Updated database, semi-empirical and theoretical calculation of Kβ/Kα intensity ratios for elements ranging from $_{11}$Na to $_{96}$Cm

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Abstract: A collection of 1118 experimental Kβ/Kα X-ray intensity ratios induced by photon impact was published recently by Daoudi et *al.* (2020). There were errors in some tabulated values. These errors are corrected here, as well as a substantial update including all experimental Kβ/Kα X-ray intensity ratios obtained from various sources for elements ranging from $_{11}$Na to $_{96}$Cm, when bombarded with photons, protons, deuterons, alpha particles, and electrons. More than 2100 experimental Kβ/Kα X-ray intensity ratios published between 1969 and 2020 (196 papers) are summarized in a table. A thorough analysis of these data is provided, as well as a table with weighted average intensity ratio values $(\mathrm{K\beta/K\alpha})_{\mathrm{W}}$. Subsequently, new semi-empirical average Kβ/Kα X-ray intensity ratios for elements in the range 11≤ Z ≤96 have been determined using an interpolation procedure which involves the analytical function $[(\mathrm{K\beta/K\alpha})_{\mathrm{W}}/(1-(\mathrm{K\beta/K\alpha})_{\mathrm{W}})]^{1/4}$ as a function of the atomic number Z and then fitting the experimental to weighted average ratios $\mathrm{S}=(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}}/(\mathrm{K\beta/K\alpha})_{\mathrm{W}}$. Furthermore, new theoretical calculations based on the Multiconfiguration Dirac-Fock Method have been performed for some elements and are presented in this work. The compilation provides a snapshot of the current status of Kβ/Kα X-ray atomic data. The need for additional quality measurements with detailed uncertainty assessments is clear.

Considerable expert judgment will be needed in the future to shift through the database to create a statistically robust evaluation.

Keywords: X-rays, fundamental atomic parameters, intensity ratios, weighted average values, semi-empirical and MCDF calculation.

Contents

1. Introduction

Fundamental atomic parameters (X-ray production cross sections, intensity ratios, fluorescence yields, and vacancy transfer probabilities of various elements) are play a central role in many applications such as analytical methods with X-rays (e.g., in nuclear safeguards applications), dosimetry and radiation protection, industrial irradiation processing, characterization of plasmas, and to benchmark theoretical models and related codes that simulate the radiation interaction with matter. Out of these fundamental atomic parameters, intensity ratios are among the most needed because of their significance in the quantitative analysis of materials, in addition to their crucial role in the determination of excitation and ionization cross sections from atomic spectra. Intensity ratios are also necessary to compute X-ray production cross-sections (Sampaio *et al.,* 2015; Madeira *et al.,* 2015). Radiative transitions are classified accordingly to the Siegbahn or the International Union of Pure and Applied Chemistry (IUPAC) notations (Jenkins *et al.,* 1991). In the Siegbahn notation Kα correspond to IUPAC K-L transitions and Kβ correspond to IUPAC K-M and K-N transitions. Fig. 1 indicates the correspondence between the Siegbahn, IUPAC, and nL_j electron configuration notations. In this figure, n, l, and j are the principal quantum number *(n)*, the orbital angular momentum *(l)*, and the total angular momentum quantum number *(j)*, respectively. The so-called "allowed transitions" are the most likely radiative transitions during the relaxation process, whereas the so-called "forbidden transitions" are far less likely to occur. The selection rules that these transitions follow distinguish them from one another. For instance, the electric-dipole selection rules: $\Delta l = \pm 1$, forbid a radiative K–L_1 transition. However, due to higher multipoles, the K–L_1 radiative transition probability still exists and contributes to the L-shell vacancies. Contrary to the radiative transitions, where the energy is released as a photon, radiationless transitions are accompanied by electron emission, thus leading to the formation of an additional hole. In the IUPAC notation, these transitions are identified by indicating the subshells that contain the initial and final holes. For instance, the K-L_2M_1 transition corresponds to the decay of an initial hole in the K shell to the L_2 subshell accompanied by the emission of an M_1 electron.

Nelson *et al.* (1970) published a table of “Best” K X-ray emission rate ratios (Kβ/Kα, $K\beta'_2/K\alpha_1$, $K\beta'_1/K\alpha_1$, $(K\beta_1+K\beta_3)/K\alpha_1$, $K\beta_3/K\beta_1$, and $K\alpha_2/K\alpha_1$). Their values were obtained using smooth curves through the experimental data plotted against the atomic number $20 \leq Z \leq 100$. Salem *et al.* (1974) used least-squares fits to the available experimental points plotted as a function of atomic number *Z*, obtaining the “most probable” values of K X-ray emission ratios (Kβ/Kα, $K\beta_3/K\beta'_1$, $K\beta_5/K\alpha_1$, $K\beta_4/K\alpha_1$, $K\beta'_2/K\alpha_1$, $K\beta_1/K\alpha_1$, $K\alpha_3/K\alpha_1$, and $K\alpha_2/K\alpha_1$) for elements $12 \leq Z \leq 100$. In the same year, Scofield (1974) performed a relativistic Hartree–Slater calculation of the K X-ray emission rates and ratios (Kβ/Kα, $K\alpha_2/K\alpha_1$, $K\beta_3/K\beta_1$, $K\beta'_1/K\alpha_1$, $K\beta'_2/K\alpha_1$, $K\alpha_3/K\alpha_1$, $K\beta_1/K\alpha_1$, $K\beta_2/K\beta_1$ and $K\beta_5/K\beta_1$) for elements Z = 5 to 104. Khan and Karimi (1980) reviewed experimental Kβ/Kα intensity ratios obtained from ionization by protons, deuterons, heliums, oxygens, electrons, photons, and internal conversion. In their work (sometimes referred to as the 1974 data review) they gathered all the available data published from 1972 to 1975 for elements with $12 \leq Z \leq 63$ (214 values were regrouped in their table). They also included in their survey the most probable Kβ/Kα intensity ratios by making use of the analytical function Kβ/Kα = $a_0 + \sum_{i=1}^{9} a_i Z^i$. Sieber *et al*. (1992) collected experimental and theoretical radiative transition-rate ratios (Kβ/Kα, $K\alpha_2/K\alpha_1$, $K\alpha_3/K\alpha_1$ and $K\beta_1/K\alpha_1$) in a graphical representation as a function of atomic number *Z*. Kahoul *et al.* (2014) surveyed the measured Kβ/Kα intensity ratio values published in the period from 1980 to 2011, for elements in the range $16 \leq Z \leq 92$ (41 papers and 369 values). The paper also presents new semi-empirical and empirical intensity ratios by using an analytical function that fits the weighted- and unweighted-mean values of the experimental data in terms of the atomic number ($\bar{S} = \sum_{n=0}^{3} a_n Z^n$ and $\bar{R} = \sum_{n=0}^{3} b_n Z^n$, respectively).

Finally, in 2020 Daoudi *et al.* (2020) presented a substantial compilation of the measured Kβ/Kα intensity ratios for $11 \leq Z \leq 96$, published from 1969 to 2018 (127 papers and 1118 values). Using weighted average values $(\mathrm{K\beta/K\alpha})_{\mathrm{W}}$ and an empirical tenth order polynomial for the interpolation: Kβ/Kα = $\sum_{i=1}^{10} a_i\, Z^i$, they were able to suggest recommended weighted values that to guide the calculation of new empirical and semi-empirical data.

Thus, so far, researchers have used numerous experimental procedures and a wide variety of experimental conditions to study Kβ/Ka intensity ratios. For this ratio, over a thousand of measured data points can be found in the literature. To harvest the valuable and essential information from this immense number of data, an extensive analysis is required. In this work, about 1000 additional Kβ/Kα X-ray intensity ratios values published from 1969 to 2020 have been added to over 1100 values collected previously by our group (Daoudi *et al.,* 2020), thus constituting a new database of 2122 values for elements with $11 \leq Z \leq 96$. Firstly, corrections to several tabulated values in (Daoudi *et al.*, 2020) are given in the present work. After that, following thorough data analysis, weighted average values for each element have been determined. The weighted average reported along with the internal standard error represents a preliminary attempt to summarize the elemental data with two numbers. The approach relies on the experimental values being reported fairly in the original papers, which emerges as an evident concern. Moreover, in the present work new semi-empirical average Kβ/Kα X-ray intensity ratios for elements in the same range have been calculated, as well as new theoretical calculations using the multiconfiguration Dirac-Fock method (MCFD) for a few elements.

2. Erratum to "Review of experimental photon-induced Kβ/Kα intensity ratios" [At. Data Nucl. Data Tables 132 (2020) 101308]

In the original paper (Daoudi *et al.,* 2020) we found an error in Table 1 and Table 2 related to the determination of the standard deviation on the experimental Kβ/Kα X-ray intensity ratios for elements with $11 \leq Z \leq 96$, which impacts the calculation of the weighted average values (fourth column in Table 1) and also on the recommended weighted average values (fourth column in Table 2). In the present work in order to create the erratum, we have followed the data selection and analysis methods of (Daoudi *et al.*, 2020) but corrected the numerical implementation. The corrected values presented in Table 2 (given in boldface in the second column) and Table A (Appendix) supersede the values published in Table 1 and Table 2 of (Daoudi *et al.*, 2020), whereas the values listed in Table 2 (of this paper) which are not in bold are those of (Daoudi *et al.*, 2020) which did not require correction. Finally, the values in italics (Table 2 of this work) are those that we have added in this article. It should be emphasized that the data compiled in this work (Table 2) can be summarized in five categories:

1) Kβ/Kα X-ray intensity ratios are given and their corresponding uncertainties (standard deviation Δ(Kβ/Kα)) are reported as a percentage (p%) in the text (Hansen *et al.*, 1970b; Salem *et al.*, 1972; Slivinsky and Ebert, 1972b; Wilson *et al.*, 1977; Möser, 1985; Braziewicz *et al.*, 1986; Campbell *et al.*, 1986; Mehta *et al.*, 1986; Coelho *et al.*, 1989; LaBrecque and Rosales, 1990; Stoev and Dlouhy, 1993; Hajivaliei *et al.*, 2000; Ximeng *et al.*, 2001; Ximeng *et al.*, 2003; Cengiz *et al.*, 2008; Cengiz *et al.*, 2010b; Han and Demir, 2010b; Cengiz *et al.*, 2011; Onder *et al.*, 2013; Kaçal *et al.*, 2015; Özdemir *et al.*, 2016; and Singh *et al.*, 2018). In this case, the (absolute) standard deviation Δ(Kβ/Kα) is calculated:

$$\Delta\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right) = 0.01 \times (p\%) \times \frac{\mathrm{K\beta}}{\mathrm{K\alpha}} \tag{1}$$

2) Partial intensities and their corresponding uncertainties are given: $\mathrm{K\beta}_i \pm \Delta(\mathrm{K\beta}_i)$ for $i = 1\ to\ 5$ and $\mathrm{K\alpha}_j \pm \Delta(\mathrm{K\alpha}_j)$ for $j = 1\ to\ 2$ (de Pinho, 1971; McCrary *et al.*, 1971; Schmidt-Ott and Fink, 1972; Mehta *et al.*, 1987a; Chand *et al.*, 1988; Chand *et al.*,

1989; Dasmahapatra and Mukherjee, 1995; and Hatzistergos and Lifshi, 2006). In these instances, the sought after ratio is calculated as follows:

$$\frac{K\beta}{K\alpha} = \frac{\sum_i^5 K\beta_i}{\sum_j^2 K\alpha_j} \tag{2}$$

The standard deviation on the ratio is estimated according to the propagation of variance by the following expression:

$$\Delta\left(\frac{K\beta}{K\alpha}\right) = \frac{K\beta}{K\alpha} \times \sqrt{\left(\frac{\Delta(K\beta)}{K\beta}\right)^2 + \left(\frac{\Delta(K\alpha)}{K\alpha}\right)^2} \tag{3}$$

$$= \frac{K\beta}{K\alpha} \times \sqrt{\frac{\sum_i^5\left((\Delta\left(K\beta_i\right))^2\right)}{(\sum K\beta_i)^2} + \frac{\sum_j^2\left((\Delta\left(K\alpha_j\right))^2\right)}{\left(\sum K\alpha_j\right)^2}} \tag{4}$$

3) Kα/Kβ X-ray intensity ratios and their corresponding uncertainties Δ(Kα/Kβ) are given in the text of the reporting paper (Richard *et al.*, 1970; Mistry and Quarles, 1971a; Mistry and Quarles, 1971b; Bissinger *et al.*, 1972; Mohler and Cothern, 1973; Lear and gray, 1973; Criswell and Gray, 1974; Berényi *et al.*, 1978; and Keith and Loomis, 1978). In which case the ratio Kβ/Kα is calculated this way:

$$\frac{K\beta}{K\alpha} = \frac{1}{\frac{K\alpha}{K\beta}} \tag{5}$$

And the associated standard deviation on the ratio Δ(Kβ/Kα) is calculated using this formula:

$$\Delta\left(\frac{K\beta}{K\alpha}\right) = \Delta\left(\frac{1}{\frac{K\alpha}{K\beta}}\right) = \frac{\Delta\left(\frac{K\alpha}{K\beta}\right)}{\left(\frac{K\alpha}{K\beta}\right)^2} \tag{6}$$

4) Kα/Kβ X-ray intensity ratios are given by the reporting authors and their corresponding uncertainties are mentioned as a percentage (p%) in the text (Slivinsky

and Ebert, 1969; Close *et al.*, 1973; and Tawara *et al.*, 1975). So, the standard deviation on the ratio Δ(Kβ/Kα) is calculated using equation (6):

$$\Delta\left(\frac{K\beta}{K\alpha}\right) = \frac{0.01 \times (p\%) \times \frac{K\alpha}{K\beta}}{\left(\frac{K\alpha}{K\beta}\right)^2} = \frac{0.01 \times (p\%)}{\left(\frac{K\alpha}{K\beta}\right)} \quad (7)$$

where Δ(Kα/Kβ) is calculated according to equation (8):

$$\Delta\left(\frac{K\alpha}{K\beta}\right) = 0.01 \times (p\%) \times \frac{K\alpha}{K\beta} \quad (8)$$

5) As for the rest of the articles reviewed, the uncertainties (standard deviations) Δ(Kβ/Kα)) of the Kβ/Kα X-ray intensity ratios are mentioned directly in the text (154 papers) and can be immediately adopted.

In addition, we took the opportunity to correct some peculiarities between Table 1 and Table 2 of (Daoudi *et al.,* 2020).

3. Survey of the experimental works

In Table 1 we present an extensive survey of the Kβ/Kα intensity ratio measurements, published between 1969 and 2020, performed with a variety of experimental methods and under various conditions. This table contains a list of the atomic parameters for elements from $_{11}$Na to $_{96}$Cm and the references from where they were obtained, in addition to the excitation sources used, the target samples involved, and the X-ray spectrometers.

Concerning the excitation sources, they can either be charged particles or photons. Among charged particles we find proton beams with different energies, alpha particles, deuterons, and electrons. As for photon sources, the 59.5 keV γ-rays emitted from a ^{241}Am radioactive source are often used where energetically possible, but the 122 keV γ-rays from a ^{57}Co radioactive source, and the 22.69 keV X-rays from a ^{109}Cd radioactive source are also popular choices.

Many other radioactive sources can also be found. Regarding the target samples, they might either be pure elements, alloys, or compounds. One can find these targets in the form of powder samples, foils, pellets, or circular discs. As for measuring the X-ray emissions, a variety of detectors are utilized, the most widely used being single crystal semiconductors, such as Si(Li) detectors, with a resolution that varies according to the maker and model, or Ge(Li) detectors. Ge(Li) spectrometers were later replaced by high purity germanium (HPGe) detectors with much better resolution. More recently, we found the Ultra-LEGe detector, which offers reduced attenuation correction.

It is worth noting that some of the authors cited in this table (de Pinho, 1971; McCrary *et al.,* 1971; Mehta *et al.,* 1986; Mehta *et al.,* 1987a; Mehta *et al.,* 1987b; Chand *et al.,* 1988; Chand *et al.,* 1989; Stoev and Dlouhy, 1993; Dasmahapatra and Mukherjee, 1995; Castellano *et al.,* 2002; Perino *et al.,* 2002; Hatzistergos and Lifshi, 2006; Gójska *et al.,* 2020) have not calculated the parameter Kβ/Kα themselves. Nevertheless, we have been able to determine the value of Kβ/Kα from other results mentioned in their work.

4. Data analysis

The collected Kβ/Kα intensity ratio values have been gathered from the cited papers and are presented in a four-digit format with related measurement errors estimated at the standard deviation level. Table 2 summarizes the compiled database of these Kβ/Kα intensity ratios for elements with $11 \leq Z \leq 96$, as well as the references from where they were obtained and the weighted average values. It should be noted that the cited experimental values reported without uncertainties were excluded from the calculation of the weighted average values $(K\beta/K\alpha)_W$. Otherwise, all data were included, which is a departure from (Daoudi *et al.,* 2020), who rejected data outside a reasonably broad band of ±10 % about the weighted mean. The formula used to calculate the weighted average values in the present work is:

$$(\mathrm{K\beta/K\alpha})_{\mathrm{W}} \pm \varepsilon = \frac{1}{\sum_{i=1}^{N} \frac{1}{\left(\Delta\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{EXP}-i}\right)^2}} \cdot \sum_{i=1}^{N} \frac{\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{EXP}-i}}{\left(\Delta\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{EXP}-i}\right)^2} \pm \frac{1}{\left(\sum_{i=1}^{N} \frac{1}{\left(\Delta\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{EXP}-i}\right)^2}\right)^{\frac{1}{2}}} \quad (9)$$

In Eq.1, $(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}-i}$ represents the i^{th} experimental value, $\Delta(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}-i}$ is the assigned uncertainty (standard deviation) of the i^{th} experimental value, and *N* indicates the number of experimental data points for the element. The overall error estimate obtained using (9) is the internal standard deviation and relies on the experimentally reported uncertainty estimates being reasonably estimated. Before going any further, two important points must be remembered:

- As previously stated, Table 2 contains a total of 2122 Kβ/Kα intensity ratio measurements, 1118 among them having been previously gathered by our group (Daoudi *et al.,* 2020), whereas 1004 new values (given in italics) have been added in this work. Recall that in (Daoudi *et al.,* 2020) the sources were exclusively radiative (photon impact). In contrast, in the current work, the sources analyzed were both photons and charged particles (protons, deuterons, alpha particles and electrons).
- In Table 2, data in bold are those of Daoudi *et al.* (2020) that we have rectified in this work, while the values that didn't need to be corrected are those that aren't bolded.

Figure 2 gives the distribution of the number of data points according to the target atomic number *Z*. The high number of collected data (2122), along with the various experimental methods and conditions, result in a significant spread of experimental data for some elements. However, we should present general observations (see Fig. 2):

- Except for a few examples with no data ($_{84}$Po, $_{85}$At, $_{87}$Fr, $_{89}$Np, $_{91}$Am, $_{93}$Np and $_{95}$Am), all targets from $_{11}$Na to $_{96}$Cm are covered.

- For some elements there is only a single value ($_{61}$Pm and $_{88}$Ra), and for others only two values ($_{11}$Na, $_{12}$Mg, $_{13}$Al, $_{18}$Ar, $_{94}$Pu and $_{96}$Cm).
- The number of measurements for the following elements is between three and ten, $_{16}$S, $_{17}$Cl, $_{19}$K, $_{31}$Ga, $_{36}$Kr, $_{43}$Tc, $_{54}$Xe, $_{69}$Tm, $_{71}$Lu, $_{72}$Hf, $_{75}$Re, $_{76}$Os, $_{77}$Ir, $_{78}$Pt, $_{80}$Hg, $_{81}$Tl, $_{83}$Bi, $_{86}$Rn, $_{90}$Th and $_{92}$U.
- Metallic elements and medium-*Z* targets represent most of the measurements. Nine elements with $22 \leq Z \leq 30$ account for 37.9% of the total number of experimental values. Nickel ($_{28}$Ni) and copper ($_{29}$Cu) are the more frequently measured materials; these two elements alone account for 11.5% of all data values (with 117 and 126 experimental values, respectively).
- The lanthanides ($57 \leq Z \leq 71$) are generally well reported with between seven and fifty experimental values per element apart from $_{61}$Pm which have only one reported value.
- It is correct to conclude that the Kβ/Kα intensity ratio values for the rest of the elements are fairly well covered.

We have been able to establish a database that regroups 2122 values for Kβ/Kα intensity ratios, Fig. 3 shows a histogram of the number of experimental values reported between 1969 and 2020, sorted by the original work's publication year.

The average number of experimental Kβ/Kα intensity ratio measurements per year in the first decade after 1969 was 57.5 values. 64.5% of these values were published in the years 1972, 1974 and 1977. The number of data points was at its peak (177 values) in 1977; however, no data have been published in 1979. From 1980 to 2000, the total number of data points that were published was 407 (with an average of 19.4 per year), which is a relatively low number; in fact, no value has been published in 1982–1984 and 1991. Nevertheless, throughout the last two decades, a significant increase in the number of measurements was observed (approximately 52% of all published values). This increase reached a peak (175 values) in 2007, owing mainly to the work of Ertuğral *et al.* 2007 (59 values).

After using Eq. (1) to calculate the weighted average value $(\mathrm{K\beta/K\alpha})_{\mathrm{W}}$ for all elements (last column in Table 2), we calculated the ratio of the experimental Kβ to Kα intensity ratios with respect to the corresponding weighted average value for each element: $\mathrm{S} = \frac{(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}}}{(\mathrm{K\beta/K\alpha})_{\mathrm{W}}}$, then we plotted the ratio S against the atomic number *Z*, as shown in Fig. 4(a) and Fig. 4(b). It is noteworthy that some $(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}}$ values show an unexpectedly large disparity in comparison to the weighted values, especially the value of Khelil and Gray (1975) for the $_{56}$Ba and the value of Baydaş *et al.* (2003) for the $_{28}$Ni, where the ratio S is located outside the range [0.7–1.3]. Furthermore, the ratio S of the values of Wilson *et al*. (1977) for *Z*=41, 42, 45, 55, and those of Baydaş *et al*. (2003) for *Z*=22-27 and *Z*=29 is located outside the range [0.8–1.2], along with a few other values (Salem *et al*., 1972; Ximeng *et al*., 2001; Castellano *et al*., 2002; Porikli and Kurucu, 2008b; Porikli and Kurucu, 2011a; and Demir and Şahin, 2013). This large absolute dispersion is, in part, a result of the considerable number of experimental values published for those elements. However, it is clear that the majority of the values of the ratio S lie close to unity (between 0.9 and 1.1) as would be expected given the performance capability of high-resolution X-ray spectroscopy.

A natural way to visually present the deviation of the individual experimental points from the corresponding weighted mean for the element is to plot the signed deviation in multiples of the combined standard deviation defined by equation (10).

$$z_i = \frac{\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{EXP}-i} - \left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{W}}}{\sqrt{\left(\Delta\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{EXP}-i}\right)^2 + \left(\Delta\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{W}}\right)^2}} \qquad (10)$$

where $(K\beta/K\alpha)_{EXP\text{-}i}$ and $(K\beta/K\alpha)_W$ refer to the i^{th}-experimental and corresponding elemental weighted average Kβ/Kα intensity ratio, respectively, and $\Delta(K\beta/K\alpha)_{EXP\text{-}i}$ and $\Delta(K\beta/K\alpha)_W$ are the associated asserted standard deviations.

The average z-score is defined by:

$$\bar{z} = \frac{\sum_{i=1}^{n} z_i}{n} \quad (11)$$

where n indicates the number of experimental points for each element.

The distribution of equations (10) and (11) according to the atomic number *Z* are represented in Fig. 5. The examination of this figure exhibits a scatter far more significant than expected based on the reported experimental uncertainties of some of the atomic elements, mainly in the range $22 \leq Z \leq 30$ (Bodart et al., 1975; Möser, 1985; Bhuinya and Padhi, 1993; Baydaş et al., 2003; Singh et al., 2018; Chang *et al.,* 1994; Yalçin, 2007; Küçükönder et al., 1993a, 1993b; Rao et al., 1987, Stoev and Dlouhy, 1993; and Han et al., 2007), where z varies between: -20.6 (Yalçin, 2007) to 15.6 (Bhuinya and Padhi, 1993), suggesting that the uncertainties reported by the experimenters may not be estimated in a self-consistent way, may be underreported and may contain unrecognized error contributions, the most outlying point being ~34 for V-metal (Chang *et al.*, 1994). Such a significant value would have a minuscule probability of being observed if the uncertainty assessments were reasonable. In fact, a thorough reading of this article shows that the Kb/Ka-value reported for V-metal is biased and that the reported uncertainty is underestimated since the correction for the relative efficiency of the detector and differential air attenuation has not been applied. However, many of the experiments are only briefly described and pay scant attention to the uncertainty quantification. In conclusion, what can be deduced from Fig. 5 is that future high-quality experimental data, accompanied by a detailed description and thorough uncertainty analysis, are needed to help resolve discrepancies and improve the quality of the experimental guidance. The present work is a preliminary step to enabling a comprehensive evaluation. Workers interested in a particular element can follow the references provided to the original papers.

5. Semi-empirical calculation

Many attempts have been made to calculate the Kβ/Kα intensity ratio, whether theoretically or by using empirical and semi-empirical formulae (fitting the experimental values using various functional forms). Among the authors who used semi-empirical calculations, we find Nelson *et al*. (1970), Khan and Karimi (1980), Kahoul *et al*. (2014), and Daoudi *et al.* (2020). In our work, the method used to deduce the empirical Kβ/Kα intensity ratios was the one proposed by Kup Aylikci *et al*. (2011), and Kahoul *et al*. (2014). Following that, we plotted the quantity $\left((K\beta/K\alpha)_W/\left(1-(K\beta/K\alpha)_W\right)\right)^{\frac{1}{4}}$ vs. *Z*, as shown in Fig. 6, where $(K\beta/K\alpha)_W$ is the weighted average value (last column in Table 2). Then, we have fitted those values by a seventh order polynomial as:

$$\left((K\beta/K\alpha)_W/\left(1-(K\beta/K\alpha)_W\right)\right)^{\frac{1}{4}} = \sum_{i=0}^{7} a_i Z^i = g(Z) \qquad (12)$$

Subsequently, we plotted the ratio S against the atomic number *Z*, and then fitted the points by a simple third-degree polynomial, as seen in Fig. 7:

$$S = \frac{(K\beta/K\alpha\,)_{EXP}}{(K\beta/K\alpha\,)_W} = \sum_{i=0}^{3} b_i Z^i = f(Z) \qquad (13)$$

It should be pointed out that, the data presented in Table 2 without error were also included in the fitting. From equations (12) and (13), the semi-empirical Kβ/Kα intensity ratio can be expressed as follows:

$$\left(\frac{\mathrm{K\beta}}{\mathrm{K\alpha}}\right)_{\mathrm{Semi-emp}} = \mathrm{f}(Z) \times \frac{\mathrm{g}(Z)^4}{1+\mathrm{g}(Z)^4} \tag{14}$$

Table 3 contains a list of the fitting parameters for both equations (12) and (13), whereas a summary of the semi-empirical calculations of Kβ/Kα intensity ratios for elements with $11 \leq Z \leq 96$ according to their target atomic numbers is presented in Table 4. In order to see visually the difference between the weighted average and semi-empirical Kβ/Kα intensity ratio values, they were plotted against the atomic number Z in Fig. 8. It is clear that the weighted average and semi-empirical values are in good accord with one another. Although, a deviation of 0.64% to 17% is observed in the region $17 \leq Z \leq 47$, but generally speaking, the two plots are in good agreement.

6. Relativistic calculations

For 21 elements we provide the Kβ/Kα intensity ratios calculated according to the multiconfiguration Dirac-Fock (MCDF) method. The intensity ratio is given by:

$$(\mathrm{K\alpha/K\beta}) = \frac{\sum_i (2J_i+1)\left[\sum_{j_3} W_{ij_3}^{\mathrm{R}}(\mathrm{KM_3}) + \sum_{j_4} W_{ij_4}^{\mathrm{R}}(\mathrm{KM_2}) + \sum_{j_5} W_{ij_5}^{\mathrm{R}}(\mathrm{KM_{45}})\right]}{\sum_i (2J_i+1)\,\omega_i\left[\sum_{j_1} W_{ij_1}^{\mathrm{R}}(\mathrm{KL_3}) + \sum_{j_2} W_{ij_2}^{\mathrm{R}}(\mathrm{KL_2})\right]} \tag{15}$$

where $W_{ij}^{\mathrm{R}}(KX)$ is the partial radiative transition rate for the emission line KX (X=L_2, L_3, M_2, M_3, M_{45}) and ω_i is the fluorescence yield of the atomic level i of the K-shell one-hole configuration with total angular momentum J_i. In general, there are many initial levels belonging to a single configuration and the fluorescence yields in the equation do not cancel since they are inside the summations. This means that we also need to calculate the Auger transitions to get the ω_i values. However, these vary very little in each configuration and do not affect the ratio of intensities. Thus, to a good approximation, we can write:

$$(\mathrm{K}\alpha/\mathrm{K}\beta) \approx \frac{\sum_i (2J_i+1)\left[\sum_{j_3} W^{\mathrm{R}}_{ij_3}(\mathrm{KM}_3) + \sum_{j_4} \mathrm{W}^{\mathrm{R}}_{ij_4}(\mathrm{KM}_2) + \sum_{j_5} \mathrm{W}^{\mathrm{R}}_{ij_5}(\mathrm{KM}_{45})\right]}{\sum_i (2J_i+1)\left[\sum_{j_1} W^{\mathrm{R}}_{ij_1}(\mathrm{KL}_3) + \sum_{j_2} W^{\mathrm{R}}_{ij_2}(\mathrm{KL}_2)\right]} \tag{16}$$

This expression simplifies our calculations since we only need the radiative transition rates. The level energies and the transition rates were calculated using the MCDFGME code developed by Desclaux and Indelicato (Desclaux, 1975; Gorceix *et al.,* 1987; Indelicato and Desclaux, 1990). The code solves the Dirac-Coulomb-Breit Hamiltonian, including QED corrections, by the self-consistent method, and some higher order terms perturbatively. The wave functions are calculated in single configuration approach with full relaxation. The radiative transition rates are calculated in the Babushkin (length) gauge. Further details can be found in (Sampaio *et al.,* 2022). Table 4 shows the semi-empirical Kβ/Kα intensity ratio values compared with the theoretical calculations, using the MCDF method for elements with 11≤ Z ≤ 96. It appears from this table that there is an excellent agreement between semi-empirical Kβ/Kα intensity ratios and theoretical calculations in the range of 11 ≤Z≤ 96. Both semi-empirical and theoretical values increase with the atomic number Z. However, starting from Z = 18 to Z = 30 the theoretical values deviate from the semi-empirical ones with a deviation that reaches a maximum of 11% for the $_{29}$Cu. It is thought that the disagreement in this region is due to the fact that that the uncertainties provided by the experimenters may contain several unacknowledged error contributions and may be underreported (as mentioned in more detail in the previous section), which may have led to an overestimation of the semi-empirical values within the mentioned atomic range.

6. Conclusion

More than 2100 experimental X-ray intensity ratios for elements with 11≤ Z ≤ 96 obtained from various sources published between 1969 and 2020 (196 papers) were reviewed and presented in a tabular form. About 1100 values had been gathered in a previous paper, whereas about 1000 values were added in the present study. Each element's weighted average value was calculated. In addition, new semi-empirical average Kβ/Kα X-ray intensity ratios were obtained for elements in the same range, while new theoretical calculations, using the multiconfiguration Dirac-Fock (MCDF) method, were accomplished for some elements and are reported in this paper. This work constitutes a massive database and a reliable archive for researchers in the field of atomic inner-shell ionization processes.

7. Acknowledgements

We gratefully acknowledge the support of the DGRSDT, Ministry of Higher Education and Scientific Research, Algeria. This work was done with the support of Mohamed El Bachir El Ibrahimi University, under project (PRFU) No: B00L02UN340120220001. This work was also supported by the Fundação para a Ciência e Tecnologia (FCT), Portugal through contracts UIDP/50007/2020 (LIP) and UID/FIS/04559/2020 (LIBPhys). S.C. warmly acknowledges the financial support of Lancaster University, and A.F. gratefully acknowledges the support of the Joint Research Centre of the European Commission.

