2.05+0	1.47+0	1.11+0	8.46−1	6.35−1	4.64−1

(*continued on next page*)

Table 1 (*continued*)

	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	7.23−3	−1.83−3	−5.67−3	−8.03−3	−9.73−3	−1.11−2
$3p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.305+1	1.129+1	9.653+0	8.262+0	7.104+0	6.142+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.973	1.282	1.414	1.485	1.527	1.552
6347.5 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	7.44−1	4.86−1	2.36−1	9.70−2	3.76−2	3.04−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.50−1	3.45−2	4.79−3	−4.56−3	−7.07−3	−6.84−3
$3p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	4.477+1	3.430+1	2.668+1	2.113+1	1.702+1	1.390+1	1.151+1
E_b=	β	0.000	0.000	0.000	0.000	1.045	1.328	1.470	1.556	1.613	1.651	1.677
5117.1 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	3.18−1	9.84−2	−3.89−2	−8.88−2	−7.96−2	−3.18−2	4.15−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	7.14−2	2.37−2	1.79−2	2.12−2	2.66−2	3.21−2	3.72−2
$3d_{3/2}$	σ	0.000+0	0.000+0	0.000+0	1.050+2	6.588+1	4.262+1	2.884+1	2.027+1	1.471+1	1.095+1	8.335+0
E_b=	β	0.000	0.000	0.000	0.532	0.918	1.088	1.172	1.214	1.232	1.236	1.230
4485.3 eV	γ	0.00+0	0.00+0	0.00+0	−3.20−1	−3.20−1	−1.28−1	9.78−2	3.24−1	5.41−1	7.41−1	9.22−1
	δ	0.00+0	0.00+0	0.00+0	−6.58−2	2.31−2	6.99−2	9.80−2	1.18−1	1.33−1	1.45−1	1.55−1
$3d_{5/2}$	σ	0.000+0	0.000+0	0.000+0	1.442+2	8.716+1	5.542+1	3.702+1	2.576+1	1.851+1	1.367+1	1.033+1
E_b=	β	0.000	0.000	0.000	0.855	1.105	1.189	1.215	1.214	1.199	1.176	1.148
4249.9 eV	γ	0.00+0	0.00+0	0.00+0	−3.82−1	−2.19−1	3.75−2	2.91−1	5.26−1	7.38−1	9.26−1	1.09+0
	δ	0.00+0	0.00+0	0.00+0	−3.90−2	2.73−2	6.26−2	8.66−2	1.06−1	1.23−1	1.38−1	1.52−1
$4s_{1/2}$	σ	1.780+1	1.130+1	7.653+0	5.508+0	4.151+0	3.239+0	2.597+0	2.126+0	1.772+0	1.498+0	1.282+0
E_b=	β	1.265	1.465	1.549	1.594	1.625	1.647	1.665	1.680	1.694	1.707	1.719
1816.0 eV	γ	1.07+0	1.03+0	8.68−1	7.05−1	5.53−1	4.19−1	3.01−1	1.98−1	1.09−1	3.41−2	−2.87−2
	δ	1.30−2	2.43−3	−1.99−3	−4.63−3	−6.50−3	−7.95−3	−9.15−3	−1.02−2	−1.11−2	−1.18−2	−1.25−2
$4p_{1/2}$	σ	1.633+1	1.266+1	9.403+0	7.097+0	5.485+0	4.335+0	3.494+0	2.862+0	2.379+0	2.001+0	1.702+0
E_b=	β	0.473	1.265	1.487	1.580	1.627	1.652	1.664	1.669	1.668	1.664	1.656
1616.5 eV	γ	4.42−1	7.82−1	4.77−1	2.41−1	1.01−1	3.25−2	1.32−2	2.83−2	6.71−2	1.22−1	1.86−1
	δ	1.62−1	7.58−3	−1.42−2	−1.77−2	−1.74−2	−1.64−2	−1.52−2	−1.38−2	−1.22−2	−1.05−2	−8.58−3
Z = 99, Es: [Rn]$5f^6_{5/2}$ $5f^5_{7/2}$ $7s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	7.794+0	7.237+0	6.215+0	5.360+0	4.655+0	4.072+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	1.464	1.508	1.546	1.575	1.600	1.621
6985.4 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.96+0	1.62+0	1.23+0	9.48−1	7.25−1	5.43−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	2.12−2	−3.79−4	−5.07−3	−7.85−3	−9.81−3	−1.13−2
$3p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.276+1	1.122+1	9.663+0	8.314+0	7.177+0	6.226+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.820	1.223	1.380	1.463	1.512	1.542
6560.7 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	7.03−1	5.80−1	3.04−1	1.36−1	5.46−2	3.09−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	2.21−1	4.98−2	9.25−3	−3.60−3	−7.45−3	−7.80−3
$3p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	4.543+1	3.499+1	2.729+1	2.166+1	1.747+1	1.429+1	1.184+1