Figure caption:

Fig. 1. Correspondence between Siegbahn and IUPAC Notation for radiative transitions.

Fig. 2. Distribution of the experimental Kβ/Kα values according to the atomic number *Z*.

Fig. 3. Histogram of data for experimental Kβ/Kα intensity ratios. The vertical lines indicate the annual number of published intensity ratios as compiled in this work.

Fig. 4(a). The distribution of $(K\beta/K\alpha)_{EXP}/(K\beta/K\alpha)_{W}$ for each reference from which the databases are extracted according to the atomic number *Z* (from 1969 to 2002). ●: (Slivinsky and Ebert, 1969) ; ●: (Hansen *et al.,* 1970a) ; ●: (Hansen *et al.,* 1970b) ; ●: (Richard *et al.,* 1970) ; ●: (de Pinho, 1971) ; ○: (McCrary *et al.,* 1971) ; ○: (Mistry and Quarles, 1971a) ; ○: (Mistry and Quarles, 1971b) ; ⊖: (Bissinger *et al.,* 1972) ; ⊖: (Salem *et al.,* 1972) ; ⊖: (Schmidt-Ott and Fink, 1972) ; ⊖: (Schmidt-Ott *et al.,* 1972) ; ▲: (Slivinsky and Ebert, 1972a) ; ▲: (Slivinsky and Ebert, 1972b) ; ▲: (Close *et al.,* 1973) ; ▲: (Lear and Gray, 1973) ; ▲: (Mohler and Cothern, 1973) ; △: (Winters *et al.,* 1973) ; △: (Akselsson and Johansson, 1974) ; △: (Criswell and Gray, 1974) ; △: (Li and Watson, 1974) ; △: (Smith *et al.,* 1974) ; △: (Bodart *et al.,* 1975) ; △: (Khelil and Gray, 1975) ; △: (McDaniel *et al.,* 1975) ; ■: (Tawara *et al.,* 1975) ; ■: (Paić and Pečar, 1976) ; ■: (Deconninck and Longree, 1977) ; ■: (Wilson *et al.,* 1977) ; ■: (Berényi *et al.,* 1978) ; □: (Keith and Loomis, 1978) ; □: (Marques *et al.,* 1978) ; □: (Kamal *et al.,* 1980) ; □: (Marques *et al.,* 1980) ; ⊟: (Shearer-Izumi *et al.,* 1980) ; ⊟: (Dost *et al.,* 1981) ; ⊟: (Martins *et al.,* 1981) ; ⊟: (Casnati *et al.,* 1985) ; ▼: (Möser, 1985) ; ▼: (Braziewicz *et al.,* 1986) ; ▼: (Campbell *et al.,* 1986) ; ▼: (Kasagi *et al.,* 1986) ; ▼: (Mehta *et al.,* 1986) ; ▽: (Rao *et al.,* 1986) ; ▽: (Bhan *et al.,* 1987) ; ▽: (Borowski *et al.,* 1987) ; ▽: (Mehta *et al.,* 1987a) ; ▽: (Mehta *et al.,* 1987b) ; ▽: (Perujo *et al.,* 1987) ; ▽: (Rao *et al.,* 1987) ; ▽: (Chand *et al.,* 1988) ; ◀: (Tham and Preiss, 1988) ; ◀: (Chand *et al.,* 1989) ; ◀: (Coelho *et al.,* 1989) ; ◀: (Marchetti and Franck, 1989) ; ◀: (LaBrecque and Rosales, 1990) ; ◁: (Bhuinya and Padhi, 1992) ; ◁: (Bhuinya and Padhi, 1993) ; ◁: (Küçükönder *et al.,* 1993a) ; ◁: (Küçükönder *et al.,* 1993b) ; ◁: (Küçükönder *et al.,* 1993c) ; ◁: (Stoev and Dlouhy, 1993) ; ◁: (Büyükkasap *et al.,* 1994) ; ◁: (Chang *et al.,* 1994) ; ▶: (Dhal and Padhi, 1994) ; ▶: (Zararsiz, 1994) ; ▶: (Dasmahapatra and Mukherjee, 1995) ; ▶: (Padhi and Dhal, 1995) ; ▶: (Söğüt *et al.,* 1995) ; ▷: (Rebohle *et al.,* 1996) ; ▷: (Büyükkasap, 1997) ; ▷: (Ertuğrul *et al.,* 1997) ; ▷: (Bé *et al.,* 1998) ; ▷: (Durak and Özdemir, 1998) ; ▷: (Raj *et al.,* 1998b) ; ▷: (Raj *et al.,* 1998a) ; ▷: (Cipolla, 1999) ; ◆: (Raj *et al.,* 1999a) ; ◆: (Raj *et al.,* 1999b) ; ◆: (Raj *et al.,* 1999c) ; ◆: (Durak and Özdemir, 2000) ; ◆: (Hajivaliei *et al.,* 2000) ; ◇: (Pawłowski and Polasik, 2000) ; ◇: (Raj *et al.,* 2000a) ; ◇: (Raj *et al.,* 2000b) ; ◇: (Ertuğrul *et al.,* 2001a) ; ◇: (Ertuğrul *et al.,* 2001b) ; ◇: (Raj *et al.,* 2001) ; ◇: (Söğüt *et al.,* 2001) ; ◇: (Ximeng *et al.,* 2001) ; ⬢: (Castellano *et al.,* 2002) ; ⬢: (Çalışkan *et al.,* 2002) ; ⬢: (Ertuğrul, 2002a) ; ⬢: (Ertuğrul, 2002b) ; ⬢: (Ertuğrul, 2002c) ; ⬟: (Ertuğrul et al., 2002) ; ⬟: (İçelli and Erzeneoglu, 2002) ; ⬟: (Jonnard *et al.,* 2002) ; ⬟: (Pawłowski *et al.,* 2002) ; ⬟: (Perino *et al.,* 2002).

Fig. 4(b). The distribution of $(K\beta/K\alpha)_{EXP}/(K\beta/K\alpha)_{W}$ for each reference from which the databases are extracted according to the atomic number *Z* (from 2002 to 2020). ●: (Raj *et al.,*

2002) ; ●: (Söğüt *et al.*, 2002) ; ●: (Baydaş *et al.*, 2003) ; ●: (Ertuğrul, 2003) ; ●: (Ximeng *et al.*, 2003) ; ○: (Baydaş, 2005) ; ○: (Çevik *et al.*, 2005) ; ○: (Doğan and Bacaksiz, 2005) ; ⊖: (Şahin *et al.*, 2005) ; ⊖: (Bacaksiz *et al.*, 2006) ; ⊖: (Bennal and Badiger, 2006) ; ⊖: (Hatzistergos and Lifshi, 2006) ; ▲: (Öz, 2006) ; ▲: (Aylikci *et al.*, 2007) ; ▲: (Bennal and Badiger, 2007) ; ▲: (Çevik et al., 2007) ; ▲: (Demir and Şahin, 2007a) ; △: (Demir and Şahin, 2007b) ; △: (Ertuğral *et al.*, 2007) ; △: (Ertuğral, 2007) ; △: (Han *et al.*, 2007) ; ⧍: (Kalayci *et al.*, 2007) ; ⧍: (Kaya *et al.*, 2007) ; ⧍: (Yalçin, 2007) ; ⧍: (Apaydin *et al.*, 2008) ; ■: (Cengiz *et al.*, 2008) ; ■: (Han *et al.*, 2008) ; ■: (Porikli and Kurucu, 2008a) ; ■: (Porikli and Kurucu, 2008b) ; ■: (Porikli *et al.*, 2008) ; □: (Söğüt *et al.*, 2008) ; □: (Han and Demir, 2009) ; □: (Kup Aylikci *et al.*, 2009) ; □: (Bennal *et al.*, 2010) ; ⊟: (Cengiz et al., 2010a) ; ⊟: (Cengiz et al., 2010b) ; ⊟: (Han and Demir, 2010a) ; ⊟: (Han and Demir, 2010b) ; ▼: (Han and Demir, 2010c) ; ▼: (Han and Demir, 2010d) ; ▼: (Kup Aylikci et al., 2010a) ; ▼: (Kup Aylikci et al., 2010b) ; ▼: (Cengiz et al., 2011) ; ▽: (Kup Aylikci *et al.*, 2011) ; ▽: (Porikli and Kurucu, 2011a) ; ▽: (Porikli and Kurucu, 2011b) ; ▽: (Porikli et al., 2011) ; ⧨: (Saydam et al., 2012) ; ⧨: (Turşucu et al., 2012) ; ⧨: (Anand et al., 2013) ; ⧨: (Demir and Şahin, 2013) ; ◀: (Doğan et al., 2013) ; ◀: (Onder et al., 2013) ; ◀: (Sreevidya *et al.*, 2013) ; ◀: (Turşucu et al., 2013) ; ◀: (Turşucu and Demir, 2013) ; ◁: (Anand et al., 2014) ; ◁: (Cengiz et al., 2014) ; ◁: (Doğan et al., 2014b) ; ◁: (Doğan et al., 2014a) ; ◁: (George et al., 2014) ; ◁: (Sita Mahalakshmi et al., 2014) ; ▶: (Sreevidya *et al.*, 2014) ; ▶: (Akman *et al.*, 2015) ; ▶: (Aksoy *et al.*, 2015) ; ▶: (Anand et al., 2015) ; ▶: (Aylikci et al., 2015) ; ▷: (Kaçal et al., 2015) ; ▷: (Mirji et al., 2015a) ; ▷: (Mirji et al., 2015b) ; ▷: (Perişanoğlu and Demir, 2015) ; ▷: (Akman et al., 2016a) ; ▷: (Akman, 2016a) ; ▷: (Akman, 2016b) ; ◆: (Alim et al., 2016) ; ◆: (Doğan *et al.*, 2016) ; ◆: (Köksal *et al.*, 2016) ; ◆: (Özdemir et al., 2016) ; ◆: (Perişanoğlu et al., 2016) ; ◇: (Akkuş et al., 2017) ; ◇: (Cengiz *et al.*, 2017) ; ◇: (Kup Aylikci *et al.*, 2017) ; ◇: (Ménesguen *et al.*, 2017) ;◇: (Uğurlu *et al.*, 2017) ; ◇: (Yilmaz, 2017) ; ◇: (Anand et al., 2018) ; ◇: (Köksal *et al.*, 2018) ; ⬣: (Singh et al., 2018) ; ⬣: (Söğüt *et al.*, 2018) ; ⬣: (Yilmaz, 2018) ; ⬣: (Cengiz *et al.*, 2019) ; ⬣: (Uğurlu *et al.*, 2019) ; ⬟: (Uğurlu, 2019) ; ⬟: (Gójska *et al.*, 2020) ; ⬟: (Perişanoğlu *et al.*, 2020) ; ⬟: (Uğurlu and Demir, 2020).

Fig. 5. Distribution of equation (10) and (11) according to the atomic number Z.

Fig. 6. Distribution of $((K\beta/K\alpha)_W/(1-(K\beta/K\alpha)_W))^{\frac{1}{4}}$ as a function of the atomic number.

Fig. 7. Distribution of $(K\beta/K\alpha)_{EXP}/\ (K\beta/K\alpha)_W$ for each reference from which the databases are extracted according to the atomic number *Z* (from 1969 to 2020).

Fig. 8. Distribution of semi-empirical $(K\beta/K\alpha)_{Semi-emp}$ and weighted average $(K\beta/K\alpha)_W$ intensity ratio values against the atomic number *Z*.

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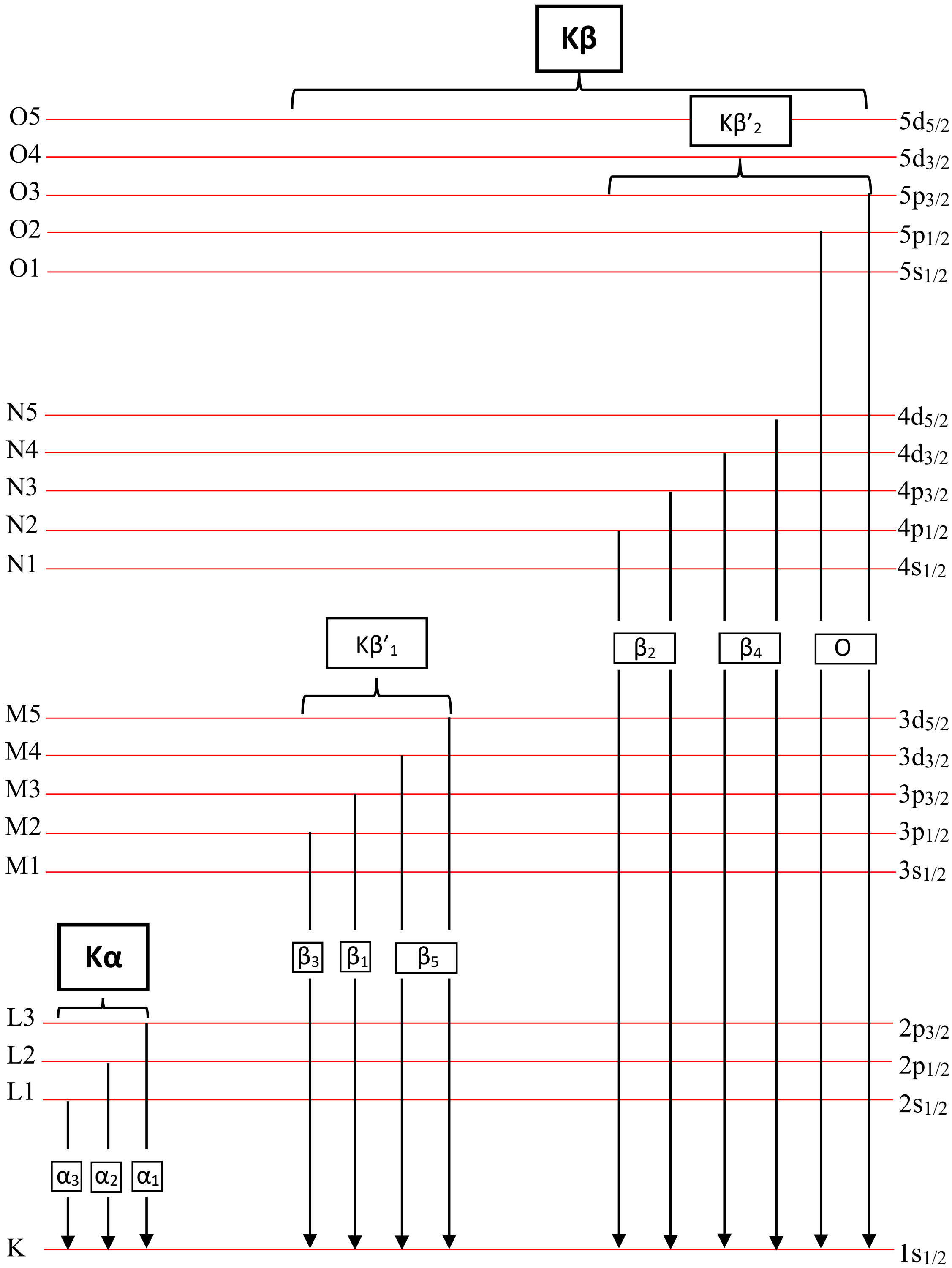
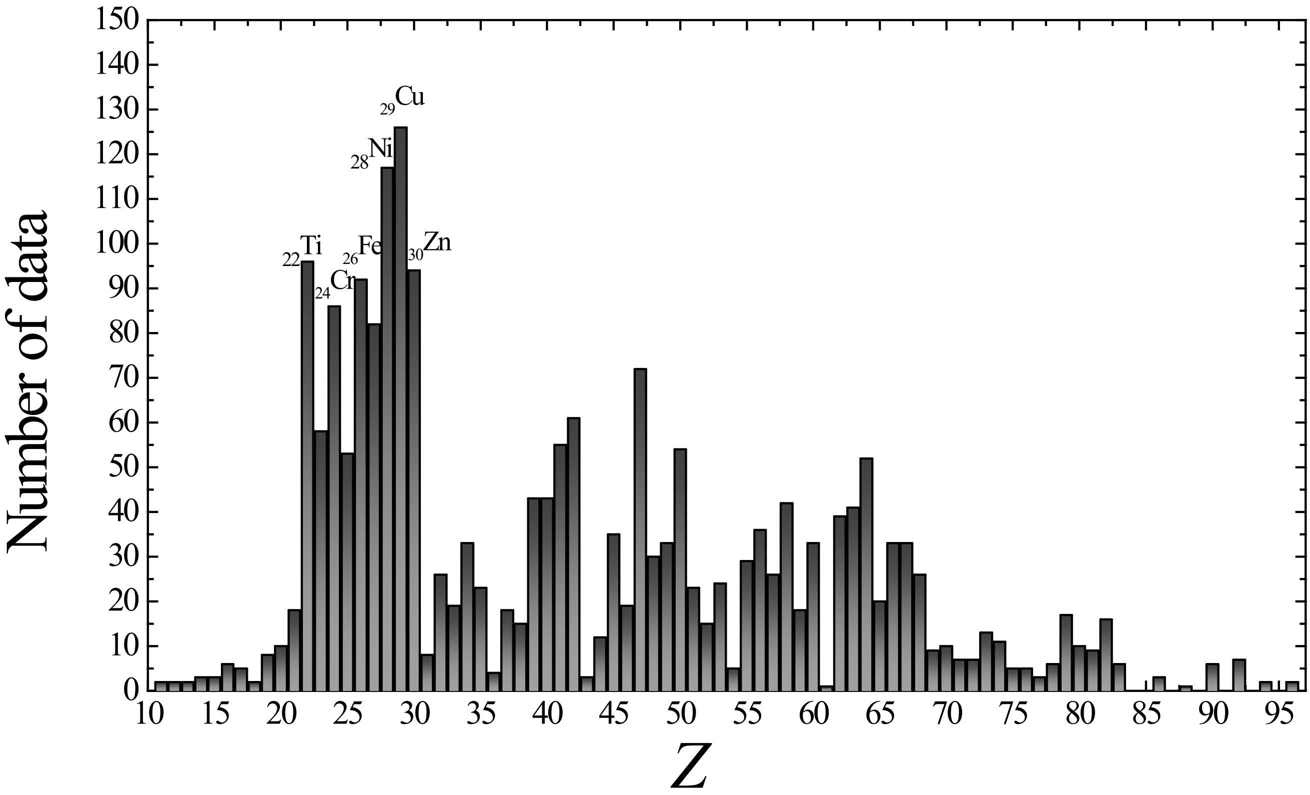


Kβ
Kβ'₂
O5
O4
O3
O2
O1
5d5/2
5d3/2
5p3/2
5p1/2
5s1/2
N5
N4
N3
N2
N1
4d5/2
4d3/2
4p3/2
4p1/2
4s1/2
Kβ'₁
β2
β4
O
M5
M4
M3
M2
M1
3d5/2
3d3/2
3p3/2
3p1/2
3s1/2
Kα
β3
β1
β5
L3
L2
L1
2p3/2
2p1/2
2s1/2
α3
α2
α1
K
1s1/2

Figure 1: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Z
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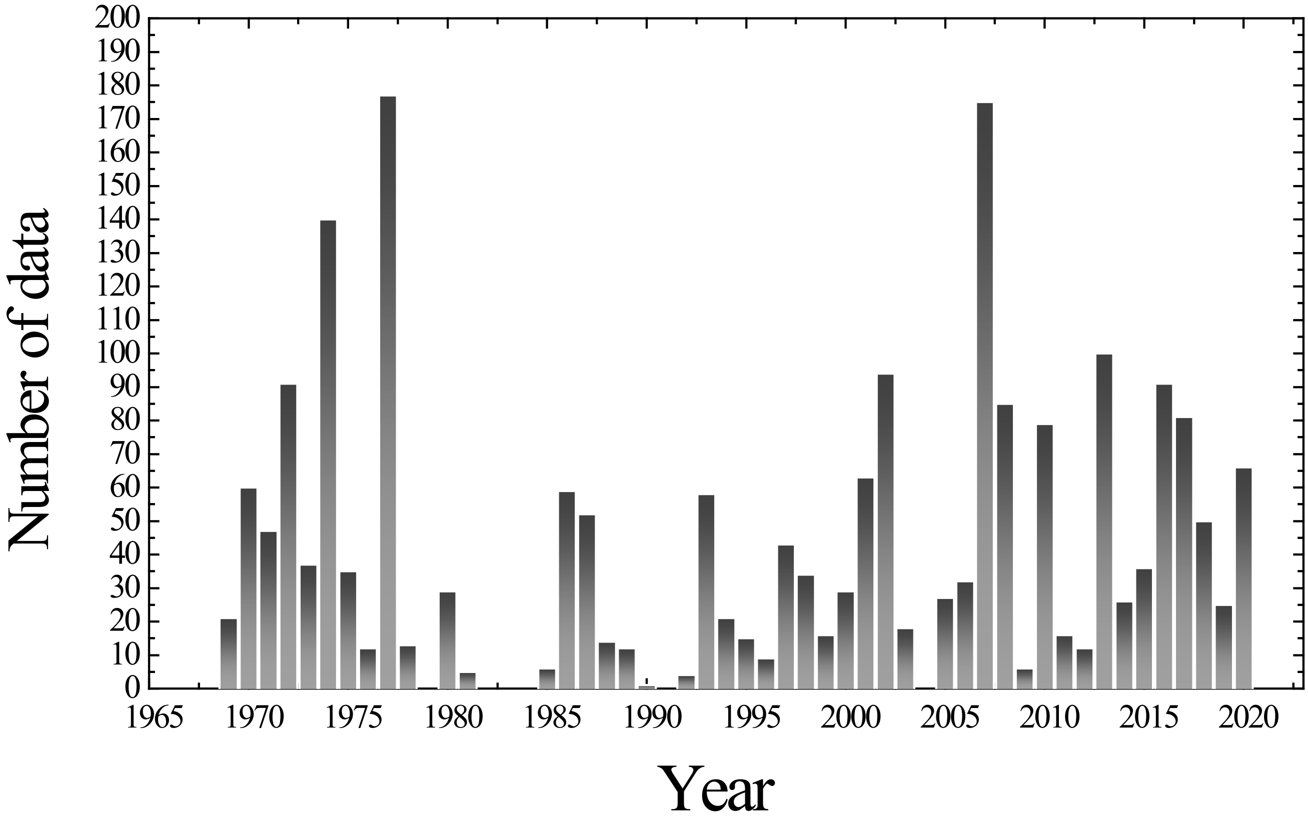
$_{26}$Fe
$_{28}$Ni
$_{29}$Cu
$_{30}$Zn
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95

Figure 2:


Number of data
Year
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70
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120
130
140
150
160
170
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190
200
1965
1970
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1980
1985
1990
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2000
2005
2010
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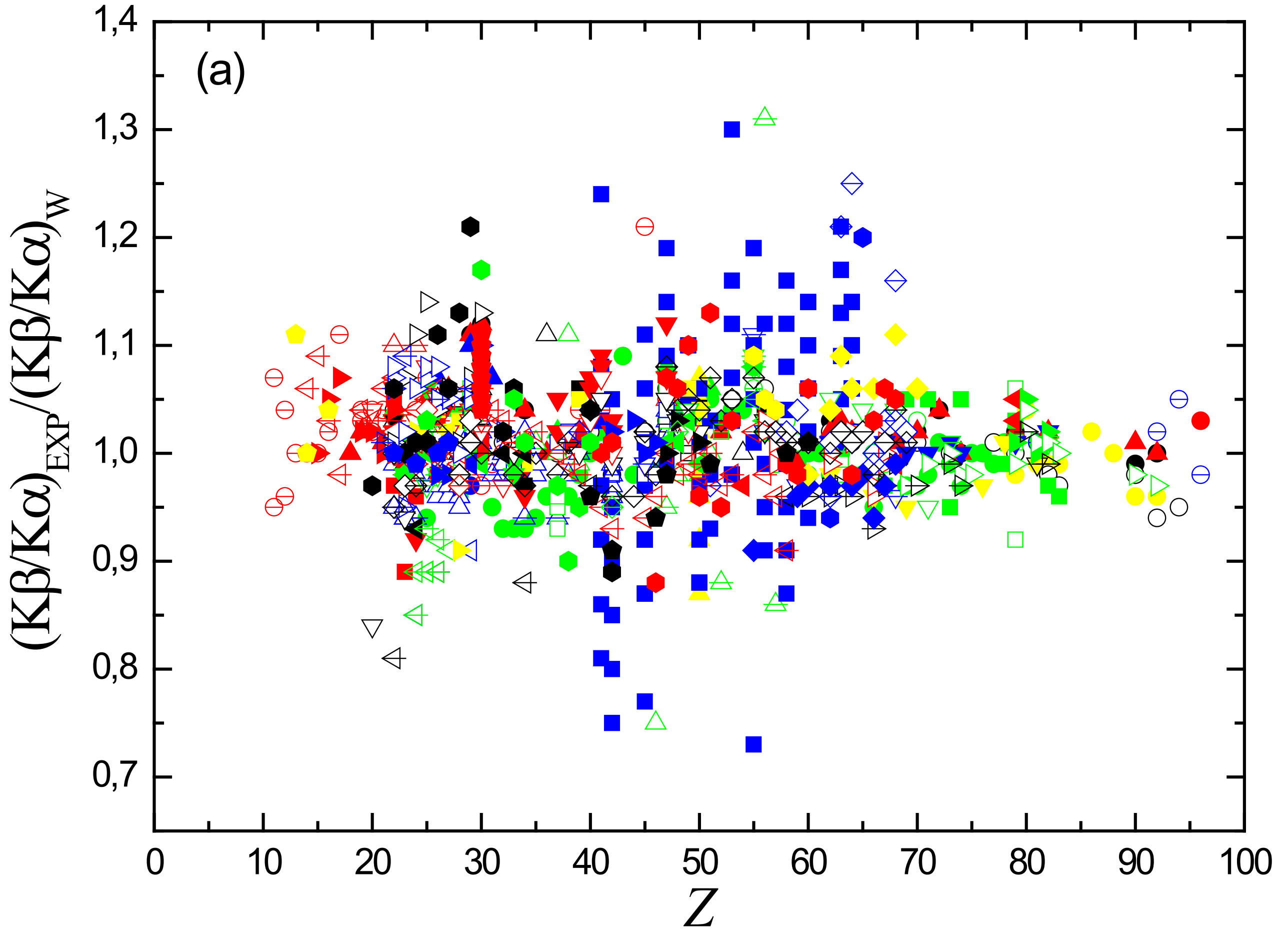
2020

Figure 3:



(a)
(Kβ/Kα)$_{EXP}$/(Kβ/Kα)$_W$
1,4
1,3
1,2
1,1
1,0
0,9
0,8
0,7
0
10
20
30
40
50
60
70
80
90
100
Z

Figure 4(a):

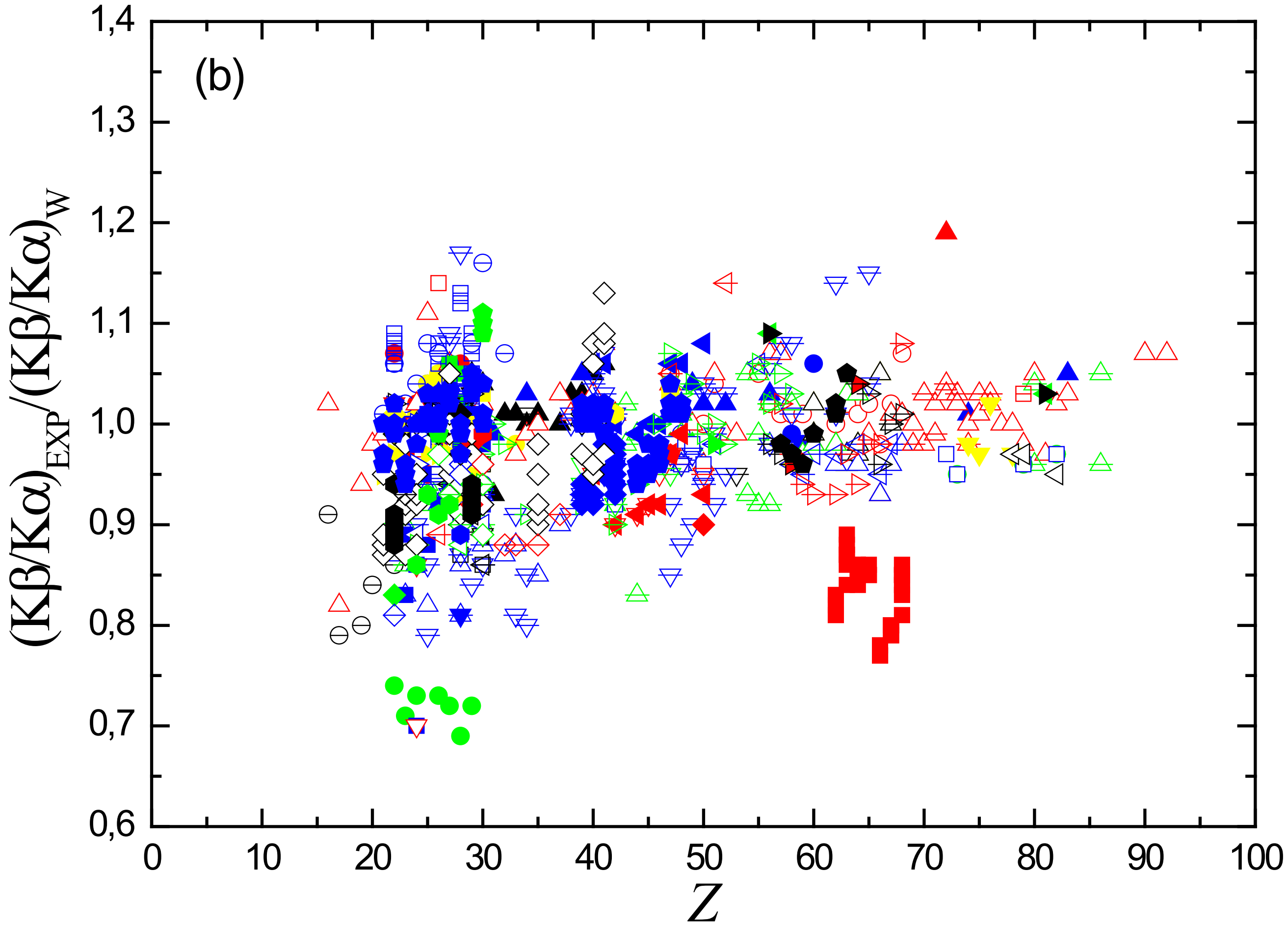
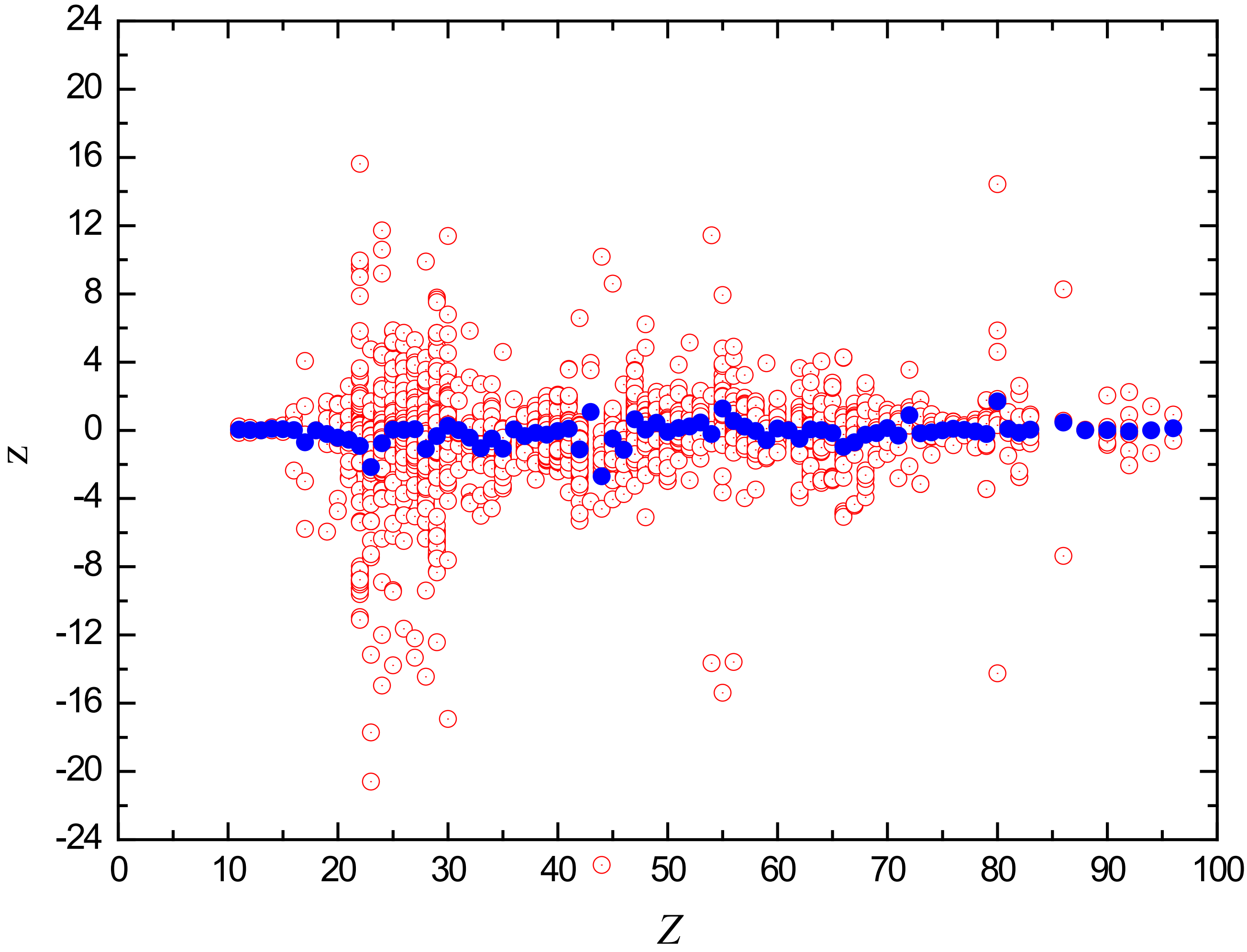

(b)
1,4
1,3
1,2
1,1
1,0
0,9
0,8
0,7
0,6
0
10
20
30
40
50
60
70
80
90
100
$(K\beta/K\alpha)_{EXP}/(K\beta/K\alpha)_W$
Z

Figure 4(b):



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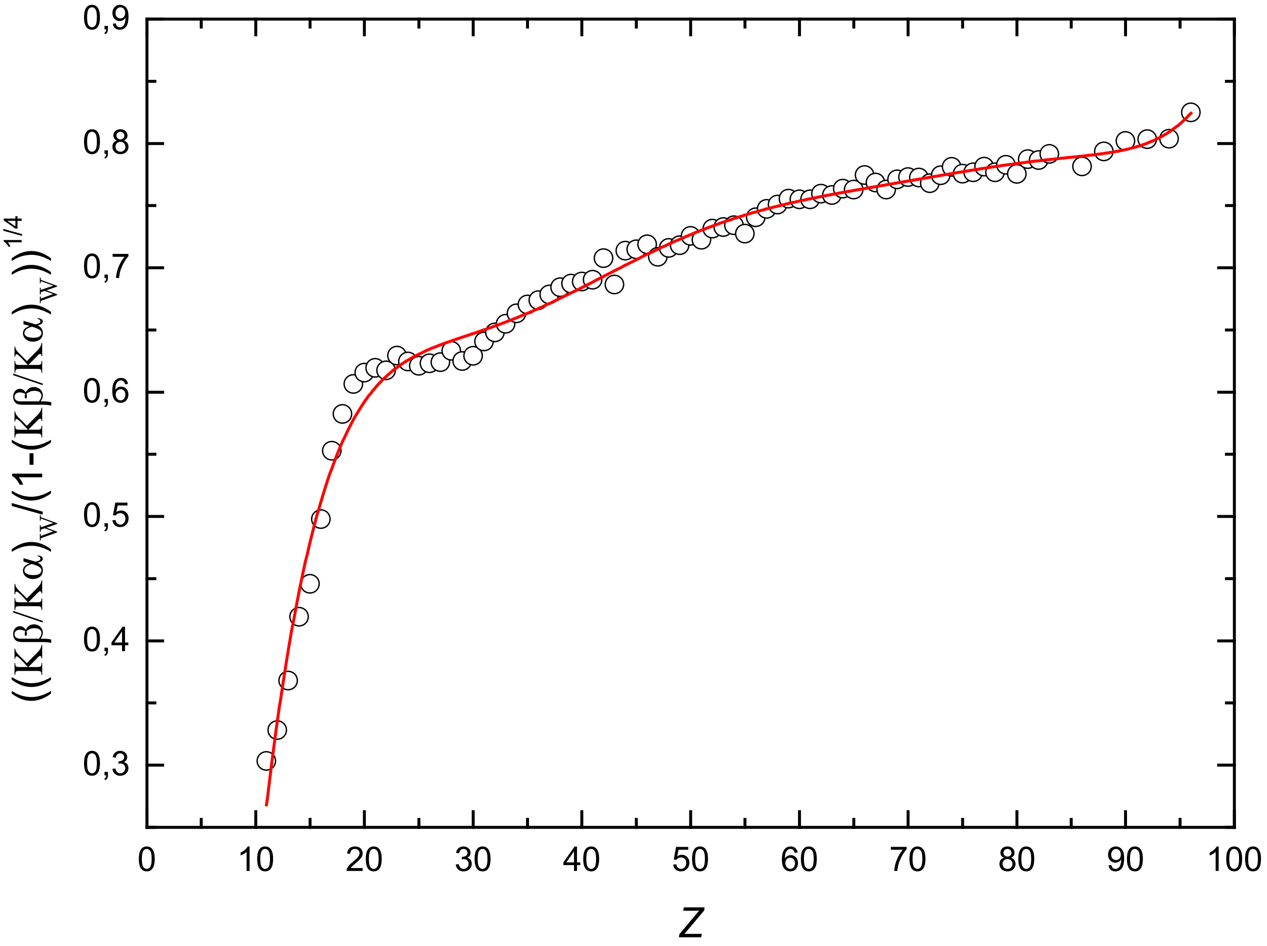

0,9
0,8
0,7
0,6
0,5
0,4
0,3
0
10
20
30
40
50
60
70
80
90
100
Z
$((K\beta/K\alpha)_W/(1-(K\beta/K\alpha)_W))^{1/4}$

Figure 6:

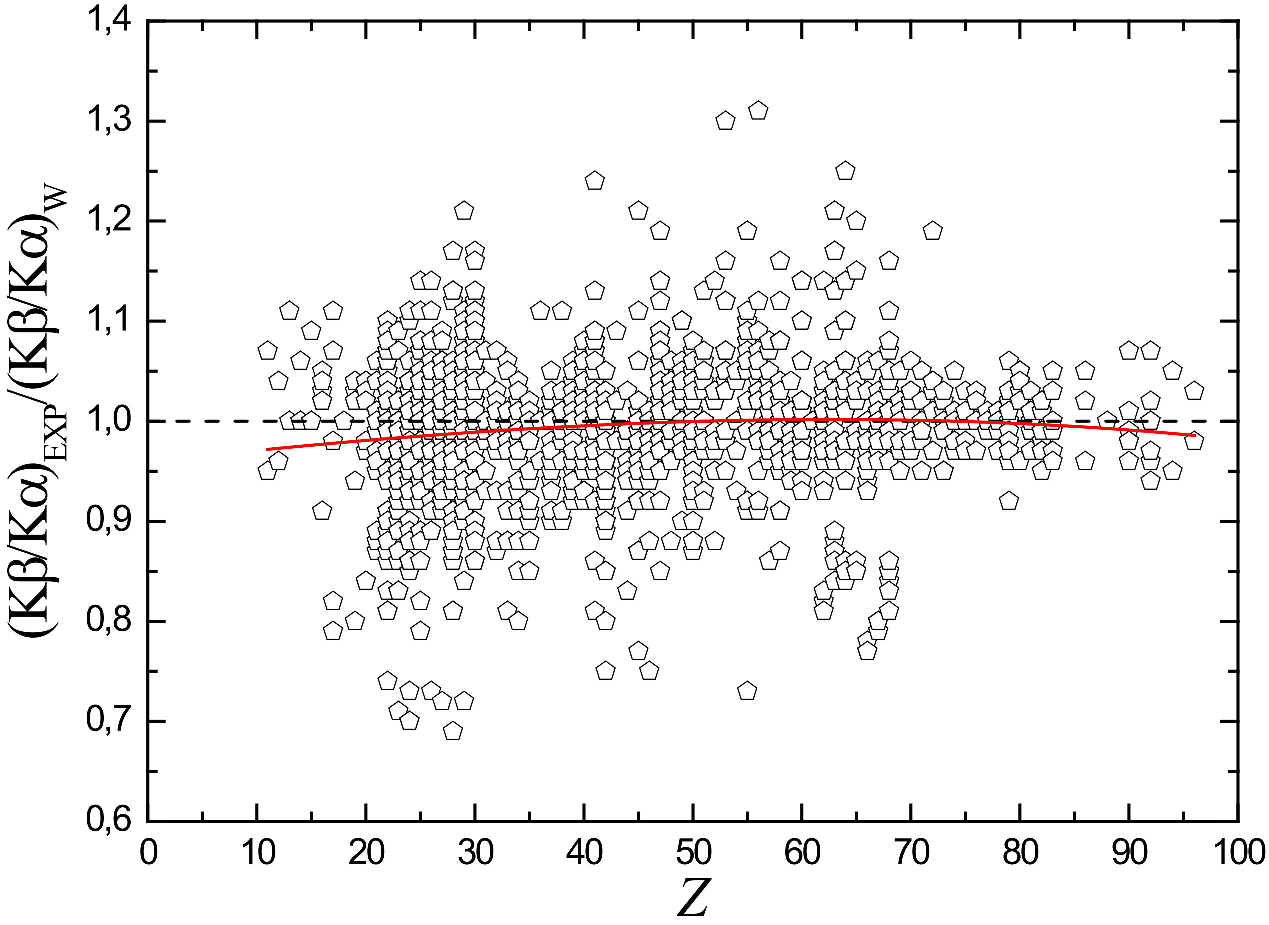
1,4
1,3
1,2
1,1
1,0
0,9
0,8
0,7
0,6
0
10
20
30
40
50
60
70
80
90
100
$(K\beta/K\alpha)_{EXP}/(K\beta/K\alpha)_{W}$
Z

Figure 7:

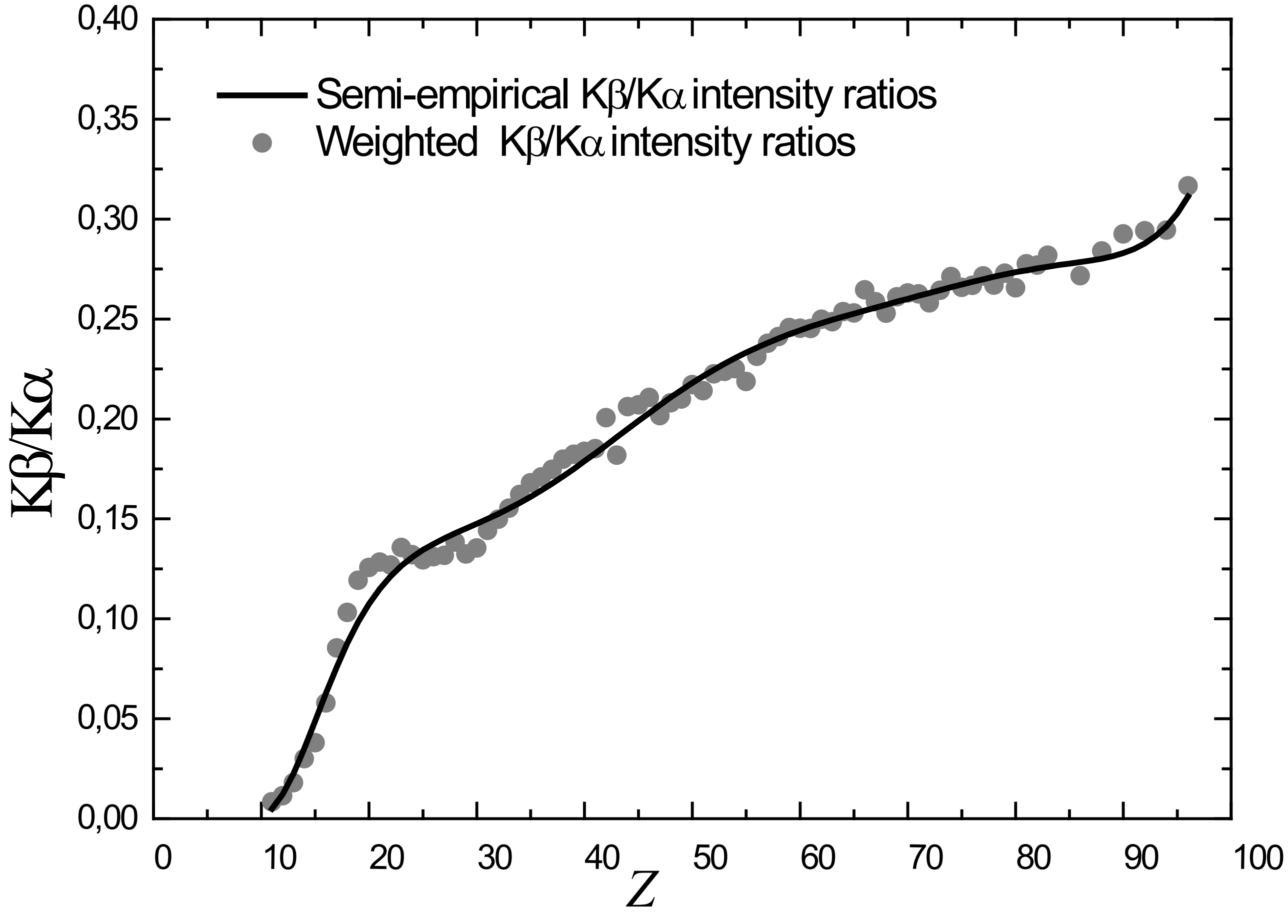
Semi-empirical Kβ/Kα intensity ratios
Weighted Kβ/Kα intensity ratios
Kβ/Kα
Z
0,00
0,05
0,10
0,15
0,20
0,25
0,30
0,35
0,40
0
10
20
30
40
50
60
70
80
90
100

Figure 8:

Explanation of Tables

Table 1. Summary of the atomic parameters for elements ranging from $_{11}$Na to $_{96}$Cm, the excitation sources, the target samples and the detectors. The references from which these data are obtained is also included.

References	References from which the data were extracted.
Atomic parameters	The atomic parameters available in the references.
Target samples	The target sample utilized during the measurement of the Kβ to Kα intensity ratios.
Excitation sources	The excitation sources used to bombard the samples.
Detectors	The detectors employed for the detection of the K-shell X rays.

Table 2. Summary of the experimental Kβ/Kα intensity ratios from $_{11}$Na to $_{96}$Cm according to their target atomic numbers. The ratio of the experimental Kβ/Kα intensity ratios with respect to the weighted average value: $\mathrm{S} = \frac{(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}}}{(\mathrm{K\beta/K\alpha})_{\mathrm{W}}}$, the weighted average values $(\mathrm{K\beta/K\alpha})_{\mathrm{W}}$ and the references from which the databases are extracted are also listed.

Z	Atomic number of the target element.
Symbol	Symbol of the target element.
$(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}-i}$	The Kβ to Kα experimental intensity ratio. The values of Daoudi *et al.* (2020) corrected are written in boldface.
$\Delta(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}-i}$	The uncertainty of the i^{th} Kβ to Kα experimental value.
$\mathrm{S} = \frac{(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}}}{(\mathrm{K\beta/K\alpha})_{\mathrm{W}}}$	The ratio of the experimental Kβ to Kα intensity ratios with respect to the weighted average value.
References	References from which the database is obtained. References in boldface correspond to the corrected values of Daoudi *et al.* (2020).
$(\mathrm{K\beta/K\alpha})_{\mathrm{W}}$	Weighted average Kβ to Kα intensity ratio value.
$\varepsilon = \frac{1}{\sqrt{\sum_{i=1}^{N}(\Delta(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}-i})^{-2}}}$	Internal standard deviation associated with the calculated weighted average Kβ to Kα value.

Table 3. The fitting coefficients for the calculation of the semi-empirical Kβ/Kα intensity ratios according to the formula (12) and (13).

References	References from which the data are extracted.
Z-range	The atomic number of the target element range.
a_i	Coefficients of the seventh order polynomial fit.
b_i	Coefficients of the third order polynomial fit.
Values	The values of the coefficients of the polynomial fit.

Table 4. The semi-empirical Kβ/Kα intensity ratios compared with the theoretical calculation for elements with $11 \leq Z \leq 96$.

References	References from which the data are extracted.
Semi-empirical calculation	Semi-empirical Kβ to Kα intensity ratio values calculated according to the equation (14).
Theoretical calculation	Theoretical calculations based on the configuration mixing Dirac-Fock (MCDF) method.

Table 1. Summary of the atomic parameters for elements ranging from $_{11}$Na to $_{96}$Cm, the excitation sources, the target samples and the detectors. The references from which these data are obtained are also included.

References	Atomic parameters	Excitation sources	Target samples	Detectors
(Slivinsky and Ebert, 1969)	Kβ/Kα	Commercial X-ray tube	Z = 29-92 (pure metals and oxides)	High resolution Ge(Li)
(Hansen *et al.*, 1970a)	$K\alpha_2/K\alpha_1$, $K\beta'_1/K\alpha_1$, $K\beta'_2/K\alpha_1$ & Kβ/Kα	4 μg ^{249}Cf source	Z = 96 (after the alpha decay of ^{249}Cf)	Ge(Li) detector with a resolution of 325 eV FWHM at 6.4 keV and 465 eV FWHM at 120 keV
(Hansen *et al.*, 1970b)	$K\alpha_2/K\alpha_1$, $K\beta'_1/K\alpha_1$ $K\beta'_2/K\alpha_1$ & Kβ/Kα	Thin films of mylar on which a carrier-free radioactive source has been installed	Z = 18-90	Si(Li) detector with a resolution of 260 eV FWHM at 6.4 keV for low Z-elements ($Z \leq$ 38), and Ge(Li) with a resolution of 460 eV FWHM at 6.4 keV for high Z-elements
(Richard *et al*, 1970)	Kβ/Kα	Protons with incidence energies between 6 and 10 MeV	Cu (Cu foil)	Cooled Si(Li) detector with a resolution of 280 eV
(de Pinho, 1971)	$K\alpha_2$, $K\alpha_1$, $K\beta_3$, $K\beta_1$, $K\beta_5$, $K\beta_2$, $K\beta_4$ & $K\beta'$	Nuclear decay or external conversion of 662 keV photons generated from a ^{137}Cs source (K-electron capture or internal conversion)	Z = 17-82 Au, Hg, Tl, Pb, Bi, Rn, Ra, Th and U	Ge(Li) detector with a resolution of 700 eV FWHM at 122 keV
(McCrary *et al*, 1971)	$K\alpha_1$, $K\alpha_2$, $K\beta_{1,3}$ & $K\beta_2$	High-energy X-rays	Z = 20-94 28 elements ranging from calcium to plutonium (pure foils and composites CaF_2, RbF, NaI, BaF_2 and CeO_2)	Ge(Li) detector with a resolution of 570 eV FWHM at 14 keV, Si(Li) with a resolution of 230 eV FWHM at 6 keV, and a Bragg-diffraction spectrometer. A Nal (Tl) counter detects the X-rays.
(Mistry and Quarles, 1971a)	Kα/Kβ & $K\alpha_2/K\alpha_1$	Electrons with 40 to 140 keV incident energy	Z = 27-79 Cu, Zn, Ag, Sn, Dy and Au (made only from pure elements or their compounds)	Ge(Li) detector with a resolution of 420 eV FWHM at 6.4 keV
(Mistry and Quarles, 1971b)	Kα/Kβ	Electrons with 60 to 140 keV incident energy	Z = 57-70 (nine rare earth element oxides were used to make thin targets)	Ge(Li) detector with a resolution of 420 eV FWHM at 6.4 keV
(Bissinger *et al.*,1972)	Kβ/Kα & $K\beta_{1,3}/K\beta_2$	Proton beams from 2 to 30 MeV	Ag (self-supporting foil targets)	Si(Li) detector with a resolution of 540 eV at 6 keV)
(Salem *et al.*, 1972)	Kβ/Kα	Commercial $_{24}$Cr X-ray tube for low-Z elements and commercial $_{74}$W X-ray tube for samples with $Z \geqslant 23$	Z = 11-45 26 elements ranging from sodium to rhodium (with the exception of $_{17}$Cl and $_{35}$Br, which were in crystal form, all of	Single-crystal spectrometer (a flow proportional counter using a combination of argon and methane serves as the detection unit)

			the samples were amorphous)	
(Schmidt-Ott *et al.,* 1972)	$K\alpha_2/K\alpha_1$, $K\beta'_1/K\alpha_1$ $K\beta'_2/K\alpha_1$ & Kβ/Kα	^{113}Sn, ^{203}Hg, ^{137}Cs, ^{243}Am and ^{249}Cf decays that cause the emission of photons energies of 24.1, 72.9, 31.0, 103.7 and 109.1 keV, respectively.	*Z* = 81, 92, 94 and 96	A deep high-purity Ge detector having a resolution of 475 eV FWHM at 122 keV, along with two Ge(Li) detectors with a resolution of 436 eV FWHM at 14.4 keV, and 343 eV FWHM at 6.4 keV, respectively.
(Schmidt-Ott and Fink, 1972)	Kβ/Kα	Electron capture decays of ^{139}Ce(140 d) and ^{133}Ba(10.4 y)	Z = 55	Three Ge(Li) detectors with a resolution of 342 eV FWHM at 6.4 keV, 436 eV FWHM at 14.4 keV, and 4 keV FWHM at 1330 keV)
(Slivinsky and Ebert, 1972a)	Kβ/Kα	Extensively filtered bremsstrahlung beam emitted by a commercial X-ray tube	*Z* = 18-39 (solid targets)	Si(Li) detector with a resolution of 195 eV for the ^{55}Fe 5.9 keV photons
(Slivinsky and Ebert, 1972b)	Kβ/Kα	Mo target X-ray tube performing at 30 kV	*Z* = 18-39 (pure samples placed in a vacuum)	Si(Li) detector with a resolution of 185 eV FWHM at 6.4 keV and Ge(Li) with a resolution of 550 eV FWHM at 60 keV
(Close *et al.,* 1973)	Kα/Kβ	1.00, 2.25, and 3.70 MeV protons	Ti, V, Fe, Ni, Cu, Ge, Rb, Zr, Ag, Sn and Sb (targets in the form of self-supporting foils or films vaporized onto Ca backings)	Si(Li) detector with a resolution of 175 eV at 5.9 keV
(Lear and Gray, 1973)	Kα/Kβ	Proton beam of 2 keV	Fe, Co, Cu, Zn, Ga, Ge and As (Standard vacuum evaporation techniques were used to prepare the targets)	Si(Li) detector with a resolution of 172 eV at 5.898 keV
(Mohler and Cothern, 1973)	Kβ/Kα	25 mC of bremsstrahlung emitted by a ^{147}Pm source	Sn (tin was vacuum deposited onto aluminum backings to create samples)	Solid state Si(Li)
(Winters *et al.,* 1973)	Kβ/Kα	Protons with energies ranging from 1.5 to 5.0 MeV	Kr and Xe (thin targets of gas)	Si(Li) detector that was cooled by liquid nitrogen, having a resolution of 200 eV FWHM at 6 keV and 165 eV FWHM at 1.63 keV
(Akselsson and Johansson, 1974)	Kβ/Kα	Protons with energies ranging from 1.5 to 11 MeV	Fe, Co, Cu, Ni and Ag (thin targets and self-supporting foils).	Si(Li) detector with a resolution of 0.27 keV FWHM at 6.4 keV
(Criswell and Gray, 1974)	Kα/Kβ	Protons with energies ranging from 0.4 to 2.0 MeV	Se, Br, Rb, Sr, Y, Mo and Pd (thin targets)	Si(Li) detector placed externally to the target chamber, having a resolution of 172 eV at 5.898 keV)
(Li and	Kβ/Kα	Deutons and α particles of	*Z* = 19-47 (vacuum	Si(Li) detector with a

Watson, 1974)		2.88, 6.25, 7.50, and 12.50 MeV/amu, as well as carbon ions having energies of 2.35, 3.75, 6.25 and 8.33 MeV/amu	evaporation techniques were used to prepare all the targets)	resolution of 240 eV FWHM at 6.4 keV
(Smith *et al.,* 1974)	Kβ/Kα	15 and 20 keV electrons	*Z* = 20-30 (pure elements and known-composition compounds: $CaSiO_3$, $CaAl_2O_4$, $Ca_2P_2O_7$, Cr_2O_3, FeS and ZnS)	Si(Li) detector with a resolution of 160 eV FWHM at 5.9 keV
(Bodart et al, 1975)	Kβ/Kα	Protons with energies ranging from 0.4 to 2.3 MeV	Ti, V, Cr, Mn, Fe, Co, Ni and Cu (evaporation on a mylar support techniques were used to obtain thin targets)	Si(Li) detector with a resolution of 157 eV for ^{55}Fe rays
(Khelil and Gray, 1975)	Kβ/Kα	Protons with energies ranging from 0.6 to 2.0 MeV	Ag, Cd, Sn, Sb, Te, Ba and La (vacuum evaporation techniques were used to prepare thin targets)	Si(Li) detector with a resolution of 168 eV at 5.898 keV
(McDaniel *et al.,* 1975)	Kβ/Kα	alpha particles with energies ranging from 0.5 to 2.5 MeV	Ti, V, Cr, Fe, Ni, Cu, Zn, Ga, As, Se, Rb, Sr and Y (thin targets)	Si(Li) detector with a resolution of 172 eV FWHM at 5.898 keV
(Tawara *et al.,* 1975)	Kβ/Kα	Electrons having energies of 70, 150 and 270 MeV	*Z* = 13, 14, 20, 29, 30, 34, 39, 49, 50 and 56 (vacuum evaporation techniques were used to prepare thin targets)	Si(Li) detector and a flow-mode proportional counter
(Paić and Pečar, 1976)	Kβ/Kα	Mo target X-ray tube performing at 30 kV (X-rays and K-electron capture-induced K vacancies)	Ti, V, Cr, Fe, Cu and Zn (solutions were used to make targets, which were then placed on metallic foils or thin plastic to dry)	Si(Li) detector having a resolution of 180 eV at 6.4 keV
(Deconninck and Longree, 1977)	$K\alpha_2/K\alpha_1$, Kβ/Kα & $K\beta'_1/K\alpha_1$	alpha particles with energies ranging from 40 to 110 MeV	Ho, Tm, Lu, Ta, W, Pt, Au, Pb and Bi (natural and separated isotopes)	Intrinsic germanium detector with a resolution of 475 eV for X-rays having an energy of 100 keV)
(Wilson *et al.,* 1977)	Kβ/Kα	alpha particles and protons with energies ranging from 0.6 to 2.4 MeV	*Z* = 41-64 (thin targets)	Ortec Si(Li) detector with a resolution of 165 eV FWHM at 5.9 keV and an Ortec intrinsic Ge detector with a resolution of 237 eV FWHM at 5.9 keV and 511 eV at 122 keV
(Berényi *et al.,* 1978)	Kβ/Kα	300-600 keV electrons	Fe, Co, Ni, Cu, Se, Y, Ag, In and Sn (vacuum evaporation techniques were used to prepare targets,	Kevex with a resolution of 195 eV FWHM at 6.4 keV

			self-supporting targets were set for Cu and Se.)	
(Keith and Loomis, 1978)	Kβ/Kα	Fluorescent X-rays from appropriate radiators are passed through a basic Bragg monochromator using LiF (200) flat crystal or a graphite to create monoenergetic X-rays. A dual target (W-Cr) X-ray tube provided the primary radiation for excitation of the radiators	Ni (high purity nickel foils)	intrinsic germanium detector with a resolution of 168 eV FWHM for Mn $K\alpha$ rays (5.895 keV)
(Marques *et al.,* 1978)	Kβ/Kα	^{103}Pd, ^{105}Ag and ^{113}Sn carrier-free radioactive sources	Rh, Pd and In	Si(Li) detector with a resolution of 195 eV FWHM at 6.4 keV
(Shearer-Izumi *et al.,* 1980)	Kβ/Kα	Deuteron and oxygen ions with energies of 5 MeV amu^{-1}	Cr, Fe, Cu, Ag, In and Sm (targets are either thicker or thinner)	ORTEC Si(Li) detector having a resolution of 180 eV at 6.4 keV
(Kamal *et al.,* 1980)	Kβ/Kα	Protons with energies of 23.6, 32.1, and 43.6 MeV	Cu, Rb, Ag, Eu and Au (thin target ≈ 200 μg/cm^2)	Planar Ge(Li) detector
(Marques *et al.,* 1980)	Kβ/Kα	Radioactive sources of ^{75}Se, ^{85}Sr, ^{88}Y, ^{103}Pd, ^{105}Ag, ^{109}Cd, ^{113}Sn and ^{139}Ce (most of them are carrier-free)	*Z* = 33, 37, 38, 45, 46, 47, 49 and 57	Si(Li) detector with a resolution of 195 eV FWHM at 6.4KeV
(Dost *et al.,* 1981)	Kβ/Kα, $K\alpha_2/K\alpha_1$, $K\beta_1'/K\alpha_1$ & $K\beta_2'/K\alpha_1$	alpha particles with energies ranging from 9 to 155 MeV	Sn, Ho, Tm, Au, Pb and Bi	A high-purity Ge X-ray detector, an intrinsic Ge detector for the counting of X-rays and low energy γ-rays, and a Ge(Li) detector for the counting of γ-rays
(Martins *et al.,* 1981)	Kβ/Kα	Decays of ^{133}Ba, ^{137}Cs, ^{125}Sb and ^{125m}Te	*Z* = 52,55,56	Si(Li) detector having a resolution of 210 eV FWHM at 6.4 KeV
(Casnati *et al.,* 1985)	Kβ/Kα	59.54 keV γ-photons emitted by a 500 mCi Am-241 source	Cu, Mo and Cd (target foils)	EG&G planar HPGe detector with a resolution FWHM less or equal than 325 eV at 5.9 keV
(Möser, 1985)	Kβ/Kα	15 keV electrons	Ti, TiO, Ti_2O_3, Ti_3O_5, and TiO_2 (high purity samples)	KEVEX Si(Li) detector with a resolution of 152 eV for the Mn $K\alpha$ line
(Braziewicz *et al.,* 1986)	Kβ/Kα	Proton and ^{4}He ion with energies ranging from 1.5 to 3.8 MeV	Ti, Rb, Zr, Nb, Mo, Pd, Ag and Sb (thin targets bombarded by protons) Ti, Cr, Co, Cu, Se, Rb, Zr, Nb, Mo, Pd, Ag and Sn (thin targets bombarded by ^{4}He ions)	Si(Li) detector having a resolution of 220 eV for the ^{57}Co rays at 6.4 keV
(Campbell *et al.,* 1986)	Kβ/Kα	Thin electron-capture sources of ^{51}Cr, ^{54}Mn, ^{55}Fe, ^{57}Co, ^{65}Zn, and ^{75}Se	*Z* = 23, 24, 25, 26, 29 and 33.	Two Si(Li) detectors, one having a resolution of 185 eV at 6.4 keV

				and the other one with a resolution of 170 eV at 6.4 keV
(Kasagi *et al.,* 1986)	Kβ/Kα $K\alpha_2/K\alpha_1$ & $K\alpha_3/K\alpha_1$	3.5 MeV protons	*Z* = 62-82 (metallic foils of Sm, Ho, Tm, Lu, Ta, W, Au and Pb)	ORTEC LEPS Ge(Li) detector with a resolution of 600 eV at 122 keV
(Mehta *et al.,* 1986)	$K\alpha_1, K\alpha_2, K\alpha_{1,2}, K\beta_{1,3}, K\beta_2', K\beta_1, K\beta_2$ & Kβ	Decays of ^{192}Ir, ^{160}Tb, ^{169}Yb and ^{152}Eu	*Z* = 62, 64, 66, 69, 76, and 78	Coaxial HPGe detector, vertical plane HPGe detector and vertical Si(Li) detector
(Rao *et al.,* 1986)	Kβ/Kα	X-ray generator with a voltage that varies from 5 to 50 kV and a current of 5 to 500 µA.	*Z* = 20-50 (self-supporting foils)	Si(Li) detector having 160 eV FWHM resolution at 5.9 keV
(Bhan *et al.,* 1987)	Kβ/Kα	Decays of a 5 mCi ^{109}Cd and a 10 mCi ^{125}I sources	*Z* = 20-49 (thin-film samples)	Kevex Si(Li) detector with a resolution at 6.4 keV greater than 230 eV
(Borowski *et al.,* 1987)	Kβ/Kα	97.5 and 42.8 keV photons emitted from a ^{153}Gd source, as well as 59.5 keV gamma rays produces by a ^{241}Am source. The activity of each source is up to 30 mCi	*Z* = 56-71 (pure metal foils, metal oxides and various compound)	HpGe detector having a resolution of 154 eV and 500 eV at 5.9 keV and 122 keV, respectively
(Mehta *et al.,* 1987a)	$K\alpha_1, K\alpha_2, K\beta_1', K\beta_2', K\beta_{1,3}, K\beta_2, K\alpha_{1,2}, K\beta_1$ & $K\beta_2$	Decays of ^{210}Pb, ^{177}Lu, ^{170}Tm and ^{141}Ce sources	*Z* = 59, 68, 70, 72, and 84	a vertical planar HPGe detector having 459 eV FWHM resolution at 122 keV and a vertical Si(Li) detector with 165 eV resolution at 5.9 keV
(Mehta *et al.,* 1987b)	$K\alpha_1, K\alpha_2, K\beta_1', K\beta_2'$ & $K\alpha_{1,2}$	Decays of ^{137}Cs and ^{203}Hg sources	*Z* = 56 and 81	a vertical planar HPGe detector having 459 eV FWHM resolution at 122 keV and a vertical Si(Li) detector with 165 eV resolution at 5.9 keV
(Perujo *et al.,* 1987)	Kβ/Kα	1.0 and 2.0 MeV protons	*Z* = 22-32 (thin films of Ti, Cr, Fe, Cu, Zn, Ni and Ge. Evaporation onto mylar backings techniques were used to prepare the targets)	Si(Li) detector with a resolution of 172 eV FWHM at 5.9 keV
(Rao *et al.,* 1987)	Kβ/Kα	59.5 and 122 keV gamma-rays emitted by a ^{241}Am and ^{57}Co source, respectively. In addition to radioisotopes decaying by electron capture	Mn and Fe together with six other elements with $49 < Z < 82$ (targets were in the form of powders as oxides or foils)	Si(Li) having a resolution of 160 eV at 5.9 keV and a HpGe detector with a resolution of 180 eV at 5.9 keV
(Chand *et al.,* 1988)	Kα, Kβ, $K\alpha_2$, $K\alpha_1$, $K\beta_1'$ & $K\beta_2'$	Decays ^{103}Ru, ^{131}Ba, ^{134}Cs and ^{166m}Ho	*Z* = 45, 55, 56, and 68.	A coaxial HPGe detector, a vertical planar HPGe detector and a Si(Li) detector