E_b=	β	0.000	0.000	0.000	0.000	0.957	1.283	1.439	1.533	1.596	1.638	1.667
5260.8 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	3.42−1	1.35−1	−1.95−2	−8.47−2	−8.76−2	−4.95−2	1.61−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	9.10−2	2.74−2	1.81−2	2.06−2	2.59−2	3.16−2	3.69−2
$3d_{3/2}$	σ	0.000+0	0.000+0	0.000+0	1.078+2	6.882+1	4.470+1	3.030+1	2.133+1	1.550+1	1.155+1	8.804+0
E_b=	β	0.000	0.000	0.000	0.437	0.871	1.061	1.155	1.204	1.227	1.235	1.232
4619.1 eV	γ	0.00+0	0.00+0	0.00+0	−2.73−1	−3.48−1	−1.74−1	4.66−2	2.70−1	4.86−1	6.89−1	8.74−1
	δ	0.00+0	0.00+0	0.00+0	−7.83−2	1.21−2	6.42−2	9.48−2	1.16−1	1.31−1	1.44−1	1.54−1
$3d_{5/2}$	σ	0.000+0	0.000+0	0.000+0	1.495+2	9.113+1	5.809+1	3.887+1	2.707+1	1.948+1	1.440+1	1.089+1
E_b=	β	0.000	0.000	0.000	0.789	1.082	1.180	1.213	1.216	1.204	1.183	1.156
4372.7 eV	γ	0.00+0	0.00+0	0.00+0	−3.81−1	−2.60−1	−9.54−3	2.44−1	4.80−1	6.95−1	8.87−1	1.06+0
	δ	0.00+0	0.00+0	0.00+0	−5.36−2	1.99−2	5.81−2	8.33−2	1.03−1	1.20−1	1.36−1	1.49−1
$4s_{1/2}$	σ	1.749+1	1.128+1	7.676+0	5.543+0	4.188+0	3.274+0	2.629+0	2.156+0	1.799+0	1.522+0	1.304+0
E_b=	β	1.195	1.421	1.514	1.564	1.597	1.622	1.642	1.658	1.672	1.685	1.698
1884.0 eV	γ	1.06+0	1.06+0	9.12−1	7.53−1	6.01−1	4.65−1	3.44−1	2.39−1	1.47−1	6.83−2	1.37−3
	δ	1.60−2	3.36−3	−1.60−3	−4.52−3	−6.58−3	−8.17−3	−9.47−3	−1.06−2	−1.16−2	−1.24−2	−1.31−2
$4p_{1/2}$	σ	1.559+1	1.239+1	9.329+0	7.101+0	5.520+0	4.383+0	3.545+0	2.914+0	2.428+0	2.048+0	1.745+0
E_b=	β	0.314	1.216	1.462	1.564	1.617	1.645	1.660	1.667	1.668	1.665	1.659
1680.1 eV	γ	2.89−1	8.31−1	5.31−1	2.81−1	1.27−1	4.62−2	1.66−2	2.30−2	5.46−2	1.04−1	1.64−1
	δ	1.98−1	1.14−2	−1.46−2	−1.89−2	−1.87−2	−1.76−2	−1.63−2	−1.49−2	−1.33−2	−1.16−2	−9.75−3
Z=100, Fm: [Rn]$5f^6_{5/2}$ $5f^6_{7/2}$ $7s^2_{1/2}$												
		k (eV)										
Shell		2000	3000	4000	5000	6000	7000	8000	9000	10000	11000	12000
$3s_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	7.181+0	6.200+0	5.363+0	4.669+0	4.092+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.000	1.472	1.511	1.542	1.569	1.592
7212.6 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.77+0	1.35+0	1.06+0	8.22−1	6.29−1
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	1.47−3	−4.23−3	−7.52−3	−9.80−3	−1.15−2
$3p_{1/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	0.000+0	1.231+1	1.112+1	9.648+0	8.346+0	7.236+0	6.299+0
E_b=	β	0.000	0.000	0.000	0.000	0.000	0.554	1.152	1.341	1.437	1.495	1.530
6779.0 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	4.08−1	6.75−1	3.82−1	1.85−1	7.91−2	3.74−2
	δ	0.00+0	0.00+0	0.00+0	0.00+0	0.00+0	3.35−1	7.17−2	1.55−2	−1.97−3	−7.60−3	−8.70−3
$3p_{3/2}$	σ	0.000+0	0.000+0	0.000+0	0.000+0	4.603+1	3.569+1	2.791+1	2.219+1	1.793+1	1.468+1	1.218+1
E_b=	β	0.000	0.000	0.000	0.000	0.843	1.232	1.405	1.508	1.576	1.623	1.656
5408.7 eV	γ	0.00+0	0.00+0	0.00+0	0.00+0	3.43−1	1.73−1	3.77−3	−7.73−2	−9.28−2	−6.47−2	−7.29−3
	δ	0.00+0	0.00+0	0.00+0	0.00+0	1.19−1	3.26−2	1.88−2	2.00−2	2.51−2	3.09−2	3.64−2
$3d_{3/2}$	σ	0.000+0	0.000+0	0.000+0	1.099+2	7.179+1	4.683+1	3.182+1	2.243+1	1.632+1	1.218+1	9.292+0
E_b=	β	0.000	0.000	0.000	0.348	0.818	1.030	1.136	1.193	1.221	1.232	1.232
4754.7 eV	γ	0.00+0	0.00+0	0.00+0	−2.03−1	−3.71−1	−2.17−1	−3.75−3	2.17−1	4.31−1	6.35−1	8.24−1
	δ	0.00+0	0.00+0	0.00+0	−7.16−2	−4.66−4	5.78−2	9.13−2	1.13−1	1.30−1	1.43−1	1.54−1

(*continued on next page*)

Table 1 (*continued*)

$3d_{5/2}$	σ	0.000+0	0.000+0	0.000+0	1.543+2	9.517+1	6.084+1	4.077+1	2.843+1	2.048+1	1.516+1	1.147+1
E_b=	β	0.000	0.000	0.000	0.714	1.057	1.169	1.209	1.217	1.208	1.189	1.164
4496.7 eV	γ	0.00+0	0.00+0	0.00+0	−3.63−1	−2.99−1	−5.63−2	1.98−1	4.34−1	6.50−1	8.46−1	1.02+0
	δ	0.00+0	0.00+0	0.00+0	−6.94−2	1.17−2	5.33−2	7.98−2	9.99−2	1.17−1	1.33−1	1.47−1
$4s_{1/2}$	σ	1.694+1	1.124+1	7.689+0	5.571+0	4.219+0	3.305+0	2.658+0	2.183+0	1.824+0	1.546+0	1.326+0
E_b=	β	1.117	1.372	1.475	1.530	1.567	1.595	1.617	1.634	1.649	1.663	1.675
1954.2 eV	γ	1.00+0	1.09+0	9.57−1	8.03−1	6.51−1	5.13−1	3.90−1	2.82−1	1.88−1	1.06−1	3.46−2
	δ	2.00−2	4.46−3	−1.12−3	−4.35−3	−6.64−3	−8.38−3	−9.79−3	−1.10−2	−1.20−2	−1.30−2	−1.38−2
$4p_{1/2}$	σ	1.484+1	1.210+1	9.231+0	7.087+0	5.543+0	4.422+0	3.590+0	2.960+0	2.474+0	2.091+0	1.786+0
E_b=	β	0.134	1.164	1.434	1.547	1.605	1.638	1.656	1.664	1.667	1.665	1.661
1743.0 eV	γ	8.48−2	8.77−1	5.88−1	3.26−1	1.57−1	6.30−2	2.29−2	2.02−2	4.43−2	8.72−2	1.43−1
	δ	2.41−1	1.60−2	−1.50−2	−2.02−2	−2.02−2	−1.90−2	−1.75−2	−1.61−2	−1.45−2	−1.28−2	−1.10−2