(Tham and Preiss, 1988)	Kβ/Kα	Decays of a 15 mCi ^{109}Cd source. The Ag Ka X-ray was used as a primary beam	*Z* = 24-35 (thin samples) The compounds were finely ground into a powder	Si(Li) detector that was cooled by liquid nitrogen, having a resolution of 163 eV at 5.9 keV
(Chand *et al.,* 1989)	Kα,$K\alpha_1$, $K\alpha_2$, $K\beta_1'$ & $K\beta_2'$	Decays of ^{131}I, ^{166}Ho, ^{198}Au and ^{199}Au	*Z* = 54, 68, and 80.	Two coaxial HPGe detectors, a vertical planar HPGe detector and two Si(Li) detectors
(Coelho *et al.,* 1989)	Kβ/Kα	59.5 keV photons from a 100 mCi ^{241}Am annular radioactive source	Mn, Cu, Zn, Ag, Cd, In and Sn	HPGe detector
(Marchetti and Franck, 1989)	Kβ/Kα	70 keV X-rays produced by the second harmonic of a double crystal monochromator	Cu	Si(Li) detector
(LaBrecque and Rosales, 1990)	Kβ/Kα	Decays of a 7 mCi ^{109}Cd annular radioactive source	Co (thin films of pure cobalt and various chemical forms and quantities of cobalt compounds)	Si(Li) detector with a resolution of 155 eV FWHM at 5.9 keV
(Bhuinya and Padhi, 1992)	Kβ/Kα	59.54 keV photons emitted by a ^{241}Am point source of 200 mCi activity	Ti, Cr and Ni in Ti_xNi_{1-x} and Cr_xNi_{1-x} alloys for the following concentrations: x = 1.0, 0.74, 0.55, 0.35 and 0.0 and x = 1.0, 0.58, 0.20 and 0.0, respectively. (Pure metals and alloys)	Si(Li) detector
(Bhuinya and Padhi, 1993)	Kβ/Kα	59.54 keV photons emitted by a ^{241}Am point source of 200 mCi activity, as well as 4.07 MeV protons	Ti, Cr and Ni in Ti_xNi_{1-x} and Cr_xNi_{1-x} alloys (pure metals and alloys)	Si(Li) detector having a resolution of ~170 eV FWHM at 5.9 keV
(Küçükönder *et al.,* 1993a)	Kβ/Kα	59.54 keV gamma rays emitted by a ^{241}Am point source of 100 mCi activity	Cr, Mn, Co and Cu (powder samples of pure elements and compounds pertaining to the 3d shell)	Ge(Li) detector with a resolution of 190 eV FWHM at 5.9 keV
(Küçükönder *et al.,* 1993b)	Kβ/Kα	59.54 keV gamma rays emitted by a ^{241}Am annular source of 3.7 GBq activity	Cr, Mn and Cu (powder samples of pure elements their and their chemical compounds)	Ge(Li) detector with a resolution of 190 eV FWHM at 5.9 keV
(Küçükönder *et al.,* 1993c)	Kβ/Kα	Extensively filtered 59.6 keV gamma rays emitted by a ^{241}Am point source of 100 mCi activity	Ti, V, Fe, Se, Br, Zr and Ce (powder samples of pure elements and their compounds: Ti, TiO_2, V_2O_3, V_2O_4, V_2O_5, Fe, $FeSO_4$, $Fe(NO_3)_3$, $9H_2O$, FeF_3, $FeCl_3$, $6H_2O$, FeS, Fe_2O_3, Se, SeO_2, KBr, $KBrO_3$, Zr, $ZrCl_4$, Ce, $Ce(SO_4)_2$, $4H_2O$,	Ge(Li) detector with a resolution of 190 eV FWHM at 5.9 keV

			$CeCl_3$, $7H_2O$)	
(Stoev and Dlouhy, 1993)	$K\alpha_1, K\alpha_2$, $K\beta_{1,3}$ & $K\beta_2$	60 kV, 2.5 mA with a 50 µm Sn+150 µm Mo filter; 40 kV, 3.0 mA with a 200 µm Ag filter; 8 kV, 0.6 mA with no filter	*Z* = 14-92 (thin film samples)	EDXRF Spectrometer equipped with Si(Li) detector having a resolution of 145 eV for the Mn Kα line
(Büyükkasap *et al.,* 1994)	Kβ/Kα	59.5 and 122 keV gamma-rays emitted by a ^{241}Am and ^{57}Co annular source of 100 mCi activity, respectively. In addition to electron capture of ^{54}Mn, ^{55}Fe, ^{57}Co, ^{133}Ba, and decays of ^{137}Cs by emitting β^- particles	Cr, Mn, Fe, Cs and Ba (the samples were prepared from pure elements and their compounds: CsCI, $BaSO_4$)	Ge(Li) detector with a resolution of 190 eV FWHM at 5.9 keV
(Chang *et al.,* 1994)	Kβ/Kα	A radiation produced from a Am^{241} annular source of 1.5 Ci activity, which was irradiated on a Mo foil.	V (powder samples of pure element and its compounds: VO, V_2O_3, VO_2, V_6O_{13}, V_2O_5, VN and VC)	Si(Li) detector with a 200 eV resolution at 5.9 keV
(Dhal and Padhi, 1994)	Kβ/Kα & $K\beta_2'/K\beta_1'$	59.54 keV gamma rays produced from a ^{241}Am radioactive source of 200 mCi activity, as 60 keV gamma rays	Mn, Ni, Cu, Ga, Ge, Ag, Cd, Sn and Sb (pure elements, alloys, and compounds	Si(Li)
(Zararsiz, 1994)	Kβ/Kα	^{55}Fe source of 10 mCi activity (Mn K X-rays)	*Z* = 15-22 (the samples were P_2O_5, S, NaCI, KF, CaO, ScO_3, Ti)	Si(Li) detector having a 175 eV resolution at 5.9 keV
(Dasmahapatra and Mukherjee, 1995)	Kα1, Kα2, $K\beta_1'$ & $K\beta_2'$	Decays of ^{197}Hg, ^{204}Tl, ^{203}Hg, and ^{207}Bi(31.55y)	*Z* = 79-82	Two large volume HPGe detectors, together with a small volume HPGe (LEPS) detector
(Padhi and Dhal, 1995)	Kβ/Kα & $K\beta_2'/K\beta_1'$	59.54 keV gamma rays produced from a ^{241}Am point source of 200 mCi activity	Fe, Co, Ni, Cu, Mo, Ru, Rh and Pd (high purity thick samples)	Si(Li) detector with a 165eV resolution at 5.9 keV
(Söğüt *et al.,* 1995)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am source of 100 mCi activity	Cr and Ni (powder samples of pure elements, Cr_xNi_{1-x} and Cr_xAl_{1-x} alloys)	Si(Li) detector having 160 eV resolution at 5.9 keV
(Rebohle *et al.,* 1996)	Kβ/Kα	Commercial X-ray tube	Ti, V, Cr and Mn (metallic foils and thick pressed discs of pure 3d elements and some of their compounds)	Si(Li) detector having 145eV resolution for Fe Kα X-rays
(Büyükkasap, 1997)	Kβ/Kα	122 keV photons produced from a ^{57}Co radioactive source of 10 mCi activity	Ba, La, Sm, Gd, Dy and Ho (powder samples)	Ge(Li) detector with 190 eV resolution at 5.9 keV
(Ertuğrul *et al*, 1997)	Kβ/Kα, $K\alpha_2/K\alpha_1$, &$K\beta_1/K\alpha_1$	122 keV photons produced from a ^{57}Co radioactive source	*Z* = 69-92	Ge(Li) detector with 190 eV resolution at 5.9 keV

(Bé *et al.,* 1998)	Kβ/Kα	W target X-ray tube performing at 50 Kv	Ti, V, Cr, Mn, Fe, Co, Ni and Cu (pure element foils)	Si(Li) detector and with a resolution of (165±25) eV FWHM at 5.9 keV
(Durak and Özdemir, 1998)	Kβ/Kα, $K\alpha_2/K\alpha_1$, & $K\beta_1/K\alpha_1$	123.6 keV photons produced from a ^{57}Co radioactive source of 100 mCi activity	Nd, Sm, Eu, Gd, Dy, Ho, Er, Yb, Ta, W, Hg and Pb (pure circular disc samples)	Collimated Ge(Li) detector having 190 eV FWHM resolution at 5.9 keV
(Raj *et al.,* 1998a)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	Ni and Cu (thick samples of pure elements and their compounds : Ni_2Si, NiSi, Ni_2Si_3, $NiSi_2$, Cu_2Si, CuSi, and $CuSi_2$)	Si(Li) detector with a resolution of ~165 eV at 5.9 keV
(Raj *et al.,* 1998b)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	Ti, V, Cr and Fe (powder samples of pure metals and their compounds: TiC, VC, CrB, CrB_2 and FeB)	Si(Li) detector with a resolution of ~165 eV at 5.9 keV
(Cipolla, 1999)	Kβ/Kα	Protons with energies ranging from 50 to 300 KeV	Z = 21 to 32 (thick targets of elements)	Si(Li) detector with a resolution of 145 eV at 5.9 keV
(Raj *et al.,* 1999a)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	Ti, V, Cr and Co (powder samples of pure metals and their disilicide compounds)	Canberra Si(Li) detector having ~165 eV resolution at 5.9 keV
(Raj *et al.,* 1999b)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	V, Cr and Fe (powder samples of pure metals and their compounds: V_3Si, Cr_3Si and FeSi)	Canberra Si(Li) detector having ~165 eV resolution at 5.9 keV
(Raj *et al.,* 1999c)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	V and Ni (thick pellets of pure elements and V_xNi_{1-x} alloys with various compositions: x = 0.00, 0.10, 0.20, 0.35, 0.50, 0.75, 1.00)	Canberra Si(Li) detector having ~165 FWHM eV resolution at 5.9 keV
(Durak and Özdemir, 2000)	Kβ/Kα, $K\alpha_2/K\alpha_1$, &$K\beta_1'/K\alpha_1$	59.54 keV gamma rays produced from a ^{241}Am point-source of 100 mCi activity	Z = 55-68 (pure rectangular samples)	Si(Li) detector with a resolution of 188 eV FWHM for the 5.9 keV Mn $K\alpha$ line
(Hajivaliei *et al.,* 2000)	$K\alpha_1/K\alpha$, $K\alpha_2/K\alpha$, $K\beta_1/K\alpha$, $K\beta_2/K\alpha$ & $K\beta/K\alpha$	20, 22, and 25 MeV protons	Nd, Sm, Eu, Gd, Dy, Er and Yb (Nd, Sm, Eu, Gd, Dy, Er were in the form of thin targets, while Yb were evaporated)	A low energy Ge (LEGe) detector with a resolution of 180 eV FWHM at 5.96 keV

(Pawłowski and Polasik, 2000)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	Ti, V, Cr, Co, Ni and Cu (3d-transition pure metals and their compounds: $YBa_2Cu_3O_{7-\delta}$, $YBa_2(Cu_{1-0.033}Zn_{0.033})_3O_{7-\delta}$, $TiSi_2$, V_3Si, VSi_2, Cr_3Si, $CrSi_2$ $CoSi_2$, $NiSi_2$, $CuSi_2$, CrB, CrB_2, FeB)	Solid state detector with 165 eV FWHM resolution at 5.9 keV
(Raj *et al.,* 2000a)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	Cr, Mn and Co (powder samples of pure metals and their compounds: CrSe, MnSe, MnS, CoS compounds)	Canberra Si(Li) detector having ~165 eV resolution at 5.9 keV
(Raj *et al.,* 2000b)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	Fe and Ni (powder samples of pure metals and Fe_xNi_{1-x} alloys for with various compositions: x = 0.20, 0.50, 0.58)	Canberra Si(Li) detector having ~165 eV resolution at 5.9 keV
(Ertuğrul *et al.,* 2001a)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am point-source of 100 mCi activity	*Z* = 57-69	Si(Li) detector with a resolution of 60 eV FWHM at 5.9 keV)
(Ertuğrul *et al.,* 2001b)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am point-source	*Z* = 22-69 (high purity powder samples)	Si(Li) detector with a resolution of 160 eV FWHM at 5.9 keV)
(Raj *et al.,* 2001)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point-source of 200 mCi activity	Fe and Ni (powder OF pure metals and Fe_xNi_{1-x} alloys with compositions: x = 0.20, 0.50, 0.58)	Canberra Si(Li) detector having ~165 eV resolution at 5.9 keV
(Söğüt *et al.,* 2001)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive source of 100 mCi activity	Mo, Ag, Cd, Ba, La and Ce (powder samples of pure elements and some of their compounds)	Si(Li) detector having 155 eV resolution at 5.9 keV
(Ximeng *et al.,* 2001)	Kβ/Kα , $K\alpha_2/K\alpha_1$, $K\beta_1'/K\alpha_1$, $K\beta_2'/K\beta1'$, & $K\beta_3/K\beta_2$	3 MeV protons	*Z* = 39, 51, 62, 63, 64, 66, 67 (targets were created from nitrates of Y, Sb, Sm, Eu, Gd, Dy, Ho, Er on Mylar films)	ORTEC Si(Li) detector having a resolution of 195 eV at 5.9 KeV
(Castellano *et al.,* 2002)	Kα/(Kβ + Kα)	2 nA and 4 nA beam current	Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ge, As, Zr and Mo (pure samples)	Si(Li) detectors at energies between 10 and 30 keV
(Çalışkan *et al.,* 2002)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive source	*Z* = 41-68 (pure targets)	Si(Li) detector having 160 eV resolution at 5.96 keV
(Ertuğrul, 2002a)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive source	*Z* = 30-40 (Zn, As, Se, Rb, Sr, Y and Zr)	Ge(Li) detector having 190 eV resolution at 5.96 keV

(Ertuğrul, 2002b)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive source of 100 mCi activity	Sm and Tb (high purity samples)	Si(Li) detector having ~160 eV resolution at 5.96 keV
(Ertuğrul, 2002c)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive source of 100 mCi activity	Cs, Ba and La (high purity samples)	Si(Li) detector having ~160 eV resolution at 5.96 keV
(Ertuğrul et al., 2002)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive point-source of 100 mCi activity	Zr, Mo, Pd, Ag, Sb, Ce and Nd (thin and uniform samples with high purity)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(İçelli and Erzeneoğlu, 2002)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular source of 100 mCi activity	Zn (pure powder targets of zinc)	High-resolution Si(Li) detector with 160 eV FWHM resolution at 5.96 keV
(Jonnard *et al.*, 2002)	Kβ/Kα	9.5 keV electrons	Mg (high purity metal plates)	Bent crystal vacuum spectrometer
(Pawłowski *et al.,* 2002)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive point-source of 200 mCi activity	Ti, Cr, Fe and Co (pure metals and alloys: $Cr_{0.26}Fe_{0.74}$, $Cr_{0.80}Co_{0.20}$ and $Ti_{0.80}Cr_{0.20}$ in powder form)	Canberra Si(Li) detector having ~165 eV resolution at 5.9 keV
(Perino *et al.,* 2002)	$K\alpha_1$, $K\alpha_2$ & $K\beta_{1,3}$	Rhodium target X-ray tube	Al, Si and S (samples were set in the elemental state and in various valence states: Al_2O_3, SiO_2, ZnS, $Na_2S_2O_5$, Na_2SO_4, FeS_2, $(NH_4)_2SO_4$, $FeSO_4.7H_2O$ and $ZnSO_4.7H_2O$)	Ge and PET analyzer crystals are used in a wavelength-dispersive spectrometer.
(Raj *et al.,* 2002)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive source of 200 mCi activity	*Z* = 22-29 (samples were in the form of high-purity thick foils)	Canberra Si(Li) detector having ~165 eV resolution at 5.9 keV
(Söğüt *et al.,* 2002)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive source	Ti, V, Cr, Mn, Fe, Co, Ni, Cu and Zn (powder samples of pure elements and their compounds in various oxidation states)	Si(Li) solid state detector having 155 eV resolution at 5.9 keV
(Baydaş *et al.,* 2003)	Kβ/Kα	10 keV photons produced by secondary excitation technique	*Z* = 22-29 (powder samples)	Si(Li) detector having 160 eV resolution at 5.9 keV
(Ertuğrul, 2003)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive point-source of 100 mCi activity	Ce, Pr and Nd (high purity samples)	Si(Li) detector having ~165 eV resolution at 5.96 keV
(Ximeng *et al.,* 2003)	Kβ/Kα	3 MeV protons	*Z* = 23-33 (thin targets)	Ortec Si(Li) detector having a resolution of 195 eV at 5.9 keV

(Baydaş, 2005)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive point-source	Ag, Cd, Sn, Sb, Cs, Ba, La, Ce, Pr, Sm, Eu, Gd, Tb, Dy, Ho and Er (circular samples)	Si(Li) detector with a resolution of 160 eV FWHM at 5.96 keV
(Çevik *et al.,* 2005)	Kβ/Kα	59.543 keV gamma rays produced from a ^{241}Am radioactive source	Mn, Ni, and Cu (powder samples of pure elements and complexes)	Si(Li) solid state detector having 157 eV resolution at 5.9 keV
(Doğan and Bacaksiz, 2005)	Kβ/Kα	5.96 and 59.543 keV photons produced from annular 5 and 50 mCi ^{55}Fe and ^{241}Am radioactive sources	Cd and Zn (thin films of pure elements and $Cd_{1-x}Zn_xS$ alloys)	Si(Li) detector having 160 eV resolution at 5.9 keV
(Şahin *et al.,* 2005)	Kβ/Kα	5.96 keV photons emitted by a ^{55}Fe radioactive source	*Z* = 16-23 (pure samples with various thickness)	Collimated Si(Li) detector
(Bacaksiz *et al.,* 2006)	Kβ/Kα	59.543 keV gamma rays produced from an annular ^{241}Am radioactive source of 50 mCi activity	Cd and Zn (thin films of pure elements and alloys $Cd_{1-x}Zn_xO$: x = 0, 0.05, 0.10, 0.15, 0.20, 0.30, 0.40, 0.50, and 0.60)	Si(Li) detector having 160 eV resolution at 5.9 keV
(Bennal and Badiger, 2006)	$K\alpha_2/K\alpha_1$, $K\beta_1/K\alpha_1$, & Kβ/Kα	10^4 Bq ^{57}Co gamma source that produces photons with energies of 122 keV 136 keV	Ta, Au and Pb (thin foils of pure targets)	ORTEC HPGe detector with 700 eV resolution at 122 keV
(Hatzistergos and Lifshi, 2006)	Kβ & Kα	Thermionic emission gun	*Z* = 12-32	EDAX EDS detector
(Öz, 2006)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive point-source	Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Rb, Sr, Y, Zr, Nb and Mo (circular samples of various thickness)	Si(Li) detector having 160 eV FWHM resolution at 5.9 keV
(Bennal and Badiger, 2007)	Kβ/Kα	~10 µCi ^{57}Co gamma source that produces photons with energies of 123.6 keV	Mo, Ag, Cd, In and Sn (thin foils of pure elemental targets)	ORTEC HPGe detector with 700 eV resolution at 88 keV
(Çevik et al., 2007)	Kβ/Kα	123.6 and 59.5 keV photons produced from 25 and 50 mCi ^{57}Co and ^{241}Am radioactive sources	Cr, Fe, Co, Cu, Zn, Ga, Se, Y, Mo, Cd, In, Sn, Te, Ba, Ta, W and Bi (high purity metals)	Super Si(Li) detector having 150 eV resolution at 5.9 keV
Demir and Şahin, 2007a)	$K\alpha_2/K\alpha_1$, $K\beta_1'/K\alpha_1$ & Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive source of 100 mCi activity	Nd, Gd, Dy, Eu and Ho (pure foils of Gd and Dy, and Nd, Eu and Ho in powder form)	Si(Li) detector having 180 eV resolution at 5.9 keV
Demir and Şahin, 2007b)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive source of 100 mCi activity	Nd, Gd, Dy, Eu and Ho (pure foils of Gd and Dy, and Nd, Eu and Ho in powder form)	Si(Li) detector having 180 eV resolution at 5.9 keV

(Ertuğral *et al.*, 2007)	Kβ/Kα	1.85 GBq ^{55}Fe, ^{241}Am, and 0.925 GBq ^{57}Co annular radioactive sources producing 5.9, 59.5, and 123.6 keV gamma rays.	Z = 16-92 (high purity powder samples)	Si(Li) detector having 160 eV FWHM resolution at 5.9 keV
(Ertuğral, 2007)	Kβ/Kα	123.6 keV photons produced from a ^{57}Co radioactive source of 25 mCi activity	Ce, Pr, Nd, Sm, Eu and Gd (high purity targets of CeO_2, Pr_3O_4, Nd_2O_3, Sm_2O_3, Eu_2O_3 and Gd_2O_3)	Si(Li) detector having 160 eV FWHM resolution at 5.9 keV
(Han *et al.,* 2007)	Kβ/Kα	59.54 keV gamma rays produced from a filtred ^{241}Am radioactive point-source of 100 mCi activity	Z = 22-68 (pure rectangular samples of thickness)	Si(Li) detector having 160 eV FWHM resolution at 5.9 keV
(Kalayci *et al.,* 2007)	Kβ/Kα	Decays of a 10 mCi ^{109}Cd annular radioactive source (producing a primary beam with energy ranging from 22 to 25 keV)	Ni (powder samples of pure elements and Ni–Si alloys : Ni in Ni_3Si, Ni_2Si and NiSi)	Planar Si(Li) detector having 190 eV resolution at 5.9 keV
(Kaya *et al*, 2007)	Kβ/Kα	123.6 keV gamma rays produced from a ^{57}Co annular radioactive source of 25 mCi activity	Z = 69-76	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Aylikci *et al.,* 2007)	$K\alpha_2/K\alpha_1$, $K\beta_2/K\alpha_1$, $K\beta_1/K\alpha_1$ & Kβ/Kα	123.6 keV gamma rays produced from a ^{57}Co annular radioactive source of 25 mCi activity	Hf (pure element and its compounds in powder form)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Yalçin, 2007)	$K\alpha_2/K\alpha_1$, $K\beta_1/K\alpha_1$ & Kβ/Kα	Decays of ^{51}Cr, ^{55}Fe, ^{67}Ga, ^{99}Tc, ^{111}In, ^{131}I, ^{133}Ba, ^{133}Xe, ^{137}Cs, ^{201}Tl and ^{226}Ra, as well as a 100 mCi ^{241}Am, and a 100 mCi ^{60}Co annular radioactive sources producing 59.5, and 123.6 keV gamma rays.	V, Mn, Zn, Tc, Ru, Cd, Xe, Cs, Ba, Hg and Rn (high purity powder samples)	Si(Li) detector having 160 eV FWHM resolution at 5.9 keV
(Apaydin *et al.,* 2008)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am annular radioactive source	Co, Ni, Cu and Zn (powder samples of pure elements and complexes: 2B-Co, 2B-Ni, Cyc-Ni-Pc, CycZn-Pc, 2B-Co-Pc, 2B-Ni-Pc, 2B-Cu-Pc, 2B-Zn-Pc, Py-Co-Pc , Py-Ni-Pc, Py-Cu-Pc, Py-Zn-Pc , Poly-Co-Pc, Poly-Ni-Pc, Poly-Cu-Pc, and Poly-Zn-Pc)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Cengiz *et al.,* 2008)	Kβ/Kα	5.96 and 59.5 keV photons produced from annular ^{55}Fe and ^{241}Am radioactive sources, respectively.	Nb (powder samples of pure element and its compounds: $NbCl_5$, $NbBr_5$, Nb_2O_5, NbC and NbN)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV

(Han *et al.*, 2008)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am point source at five angles that varies from 120° to 160°	Sm, Eu, Gd, Tb, Dy, Ho and Er (spectroscopically pure targets)	Si(Li) detector having 160 eV FWHM resolution at 5.9 keV
(Porikli and Kurucu, 2008a)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioisotope source of 10 mCi activity	Ni and Co (pure elements and their compounds in powder form)	Si(Li)
(Porikli and Kurucu, 2008b)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioisotope source of 10 mCi activity	V, Cr, Mn, Fe, Co, Ni, Cu and Zn (high purity powder samples)	Si(Li) detector having 180 eV resolution at 5.9 keV
(Porikli *et al.*, 2008)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioisotope source of 10 mCi activity	Zn and Cu (powder samples of pure elements and their compound: $CuBr$, $Cu_2O, CuI, CuCl$, $Cu_2Te, Cu_5Si, CuSO_4$, $CuSeO_4.5H_2O$, $CuCl_2, Cu(NO_3)_2$, $CuS, CuSe, CuF_2$, $CuF_2.3H_2O, CuBr_2$, $Cu(ClO_4)_2.6H_2O$, $ZnSO_4.5H_2O$, $Zn(C_2H_3O_2)_2, ZnF_2$, $Zn(NO_3)_2.6H_2O$, $ZnO, ZnSn\ ZnSe$, $ZnTe$ and $ZnF_2.4H_2O$)	Si(Li) detector having 180 FWHM eV resolution at 5.9 keV
(Söğüt *et al.*, 2008)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive source of 50 mCi activity	Fe and Zn (thin films and powder samples of pure elements and Fe_xZn_{1-x} alloys)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Han and Demir, 2009)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioisotope source of 10 mCi activity	Fe, Cr and Ni (powder samples of pure metals and alloys of Fe_xNi_{1-x} (x=0.8, 0.7, 0.6, 0.5, 0.4, 0.3, and 0.2); Ni_xCr_{1-x} (x=0.8, 0.6, 0.5, 0.4, and 0.2); Fe_xCr_{1-x} (x=0.9, 0.7, and 0.5); and $Fe_xCr_yNi_{1-(x+y)}$ (x=0.7−y=0.1, x=0.5−y=0.2, x=0.4−y=0.3, x=0.3−y=0.3, x=0.2−y=0.2, and x=0.1−y=0.2)	Si(Li) detector having 180 FWHM eV resolution at 5.9 keV
(Kup Aylikci et al., 2009)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Co and Zn (pure elements and their alloys Zn_xCo_{1-x})	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Bennal et al., 2010)	Kβ/Kα	123.6 keV gamma rays emitted by a weak ^{57}Co source	Z = 42-82 (thin elemental target)	ORTEC HPGe detector having 700 eV resolution at 88 keV

(Cengiz et al., 2010a)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Co, Ni, Cu, and Zn (powder samples of pure elements and various complexes)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Cengiz et al., 2010b)	Kβ/Kα	^{241}Am and ^{57}Co annular radioactive sources producing 59.5 and 123.6 keV gamma rays	Au (powder samples of pure elements and its compounds: AuCl, Au_2O_3 and $AuBr_3$)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Han and Demir, 2010a)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioactive point source of 10 mCi activity	Ti and Co (powder samples of pure metals and alloys of Ti_xCo_{1-x} : x = 0.7, 0.6, 0.5, 0.4, and 0.3)	Si(Li) detector having 160 FWHM eV resolution at 5.9 keV
(Han and Demir, 2010b)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioactive point source of 10 mCi activity	Fe, Ni, Ti, Co (pure elements and alloys of Fe_xNi_{1-x}, Ti_xNi_{1-x} & Co_xCu_{1-x})	Si(Li) detector having 160 FWHM eV resolution at 5.9 keV
(Han and Demir, 2010c)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioactive point source of 10 mCi activity	Co and Cu (pure metals and alloys of Co_xCu_{1-x} : x = 0.8, 0.7, 0.6, 0.5, 0.4, 0.3 and 0.2)	Si(Li) detector having 160 FWHM eV resolution at 5.9 keV
(Han and Demir, 2010d)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioactive point source of 10 mCi activity	Ti and Ni (powder samples of pure metals and alloys of Ti_xNi_{1-x} : x=0.7, 0.6, 0.5, 0.4 and 0.3)	Si(Li) detector having 160 FWHM eV resolution at 5.9 keV
(Kup Aylikci et al., 2010a)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Co and Zn (pure elements and their alloys Zn_xCo_{1-x})	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Kup Aylikci et al., 2010b)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Ni (pure metals and superalloy specimens)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Cengiz et al., 2011)	Kβ/Kα, $K\beta_1'/K\alpha_1$, & $K\beta_2'/K\alpha_1$	123.6 keV gamma rays emitted by a weak ^{57}Co source of 925 MBq activity	*Z* = 73-81 (powder samples of pure elements and their compounds)	Ultra-LEGe detector having 150 eV resolution at 5.96 keV
(Kup Aylikci *et al.,* 2011)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Co and Zn (pure metals and alloys of $Zn_{1-x}Co_x$)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Porikli et al., 2011)	$K\beta_1/K\alpha$, $K\beta_2/K\alpha$, $K\beta_2/K\beta_1$, & Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioactive source	Y, Zr, Nb, and Mo (pure elements and compounds of 4d transition metals in powder form, then turned into pellets)	Si(Li) detector having 180 eV resolution at 5.9 keV
(Porikli and Kurucu, 2011a)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioactive point source	Cr (pure element and its compounds in powder form, then turned into pellets)	Si(Li) detector having 155 eV resolution at 5.9 keV

(Porikli and Kurucu, 2011b)	Kβ/Kα, $K\beta_{1,3}/K\alpha$, $K\beta_{2,4}/K\alpha$, & $K\beta_{2,4}/K\beta_{1,3}$	Decays of a 10 mCi ^{109}Cd and a 100 mCi ^{241}Am radioactive sources	Y (pure element and its compounds in powder form, then turned into pellets)	Si(Li)
(Saydam et al., 2012)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Fe, Se, Te (samples with various weight and thickness of pure elements and their complexes: FeSe, FeTe, TeSe)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Turşucu et al., 2012)	Kβ/Kα	5.66 µCi ^{133}Ba gamma source at 80.997 keV of excitation energy	*Z* = 40-50 (thin foil targets)	CdTe semiconductor detector having a resolution lower than 1.2 keV at 122 keV
(Anand et al., 2013)	Kβ/Kα	32.86 keV Ba K X-rays that led to the internal conversion of Cs^{137}	Mo and Ag (thin foils of pure elements)	Si(Li) detector having 140 eV resolution at 5.9 keV
(Demir and Şahin, 2013)	Kβ/Kα	59.537 keV gamma rays produced from a ^{241}Am radioactive source of 100 mCi activity	*Z* = 24-65 (spectroscopically pure samples)	Si(Li) detector having 180 eV FWHM resolution at 5.9 keV
(Doğan et al., 2013)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Zn and Cr (pure elements and $Zn_{1-x}Cr_x$ alloys)	Ultra-LEGe detector having 150 eV resolution at 5.96 keV
(Onder et al., 2013)	Kβ/Kα	80.998 keV gamma rays emitted by a ^{133}Ba radioactive source of 10 mCi activity	*Z* = 40-50 (thin samples)	CdTe detector
(Sreevidya *et al.,* 2013)	Kβ/Kα	IC of $_{80}Hg^{203}$ and $_{55}Cs^{137}$	Tl and Ba	Si(Li)
(Turşucu and Demir, 2013)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am annular radioactive source of 5Ci activity	Ce (samples with various thicknesses of pure element and its compounds: $CeCl_3$, CeF_3, Ce $(NO_3)_3$, Ce_2 $(SO_4)_3$ and Ce_2O_3) Samples were then turned into cylindrical pellets	HPGe detector having 182 eV resolution at 5.9 keV
(Turşucu et al., 2013)	Kβ/Kα	59.537 keV gamma rays produced from a ^{241}Am radioactive point source	Zr, Nb, Mo, Ru, Rh, Pd, Ag, Cd and Sn (spectroscopically pure targets with various thicknesses, except for Ru which is in powder form)	Si(Li) detector having 180 eV FWHM resolution at 5.9 keV
(Anand et al., 2014)	$K\alpha_2/K\alpha_1$, $K\beta_2/K\alpha_1$, $K\beta'_1/K\alpha_1$, & Kβ/Kα	123.6 keV photons produced from a weak ^{57}Co radioactive source of ~10^4 Bq activity	Pt, Au and Pb (thin foils of pure elements)	HPGe detector having 200 eV resolution at 5.9 keV

(Cengiz et al., 2014)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Ni and Ti (powder samples of pure metals and NiTi alloys)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Doğan et al., 2014a)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am annular radioactive source of 50 mCi activity	Co, Ni, Cu and Zn (powder samples of pure elements and phthalocyanine complexes)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Doğan et al., 2014b)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am annular radioactive source of 50 mCi activity	Cr and Zn (pure metals and various $Zn_{1-x}Cr_x$ alloys)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(George et al., 2014)	Kβ/Kα	EC dacay of ~ 2 μCi ^{57}Co, ^{109} Cd, and ^{125}I by emitting K X-ray photons of Fe, Ag, and Te, respectively.	Fe, Ag and Te	Si(Li) detector having 140 eV resolution at 5.9 keV
(Sita Mahalakshmi *et al.,* 2014)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive source of 100 mCi activity	Sb, Cs, La, Ce, Pr, Nd, Sm, Gd, Dy and Ho (powder samples)	HPGe detector
(Sreevidya *et al.,* 2014)	$K\alpha_2/K\alpha_1$, $K\beta'_1/K\alpha_1$ & $K\beta$/Kα	IC decay of ~ 2 μCi ^{137}Cs and ^{203}Hg by emitting K X-ray photons of Ba and Tl, respectively.	Ba and Tl	Si(Li) detector having 140 eV resolution at 5.9 keV
(Akman *et al.,* 2015)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source of 100 mCi activity	Ce and Gd (pure, thin, and uniform samples of La_2O_3, Ce, Gd)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Aksoy *et al.,* 2015)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source of 50 mCi activity	Zr and Sb (powder samples of pure elements and their compounds: Zr, ZrF_4, ZrI_4, $ZrCl_4$, $ZrBr_4$, ZrC, Sb, SbI_3, O_3Sb_2, S_3Sb_2 and Br_3Sb)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Anand et al., 2015)	Kβ/Kα	32.86 keV Ba K X-rays from a 10^4 Bq ^{137}Cs source	Co, Ni, Cu and Zn (high purity thin foils)	Low energy HPGe detector having 200 eV resolution at 5.9 keV
(Aylikci et al., 2015)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	*Z* = 21-30 (3d transition elements)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Kaçal et al., 2015)	Kβ/Kα	22.6 keV photons produced from a ^{109}Cd radioactive source of 10 mCi activity	Ti, Cr, Fe, Co, Ni and Cu (circular samples of high purity and various thicknesses)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Mirji et al., 2015a)	Kβ/Kα	6.5, 10 and 11 keV synchrotron radiation	Cr, Cu and Zn (pure elements and their compounds)	Silicon drift detector with 130 eV resolution at 5.9 keV
(Mirji et al., 2015b)	Kβ/Kα	6.5, 10 and 11 keV synchrotron radiation	Cr, Cu and Zn (pure elements and their compounds)	Silicon drift detector with 130 eV resolution at 5.9 keV

(Perişanoğlu and Demir,2015)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive point source of 200 mCi activity	Ni and Cr (foil samples of pure elements and Ni_xCr_{1-x} : x = 0.40; 0.50; 0.60; 0.80) alloys)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Akman., 2016a)	$K\alpha_2/K\alpha_1$, $K\beta'_1/K\alpha_1$, $K\beta'_2/K\alpha_1$, & Kβ/Kα	59.5 keV γ-rays from a 100 mCi ^{241}Am annular radioactive source	La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy and Er (spectroscopically pure targets with various thicknesses)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Akman, 2016b)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source of 100 mCi activity	*Z* = 30-58 (powder samples of pure elements and their compounds)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Akman et al., 2016a)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source of 100 mCi activity	*Z* = 56-68 (thin and uniform samples with high purity)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Alim et al., 2016)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive point source of 200 mCi activity	Fe and Ni (metal foils of Invar ($Fe_{0.64}Ni_{0.36}$); Permalloy ($Fe_{0.20}Ni_{0.80}$); and Fe_xNe_{1-x} (x=0, 0.40, 0.52, 0.55, 0.61, and 1) alloys)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Doğan *et al.,* 2016)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source of 50 mCi activity	Cu and Sn (thin films of pure metals and various alloys Cu_xSn_{1-x} : x = 0.48, 0.41, 0.14, and 0.06)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Köksal *et al.,* 2016)	Kβ/Kα	5.96 keV photons produced from a 50 mCi ^{55}Fe radioactive source	Ti (powder samples of pure element and some of its compound $TiCl_3, TiO, Ti_2O_3$ and TiS_2)	Ultra-LEGe detector having 140 eV resolution at 5.9 keV
(Özdemir et al., 2016)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive point source of 100 mCi activity	Mo, Nb, Zr and Y (thin and uniform samples with high purity, pressed in order to obtain various weight and thickness)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Perişanoğlu et al., 2016)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive point source of 200 mCi activity	Ti and Ni (powder samples of pure elements and Ti_xNi_{1-x} (x =0.30; 0.40; 0.50; 0.60; 0.70) alloys, which were then pelletized)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Akkuş et al., 2017)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive point source of 100 mCi activity	Sc, V, Cr, Ni, Cu, Zn, Br, Y, Zr and Nb (turned from the powdered samples to cylindrical pellets)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV

(Cengiz *et al.,* 2017)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source of 50 mCi activity	Zn (pure element and peripherally and non-peripherally tetra-substituted zinc (II) phthalocyanine complexes)	Ultra-LEGe detector having 140 eV resolution at 5.9 keV
(Kup Aylikci *et al.,* 2017)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Zn, Fe (pure elements and $Zn_{1-x}Fe_x$ alloys)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Ménesguen *et al.,* 2017)	Kβ/Kα & $K\beta_{1,3}$ / $K\alpha_{1,2}$	3.75 keV to 30 keV photons	Ni (high purity metal foils)	Bragg diffraction. the monochromator device contains a double Si(111) crystal
(Uğurlu et al., 2017)	Kβ/Kα	22.69 keV photons produced from a ^{109}Cd radioactive point source of 10 mCi activity	Fe, Ni, Co, Ti and V (metal foils of pure elements, $Fe_{49}Co_{49}V_2$, $Fe_{54}Ni_{29}Co_{17}$, and $Ti_{50}Co_{50}$)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Yilmaz, 2017)	Kβ/Kα	16.896 keV photons produced from secondary source	Cu, Ge, As, Br and Rb (high purity powder samples)	Si(Li) detector having 160 eV FWHM resolution at 5.96 keV
(Anand et al., 2018)	Kβ/Kα	32.86 keV Ba K X-rays from a 10^4 Bq ^{137}Cs source	Co, Ni and Zn (pure thin foils)	Low energy HPGe detector
(Köksal *et al.,* 2018)	Kβ/Kα	5.96 keV photons emitted by a ^{55}Fe annular radioactive source of 50 mCi activity	Ti (powder samples of pure element and some of its compounds and complexes)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Singh et al., 2018)	Kβ/Kα	10 to 25 keV electrons	Ti and Cu (pure elements)	Energy dispersive Si PIN photodiode detector having 160 eV FWHM resolution at 5.9 keV
(Söğüt *et al.,* 2018)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am radioactive source of 50 mCi activity	Zn (thin films of pure element, undoped ZnO, and boron and fluorine-doped ZnO)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Yilmaz, 2018)	Kβ/Kα	16.896 keV photons produced from secondary source	Cr, Mn, Fe and Co (pure powder samples)	Si(Li) detector having 160 eV resolution at 5.9 keV
(Cengiz *et al.,* 2019)	Kβ/Kα	59.5 keV gamma rays produced from a ^{241}Am annular radioactive source	Ni (pure element and Ni-B alloy)	Ultra-LEGe detector having 150 eV resolution at 5.9 keV
(Uğurlu et al.,2019)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive point source of 200 mCi activity in Pb capsule collimator	Mo and Ag (powder samples of pure metals and alloys of Mo_xAg_{1-x} $(0 \leq x \leq 1)$) Various magnetic fields and concentration range were used	Si(Li) detector

(Uğurlu, 2019)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive source of 200 mCi activity	La, Ce, Pr, Nd, Sm and Eu (powder samples in various magnetic fields (B= 0, 0.4, 0.8 T))	High resolution Si(Li)
(Gójska *et al.*, 2020)	$K\beta_{1,2,3}$/ $K\alpha_{1,2}$	X-ray tube	Ag (pure element and Ag-Cu alloys with 5%, 10%, 30%, 75%, 80% and 90% of silver)	Si detector having a resolution of 150 ± 5 eV at 5.9 keV
(Perişanoğlu et al., 2020)	Kβ/Kα	Decays of a 40 mCi ^{109}Cd radioactive point source and a 3 Ci ^{241}Am annular source by emitting photons of 22.1 and 59.54 keV	Zn, and Mn (nano size and powder samples of pure metals and mixed Zn-Mn, Zn- Co, Zn-Ni spinel ferrites in the)	HPGe detector
(Uğurlu and Demir, 2020)	Kβ/Kα	59.54 keV gamma rays produced from a ^{241}Am radioactive point source of 200 mCi activity in Pb capsule collimator	Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu and Zn (3d transition elements) and Y, Zr, Nb, Mo, Ru, Rh, Pd, Ag and Cd (4d transition elements) powder samples in various magnetic fields	Si(Li) detector covered by a filter of Pb, Fe and Al

Table 2. Summary of the experimental Kβ/Kα intensity ratios from $_{11}$Na to $_{96}$Cm according to their target atomic numbers. The references from which the databases are extracted and the weighted average values $(\mathrm{K\beta/K\alpha})_{\mathrm{W}}$ were also listed.

Z, Symbol	$(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}-i}$ $\pm\ \Delta(\mathrm{K\beta/K\alpha})_{\mathrm{EXP}-i}$	References	$(\mathrm{K\beta/K\alpha})_{\mathrm{W}}\ \pm\ \varepsilon$
Z=11, Na	**0.008 ± 0.0020** **0.009 ± 0.0023**	**(Salem et al., 1972)** **(Salem et al., 1972)**	0.0084 ± 0.0015
Z=12, Mg	**0.011 ± 0.0028** **0.012 ± 0.0030**	**(Salem et al., 1972)** **(Salem et al., 1972)**	0.01147 ± 0.0020
Z=13, Al	**0.018 ± 0.00036** *0.02*	**(Salem et al., 1972)** *(Perino et al., 2002)*	0.018 ± 0.00036
Z=14, Si	**0.030 ± 0.00060** *0.0318 ± 0.0103* *0.03*	**(Salem et al., 1972)** *(Stoev and Dlouhy, 1993)* *(Perino et al., 2002)*	0.030 ± 0.001
Z=15, P	**0.038 ± 0.00076** *0.0415 ± 0.0127* 0.0378 ± 0.0018	**(Salem et al., 1972)** *(Stoev and Dlouhy, 1993)* (Zararsiz, 1994)	0.0380 ± 0.0007
Z=16, S	**0.059 ± 0.0012** *0.0597 ± 0.0152* 0.0609 ± 0.0027 *0.06 ± 0.01* 0.0525 ± 0.0021 0.0591 ± 0.004	**(Salem et al., 1972)** *(Stoev and Dlouhy, 1993)* (Zararsiz, 1994) *(Perino et al., 2002)* (Şahin et al., 2005) (Ertuğral et al., 2007)	0.0579 ± 0.0009
Z=17, Cl	**0.095 ± 0.0019** *0.0836 ± 0.0071* 0.0911 ± 0.0038 0.0678 ± 0.0027 0.0698 ± 0.005	**(Salem et al., 1972)** *(Stoev and Dlouhy, 1993)* (Zararsiz, 1994) (Şahin et al., 2005) (Ertuğral et al., 2007)	0.0854 ± 0.0014
Z=18, Ar	0.1032 ± 0.0067 *0.1032 ± 0.0067*	(Slivinsky and Ebert, 1972a) *(Slivinsky and Ebert, 1972b)*	0.1032 ± 0.0047
Z=19, K	**0.123 ± 0.0025** **0.124 ± 0.0025** 0.1217 ± 0.0055 *0.1217 ± 0.0055* *0.1242 ± 0.0101* 0.1220 ± 0.0040 0.0951 ± 0.0038 0.1126 ± 0.008	**(Salem et al., 1972)** **(Salem et al., 1972)** (Slivinsky and Ebert, 1972a) *(Slivinsky and Ebert, 1972b)* *(Stoev and Dlouhy, 1993)* (Zararsiz, 1994) (Şahin et al., 2005) (Ertuğral et al., 2007)	0.1192 ± 0.0014
Z=20, Ca	**0.1280 ± 0.0040** **0.128 ± 0.0026** **0.130 ± 0.0026** 0.105 ± 0.005 *0.1297 ± 0.005* *0.1289 ± 0.0019* 0.1280 ± 0.0050 *0.122 ± 0.004* 0.1050 ± 0.0042 0.1228 ± 0.006	**(McCrary et al., 1971)** **(Salem et al., 1972)** **(Salem et al., 1972)** (Rao et al., 1986) *(Bhan et al., 1987)* *(Stoev and Dlouhy, 1993)* (Zararsiz, 1994) *(Castellano et al., 2002)* (Şahin et al., 2005) (Ertuğral et al., 2007)	0.1256 ± 0.0011
Z=21, Sc	**0.133 ± 0.0027** 0.1302 ± 0.0026 *0.1302 ± 0.0026* *0.1359 ± 0.0028* 0.1290 ± 0.0050 *0.1292 ± 0.0056* *0.1296 ± 0.0013* 0.1268 ± 0.005 0.1215 ± 0.0063	**(Salem et al., 1972)** (Slivinsky and Ebert, 1972a) *(Slivinsky and Ebert, 1972b)* *(Stoev and Dlouhy, 1993)* (Zararsiz, 1994) *(Cipolla, 1999)* *(Hatzistergos and Lifshi, 2006)* (Ertuğral et al., 2007) (Aylikci et al., 2015)	0.1284 ± 0.0008

	0.1119 ± 0.0060	(Akkuş et al., 2017)	
	0.1124 ± 0.0056	(Akkuş et al., 2017)	
	0.1224 ± 0.0054	(Akkuş et al., 2017)	
	0.1127 ± 0.0054	(Akkuş et al., 2017)	
	0.1140 ± 0.0061	(Akkuş et al., 2017)	
	0.1140 ± 0.0078	(Akkuş et al., 2017)	
	0.1282 ± 0.006	*(Uğurlu and Demir, 2020)*	
	0.1249 ± 0.005	*(Uğurlu and Demir, 2020)*	
	0.1232 ± 0.007	*(Uğurlu and Demir, 2020)*	
Z=22, Ti	**0.1320 ± 0.0040**	**(McCrary et al., 1971)**	0.1269 ± 0.0001
	0.135 ± 0.0027	**(Salem et al., 1972)**	
	0.1319 ± 0.0017	(Slivinsky and Ebert, 1972a)	
	0.1319 ± 0.0017	*(Slivinsky and Ebert, 1972b)*	
	0.1321 ± 0.0066	*(Close et al., 1973)*	
	0.129 ± 0.002	*(Li and Watson, 1974)*	
	0.128 ± 0.001	*(Li and Watson, 1974)*	
	0.128 ± 0.002	*(Li and Watson, 1974)*	
	0.130 ± 0.003	*(Li and Watson, 1974)*	
	0.127 ± 0.003	*(Li and Watson, 1974)*	
	0.126 ± 0.002	*(Li and Watson, 1974)*	
	0.126 ± 0.002	*(Li and Watson, 1974)*	
	0.127 ± 0.001	*(Li and Watson, 1974)*	
	0.1402 ± 0.0014	*(Bodart et al, 1975)*	
	0.121 ± 0.016	*(McDaniel et al., 1975)*	
	0.133 ± 0.002	(Paić and Pečar, 1976)	
	0.123 ± 0.002	*(Paić and Pečar, 1976)*	
	0.1309 ± 0.0004	*(Möser, 1985)*	
	0.1310 ± 0.0004	*(Möser, 1985)*	
	0.1306 ± 0.0004	*(Möser, 1985)*	
	0.130 ± 0.013	*(Braziewicz et al., 1986)*	
	0.127 ± 0.013	*(Braziewicz et al., 1986)*	
	0.1340 ± 0.005	*(Bhan et al., 1987)*	
	0.1271 ± 0.0010	*(Perujo et al., 1987)*	
	0.1304 ± 0.0010	*(Perujo et al., 1987)*	
	0.1282 ± 0.0014	(Bhuinya and Padhi, 1992)	
	0.1289 ± 0.0014	*(Bhuinya and Padhi, 1993)*	
	0.1364 ± 0.0006	*(Bhuinya and Padhi, 1993)*	
	0.1354 ± 0.0039	*(Stoev and Dlouhy, 1993)*	
	0.1320 ± 0.0060	(Zararsiz, 1994)	
	0.1395 ± 0.0016	(Rebohle et al., 1996)	
	0.1359 ± 0.0017	(Bé et al., 1998)	
	0.1368 ± 0.0017	(Bé et al., 1998)	
	0.1265 ± 0.0006	(Raj et al., 1998b)	
	0.1350 ± 0.0081	*(Cipolla, 1999)*	
	0.1265 ± 0.0006	(Raj et al., 1999a)	
	0.1265 ± 0.0006	*(Pawłowski and Polasik, 2000)*	
	0.121 ± 0.010	(Ertuğrul et al., 2001b)	
	0.135 ± 0.004	*(Castellano et al., 2002)*	
	0.1265 ± 0.0006	(Pawłowski et al., 2002)	
	0.1265 ± 0.0006	(Raj et al., 2002)	
	0.1364 ± 0.0134	(Söğüt et al., 2002)	
	0.094 ± 0.003	*(Baydaş et al., 2003)*	
	0.1089 ± 0.0043	(Şahin et al., 2005)	
	0.1349 ± 0.0022	*(Hatzistergos and Lifshi, 2006)*	
	0.1282 ± 0.008	(Ertuğral et al., 2007)	
	0.110 ± 0.009	(Han et al., 2007)	
	0.1288 ± 0.0014	(Han and Demir, 2010a)	
	0.1284 ± 0.0051	**(Han and Demir, 2010b)**	
	0.1301 ± 0.0052	**(Han and Demir, 2010b)**	
	0.1344 ± 0.0054	**(Han and Demir, 2010b)**	

	0.1380 ± 0.0055	**(Han and Demir, 2010b)**	
	0.1370 ± 0.0055	**(Han and Demir, 2010b)**	
	0.1352 ± 0.0054	**(Han and Demir, 2010b)**	
	0.1362 ± 0.0054	**(Han and Demir, 2010b)**	
	0.1372 ± 0.0055	**(Han and Demir, 2010b)**	
	0.1148 ± 0.0064	(Cengiz et al., 2014)	
	0.1233 ± 0.0063	(Aylikci et al., 2015)	
	0.129 ± 0.0077	**(Kaçal et al., 2015)**	
	0.1049 ± 0.0063	(Köksal et al., 2016)	
	0.1284 ± 0.0039	(Perişanoğlu et al., 2016)	
	0.1281 ± 0.0038	(Perişanoğlu et al., 2016)	
	0.1270 ± 0.0044	(Perişanoğlu et al., 2016)	
	0.1268 ± 0.0044	(Perişanoğlu et al., 2016)	
	0.1260 ± 0.0050	(Perişanoğlu et al., 2016)	
	0.1258 ± 0.0051	(Perişanoğlu et al., 2016)	
	0.1252 ± 0.0025	(Uğurlu et al., 2017)	
	0.1028 ± 0.0057	(Köksal et al., 2018)	
	0.1149 ± 0.0014	*(Singh et al., 2018)*	
	0.1134 ± 0.0014	*(Singh et al., 2018)*	
	0.1139 ± 0.0014	*(Singh et al., 2018)*	
	0.1153 ± 0.0014	*(Singh et al., 2018)*	
	0.1149 ± 0.0014	*(Singh et al., 2018)*	
	0.1139 ± 0.0014	*(Singh et al., 2018)*	
	0.1150 ± 0.0014	*(Singh et al., 2018)*	
	0.1143 ± 0.0014	*(Singh et al., 2018)*	
	0.1146 ± 0.0014	*(Singh et al., 2018)*	
	0.1157 ± 0.0014	*(Singh et al., 2018)*	
	0.1145 ± 0.0014	*(Singh et al., 2018)*	
	0.1137 ± 0.0014	*(Singh et al., 2018)*	
	0.1142 ± 0.0014	*(Singh et al., 2018)*	
	0.1144 ± 0.0014	*(Singh et al., 2018)*	
	0.1154 ± 0.0014	*(Singh et al., 2018)*	
	0.1146 ± 0.0014	*(Singh et al., 2018)*	
	0.1146 ± 0.0014	*(Singh et al., 2018)*	
	0.1113 ± 0.0014	*(Singh et al., 2018)*	
	0.1194 ± 0.0014	*(Singh et al., 2018)*	
	0.1193 ± 0.0014	*(Singh et al., 2018)*	
	0.1291 ± 0.008	*(Uğurlu and Demir, 2020)*	
	0.1269 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.1256 ± 0.006	*(Uğurlu and Demir, 2020)*	
	0.131	*(Smith et al., 1974)*	
	0.130	*(Smith et al., 1974)*	
	0.129	*(Smith et al., 1974)*	
	0.1034	*(Küçükönder et al., 1993c)*	
	0.1289	*(Han and Demir, 2010d)*	
Z=23, V	**0.137 ± 0.0027**	**(Salem et al., 1972)**	0.1356 ± 0.0002
	0.1339 ± 0.0011	(Slivinsky and Ebert, 1972a)	
	0.1339 ± 0.0011	*(Slivinsky and Ebert, 1972b)*	
	0.1351 ± 0.0068	*(Close et al., 1973)*	
	0.128 ± 0.002	*(Li and Watson, 1974)*	
	0.129 ± 0.002	*(Li and Watson, 1974)*	
	0.131 ± 0.003	*(Li and Watson, 1974)*	
	0.131 ± 0.003	*(Li and Watson, 1974)*	
	0.128 ± 0.001	*(Li and Watson, 1974)*	
	0.128 ± 0.002	*(Li and Watson, 1974)*	
	0.129 ± 0.001	*(Li and Watson, 1974)*	
	0.129 ± 0.001	*(Li and Watson, 1974)*	
	0.1331 ± 0.0008	*(Bodart et al, 1975)*	
	0.128 ± 0.006	*(McDaniel et al., 1975)*	
	0.134 ± 0.002	(Paić and Pečar, 1976)	

	0.121 ± 0.002 *0.1330 ± 0.0013* *0.1371 ± 0.0014* 0.128 ± 0.005 *0.1348 ± 0.0035* 0.1479 ± 0.0003 0.1456 ± 0.0021 0.1363 ± 0.0017 0.1385 ± 0.0017 0.1312 ± 0.0008 *0.1287 ± 0.0136* 0.1312 ± 0.0008 0.1312 ± 0.0008 *0.1327 ± 0.0007* *0.1312 ± 0.0008* *0.135 ± 0.004* 0.1312 ± 0.0008 *0.1316 ± 0.0111* *0.096 ± 0.003* *0.136 ± 0.0054* 0.1244 ± 0.0050 *0.1384 ± 0.0025* 0.1294 ± 0.006 0.113 ± 0.009 0.1166 ± 0.0009 0.1227 ± 0.0007 0.1363 ± 0.044 0.1213 ± 0.046 0.1129 ± 0.049 0.1232 ± 0.0063 0.1178 ± 0.0076 0.1283 ± 0.0067 0.1334 ± 0.0063 0.1228 ± 0.0063 0.1243 ± 0.0059 0.1253 ± 0.0065 0.1256 ± 0.0023 *0.1303 ± 0.007* *0.1286 ± 0.006* *0.1271 ± 0.005* *0.134* *0.132* *0.132*	*(Paić and Pečar, 1976)* *(Campbell et al., 1986)* *(Campbell et al., 1986)* (Rao et al., 1986) *(Stoev and Dlouhy, 1993)* (Chang *et al.,* 1994) (Rebohle et al., 1996) (Bé et al., 1998) (Bé et al., 1998) (Raj et al., 1998b) *(Cipolla, 1999)* (Raj et al., 1999a) (Raj et al., 1999b) *(Raj et al., 1999c)* *(Pawłowski and Polasik, 2000)* *(Castellano et al., 2002)* (Raj et al., 2002) *(Söğüt et al., 2002)* *(Baydaş et al., 2003)* *(Ximeng et al., 2003)* (Şahin et al., 2005) *(Hatzistergos and Lifshi, 2006)* (Ertuğral et al., 2007) (Han et al., 2007) (Yalçin, 2007) (Yalçin, 2007) (Porikli and Kurucu, 2008b) (Porikli and Kurucu, 2008b) (Porikli and Kurucu, 2008b) (Aylikci et al., 2015) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Uğurlu et al., 2017) *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Smith et al., 1974)* *(Smith et al., 1974)* *(Smith et al., 1974)*	
Z=24, Cr	**0.1350 ± 0.0040** **0.138 ± 0.0028** 0.1344 ± 0.0011 *0.1344 ± 0.0011* *0.128 ± 0.001* *0.130 ± 0.001* *0.130 ± 0.002* *0.130 ± 0.002* *0.129 ± 0.002* *0.129 ± 0.002* *0.130 ± 0.002* *0.129 ± 0.002* *0.1452 ± 0.0011* *0.124 ± 0.006* 0.134 ± 0.002 *0.127 ± 0.002* *0.128 ± 0.004*	**(McCrary et al., 1971)** **(Salem et al., 1972)** (Slivinsky and Ebert, 1972a) *(Slivinsky and Ebert, 1972b)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Bodart et al, 1975)* *(McDaniel et al., 1975)* (Paić and Pečar, 1976) *(Paić and Pečar, 1976)* *(Shearer-Izumi et al., 1980)*	0.1321 ± 0.0002

	0.1334 ± 0.0013	*(Campbell et al., 1986)*	
	0.1358 ± 0.0014	*(Campbell et al., 1986)*	
	0.121 ± 0.012	*(Braziewicz et al., 1986)*	
	0.132 ± 0.005	(Rao et al., 1986)	
	0.1356 ± 0.0045	*(Bhan et al., 1987)*	
	0.1345 ± 0.0011	*(Perujo et al., 1987)*	
	0.1317 ± 0.0011	*(Perujo et al., 1987)*	
	0.1234 ± 0.0025	(Tham and Preiss, 1988)	
	0.1232 ± 0.0025	(Tham and Preiss, 1988)	
	0.1334 ± 0.0009	(Bhuinya and Padhi, 1992)	
	0.1338 ± 0.0009	(Bhuinya and Padhi, 1993)	
	0.1378 ± 0.0005	*(Bhuinya and Padhi, 1993)*	
	0.1124 ± 0.0013	(Küçükönder et al., 1993a)	
	0.1124 ± 0.0013	(Küçükönder et al., 1993b)	
	0.1374 ± 0.0022	*(Stoev and Dlouhy, 1993)*	
	0.1124 ± 0.0022	(Büyükkasap et al., 1994)	
	0.1174 ± 0.0023	*(Büyükkasap et al., 1994)*	
	0.1341 ± 0.0033	(Söğüt et al., 1995)	
	0.1341 ± 0.0033	(Söğüt et al., 1995)	
	0.1469 ± 0.0016	(Rebohle et al., 1996)	
	0.1394 ± 0.0017	(Bé et al., 1998)	
	0.1400 ± 0.0017	(Bé et al., 1998)	
	0.1314 ± 0.0008	(Raj et al., 1998b)	
	0.1314 ± 0.0008	(Raj et al., 1999a)	
	0.1314 ± 0.0008	(Raj et al., 1999b)	
	0.1314 ± 0.0008	*(Pawłowski and Polasik, 2000)*	
	0.1314 ± 0.0008	(Raj et al., 2000a)	
	0.128 ± 0.010	(Ertuğrul et al., 2001b)	
	0.134 ± 0.003	*(Castellano et al., 2002)*	
	0.1314 ± 0.0008	(Pawłowski et al., 2002)	
	0.1314 ± 0.0008	(Raj et al., 2002)	
	0.1341 ± 0.0130	(Söğüt et al., 2002)	
	0.096 ± 0.003	*(Baydaş et al., 2003)*	
	0.133 ± 0.0053	*(Ximeng et al., 2003)*	
	0.1379 ± 0.0013	*(Hatzistergos and Lifshi, 2006)*	
	0.132 ± 0.005	(Çevik et al., 2007)	
	0.1342 ± 0.005	(Ertuğral et al., 2007)	
	0.113 ± 0.009	(Han et al., 2007)	
	0.1325 ± 0.039	(Porikli and Kurucu, 2008b)	
	0.1134 ± 0.047	(Porikli and Kurucu, 2008b)	
	0.0922 ± 0.041	(Porikli and Kurucu, 2008b)	
	0.1325 ± 0.0045	(Porikli and Kurucu, 2011a)	
	0.1134 ± 0.0047	(Porikli and Kurucu, 2011a)	
	0.0922 ± 0.051	(Porikli and Kurucu, 2011a)	
	0.119 ± 0.006	(Demir and Şahin, 2013)	
	0.125 ± 0.006	(Demir and Şahin, 2013)	
	0.124 ± 0.006	(Demir and Şahin, 2013)	
	0.1173 ± 0.0060	(Doğan et al., 2013)	
	0.1182 ± 0.0060	(Doğan et al., 2014b)	
	0.1222 ± 0.0062	(Aylikci et al., 2015)	
	0.127 ± 0.0076	**(Kaçal et al., 2015)**	
	0.116 ± 0.004	(Mirji et al., 2015a)	
	0.116 ± 0.004	(Mirji et al., 2015b)	
	0.1320 ± 0.0039	(Perişanoğlu and Demir, 2015)	
	0.1311 ± 0.0052	(Perişanoğlu and Demir, 2015)	
	0.1264 ± 0.0050	(Perişanoğlu and Demir, 2015)	
	0.1161 ± 0.0084	(Akkuş et al., 2017)	
	0.1259 ± 0.0073	(Akkuş et al., 2017)	
	0.1320 ± 0.0079	(Akkuş et al., 2017)	
	0.1218 ± 0.0069	(Akkuş et al., 2017)	

	0.1222 ± 0.0066	(Akkuş et al., 2017)	
	0.1232 ± 0.0076	(Akkuş et al., 2017)	
	0.1142 ± 0.008	(Yilmaz, 2018)	
	0.1321 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.1300 ± 0.005	*(Uğurlu and Demir, 2020)*	
	0.1289 ± 0.006	*(Uğurlu and Demir, 2020)*	
	0.134	*(Smith et al., 1974)*	
	0.133	*(Smith et al., 1974)*	
	0.1273	*(Han and Demir, 2009)*	
Z=25, Mn	*0.1219 ± 0.0024*	*(Hansen et al., 1970b)*	0.1295 ± 0.0003
	0.138 ± 0.0028	**(Salem et al., 1972)**	
	0.1361 ± 0.0011	(Slivinsky and Ebert, 1972a)	
	0.1361 ± 0.0011	*(Slivinsky and Ebert, 1972b)*	
	0.129 ± 0.002	*(Li and Watson, 1974)*	
	0.130 ± 0.002	*(Li and Watson, 1974)*	
	0.131 ± 0.001	*(Li and Watson, 1974)*	
	0.131 ± 0.003	*(Li and Watson, 1974)*	
	0.129 ± 0.002	*(Li and Watson, 1974)*	
	0.130 ± 0.001	*(Li and Watson, 1974)*	
	0.130 ± 0.002	*(Li and Watson, 1974)*	
	0.130 ± 0.004	*(Li and Watson, 1974)*	
	0.1333 ± 0.0010	*(Bodart et al, 1975)*	
	0.1369 ± 0.0014	*(Campbell et al., 1986)*	
	0.1395 ± 0.004	*(Bhan et al., 1987)*	
	0.132 ± 0.004	(Rao et al., 1987)	
	0.126 ± 0.004	*(Rao et al., 1987)*	
	0.129 ± 0.0032	**(Coelho et al., 1989)**	
	0.1151 ± 0.0010	(Küçükönder et al., 1993a)	
	0.1362 ± 0.0039	*(Stoev and Dlouhy, 1993)*	
	0.1151 ± 0.0023	(Büyükkasap et al., 1994)	
	0.1201 ± 0.0024	*(Büyükkasap et al., 1994)*	
	0.1471 ± 0.0042	(Rebohle et al., 1996)	
	0.1383 ± 0.0017	(Bé et al., 1998)	
	0.1396 ± 0.0017	(Bé et al., 1998)	
	0.1344 ± 0.0009	(Raj et al., 2000a)	
	0.131 ± 0.013	(Ertuğrul et al., 2001b)	
	0.131 ± 0.003	*(Castellano et al., 2002)*	
	0.134 ± 0.004	(Jonnard *et al.,* 2002)	
	0.1344 ± 0.0009	(Raj et al., 2002)	
	0.1235 ± 0.0104	(Söğüt et al., 2002)	
	0.135 ± 0.0054	*(Ximeng et al., 2003)*	
	0.127 ± 0.006	(Çevik et al., 2005)	
	0.1397 ± 0.0031	*(Hatzistergos and Lifshi, 2006)*	
	0.132 ± 0.011	(Öz, 2006)	
	0.1440 ± 0.004	(Ertuğral et al., 2007)	
	0.106 ± 0.008	(Han et al., 2007)	
	0.1188 ± 0.0011	(Yalçin, 2007)	
	0.1214 ± 0.0008	(Yalçin, 2007)	
	0.1302 ± 0.037	(Porikli and Kurucu, 2008b)	
	0.1227 ± 0.041	(Porikli and Kurucu, 2008b)	
	0.1146 ± 0.043	(Porikli and Kurucu, 2008b)	
	0.102 ± 0.005	(Demir and Şahin, 2013)	
	0.111 ± 0.006	(Demir and Şahin, 2013)	
	0.111 ± 0.006	(Demir and Şahin, 2013)	
	0.1262 ± 0.0064	(Aylikci et al., 2015)	
	0.1205 ± 0.006	(Yilmaz, 2018)	
	0.1300 ± 0.0058	*(Perişanoğlu et al., 2020)*	
	0.1296 ± 0.0058	*(Perişanoğlu et al., 2020)*	
	0.1332 ± 0.008	*(Uğurlu and Demir, 2020)*	
	0.1313 ± 0.006	*(Uğurlu and Demir, 2020)*	

	0.1300 ± 0.006 *0.135*	*(Uğurlu and Demir, 2020)* *(Smith et al., 1974)*	
Z=26, Fe	*0.1283 ± 0.0025* **0.1360 ± 0.0041** **0.136 ± 0.0027** 0.1366 ± 0.0011 *0.1366 ± 0.0011* *0.1359 ± 0.0068* *0.1399 ± 0.0035* *0.1369 ± 0.0035* *0.129 ± 0.002* *0.128 ± 0.002* *0.129 ± 0.002* *0.129 ± 0.002* *0.127 ± 0.002* *0.126 ± 0.002* *0.126 ± 0.001* *0.127 ± 0.002* *0.1308 ± 0.0007* *0.129 ± 0.006* 0.135 ± 0.002 *0.129 ± 0.002* *0.1364 ± 0.0041* *0.131 ± 0.003* *0.1312 ± 0.0013* *0.1367 ± 0.0014* 0.133 ± 0.005 *0.1374 ± 0.004* *0.1350 ± 0.0010* *0.1349 ± 0.0010* 0.133 ± 0.004 *0.128 ± 0.004* *0.1383 ± 0.0018* 0.1160 ± 0.0023 *0.1210 ± 0.0024* 0.1290 ± 0.0005 0.1362 ± 0.0018 0.1372 ± 0.0017 0.1419 ± 0.0019 0.1307 ± 0.0007 *0.1380 ± 0.0093* 0.1307 ± 0.0007 *0.1307 ± 0.0007* 0.1307 ± 0.0007 0.133 ± 0.011 0.1307 ± 0.0007 *0.145 ± 0.005* 0.1307 ± 0.0007 0.1307 ± 0.0007 0.1287 ± 0.0110 *0.096 ± 0.003* *0.137 ± 0.0055* *0.1400 ± 0.0039* 0.134 ± 0.012 0.135 ± 0.007 0.1324 ± 0.005 0.120 ± 0.010 0.1329 ± 0.040 0.1303 ± 0.043 0.1204 ± 0.046	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** **(Salem et al., 1972)** (Slivinsky and Ebert, 1972a) *(Slivinsky and Ebert, 1972b)* *(Close et al., 1973)* *(Lear and Gray, 1973)* *(Akselsson and Johansson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Bodart et al, 1975)* *(McDaniel et al., 1975)* (Paić and Pečar, 1976) *(Paić and Pečar, 1976)* *(Berényi et al., 1978)* *(Shearer-Izumi et al., 1980)* *(Campbell et al., 1986)* *(Campbell et al., 1986)* (Rao et al., 1986) *(Bhan et al., 1987)* *(Perujo et al., 1987)* *(Perujo et al., 1987)* (Rao et al., 1987) *(Rao et al., 1987)* *(Stoev and Dlouhy, 1993)* (Büyükkasap et al., 1994) *(Büyükkasap et al., 1994)* (Padhi and Dhal, 1995) (Rebohle et al., 1996) (Bé et al., 1998) (Bé et al., 1998) (Raj et al., 1998b) *(Cipolla, 1999)* (Raj et al., 1999b) *(Pawłowski and Polasik, 2000)* (Raj *et al.,* 2000b) (Ertuğrul et al., 2001b) (Raj *et al.,* 2001) *(Castellano et al., 2002)* (Pawłowski et al., 2002) (Raj et al., 2002) (Söğüt et al., 2002) *(Baydaş et al., 2003)* *(Ximeng et al., 2003)* *(Hatzistergos and Lifshi, 2006)* (Öz, 2006) (Çevik et al., 2007) (Ertuğral et al., 2007) (Han et al., 2007) (Porikli and Kurucu, 2008b) (Porikli and Kurucu, 2008b) (Porikli and Kurucu, 2008b)	0.1310 ± 0.0002

	0.124 ± 0.007	(Söğüt et al., 2008)	
	0.1284 ± 0.0051	**(Han and Demir, 2010b)**	
	0.1283 ± 0.0051	**(Han and Demir, 2010b)**	
	0.1283 ± 0.0051	**(Han and Demir, 2010b)**	
	0.1336 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1333 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1307 ± 0.0052	**(Han and Demir, 2010b)**	
	0.1247 ± 0.0050	**(Han and Demir, 2010b)**	
	0.1246 ± 0.0050	**(Han and Demir, 2010b)**	
	0.1393 ± 0.0056	**(Han and Demir, 2010b)**	
	0.1411 ± 0.0056	**(Han and Demir, 2010b)**	
	0.1334 ± 0.007	(Saydam et al., 2012)	
	0.123 ± 0.006	(Demir and Şahin, 2013)	
	0.134 ± 0.007	(Demir and Şahin, 2013)	
	0.134 ± 0.007	(Demir and Şahin, 2013)	
	0.116 ± 0.003	(George et al., 2014)	
	0.1267 ± 0.0065	(Aylikci et al., 2015)	
	0.132 ± 0.0079	**(Kaçal et al., 2015)**	
	0.1323 ± 0.0019	(Alim et al., 2016)	
	0.1306 ± 0.0020	(Alim et al., 2016)	
	0.1291 ± 0.0019	(Alim et al., 2016)	
	0.1267 ± 0.0064	(Kup Aylikci *et al.,* 2017)	
	0.1298 ± 0.0026	(Uğurlu et al., 2017)	
	0.1197 ± 0.007	(Yilmaz, 2018)	
	0.1308 ± 0.0058	*(Perişanoğlu et al., 2020)*	
	0.1301 ± 0.0058	*(Perişanoğlu et al., 2020)*	
	0.1348 ± 0.009	*(Uğurlu and Demir, 2020)*	
	0.1329 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.1312 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.136	*(Smith et al., 1974)*	
	0.137	*(Smith et al., 1974)*	
	0.137	*(Smith et al., 1974)*	
	0.1160	*(Küçükönder et al., 1993c)*	
	0.1488	*(Han and Demir, 2009)*	
Z=27, Co	*0.1317 ± 0.0026*	*(Hansen et al., 1970b)*	0.1317 ± 0.0002
	0.138 ± 0.0028	**(Salem et al., 1972)**	
	0.1376 ± 0.0011	(Slivinsky and Ebert, 1972a)	
	0.1376 ± 0.0011	*(Slivinsky and Ebert, 1972b)*	
	0.1302 ± 0.0032	*(Lear and Gray, 1973)*	
	0.1399 ± 0.0025	*(Akselsson and Johansson, 1974)*	
	0.130 ± 0.001	*(Li and Watson, 1974)*	
	0.129 ± 0.003	*(Li and Watson, 1974)*	
	0.130 ± 0.002	*(Li and Watson, 1974)*	
	0.131 ± 0.001	*(Li and Watson, 1974)*	
	0.128 ± 0.003	*(Li and Watson, 1974)*	
	0.127 ± 0.002	*(Li and Watson, 1974)*	
	0.128 ± 0.001	*(Li and Watson, 1974)*	
	0.128 ± 0.002	*(Li and Watson, 1974)*	
	0.1296 ± 0.0010	*(Bodart et al, 1975)*	
	0.1344 ± 0.0040	*(Berényi et al., 1978)*	
	0.134 ± 0.013	*(Braziewicz et al., 1986)*	
	0.135 ± 0.006	(Rao et al., 1986)	
	0.1348 ± 0.0035	*(Bhan et al., 1987)*	
	0.135 ± 0.0014	**(LaBrecque and Rosales, 1990)**	
	0.1194 ± 0.0009	(Küçükönder et al., 1993a)	
	0.1388 ± 0.0016	*(Stoev and Dlouhy, 1993)*	
	0.1285 ± 0.0006	(Padhi and Dhal, 1995)	
	0.1400 ± 0.0022	(Rebohle et al., 1996)	
	0.1379 ± 0.0017	(Bé et al., 1998)	
	0.1385 ± 0.0017	(Bé et al., 1998)	

	0.1335 ± 0.0008	(Raj et al., 1999a)	
	0.1335 ± 0.0008	*(Pawłowski and Polasik, 2000)*	
	0.1335 ± 0.0008	(Raj et al., 2000a)	
	0.133 ± 0.010	(Ertuğrul et al., 2001b)	
	0.140 ± 0.005	*(Castellano et al., 2002)*	
	0.1335 ± 0.0008	(Pawłowski et al., 2002)	
	0.1335 ± 0.0008	(Raj et al., 2002)	
	0.1387 ± 0.0140	(Söğüt et al., 2002)	
	0.095 ± 0.003	*(Baydaş et al., 2003)*	
	0.1390 ± 0.0019	*(Hatzistergos and Lifshi, 2006)*	
	0.137 ± 0.011	(Öz, 2006)	
	0.137 ± 0.008	(Çevik et al., 2007)	
	0.1390 ± 0.007	(Ertuğral et al., 2007)	
	0.139 ± 0.003	(Porikli and Kurucu, 2008a)	
	0.131 ± 0.005	(Porikli and Kurucu, 2008a)	
	0.124 ± 0.005	(Porikli and Kurucu, 2008a)	
	0.1310 ± 0.037	(Porikli and Kurucu, 2008b)	
	0.1267 ± 0.038	(Porikli and Kurucu, 2008b)	
	0.1215 ± 0.042	(Porikli and Kurucu, 2008b)	
	0.1313 ± 0.0087	(Kup Aylikci et al., 2009)	
	0.1207 ± 0.0062	(Cengiz et al., 2010a)	
	0.1342 ± 0.0013	(Han and Demir, 2010a)	
	0.1342 ± 0.0054	**(Han and Demir, 2010b)**	
	0.1340 ± 0.0054	**(Han and Demir, 2010b)**	
	0.1337 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1334 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1357 ± 0.0054	**(Han and Demir, 2010b)**	
	0.1374 ± 0.0055	**(Han and Demir, 2010b)**	
	0.1333 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1325 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1324 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1324 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1342 ± 0.0063	(Han and Demir, 2010c)	
	0.1230 ± 0.0062	(Kup Aylikci et al., 2010a)	
	0.1230 ± 0.0062	(Kup Aylikci et al., 2011)	
	0.122 ± 0.006	(Demir and Şahin, 2013)	
	0.143 ± 0.007	(Demir and Şahin, 2013)	
	0.142 ± 0.007	(Demir and Şahin, 2013)	
	0.12346 ± 0.0063	(Doğan et al., 2014a)	
	0.123 ± 0.008	(Anand et al., 2015)	
	0.1273 ± 0.0065	(Aylikci et al., 2015)	
	0.134 ± 0.0080	**(Kaçal et al., 2015)**	
	0.1302 ± 0.0087	(Akkuş et al., 2017)	
	0.1319 ± 0.0078	(Akkuş et al., 2017)	
	0.1377 ± 0.0067	(Akkuş et al., 2017)	
	0.1225 ± 0.0061	(Akkuş et al., 2017)	
	0.1248 ± 0.0072	(Akkuş et al., 2017)	
	0.1269 ± 0.0063	(Akkuş et al., 2017)	
	0.1327 ± 0.0022	(Uğurlu et al., 2017)	
	0.122 ± 0.003	(Anand et al., 2018)	
	0.1211 ± 0.009	(Yilmaz, 2018)	
	0.1356 ± 0.006	*(Uğurlu and Demir, 2020)*	
	0.1341 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.1341 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.138	*(Smith et al., 1974)*	
	0.1227	*(Apaydin et al., 2008)*	
Z=28, Ni	*0.1328 ± 0.0027*	*(Hansen et al., 1970b)*	0.1384 ± 0.0001
	0.136 ± 0.0027	**(Salem et al., 1972)**	
	0.1385 ± 0.0011	(Slivinsky and Ebert, 1972a)	
	0.1385 ± 0.0011	*(Slivinsky and Ebert, 1972b)*	

	0.1435 ± 0.0072	*(Close et al., 1973)*	
	0.1359 ± 0.0018	*(Akselsson and Johansson, 1974)*	
	0.135 ± 0.001	*(Li and Watson, 1974)*	
	0.134 ± 0.003	*(Li and Watson, 1974)*	
	0.133 ± 0.001	*(Li and Watson, 1974)*	
	0.132 ± 0.001	*(Li and Watson, 1974)*	
	0.134 ± 0.001	*(Li and Watson, 1974)*	
	0.133 ± 0.001	*(Li and Watson, 1974)*	
	0.133 ± 0.001	*(Li and Watson, 1974)*	
	0.132 ± 0.001	*(Li and Watson, 1974)*	
	0.1376 ± 0.0011	*(Bodart et al, 1975)*	
	0.137 ± 0.007	*(McDaniel et al., 1975)*	
	0.1427 ± 0.0043	*(Berényi et al., 1978)*	
	0.1447 ± 0.00063	**(Keith and Loomis, 1978)**	
	0.136 ± 0.006	(Rao et al., 1986)	
	0.1380 ± 0.0035	*(Bhan et al., 1987)*	
	0.1361 ± 0.0010	*(Perujo et al., 1987)*	
	0.1357 ± 0.0010	*(Perujo et al., 1987)*	
	0.1390 ± 0.0001	(Tham and Preiss, 1988)	
	0.1389 ± 0.0001	(Tham and Preiss, 1988)	
	0.1359 ± 0.0006	(Bhuinya and Padhi, 1992)	
	0.1356 ± 0.0006	(Bhuinya and Padhi, 1992)	
	0.1368 ± 0.0006	(Bhuinya and Padhi, 1993)	
	0.1380 ± 0.0005	*(Bhuinya and Padhi, 1993)*	
	0.1371 ± 0.0006	*(Bhuinya and Padhi, 1993)*	
	0.1380 ± 0.0005	*(Bhuinya and Padhi, 1993)*	
	0.1388 ± 0.0009	*(Stoev and Dlouhy, 1993)*	
	0.1336 ± 0.0005	(Padhi and Dhal, 1995)	
	0.1265 ± 0.0031	(Söğüt et al., 1995)	
	0.1403 ± 0.0015	(Rebohle et al., 1996)	
	0.1377 ± 0.0017	(Bé et al., 1998)	
	0.1386 ± 0.0017	(Bé et al., 1998)	
	0.1363 ± 0.0006	(Raj *et al.,* 1998a)	
	0.1363 ± 0.0005	*(Raj et al., 1999c)*	
	0.1363 ± 0.0006	*(Pawłowski and Polasik, 2000)*	
	0.1346 ± 0.0012	(Raj *et al.,* 2000b)	
	0.135 ± 0.012	(Ertuğrul et al., 2001b)	
	0.1346 ± 0.0012	(Raj *et al.,* 2001)	
	0.156 ± 0.008	*(Castellano et al., 2002)*	
	0.1346 ± 0.0012	(Raj et al., 2002)	
	0.1466 ± 0.0124	(Söğüt et al., 2002)	
	0.095 ± 0.003	*(Baydaş et al., 2003)*	
	0.136 ± 0.0054	*(Ximeng et al., 2003)*	
	0.141 ± 0.012	(Çevik et al., 2005)	
	0.1429 ± 0.0017	*(Hatzistergos and Lifshi, 2006)*	
	0.138 ± 0.011	(Öz, 2006)	
	0.1330 ± 0.003	(Ertuğral et al., 2007)	
	0.119 ± 0.009	(Han et al., 2007)	
	0.1378 ± 0.0010	(Kalayci *et al.,* 2007)	
	0.145 ± 0.004	(Porikli and Kurucu, 2008a)	
	0.141 ± 0.005	(Porikli and Kurucu, 2008a)	
	0.135 ± 0.005	(Porikli and Kurucu, 2008a)	
	0.1315 ± 0.039	(Porikli and Kurucu, 2008b)	
	0.1265 ± 0.040	(Porikli and Kurucu, 2008b)	
	0.1225 ± 0.040	(Porikli and Kurucu, 2008b)	
	0.1210 ± 0.0062	(Cengiz et al., 2010a)	
	0.1311 ± 0.0052	**(Han and Demir, 2010b)**	
	0.1347 ± 0.0054	**(Han and Demir, 2010b)**	
	0.1427 ± 0.0057	**(Han and Demir, 2010b)**	
	0.1345 ± 0.0054	**(Han and Demir, 2010b)**	

	0.1285 ± 0.0051	**(Han and Demir, 2010b)**	
	0.1359 ± 0.0054	**(Han and Demir, 2010b)**	
	0.1384 ± 0.0055	**(Han and Demir, 2010b)**	
	0.1436 ± 0.0057	**(Han and Demir, 2010b)**	
	0.1384 ± 0.0055	**(Han and Demir, 2010b)**	
	0.1375 ± 0.0055	**(Han and Demir, 2010b)**	
	0.1319 ± 0.0053	**(Han and Demir, 2010b)**	
	0.1414 ± 0.0057	**(Han and Demir, 2010b)**	
	0.1549 ± 0.0062	**(Han and Demir, 2010b)**	
	0.1400 ± 0.0056	**(Han and Demir, 2010b)**	
	0.1428 ± 0.0057	**(Han and Demir, 2010b)**	
	0.1401 ± 0.0056	**(Han and Demir, 2010b)**	
	0.1444 ± 0.0058	**(Han and Demir, 2010b)**	
	0.1561 ± 0.0062	**(Han and Demir, 2010b)**	
	0.1122 ± 0.0057	(Kup Aylikci et al., 2010b)	
	0.121 ± 0.006	(Demir and Şahin, 2013)	
	0.162 ± 0.008	(Demir and Şahin, 2013)	
	0.162 ± 0.008	(Demir and Şahin, 2013)	
	0.1216 ± 0.0068	(Cengiz et al., 2014)	
	0.1239 ± 0.0063	(Doğan et al., 2014a)	
	0.125 ± 0.004	(Anand et al., 2015)	
	0.1283 ± 0.0065	(Aylikci et al., 2015)	
	0.133 ± 0.0080	**(Kaçal et al., 2015)**	
	0.1404 ± 0.0042	(Perişanoğlu and Demir, 2015)	
	0.1399 ± 0.0056	(Perişanoğlu and Demir, 2015)	
	0.1379 ± 0.005	(Perişanoğlu and Demir, 2015)	
	0.1404 ± 0.0032	(Alim et al., 2016)	
	0.1399 ± 0.0033	(Alim et al., 2016)	
	0.1379 ± 0.0031	(Alim et al., 2016)	
	0.1343 ± 0.0040	(Perişanoğlu et al., 2016)	
	0.1338 ± 0.0040	(Perişanoğlu et al., 2016)	
	0.1338 ± 0.0047	(Perişanoğlu et al., 2016)	
	0.1334 ± 0.0047	(Perişanoğlu et al., 2016)	
	0.1325 ± 0.0053	(Perişanoğlu et al., 2016)	
	0.1322 ± 0.0053	(Perişanoğlu et al., 2016)	
	0.1314 ± 0.0084	(Akkuş et al., 2017)	
	0.1323 ± 0.0085	(Akkuş et al., 2017)	
	0.1326 ± 0.0078	(Akkuş et al., 2017)	
	0.1245 ± 0.0076	(Akkuş et al., 2017)	
	0.1254 ± 0.0056	(Akkuş et al., 2017)	
	0.1297 ± 0.0062	(Akkuş et al., 2017)	
	0.133 ± 0.007	(Ménesguen *et al.,* 2017)	
	0.132 ± 0.006	(Ménesguen *et al.,* 2017)	
	0.1346 ± 0.0025	(Uğurlu et al., 2017)	
	0.125 ± 0.004	(Anand et al., 2018)	
	0.1238 ± 0.0069	*(Cengiz et al., 2019)*	
	0.1379 ± 0.008	*(Uğurlu and Demir, 2020)*	
	0.1365 ± 0.009	*(Uğurlu and Demir, 2020)*	
	0.1346 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.139	*(Smith et al., 1974)*	
	0.1122	*(Apaydin et al., 2008)*	
	0.1333	*(Han and Demir, 2009)*	
	0.1325	*(Han and Demir, 2010d)*	
Z=29, Cu	**0.1468 ± 0.0073**	**(Slivinsky and Ebert, 1969)**	0.1324 ± 0.0002
	0.1339 ± 0.0027	*(Hansen et al., 1970b)*	
	0.1282 ± 0.0016	*(Richard et al, 1970)*	
	0.1383 ± 0.0047	**(McCrary et al., 1971)**	
	0.134 ± 0.0020	**(Salem et al., 1972)**	
	0.1387 ± 0.0011	(Slivinsky and Ebert, 1972a)	
	0.1387 ± 0.0011	*(Slivinsky and Ebert, 1972b)*	

	0.1474 ± 0.007	*(Slivinsky and Ebert, 1972b)*	
	0.1346 ± 0.0067	*(Close et al., 1973)*	
	0.1451 ± 0.0036	*(Lear and Gray, 1973)*	
	0.1385 ± 0.0018	*(Akselsson and Johansson, 1974)*	
	0.137 ± 0.001	*(Li and Watson, 1974)*	
	0.136 ± 0.002	*(Li and Watson, 1974)*	
	0.136 ± 0.001	*(Li and Watson, 1974)*	
	0.137 ± 0.002	*(Li and Watson, 1974)*	
	0.135 ± 0.002	*(Li and Watson, 1974)*	
	0.134 ± 0.001	*(Li and Watson, 1974)*	
	0.134 ± 0.002	*(Li and Watson, 1974)*	
	0.134 ± 0.001	*(Li and Watson, 1974)*	
	0.1295 ± 0.0010	*(Bodart et al, 1975)*	
	0.133 ± 0.007	*(McDaniel et al., 1975)*	
	0.1381 ± 0.0069	*(Tawara et al., 1975)*	
	0.136 ± 0.002	(Paić and Pečar, 1976)	
	0.137 ± 0.002	*(Paić and Pečar, 1976)*	
	0.1401 ± 0.0041	*(Berényi et al., 1978)*	
	0.1396 ± 0.0084	*(Kamal et al., 1980)*	
	0.1398 ± 0.0084	*(Kamal et al., 1980)*	
	0.1395 ± 0.0084	*(Kamal et al., 1980)*	
	0.136 ± 0.003	*(Shearer-Izumi et al., 1980)*	
	0.1382 ± 0.0016	(Casnati et al., 1985)	
	0.136 ± 0.014	*(Braziewicz et al., 1986)*	
	0.1371 ± 0.0014	*(Campbell et al., 1986)*	
	0.1364 ± 0.0014	*(Campbell et al., 1986)*	
	0.136 ± 0.006	(Rao et al., 1986)	
	0.1367 ± 0.0035	*(Bhan et al., 1987)*	
	0.1372 ± 0.0010	*(Perujo et al., 1987)*	
	0.1374 ± 0.0010	*(Perujo et al., 1987)*	
	0.1388 ± 0.0008	(Tham and Preiss, 1988)	
	0.1387 ± 0.0008	(Tham and Preiss, 1988)	
	0.133 ± 0.0033	**(Coelho et al., 1989)**	
	0.131 ± 0.002	(Marchetti and Franck, 1989)	
	0.1211 ± 0.0019	(Küçükönder et al., 1993a)	
	0.1211 ± 0.0019	(Küçükönder et al., 1993b)	
	0.1404 ± 0.0017	*(Stoev and Dlouhy, 1993)*	
	0.1335 ± 0.0006	(Padhi and Dhal, 1995)	
	0.1412 ± 0.0016	(Rebohle et al., 1996)	
	0.1358 ± 0.0017	(Bé et al., 1998)	
	0.1388 ± 0.0017	(Bé et al., 1998)	
	0.1360 ± 0.0006	(Raj *et al.,* 1998a)	
	0.1402 ± 0.0079	*(Cipolla, 1999)*	
	0.1360 ± 0.0006	*(Pawłowski and Polasik, 2000)*	
	0.1343 ± 0.0014	*(Pawłowski and Polasik, 2000)*	
	0.134 ± 0.013	(Ertuğrul et al., 2001b)	
	0.160 ± 0.008	*(Castellano et al., 2002)*	
	0.1343 ± 0.0012	(Raj et al., 2002)	
	0.1374 ± 0.0113	(Söğüt et al., 2002)	
	0.095 ± 0.003	*(Baydaş et al., 2003)*	
	0.136 ± 0.0054	*(Ximeng et al., 2003)*	
	0.137 ± 0.011	(Çevik et al., 2005)	
	0.1430 ± 0.0014	*(Hatzistergos and Lifshi, 2006)*	
	0.139 ± 0.013	(Öz, 2006)	
	0.136 ± 0.005	(Çevik et al., 2007)	
	0.1359 ± 0.003	(Ertuğral et al., 2007)	
	0.122 ± 0.010	(Han et al., 2007)	
	0.132 ± 0.010	(Porikli et al., 2008)	
	0.124 ± 0.011	(Porikli et al., 2008)	
	0.121 ± 0.011	(Porikli et al., 2008)	

	0.1366 ± 0.033 0.1344 ± 0.033 0.1220 ± 0.034 0.1314 ± 0.0087 0.1197 ± 0.0061 **0.1390 ± 0.0056** **0.1381 ± 0.0055** **0.1379 ± 0.0055** **0.1354 ± 0.0054** **0.1384 ± 0.0055** **0.1388 ± 0.0056** **0.1390 ± 0.0056** **0.1422 ± 0.0057** **0.1444 ± 0.0058** **0.1450 ± 0.0058** 0.1370 ± 0.0052 0.120 ± 0.006 0.111 ± 0.006 0.111 ± 0.006 0.1210 ± 0.0062 0.124 ± 0.009 0.1258 ± 0.0064 **0.137 ± 0.0082** 0.123 ± 0.007 0.123 ± 0.007 0.1296 ± 0.0066 0.1287 ± 0.0085 0.1289 ± 0.0086 0.1314 ± 0.0079 0.1226 ± 0.0075 0.1244 ± 0.0069 0.1244 ± 0.0071 0.1212 ± 0.009 0.124 ± 0.003 *0.1225 ± 0.0015* *0.1207 ± 0.0014* *0.1213 ± 0.0015* *0.1215 ± 0.0015* *0.1231 ± 0.0015* *0.1206 ± 0.0014* *0.1211 ± 0.0015* *0.1223 ± 0.0015* *0.1226 ± 0.0015* *0.1211 ± 0.0015* *0.1232 ± 0.0015* *0.1211 ± 0.0015* *0.1239 ± 0.0015* *0.1239 ± 0.0015* *0.1213 ± 0.0015* *0.1217 ± 0.0015* *0.1221 ± 0.0015* *0.1210 ± 0.0015* *0.1230 ± 0.0015* *0.1247 ± 0.0015* *0.1394 ± 0.007* *0.1380 ± 0.006* *0.1362 ± 0.009* *0.141* *0.1314*	(Porikli and Kurucu, 2008b) (Porikli and Kurucu, 2008b) (Porikli and Kurucu, 2008b) (Kup Aylikci et al., 2009) (Cengiz et al., 2010a) **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** **(Han and Demir, 2010b)** (Han and Demir, 2010c) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Doğan et al., 2014a) (Anand et al., 2015) (Aylikci et al., 2015) **(Kaçal et al., 2015)** (Mirji et al., 2015a) (Mirji et al., 2015b) (Doğan *et al.,* 2016) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Yilmaz, 2017) (Anand et al., 2018) *(Singh et al., 2018)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Smith et al., 1974)* *(Apaydin et al., 2008)*	
Z=30, Zn	**0.1517 ± 0.0076**	**(Slivinsky and Ebert, 1969)**	0.1354 ± 0.0003

	0.1352 ± 0.0027	*(Hansen et al., 1970b)*	
	0.132 ± 0.0020	**(Salem et al., 1972)**	
	0.1418 ± 0.0011	(Slivinsky and Ebert, 1972a)	
	0.1418 ± 0.0011	*(Slivinsky and Ebert, 1972b)*	
	0.152 ± 0.0076	*(Slivinsky and Ebert, 1972b)*	
	0.1456 ± 0.0036	*(Lear and Gray, 1973)*	
	0.139 ± 0.003	*(Li and Watson, 1974)*	
	0.140 ± 0.002	*(Li and Watson, 1974)*	
	0.139 ± 0.001	*(Li and Watson, 1974)*	
	0.142 ± 0.002	*(Li and Watson, 1974)*	
	0.138 ± 0.002	*(Li and Watson, 1974)*	
	0.138 ± 0.002	*(Li and Watson, 1974)*	
	0.137 ± 0.001	*(Li and Watson, 1974)*	
	0.139 ± 0.003	*(Li and Watson, 1974)*	
	0.139 ± 0.007	*(McDaniel et al., 1975)*	
	0.1385 ± 0.0069	*(Tawara et al., 1975)*	
	0.137 ± 0.002	(Paić and Pečar, 1976)	
	0.136 ± 0.002	*(Paić and Pečar, 1976)*	
	0.138 ± 0.006	(Rao et al., 1986)	
	0.1415 ± 0.003	*(Bhan et al., 1987)*	
	0.1378 ± 0.0010	*(Perujo et al., 1987)*	
	0.1390 ± 0.0010	*(Perujo et al., 1987)*	
	0.134 ± 0.0034	**(Coelho et al., 1989)**	
	0.1441 ± 0.0031	*(Stoev and Dlouhy, 1993)*	
	0.1528 ± 0.0015	(Rebohle et al., 1996)	
	0.1488 ± 0.0082	*(Cipolla, 1999)*	
	0.136 ± 0.010	(Ertuğrul et al., 2001b)	
	0.147 ± 0.008	*(Castellano et al., 2002)*	
	0.158 ± 0.005	(Ertuğrul, 2002a)	
	0.147 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.146 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.144 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.143 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.141 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.142 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.146 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.150 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.148 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.147 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.145 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.144 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.147 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.149 ± 0.008	*(İçelli and Erzeneoğlu, 2002)*	
	0.1254 ± 0.0102	(Söğüt et al., 2002)	
	0.137 ± 0.0055	*(Ximeng et al., 2003)*	
	0.127 ± 0.0020	(Doğan and Bacaksiz, 2005)	
	0.1565 ± 0.0031	*(Hatzistergos and Lifshi, 2006)*	
	0.141 ± 0.010	(Öz, 2006)	
	0.136 ± 0.005	(Çevik et al., 2007)	
	0.1379 ± 0.005	(Ertuğral et al., 2007)	
	0.126 ± 0.010	(Han et al., 2007)	
	0.1225 ± 0.0007	(Yalçin, 2007)	
	0.1267 ± 0.0011	(Yalçin, 2007)	
	0.147 ± 0.011	(Porikli et al., 2008)	
	0.139 ± 0.012	(Porikli et al., 2008)	
	0.130 ± 0.012	(Porikli et al., 2008)	
	0.1359 ± 0.028	(Porikli and Kurucu, 2008b)	
	0.1334 ± 0.031	(Porikli and Kurucu, 2008b)	
	0.1247 ± 0.030	(Porikli and Kurucu, 2008b)	
	0.130 ± 0.008	(Söğüt et al., 2008)	

	0.1167 ± 0.0060	(Cengiz et al., 2010a)	
	0.1200 ± 0.0061	(Kup Aylikci et al., 2010a)	
	0.1200 ± 0.0061	(Kup Aylikci et al., 2011)	
	0.126 ± 0.006	(Demir and Şahin, 2013)	
	0.116 ± 0.006	(Demir and Şahin, 2013)	
	0.116 ± 0.006	(Demir and Şahin, 2013)	
	0.1200 ± 0.0061	(Doğan et al., 2013)	
	0.1168 ± 0.0060	(Doğan et al., 2014a)	
	0.1221 ± 0.0062	(Doğan et al., 2014b)	
	0.127 ± 0.004	(Anand et al., 2015)	
	0.1278 ± 0.0065	(Aylikci et al., 2015)	
	0.127 ± 0.005	(Mirji et al., 2015a)	
	0.127 ± 0.005	(Mirji et al., 2015b)	
	0.1317 ± 0.0059	(Akman, 2016b)	
	0.1299 ± 0.0061	(Akkuş et al., 2017)	
	0.1305 ± 0.0064	(Akkuş et al., 2017)	
	0.1307 ± 0.0059	(Akkuş et al., 2017)	
	0.1243 ± 0.0066	(Akkuş et al., 2017)	
	0.1244 ± 0.0062	(Akkuş et al., 2017)	
	0.1271 ± 0.0059	(Akkuş et al., 2017)	
	0.1304 ± 0.0074	(Cengiz *et al.,* 2017)	
	0.1200 ± 0.0061	(Kup Aylikci *et al.,* 2017)	
	0.127 ± 0.003	(Anand et al., 2018)	
	0.1338 ± 0.0096	(Söğüt *et al.,* 2018)	
	0.1503 ± 0.0067	*(Perişanoğlu et al., 2020)*	
	0.1492 ± 0.0067	*(Perişanoğlu et al., 2020)*	
	0.1484 ± 0.0066	*(Perişanoğlu et al., 2020)*	
	0.1476 ± 0.0066	*(Perişanoğlu et al., 2020)*	
	0.1415 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.1357 ± 0.005	*(Uğurlu and Demir, 2020)*	
	0.1374 ± 0.006	*(Uğurlu and Demir, 2020)*	
	0.143	*(Smith et al., 1974)*	
	0.1197	*(Apaydin et al., 2008)*	
Z=31, Ga	*0.1371 ± 0.0027*	*(Hansen et al., 1970b)*	0.1442 ± 0.0014
	0.143 ± 0.0029	**(Salem et al., 1972)**	
	0.1548 ± 0.0038	*(Lear and Gray, 1973)*	
	0.142 ± 0.007	*(McDaniel et al., 1975)*	
	0.1503 ± 0.0033	*(Stoev and Dlouhy, 1993)*	
	0.134 ± 0.011	(Öz, 2006)	
	0.143 ± 0.006	(Çevik et al., 2007)	
	0.1435 ± 0.0048	(Akman, 2016b)	
Z=32, Ge	*0.1395 ± 0.0028*	*(Hansen et al., 1970b)*	0.1498 ± 0.0003
	0.1507 ± 0.0048	**(McCrary et al., 1971)**	
	0.150 ± 0.0030	**(Salem et al., 1972)**	
	0.1493 ± 0.0012	(Slivinsky and Ebert, 1972a)	
	0.1493 ± 0.0012	*(Slivinsky and Ebert, 1972b)*	
	0.1477 ± 0.0074	*(Close et al., 1973)*	
	0.148 ± 0.002	*(Li and Watson, 1974)*	
	0.149 ± 0.004	*(Li and Watson, 1974)*	
	0.150 ± 0.001	*(Li and Watson, 1974)*	
	0.150 ± 0.001	*(Li and Watson, 1974)*	
	0.149 ± 0.002	*(Li and Watson, 1974)*	
	0.147 ± 0.002	*(Li and Watson, 1974)*	
	0.147 ± 0.003	*(Li and Watson, 1974)*	
	0.148 ± 0.003	*(Li and Watson, 1974)*	
	0.1450 ± 0.0011	*(Perujo et al., 1987)*	
	0.1449 ± 0.0011	*(Perujo et al., 1987)*	
	0.1499 ± 0.0024	(Tham and Preiss, 1988)	
	0.1498 ± 0.0023	(Tham and Preiss, 1988)	
	0.1537 ± 0.0006	*(Stoev and Dlouhy, 1993)*	

	0.1534 ± 0.0102	*(Cipolla, 1999)*	
	0.153 ± 0.008	*(Castellano et al., 2002)*	
	0.1597 ± 0.0032	*(Hatzistergos and Lifshi, 2006)*	
	0.152 ± 0.012	(Öz, 2006)	
	0.131 ± 0.010	(Han et al., 2007)	
	0.1465 ± 0.005	(Akman, 2016b)	
	0.1311 ± 0.010	(Yilmaz, 2017)	
Z=33, As	*0.1440 ± 0.0029*	*(Hansen et al., 1970b)*	0.1553 ± 0.0005
	0.1534 ± 0.0038	*(Lear and Gray, 1973)*	
	0.152 ± 0.008	*(McDaniel et al., 1975)*	
	0.1543 ± 0.025	(Marques et al., 1980)	
	0.1533 ± 0.0015	*(Campbell et al., 1986)*	
	0.1526 ± 0.0015	*(Campbell et al., 1986)*	
	0.156 ± 0.006	(Rao et al., 1986)	
	0.1574 ± 0.0006	*(Stoev and Dlouhy, 1993)*	
	0.152 ± 0.011	(Ertuğrul et al., 2001b)	
	0.164 ± 0.009	*(Castellano et al., 2002)*	
	0.163 ± 0.007	(Ertuğrul, 2002a)	
	0.152 ± 0.0061	*(Ximeng et al., 2003)*	
	0.157 ± 0.011	(Öz, 2006)	
	0.1511 ± 0.005	(Ertuğral et al., 2007)	
	0.136 ± 0.011	(Han et al., 2007)	
	0.142 ± 0.007	(Demir and Şahin, 2013)	
	0.125 ± 0.006	(Demir and Şahin, 2013)	
	0.125 ± 0.006	(Demir and Şahin, 2013)	
	0.1367 ± 0.009	(Yilmaz, 2017)	
Z=34, Se	**0.1692 ± 0.0051**	**(Slivinsky and Ebert, 1969)**	0.1622 ± 0.0003
	0.1511 ± 0.0030	*(Hansen et al., 1970b)*	
	0.1569 ± 0.0047	**(McCrary et al., 1971)**	
	0.1595 ± 0.0013	(Slivinsky and Ebert, 1972a)	
	0.1595 ± 0.0013	*(Slivinsky and Ebert, 1972b)*	
	0.169 ± 0.0051	*(Slivinsky and Ebert, 1972b)*	
	0.162 ± 0.015	*(Criswell and Gray, 1974)*	
	0.164 ± 0.001	*(Li and Watson, 1974)*	
	0.163 ± 0.004	*(Li and Watson, 1974)*	
	0.163 ± 0.001	*(Li and Watson, 1974)*	
	0.165 ± 0.001	*(Li and Watson, 1974)*	
	0.162 ± 0.002	*(Li and Watson, 1974)*	
	0.162 ± 0.001	*(Li and Watson, 1974)*	
	0.163 ± 0.001	*(Li and Watson, 1974)*	
	0.165 ± 0.002	*(Li and Watson, 1974)*	
	0.152 ± 0.010	*(McDaniel et al., 1975)*	
	0.1572 ± 0.0079	*(Tawara et al., 1975)*	
	0.1605 ± 0.0049	*(Berényi et al., 1978)*	
	0.156 ± 0.016	*(Braziewicz et al., 1986)*	
	0.1616 ± 0.0010	(Tham and Preiss, 1988)	
	0.1615 ± 0.0010	(Tham and Preiss, 1988)	
	0.1635 ± 0.0010	*(Stoev and Dlouhy, 1993)*	
	0.157 ± 0.012	(Ertuğrul et al., 2001b)	
	0.164 ± 0.010	(Ertuğrul, 2002a)	
	0.162 ± 0.011	(Öz, 2006)	
	0.167 ± 0.006	(Çevik et al., 2007)	
	0.1612 ± 0.005	(Ertuğral et al., 2007)	
	0.1645 ± 0.009	(Saydam et al., 2012)	
	0.138 ± 0.007	(Demir and Şahin, 2013)	
	0.130 ± 0.007	(Demir and Şahin, 2013)	
	0.130 ± 0.007	(Demir and Şahin, 2013)	
	0.1474 ± 0.0065	(Akman, 2016b)	
	0.1426	*(Küçükönder et al., 1993c)*	
Z=35, Br	*0.1573 ± 0.0031*	*(Hansen et al., 1970b)*	0.1680 ± 0.0004

	0.168 ± 0.0034	**(Salem et al., 1972)**	
	0.169 ± 0.013	*(Criswell and Gray, 1974)*	
	0.166 ± 0.003	*(Li and Watson, 1974)*	
	0.164 ± 0.002	*(Li and Watson, 1974)*	
	0.165 ± 0.003	*(Li and Watson, 1974)*	
	0.166 ± 0.002	*(Li and Watson, 1974)*	
	0.164 ± 0.003	*(Li and Watson, 1974)*	
	0.165 ± 0.002	*(Li and Watson, 1974)*	
	0.164 ± 0.004	*(Li and Watson, 1974)*	
	0.166 ± 0.001	*(Li and Watson, 1974)*	
	0.1713 ± 0.0006	*(Stoev and Dlouhy, 1993)*	
	0.168 ± 0.010	(Ertuğrul et al., 2001b)	
	0.169 ± 0.010	(Öz, 2006)	
	0.1682 ± 0.006	(Ertuğral et al., 2007)	
	0.143 ± 0.011	(Han et al., 2007)	
	0.1504 ± 0.0054	(Akkuş et al., 2017)	
	0.1521 ± 0.0057	(Akkuş et al., 2017)	
	0.1553 ± 0.0052	(Akkuş et al., 2017)	
	0.1589 ± 0.0057	(Akkuş et al., 2017)	
	0.1594 ± 0.0054	(Akkuş et al., 2017)	
	0.1650 ± 0.0066	(Akkuş et al., 2017)	
	0.1485 ± 0.011	(Yilmaz, 2017)	
Z=36, Kr	*0.1634 ± 0.0033*	*(Hansen et al., 1970b)*	0.1710 ± 0.0009
	0.1715 ± 0.0014	(Slivinsky and Ebert, 1972a)	
	0.1715 ± 0.0014	*(Slivinsky and Ebert, 1972b)*	
	0.189 ± 0.010	*(Winters et al., 1973)*	
Z=37, Rb	*0.1682 ± 0.0034*	*(Hansen et al., 1970b)*	0.1748 ± 0.0007
	0.1748 ± 0.0048	**(McCrary et al., 1971)**	
	0.1779 ± 0.0089	*(Close et al., 1973)*	
	0.175 ± 0.014	*(Criswell and Gray, 1974)*	
	0.165 ± 0.010	*(McDaniel et al., 1975)*	
	0.1629 ± 0.0098	*(Kamal et al., 1980)*	
	0.166 ± 0.010	*(Kamal et al., 1980)*	
	0.1670 ± 0.010	*(Kamal et al., 1980)*	
	0.1766 ± 0.0018	(Marques et al., 1980)	
	0.183 ± 0.018	*(Braziewicz et al., 1986)*	
	0.178 ± 0.018	*(Braziewicz et al., 1986)*	
	0.1751 ± 0.0008	*(Stoev and Dlouhy, 1993)*	
	0.171 ± 0.015	(Ertuğrul et al., 2001b)	
	0.170 ± 0.009	(Ertuğrul, 2002a)	
	0.175 ± 0.011	(Öz, 2006)	
	0.1806 ± 0.007	(Ertuğral et al., 2007)	
	0.158 ± 0.013	(Han et al., 2007)	
	0.1588 ± 0.012	(Yilmaz, 2017)	
Z=38, Sr	**0.1815 ± 0.0054**	**(Slivinsky and Ebert, 1969)**	0.1798 ± 0.0011
	0.1732 ± 0.0035	*(Hansen et al., 1970b)*	
	0.181 ± 0.0054	*(Slivinsky and Ebert, 1972b)*	
	0.199 ± 0.016	*(Criswell and Gray, 1974)*	
	0.176 ± 0.009	*(McDaniel et al., 1975)*	
	0.1828 ± 0.0018	(Marques et al., 1980)	
	0.1834 ± 0.003	*(Bhan et al., 1987)*	
	0.1782 ± 0.0026	*(Stoev and Dlouhy, 1993)*	
	0.181 ± 0.016	(Ertuğrul et al., 2001b)	
	0.162 ± 0.006	(Ertuğrul, 2002a)	
	0.186 ± 0.010	(Öz, 2006)	
	0.1812 ± 0.009	(Ertuğral et al., 2007)	
	0.164 ± 0.008	(Demir and Şahin, 2013)	
	0.180 ± 0.009	(Demir and Şahin, 2013)	
	0.181 ± 0.009	(Demir and Şahin, 2013)	
Z=39, Y	**0.1859 ± 0.0056**	**(Slivinsky and Ebert, 1969)**	0.1823 ± 0.0007

	0.1791 ± 0.0036	*(Hansen et al., 1970b)*	
	0.190 ± 0.0038	**(Salem et al., 1972)**	
	0.1842 ± 0.0015	(Slivinsky and Ebert, 1972a)	
	0.1842 ± 0.0015	*(Slivinsky and Ebert, 1972b)*	
	0.186 ± 0.0056	*(Slivinsky and Ebert, 1972b)*	
	0.181 ± 0.015	*(Criswell and Gray, 1974)*	
	0.183 ± 0.009	*(McDaniel et al., 1975)*	
	0.193 ± 0.010	*(Tawara et al., 1975)*	
	0.1919 ± 0.0059	*(Berényi et al., 1978)*	
	0.183 ± 0.007	(Rao et al., 1986)	
	0.1791 ± 0.0038	*(Stoev and Dlouhy, 1993)*	
	0.186 ± 0.009	*(Ximeng et al., 2001)*	
	0.174 ± 0.009	(Ertuğrul, 2002a)	
	0.188 ± 0.010	(Öz, 2006)	
	0.191 ± 0.007	(Çevik et al., 2007)	
	0.1856 ± 0.009	(Ertuğral et al., 2007)	
	0.169 ± 0.014	(Han et al., 2007)	
	0.1822 ± 0.008	(Porikli et al., 2011)	
	0.1822 ± 0.008	(Porikli and Kurucu, 2011b)	
	0.1753 ± 0.011	(Porikli and Kurucu, 2011b)	
	0.1712 ± 0.011	(Porikli and Kurucu, 2011b)	
	0.169 ± 0.009	(Demir and Şahin, 2013)	
	0.182 ± 0.009	(Demir and Şahin, 2013)	
	0.182 ± 0.009	(Demir and Şahin, 2013)	
	0.1675 ± 0.0070	(Akman, 2016b)	
	0.1686 ± 0.0076	**(Özdemir et al., 2016)**	
	0.1691 ± 0.0076	**(Özdemir et al., 2016)**	
	0.1693 ± 0.0076	**(Özdemir et al., 2016)**	
	0.1705 ± 0.0077	**(Özdemir et al., 2016)**	
	0.1707 ± 0.0077	**(Özdemir et al., 2016)**	
	0.1705 ± 0.0077	**(Özdemir et al., 2016)**	
	0.1702 ± 0.0077	**(Özdemir et al., 2016)**	
	0.1706 ± 0.0077	**(Özdemir et al., 2016)**	
	0.1815 ± 0.0063	(Akkuş et al., 2017)	
	0.1836 ± 0.0066	(Akkuş et al., 2017)	
	0.1841 ± 0.0059	(Akkuş et al., 2017)	
	0.1764 ± 0.0058	(Akkuş et al., 2017)	
	0.1763 ± 0.0053	(Akkuş et al., 2017)	
	0.1844 ± 0.0062	(Akkuş et al., 2017)	
	0.1853 ± 0.007	*(Uğurlu and Demir, 2020)*	
	0.1842 ± 0.006	*(Uğurlu and Demir, 2020)*	
	0.1822 ± 0.008	*(Uğurlu and Demir, 2020)*	
Z=40, Zr	*0.1838 ± 0.0037*	*(Hansen et al., 1970b)*	0.1838 ± 0.0011
	0.1878 ± 0.0050	**(McCrary et al., 1971)**	
	0.192 ± 0.0038	**(Salem et al., 1972)**	
	0.190 ± 0.0057	*(Slivinsky and Ebert, 1972b)*	
	0.192 ± 0.010	*(Close et al., 1973)*	
	0.194 ± 0.019	*(Braziewicz et al., 1986)*	
	0.196 ± 0.020	*(Braziewicz et al., 1986)*	
	0.190 ± 0.006	(Rao et al., 1986)	
	0.1896 ± 0.0035	*(Bhan et al., 1987)*	
	0.191 ± 0.016	(Ertuğrul et al., 2001b)	
	0.192 ± 0.016	*(Castellano et al., 2002)*	
	0.185 ± 0.006	(Ertuğrul, 2002a)	
	0.176 ± 0.018	(Ertuğrul et al., 2002)	
	0.193 ± 0.014	(Öz, 2006)	
	0.1898 ± 0.008	(Ertuğral et al., 2007)	
	0.171 ± 0.014	(Han et al., 2007)	
	0.1877 ± 0.009	(Porikli et al., 2011)	
	0.1737 ± 0.004	(Turşucu et al., 2012)	

	0.177 ± 0.009 0.193 ± 0.010 0.192 ± 0.010 **0.1737 ± 0.0078** 0.195 ± 0.023 0.17 ± 0.01 0.1848 ± 0.0071 **0.1693 ± 0.0076** **0.1695 ± 0.0076** **0.1698 ± 0.0076** **0.1717 ± 0.0077** **0.1738 ± 0.0078** **0.1743 ± 0.0078** **0.1740 ± 0.0078** **0.1741 ± 0.0078** 0.1941 ± 0.0085 0.1981 ± 0.0072 0.1991 ± 0.0075 0.1744 ± 0.0082 0.1757 ± 0.0069 0.1853 ± 0.0068 *0.1866 ± 0.008* *0.1849 ± 0.006* *0.1831 ± 0.006* *0.1780*	(Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) **(Onder et al., 2013)** (Turşucu et al., 2013) (Aksoy et al., 2015) (Akman, 2016b) **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Küçükönder et al., 1993c)*	
Z=41, Nb	*0.1886 ± 0.0038* **0.193 ± 0.0039** *0.15 ± 0.015* *0.18 ± 0.018* *0.17 ± 0.017* *0.18 ± 0.018* *0.19 ± 0.019* *0.19 ± 0.019* *0.19 ± 0.019* *0.17 ± 0.017* *0.19 ± 0.019* *0.23 ± 0.023* *0.20 ± 0.020* *0.20 ± 0.020* *0.20 ± 0.020* *0.19 ± 0.019* *0.18 ± 0.018* *0.18 ± 0.018* *0.16 ± 0.016* *0.20 ± 0.020* *0.201 ± 0.020* *0.200 ± 0.020* 0.194 ± 0.006 *0.1981 ± 0.0035* *0.1756 ± 0.0024* *0.186 ± 0.011* 0.196 ± 0.012 0.1993 ± 0.008 0.178 ± 0.014 *0.177 ± 0.012* 0.1984 ± 0.010 0.1772 ± 0.004 0.175 ± 0.009 0.190 ± 0.010 0.191 ± 0.010	*(Hansen et al., 1970b)* **(Salem et al., 1972)** *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Braziewicz et al., 1986)* *(Braziewicz et al., 1986)* (Rao et al., 1986) *(Bhan et al., 1987)* *(Stoev and Dlouhy, 1993)* *(Çalışkan et al., 2002)* (Öz, 2006) (Ertuğral et al., 2007) (Han et al., 2007) *(Cengiz et al., 2008)* (Porikli et al., 2011) (Turşucu et al., 2012) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013)	0.1851 ± 0.0010

	0.1772 ± 0.0080 0.197 ± 0.022 0.1783 ± 0.0064 **0.1758 ± 0.0079** **0.1758 ± 0.0079** **0.1761 ± 0.0079** **0.1783 ± 0.0080** **0.1788 ± 0.0080** **0.1813 ± 0.0082** **0.1812 ± 0.0082** **0.1815 ± 0.0082** 0.1997 ± 0.0073 0.2020 ± 0.0084 0.2098 ± 0.0069 0.1788 ± 0.0074 0.1797 ± 0.0059 0.1864 ± 0.0059 *0.1890 ± 0.009* *0.1866 ± 0.007* *0.1840 ± 0.007*	**(Onder et al., 2013)** (Turşucu et al., 2013) (Akman, 2016b) **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) (Akkuş et al., 2017) *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)*	
Z=42, Mo	**0.1969 ± 0.0059** *0.1930 ± 0.0039* **0.2016 ± 0.0056** *0.197 ± 0.0059* *0.196 ± 0.015* *0.193 ± 0.003* *0.197 ± 0.002* *0.198 ± 0.002* *0.199 ± 0.003* *0.192 ± 0.002* *0.195 ± 0.002* *0.197 ± 0.004* *0.198 ± 0.003* *0.21 ± 0.021* *0.21 ± 0.021* *0.18 ± 0.018* *0.19 ± 0.019* *0.17 ± 0.017* *0.16 ± 0.016* *0.15 ± 0.015* *0.17 ± 0.017* 0.1974 ± 0.0015 *0.206 ± 0.021* *0.204 ± 0.020* 0.199 ± 0.006 *0.2013 ± 0.003* *0.1871 ± 0.0025* 0.2048 ± 0.0005 0.193 ± 0.014 0.1898 ± 0.015 *0.179 ± 0.021* *0.203 ± 0.008* 0.182 ± 0.009 0.202 ± 0.010 0.185 ± 0.005 0.197 ± 0.006 0.2016 ± 0.004 0.185 ± 0.005 0.2007 ± 0.010 0.1809 ± 0.004	**(Slivinsky and Ebert, 1969)** *(Hansen et al., 1970b)* **(McCrary et al., 1971)** *(Slivinsky and Ebert, 1972b)* *(Criswell and Gray, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* (Casnati et al., 1985) *(Braziewicz et al., 1986)* *(Braziewicz et al., 1986)* (Rao et al., 1986) *(Bhan et al., 1987)* *(Stoev and Dlouhy, 1993)* (Padhi and Dhal, 1995) (Ertuğrul et al., 2001b) (Söğüt et al., 2001) *(Castellano et al., 2002)* *(Çalışkan et al., 2002)* (Ertuğrul et al., 2002) (Öz, 2006) (Bennal and Badiger, 2007) (Çevik et al., 2007) (Ertuğral et al., 2007) (Bennal et al., 2010) (Porikli et al., 2011) (Turşucu et al., 2012)	0.2006 ± 0.0004

	0.184 ± 0.007 0.193 ± 0.010 0.203 ± 0.010 0.203 ± 0.010 **0.1809 ± 0.0081** 0.201 ± 0.022 0.1804 ± 0.0063 **0.1860 ± 0.0084** **0.1881 ± 0.0085** **0.1902 ± 0.0086** **0.1912 ± 0.0086** **0.1917 ± 0.0086** **0.1942 ± 0.0087** **0.1963 ± 0.0088** **0.1958 ± 0.0088** *0.1917 ± 0.007* *0.1891 ± 0.006* *0.1877 ± 0.009* *0.2028* *0.2026* *0.2024*	(Anand et al., 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) **(Onder et al., 2013)** (Turşucu et al., 2013) (Akman, 2016b) **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** **(Özdemir et al., 2016)** *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu et al.,2019)* *(Uğurlu et al.,2019)* *(Uğurlu et al.,2019)*	
Z=43, Tc	*0.1973 ± 0.0039* 0.1776 ± 0.0008 0.1853 ± 0.0008	*(Hansen et al., 1970b)* (Yalçin, 2007) (Yalçin, 2007)	0.1818 ± 0.0006
Z=44, Ru	*0.2018 ± 0.0040* 0.2126 ± 0.0005 0.198 ± 0.016 0.1714 ± 0.0013 0.2034 ± 0.0010 0.1875 ± 0.004 **0.1875 ± 0.0084** 0.204 ± 0.018 0.1946 ± 0.0058 *0.1988 ± 0.009* *0.1957 ± 0.007* *0.1939 ± 0.007*	*(Hansen et al., 1970b)* (Padhi and Dhal, 1995) (Ertuğrul et al., 2001b) (Yalçin, 2007) (Yalçin, 2007) (Turşucu et al., 2012) **(Onder et al., 2013)** (Turşucu et al., 2013) (Akman, 2016b) *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)*	0.2061 ± 0.0004
Z=45, Rh	*0.2055 ± 0.0041* **0.2120 ± 0.0056** **0.250 ± 0.0050** *0.19 ± 0.019* *0.22 ± 0.022* *0.19 ± 0.019* *0.20 ± 0.020* *0.20 ± 0.020* *0.18 ± 0.018* *0.22 ± 0.022* *0.18 ± 0.018* *0.19 ± 0.019* *0.21 ± 0.021* *0.18 ± 0.018* *0.18 ± 0.018* *0.21 ± 0.021* *0.19 ± 0.019* *0.16 ± 0.016* *0.23 ± 0.023* *0.19 ± 0.019* *0.20 ± 0.020* *0.2033 ± 0.0020* 0.2033 ± 0.0020 0.210 ± 0.004	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** **(Salem et al., 1972)** *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Marques et al., 1978)* (Marques et al., 1980) (Rao et al., 1986)	0.2070 ± 0.0004

	0.2055 ± 0.004 *0.2053 ± 0.0061* *0.1951 ± 0.0040* 0.2078 ± 0.0005 0.212 ± 0.017 0.1906 ± 0.004 **0.1905 ± 0.0086** 0.207 ± 0.018 *0.2019 ± 0.008* *0.1987 ± 0.008* *0.1966 ± 0.006*	*(Bhan et al., 1987)* *(Chand et al., 1988)* *(Stoev and Dlouhy, 1993)* (Padhi and Dhal, 1995) (Ertuğrul et al., 2001b) (Turşucu et al., 2012) **(Onder et al., 2013)** (Turşucu et al., 2013) *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)*	
Z=46, Pd	**0.2101 ± 0.0063** *0.2091 ± 0.0042* *0.210 ± 0.0063* *0.158 ± 0.014* *0.2061 ± 0.0016* 0.2061 ± 0.0016 0.211 ± 0.004 *0.2014 ± 0.0033* 0.2124 ± 0.0005 0.207 ± 0.014 *0.186 ± 0.009* 0.198 ± 0.009 0.1993 ± 0.004 **0.1932 ± 0.0087** 0.211 ± 0.019 0.2109 ± 0.0062 *0.2066 ± 0.007* *0.2046 ± 0.006* *0.2026 ± 0.007*	**(Slivinsky and Ebert, 1969)** *(Hansen et al., 1970b)* *(Slivinsky and Ebert, 1972b)* *(Criswell and Gray, 1974)* *(Marques et al., 1978)* (Marques et al., 1980) (Rao et al., 1986) *(Stoev and Dlouhy, 1993)* (Padhi and Dhal, 1995) (Ertuğrul et al., 2001b) *(Çalışkan et al., 2002)* (Ertuğrul et al., 2002) (Turşucu et al., 2012) **(Onder et al., 2013)** (Turşucu et al., 2013) (Akman, 2016b) *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)*	0.2107 ± 0.0004
Z=47, Ag	*0.2110 ± 0.0042* **0.2185 ± 0.0058** *0.2119 ± 0.0040* *0.214 ± 0.015* *0.207 ± 0.015* *0.217 ± 0.011* *0.2123 ± 0.0068* *0.203 ± 0.004* *0.206 ± 0.006* *0.210 ± 0.005* *0.210 ± 0.006* *0.203 ± 0.004* *0.204 ± 0.006* *0.208 ± 0.004* *0.208 ± 0.006* *0.192 ± 0.044* *0.20 ± 0.020* *0.23 ± 0.023* *0.21 ± 0.021* *0.22 ± 0.022* *0.21 ± 0.021* *0.21 ± 0.021* *0.22 ± 0.022* *0.21 ± 0.021* *0.22 ± 0.022* *0.22 ± 0.022* *0.21 ± 0.021* *0.21 ± 0.021* *0.22 ± 0.022* *0.22 ± 0.022*	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** *(Mistry and Quarles, 1971a)* *(Bissinger et al.,1972)* *(Bissinger et al.,1972)* *(Close et al., 1973)* *(Akselsson and Johansson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Li and Watson, 1974)* *(Khelil and Gray, 1975)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)*	0.2016 ± 0.0003

	0.23 ± 0.023	*(Wilson et al., 1977)*	
	0.23 ± 0.023	*(Wilson et al., 1977)*	
	0.21 ± 0.021	*(Wilson et al., 1977)*	
	0.21 ± 0.021	*(Wilson et al., 1977)*	
	0.24 ± 0.024	*(Wilson et al., 1977)*	
	0.22 ± 0.022	*(Wilson et al., 1977)*	
	0.207 ± 0.010	*(Berényi et al., 1978)*	
	0.207 ± 0.012	*(Kamal et al., 1980)*	
	0.210 ± 0.013	*(Kamal et al., 1980)*	
	0.2127 ± 0.013	*(Kamal et al., 1980)*	
	0.2105 ± 0.0021	(Marques et al., 1980)	
	0.206 ± 0.004	*(Shearer-Izumi et al., 1980)*	
	0.226 ± 0.023	*(Braziewicz et al., 1986)*	
	0.212 ± 0.004	(Rao et al., 1986)	
	0.2157 ± 0.004	*(Bhan et al., 1987)*	
	0.203 ± 0.0051	**(Coelho et al., 1989)**	
	0.2010 ± 0.0010	*(Stoev and Dlouhy, 1993)*	
	0.2009 ± 0.0003	(Dhal and Padhi, 1994)	
	0.217 ± 0.015	(Ertuğrul et al., 2001b)	
	0.216 ± 0.008	*(Çalışkan et al., 2002)*	
	0.198 ± 0.010	(Ertuğrul et al., 2002)	
	0.212 ± 0.015	*(Baydaş, 2005)*	
	0.198 ± 0.003	(Bennal and Badiger, 2007)	
	0.2096 ± 0.004	(Ertuğral et al., 2007)	
	0.2101 ± 0.0139	(Kup Aylikci et al., 2009)	
	0.198 ± 0.003	(Bennal et al., 2010)	
	0.1964 ± 0.004	(Turşucu et al., 2012)	
	0.192 ± 0.005	(Anand et al., 2013)	
	0.186 ± 0.009	(Demir and Şahin, 2013)	
	0.172 ± 0.009	(Demir and Şahin, 2013)	
	0.172 ± 0.009	(Demir and Şahin, 2013)	
	0.1963 ± 0.0088	**(Onder et al., 2013)**	
	0.214 ± 0.022	(Turşucu et al., 2013)	
	0.212 ± 0.003	(George et al., 2014)	
	0.2154 ± 0.0065	(Akman, 2016b)	
	0.1962 ± 0.0038	*(Gójska et al., 2020)*	
	0.2099 ± 0.008	*(Uğurlu and Demir, 2020)*	
	0.2061 ± 0.008	*(Uğurlu and Demir, 2020)*	
	0.2039 ± 0.008	*(Uğurlu and Demir, 2020)*	
	0.2087	*(Uğurlu et al.,2019)*	
	0.2084	*(Uğurlu et al.,2019)*	
	0.2075	*(Uğurlu et al.,2019)*	
Z=48, Cd	*0.2155 ± 0.0043*	*(Hansen et al., 1970b)*	0.2080 ± 0.0004
	0.204 ± 0.046	*(Khelil and Gray, 1975)*	
	0.2141 ± 0.0012	(Casnati et al., 1985)	
	0.214 ± 0.004	(Rao et al., 1986)	
	0.210 ± 0.0053	**(Coelho et al., 1989)**	
	0.2043 ± 0.0006	*(Stoev and Dlouhy, 1993)*	
	0.2141 ± 0.0009	(Dhal and Padhi, 1994)	
	0.217 ± 0.015	(Ertuğrul et al., 2001b)	
	0.2127 ± 0.013	(Söğüt et al., 2001)	
	0.220 ± 0.013	*(Çalışkan et al., 2002)*	
	0.210 ± 0.011	*(Baydaş, 2005)*	
	0.206 ± 0.011	(Doğan and Bacaksiz, 2005)	
	0.210 ± 0.021	(Bacaksiz *et al.,* 2006)	
	0.199 ± 0.004	(Bennal and Badiger, 2007)	
	0.212 ± 0.007	(Çevik et al., 2007)	
	0.2035 ± 0.006	(Ertuğral et al., 2007)	
	0.200 ± 0.016	(Han et al., 2007)	
	0.2068 ± 0.0011	(Yalçin, 2007)	

	0.2106 ± 0.0022 0.199 ± 0.004 0.1995 ± 0.004 0.200 ± 0.010 0.184 ± 0.009 0.184 ± 0.009 **0.2057 ± 0.0093** 0.221 ± 0.024 0.2133 ± 0.0063 *0.2127 ± 0.006* *0.2105 ± 0.005* *0.2093 ± 0.005*	(Yalçin, 2007) (Bennal et al., 2010) (Turşucu et al., 2012) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) **(Onder et al., 2013)** (Turşucu et al., 2013) (Akman, 2016b) *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)* *(Uğurlu and Demir, 2020)*	
Z=49, In	*0.2192 ± 0.0044* *0.216 ± 0.011* *0.22 ± 0.022* *0.22 ± 0.022* *0.23 ± 0.023* *0.22 ± 0.022* *0.22 ± 0.022* *0.22 ± 0.022* *0.22 ± 0.022* *0.22 ± 0.022* *0.23 ± 0.023* *0.22 ± 0.022* *0.222 ± 0.011* *0.2147 ± 0.0021* 0.2147 ± 0.0021 *0.209 ± 0.003* 0.219 ± 0.004 *0.2148 ± 0.004* 0.219 ± 0.006 *0.218 ± 0.006* **0.217 ± 0.0054** *0.2079 ± 0.0008* 0.220 ± 0.018 *0.231 ± 0.011* 0.205 ± 0.003 0.219 ± 0.008 0.2098 ± 0.009 0.203 ± 0.016 0.205 ± 0.003 0.204 ± 0.010 0.188 ± 0.010 0.189 ± 0.010 0.2179 ± 0.0067	*(Hansen et al., 1970b)* *(Tawara et al., 1975)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Berényi et al., 1978)* *(Marques et al., 1978)* (Marques et al., 1980) *(Shearer-Izumi et al., 1980)* (Rao et al., 1986) *(Bhan et al., 1987)* (Rao et al., 1987) *(Rao et al., 1987)* **(Coelho et al., 1989)** *(Stoev and Dlouhy, 1993)* (Ertuğrul et al., 2001b) *(Çalışkan et al., 2002)* (Bennal and Badiger, 2007) (Çevik et al., 2007) (Ertuğral et al., 2007) (Han et al., 2007) (Bennal et al., 2010) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Akman, 2016b)	0.2100 ± 0.0006
Z=50, Sn	*0.2226 ± 0.0045* **0.2306 ± 0.0064** *0.224 ± 0.011* **0.189 ± 0.046** **0.189 ± 0.036** **0.200 ± 0.032** **0.208 ± 0.030** **0.213 ± 0.023** **0.222 ± 0.015** **0.227 ± 0.015** **0.222 ± 0.015** **0.222 ± 0.015** **0.227 ± 0.015** **0.233 ± 0.016** **0.227 ± 0.015**	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** *(Close et al., 1973)* **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)**	0.2171 ± 0.0005

	0.227 ± 0.015 **0.233 ± 0.016** **0.227 ± 0.010** **0.233 ± 0.016** **0.233 ± 0.011** **0.233 ± 0.011** *0.213 ± 0.050* *0.226 ± 0.011* *0.23 ± 0.023* *0.22 ± 0.022* *0.22 ± 0.022* *0.19 ± 0.019* *0.21 ± 0.021* *0.20 ± 0.020* *0.20 ± 0.020* *0.19 ± 0.019* *0.226 ± 0.011* *0.211 ± 0.004* *0.218 ± 0.010* 0.222 ± 0.005 **0.215 ± 0.0054** *0.2126 ± 0.0020* 0.2183 ± 0.0006 0.226 ± 0.020 *0.209 ± 0.012* *0.218 ± 0.011* 0.208 ± 0.003 0.221 ± 0.009 0.2086 ± 0.011 0.206 ± 0.017 0.208 ± 0.003 0.2061 ± 0.004 0.205 ± 0.010 0.225 ± 0.011 0.224 ± 0.011 **0.2029 ± 0.0091** 0.235 ± 0.033 0.2148 ± 0.0067 0.1949 ± 0.0099	**(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** **(Mohler and Cothern, 1973)** *(Khelil and Gray, 1975)* *(Tawara et al., 1975)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Berényi et al., 1978)* *(Dost et al., 1981)* *(Dost et al., 1981)* (Rao et al., 1986) **(Coelho et al., 1989)** *(Stoev and Dlouhy, 1993)* (Dhal and Padhi, 1994) (Ertuğrul et al., 2001b) *(Çalışkan et al., 2002)* *(Baydaş, 2005)* (Bennal and Badiger, 2007) (Çevik et al., 2007) (Ertuğral et al., 2007) (Han et al., 2007) (Bennal et al., 2010) (Turşucu et al., 2012) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) **(Onder et al., 2013)** (Turşucu et al., 2013) (Akman, 2016b) (Doğan *et al.,* 2016)	
Z=51, Sb	*0.2254 ± 0.0045* *0.226 ± 0.011* *0.213 ± 0.050* *0.21 ± 0.021* *0.21 ± 0.021* *0.22 ± 0.022* *0.21 ± 0.021* *0.22 ± 0.022* *0.20 ± 0.020* *0.20 ± 0.020* *0.2132 ± 0.0009* 0.228 ± 0.016 *0.207 ± 0.010* *0.241 ± 0.007* 0.212 ± 0.012 *0.222 ± 0.013* 0.2248 ± 0.005 0.212 ± 0.011 0.196 ± 0.010 0.196 ± 0.010 0.2105 ± 0.007	*(Hansen et al., 1970b)* *(Close et al., 1973)* *(Khelil and Gray, 1975)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Stoev and Dlouhy, 1993)* (Ertuğrul et al., 2001b) *(Ximeng et al., 2001)* *(Çalışkan et al., 2002)* (Ertuğrul et al., 2002) *(Baydaş, 2005)* (Ertuğral et al., 2007) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Sita Mahalakshmi et al., 2014)	0.2141 ± 0.0008

	0.21 ± 0.01 0.2134 ± 0.0067	*(Aksoy et al., 2015)* (Akman, 2016b)	
Z=52, Te	**0.2283 ± 0.0068** *0.2300 ± 0.0046* *0.228 ± 0.0068* *0.196 ± 0.046* 0.2280 ± 0.0034 *0.2148 ± 0.0022* 0.230 ± 0.018 *0.211 ± 0.010* 0.226 ± 0.009 0.2194 ± 0.008 0.229 ± 0.012 0.211 ± 0.011 0.211 ± 0.011 0.254 ± 0.006 0.2175 ± 0.0069	**(Slivinsky and Ebert, 1969)** *(Hansen et al., 1970b)* *(Slivinsky and Ebert, 1972b)* *(Khelil and Gray, 1975)* (Martins et al., 1981) *(Stoev and Dlouhy, 1993)* (Ertuğrul et al., 2001b) *(Çalışkan et al., 2002)* (Çevik et al., 2007) (Ertuğral et al., 2007) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (George et al., 2014) (Akman, 2016b)	0.2225 ± 0.0014
Z=53, I	*0.2319 ± 0.0046* **0.2343 ± 0.0064** *0.29 ± 0.029* *0.26 ± 0.026* *0.24 ± 0.024* *0.23 ± 0.023* *0.22 ± 0.022* *0.22 ± 0.022* *0.24 ± 0.024* *0.24 ± 0.024* *0.24 ± 0.024* *0.22 ± 0.022* *0.25 ± 0.025* *0.24 ± 0.024* *0.22 ± 0.022* *0.23 ± 0.023* *0.23 ± 0.023* *0.25 ± 0.025* *0.22 ± 0.022* *0.2191 ± 0.0022* 0.234 ± 0.016 *0.231 ± 0.009* 0.2211 ± 0.008 0.2123 ± 0.011	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Stoev and Dlouhy, 1993)* (Ertuğrul et al., 2001b) *(Çalışkan et al., 2002)* (Ertuğral et al., 2007) (Saydam et al., 2012)	0.2238 ± 0.0017
Z=54, Xe	*0.2345 ± 0.0047* *0.225 ± 0.025* *0.2181 ± 0.0087* 0.2103 ± 0.0009 0.2365 ± 0.0008	*(Hansen et al., 1970b)* *(Winters et al., 1973)* *(Chand et al., 1989)* (Yalçin, 2007) (Yalçin, 2007)	0.2251 ± 0.0006
Z=55, Cs	*0.2367 ± 0.0047* *0.2320 ± 0.0050* *0.16 ± 0.016* *0.23 ± 0.023* *0.24 ± 0.024* *0.26 ± 0.026* *0.22 ± 0.022* *0.24 ± 0.024* *0.22 ± 0.022* *0.26 ± 0.026* *0.24 ± 0.024* 0.2355 ± 0.0035 0.238 ± 0.006 *0.236 ± 0.006*	*(Hansen et al., 1970b)* *(Schmidt-Ott and Fink, 1972)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* (Martins et al., 1981) (Rao et al., 1987) *(Rao et al., 1987)*	0.2187 ± 0.0004

	0.2427 ± 0.0064 *0.2236 ± 0.0029* 0.2369 ± 0.0047 *0.2293 ± 0.0046* *0.200 ± 0.021* 0.234 ± 0.018 *0.239 ± 0.014* *0.239 ± 0.014* *0.229 ± 0.011* 0.2165 ± 0.0007 0.2021 ± 0.0010 0.2287 ± 0.0012 0.2287 ± 0.0012 0.2326 ± 0.007 0.2328 ± 0.0073	*(Chand et al., 1988)* *(Stoev and Dlouhy, 1993)* (Büyükkasap et al., 1994) *(Büyükkasap et al., 1994)* *(Durak and Özdemir, 2000)* (Ertuğrul et al., 2001b) *(Çalışkan et al., 2002)* *(Ertuğrul, 2002c)* *(Baydaş, 2005)* (Yalçin, 2007) (Yalçin, 2007) (Yalçin, 2007) (Yalçin, 2007) (Sita Mahalakshmi et al., 2014) (Akman, 2016b)	
Z=56, Ba	*0.2370 ± 0.0048* **0.2446 ± 0.0067** *0.303 ± 0.083* *0.240 ± 0.012* *0.21 ± 0.021* *0.23 ± 0.023* *0.26 ± 0.026* *0.22 ± 0.022* *0.22 ± 0.022* 0.2372 ± 0.0071 *0.238 ± 0.007* *0.2351 ± 0.0090* *0.2268 ± 0.0033* 0.2376 ± 0.0048 *0.2364 ± 0.0047* 0.2385 ± 0.0047 0.2386 ± 0.0047 0.2387 ± 0.0047 0.2369 ± 0.0047 0.2357 ± 0.0047 0.235 ± 0.017 *0.243 ± 0.007* *0.243 ± 0.007* *0.236 ± 0.014* 0.238 ± 0.010 0.2472 ± 0.005 0.227 ± 0.018 0.2118 ± 0.0013 0.2355 ± 0.0008 0.227 ± 0.012 0.245 ± 0.012 0.245 ± 0.012 0.251 ± 0.021 0.251 ± 0.004 0.2268 ± 0.0097 0.2353 ± 0.0079	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** *(Khelil and Gray, 1975)* *(Tawara et al., 1975)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* *(Wilson et al., 1977)* (Martins et al., 1981) *(Mehta et al., 1987b)* *(Chand et al., 1988)* *(Stoev and Dlouhy, 1993)* (Büyükkasap et al., 1994) *(Büyükkasap et al., 1994)* (Büyükkasap, 1997) (Büyükkasap, 1997) (Büyükkasap, 1997) (Büyükkasap, 1997) (Büyükkasap, 1997) (Ertuğrul et al., 2001b) *(Çalışkan et al., 2002)* *(Ertuğrul, 2002c)* *(Baydaş, 2005)* (Çevik et al., 2007) (Ertuğral et al., 2007) (Han et al., 2007) (Yalçin, 2007) (Yalçin, 2007) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Sreevidya et al., 2013) (Sreevidya et al., 2014) (Akman et al., 2016a) (Akman, 2016b)	0.2313 ± 0.0006
Z=57, La	*0.2435 ± 0.0049* *0.2347 ± 0.0044* *0.204 ± 0.046* 0.2414 ± 0.0036 *0.2281 ± 0.0022* 0.2391 ± 0.0048 0.2400 ± 0.0048 0.2380 ± 0.0048 0.2390 ± 0.0048	*(Hansen et al., 1970b)* *(Mistry and Quarles, 1971b)* *(Khelil and Gray, 1975)* (Marques et al., 1980) *(Stoev and Dlouhy, 1993)* (Büyükkasap, 1997) (Büyükkasap, 1997) (Büyükkasap, 1997) (Büyükkasap, 1997)	0.2378 ± 0.0010

	0.2363 ± 0.0047	(Büyükkasap, 1997)	
	0.242 ± 0.002	(Ertuğrul et al., 2001a)	
	0.243 ± 0.021	(Ertuğrul et al., 2001b)	
	0.247 ± 0.010	*(Çalışkan et al., 2002)*	
	0.247 ± 0.010	*(Ertuğrul, 2002c)*	
	0.240 ± 0.017	*(Baydaş, 2005)*	
	0.2542 ± 0.005	(Ertuğral et al., 2007)	
	0.246 ± 0.013	(Demir and Şahin, 2013)	
	0.258 ± 0.013	(Demir and Şahin, 2013)	
	0.257 ± 0.013	(Demir and Şahin, 2013)	
	0.2326 ± 0.007	(Sita Mahalakshmi et al., 2014)	
	0.2302 ± 0.0075	(Akman et al., 2016a)	
	0.243 ± 0.014	(Akman, 2016a)	
	0.2504 ± 0.0090	(Akman, 2016b)	
	0.232 ± 0.005	*(Uğurlu, 2019)*	
	0.233 ± 0.005	*(Uğurlu, 2019)*	
	0.233 ± 0.005	*(Uğurlu, 2019)*	
Z=58, Ce	**0.2415 ± 0.0072**	**(Slivinsky and Ebert, 1969)**	0.2412 ± 0.0011
	0.2420 ± 0.0048	*(Hansen et al., 1970b)*	
	0.2494 ± 0.0067	**(McCrary et al., 1971)**	
	0.2488 ± 0.0050	*(Mistry and Quarles, 1971b)*	
	0.242 ± 0.0073	*(Slivinsky and Ebert, 1972b)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.23 ± 0.023	*(Wilson et al., 1977)*	
	0.27 ± 0.027	*(Wilson et al., 1977)*	
	0.25 ± 0.025	*(Wilson et al., 1977)*	
	0.25 ± 0.025	*(Wilson et al., 1977)*	
	0.25 ± 0.025	*(Wilson et al., 1977)*	
	0.26 ± 0.026	*(Wilson et al., 1977)*	
	0.25 ± 0.025	*(Wilson et al., 1977)*	
	0.26 ± 0.026	*(Wilson et al., 1977)*	
	0.23 ± 0.023	*(Wilson et al., 1977)*	
	0.23 ± 0.023	*(Wilson et al., 1977)*	
	0.21 ± 0.021	*(Wilson et al., 1977)*	
	0.23 ± 0.023	*(Wilson et al., 1977)*	
	0.22 ± 0.022	*(Wilson et al., 1977)*	
	0.24 ± 0.024	*(Wilson et al., 1977)*	
	0.2201 ± 0.0059	*(Stoev and Dlouhy, 1993)*	
	0.245 ± 0.002	(Ertuğrul et al., 2001a)	
	0.244 ± 0.018	(Ertuğrul et al., 2001b)	
	0.240 ± 0.014	*(Çalışkan et al., 2002)*	
	0.241 ± 0.013	(Ertuğrul et al., 2002)	
	0.240 ± 0.014	*(Ertuğrul, 2003)*	
	0.244 ± 0.018	*(Baydaş, 2005)*	
	0.2460 ± 0.005	(Ertuğral et al., 2007)	
	0.2460 ± 0.005	(Ertuğral, 2007)	
	0.243 ± 0.013	(Demir and Şahin, 2013)	
	0.260 ± 0.013	(Demir and Şahin, 2013)	
	0.260 ± 0.013	(Demir and Şahin, 2013)	
	0.2316 ± 0.0052	(Turşucu and Demir, 2013)	
	0.2319 ± 0.007	(Sita Mahalakshmi et al., 2014)	
	0.2311 ± 0.016	(Akman et al., 2015)	
	0.2311 ± 0.0076	(Akman et al., 2016a)	
	0.235 ± 0.010	(Akman, 2016a)	
	0.2478 ± 0.0080	(Akman, 2016b)	
	0.234 ± 0.005	*(Uğurlu, 2019)*	
	0.234 ± 0.005	*(Uğurlu, 2019)*	
	0.234 ± 0.006	*(Uğurlu, 2019)*	
	0.2311	*(Küçükönder et al., 1993c)*	
Z=59, Pr	**0.2427 ± 0.0073**	**(Slivinsky and Ebert, 1969)**	0.2457 ± 0.0013

	0.2433 ± 0.0049	*(Hansen et al., 1970b)*	
	0.2475 ± 0.0049	*(Mistry and Quarles, 1971b)*	
	0.243 ± 0.0073	*(Slivinsky and Ebert, 1972b)*	
	0.2386 ± 0.0052	*(Mehta et al., 1987a)*	
	0.235 ± 0.028	*(Durak and Özdemir, 2000)*	
	0.255 ± 0.002	(Ertuğrul et al., 2001a)	
	0.247 ± 0.019	(Ertuğrul et al., 2001b)	
	0.240 ± 0.012	*(Çalışkan et al., 2002)*	
	0.240 ± 0.012	*(Ertuğrul, 2003)*	
	0.247 ± 0.017	*(Baydaş, 2005)*	
	0.2376 ± 0.005	(Ertuğral et al., 2007)	
	0.2376 ± 0.005	(Ertuğral, 2007)	
	0.2338 ± 0.007	(Sita Mahalakshmi et al., 2014)	
	0.230 ± 0.010	(Akman, 2016a)	
	0.236 ± 0.006	*(Uğurlu, 2019)*	
	0.236 ± 0.006	*(Uğurlu, 2019)*	
	0.236 ± 0.006	*(Uğurlu, 2019)*	
Z=60, Nd	*0.2442 ± 0.0049*	*(Hansen et al., 1970b)*	0.2453 ± 0.0012
	0.2415 ± 0.0058	*(Mistry and Quarles, 1971b)*	
	0.25 ± 0.025	*(Wilson et al., 1977)*	
	0.23 ± 0.023	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.27 ± 0.027	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.27 ± 0.027	*(Wilson et al., 1977)*	
	0.25 ± 0.025	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.25 ± 0.025	*(Wilson et al., 1977)*	
	0.26 ± 0.026	*(Wilson et al., 1977)*	
	0.235 ± 0.020	(Durak and Özdemir, 1998)	
	0.237 ± 0.014	*(Durak and Özdemir, 2000)*	
	0.24 ± 0.016	*(Hajivaliei et al., 2000)*	
	0.247 ± 0.002	(Ertuğrul et al., 2001a)	
	0.248 ± 0.018	(Ertuğrul et al., 2001b)	
	0.260 ± 0.008	*(Çalışkan et al., 2002)*	
	0.247 ± 0.014	(Ertuğrul et al., 2002)	
	0.260 ± 0.008	*(Ertuğrul, 2003)*	
	0.242 ± 0.006	(Demir and Şahin, 2007a)	
	0.249 ± 0.015	(Demir and Şahin, 2007a)	
	0.249 ± 0.015	(Demir and Şahin, 2007a)	
	0.2418 ± 0.006	(Demir and Şahin, 2007b)	
	0.2495 ± 0.015	(Demir and Şahin, 2007b)	
	0.2495 ± 0.015	(Demir and Şahin, 2007b)	
	0.2402 ± 0.005	(Ertuğral et al., 2007)	
	0.2402 ± 0.005	(Ertuğral, 2007)	
	0.2384 ± 0.007	(Sita Mahalakshmi et al., 2014)	
	0.228 ± 0.013	(Akman, 2016a)	
	0.244 ± 0.006	*(Uğurlu, 2019)*	
	0.244 ± 0.006	*(Uğurlu, 2019)*	
	0.244 ± 0.006	*(Uğurlu, 2019)*	
Z=61, Pm	*0.2452 ± 0.0049*	*(Hansen et al., 1970b)*	0.2452 ± 0.0049
Z=62, Sm	**0.2584 ± 0.0078**	**(Slivinsky and Ebert, 1969)**	0.2498 ± 0.0009
	0.2459 ± 0.0049	*(Hansen et al., 1970b)*	
	0.2539 ± 0.0066	**(McCrary et al., 1971)**	
	0.254 ± 0.0076	*(Slivinsky and Ebert, 1972b)*	
	0.242 ± 0.005	*(Shearer-Izumi et al., 1980)*	
	0.2525 ± 0.0018	*(Kasagi et al., 1986)*	
	0.245 ± 0.0074	*(Mehta et al., 1986)*	
	0.2632 ± 0.0036	(Borowski et al., 1987)	
	0.2491 ± 0.0050	(Büyükkasap, 1997)	

	0.2492 ± 0.0050	(Büyükkasap, 1997)	
	0.2495 ± 0.0050	(Büyükkasap, 1997)	
	0.2469 ± 0.0049	(Büyükkasap, 1997)	
	0.2472 ± 0.0049	(Büyükkasap, 1997)	
	0.240 ± 0.022	(Durak and Özdemir, 1998)	
	0.242 ± 0.028	*(Durak and Özdemir, 2000)*	
	0.26 ± 0.017	*(Hajivaliei et al., 2000)*	
	0.252 ± 0.002	(Ertuğrul et al., 2001a)	
	0.251 ± 0.019	(Ertuğrul et al., 2001b)	
	0.239 ± 0.012	*(Ximeng et al., 2001)*	
	0.236 ± 0.011	*(Çalışkan et al., 2002)*	
	0.236 ± 0.011	*(Ertuğrul, 2002b)*	
	0.250 ± 0.015	*(Baydaş, 2005)*	
	0.2451 ± 0.008	(Ertuğral et al., 2007)	
	0.2451 ± 0.008	(Ertuğral, 2007)	
	0.239 ± 0.019	(Han et al., 2007)	
	0.204 ± 0.012	*(Han et al., 2008)*	
	0.205 ± 0.012	*(Han et al., 2008)*	
	0.203 ± 0.012	*(Han et al., 2008)*	
	0.202 ± 0.012	*(Han et al., 2008)*	
	0.202 ± 0.012	*(Han et al., 2008)*	
	0.207 ± 0.012	*(Han et al., 2008)*	
	0.252 ± 0.013	(Demir and Şahin, 2013)	
	0.284 ± 0.014	(Demir and Şahin, 2013)	
	0.284 ± 0.014	(Demir and Şahin, 2013)	
	0.2429 ± 0.007	(Sita Mahalakshmi et al., 2014)	
	0.233 ± 0.012	(Akman, 2016a)	
	0.253 ± 0.005	*(Uğurlu, 2019)*	
	0.254 ± 0.005	*(Uğurlu, 2019)*	
	0.253 ± 0.005	*(Uğurlu, 2019)*	
Z=63, Eu	**0.2519 ± 0.0076**	**(Slivinsky and Ebert, 1969)**	0.2486 ± 0.0009
	0.2485 ± 0.0050	*(Hansen et al., 1970b)*	
	0.256 ± 0.0077	*(Slivinsky and Ebert, 1972b)*	
	0.30 ± 0.030	*(Wilson et al., 1977)*	
	0.27 ± 0.027	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.25 ± 0.025	*(Wilson et al., 1977)*	
	0.29 ± 0.029	*(Wilson et al., 1977)*	
	0.26 ± 0.026	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.29 ± 0.029	*(Wilson et al., 1977)*	
	0.247 ± 0.016	*(Kamal et al., 1980)*	
	0.243 ± 0.016	*(Kamal et al., 1980)*	
	0.2446 ± 0.016	*(Kamal et al., 1980)*	
	0.252 ± 0.007	(Rao et al., 1987)	
	0.251 ± 0.007	*(Rao et al., 1987)*	
	0.242 ± 0.018	(Durak and Özdemir, 1998)	
	0.27 ± 0.018	*(Hajivaliei et al., 2000)*	
	0.254 ± 0.003	(Ertuğrul et al., 2001a)	
	0.254 ± 0.020	(Ertuğrul et al., 2001b)	
	0.300 ± 0.015	*(Ximeng et al., 2001)*	
	0.253 ± 0.020	*(Baydaş, 2005)*	
	0.239 ± 0.015	(Demir and Şahin, 2007a)	
	0.240 ± 0.003	(Demir and Şahin, 2007a)	
	0.240 ± 0.003	(Demir and Şahin, 2007a)	
	0.2388 ± 0.015	(Demir and Şahin, 2007b)	
	0.2402 ± 0.003	(Demir and Şahin, 2007b)	
	0.2403 ± 0.003	(Demir and Şahin, 2007b)	
	0.2549 ± 0.003	(Ertuğral et al., 2007)	

	0.2549 ± 0.003	(Ertuğral, 2007)	
	0.216 ± 0.013	*(Han et al., 2008)*	
	0.218 ± 0.013	*(Han et al., 2008)*	
	0.216 ± 0.013	*(Han et al., 2008)*	
	0.215 ± 0.013	*(Han et al., 2008)*	
	0.221 ± 0.013	*(Han et al., 2008)*	
	0.209 ± 0.013	*(Han et al., 2008)*	
	0.241 ± 0.013	(Akman, 2016a)	
	0.260 ± 0.004	*(Uğurlu, 2019)*	
	0.260 ± 0.004	*(Uğurlu, 2019)*	
	0.260 ± 0.004	*(Uğurlu, 2019)*	
Z=64, Gd	**0.2577 ± 0.0077**	**(Slivinsky and Ebert, 1969)**	0.2537 ± 0.0011
	0.2481 ± 0.0050	*(Hansen et al., 1970b)*	
	0.2561 ± 0.0066	**(McCrary et al., 1971)**	
	0.2577 ± 0.0060	*(Mistry and Quarles, 1971b)*	
	0.258 ± 0.0077	*(Slivinsky and Ebert, 1972b)*	
	0.29 ± 0.029	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.27 ± 0.027	*(Wilson et al., 1977)*	
	0.29 ± 0.029	*(Wilson et al., 1977)*	
	0.27 ± 0.027	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.27 ± 0.027	*(Wilson et al., 1977)*	
	0.29 ± 0.029	*(Wilson et al., 1977)*	
	0.27 ± 0.027	*(Wilson et al., 1977)*	
	0.26 ± 0.026	*(Wilson et al., 1977)*	
	0.26 ± 0.026	*(Wilson et al., 1977)*	
	0.28 ± 0.028	*(Wilson et al., 1977)*	
	0.258 ± 0.0077	*(Mehta et al., 1986)*	
	0.2587 ± 0.0052	(Büyükkasap, 1997)	
	0.2578 ± 0.0052	(Büyükkasap, 1997)	
	0.2568 ± 0.0051	(Büyükkasap, 1997)	
	0.2565 ± 0.0051	(Büyükkasap, 1997)	
	0.2562 ± 0.0051	(Büyükkasap, 1997)	
	0.244 ± 0.021	(Durak and Özdemir, 1998)	
	0.245 ± 0.013	*(Durak and Özdemir, 2000)*	
	0.27 ± 0.018	*(Hajivaliei et al., 2000)*	
	0.257 ± 0.003	(Ertuğrul et al., 2001a)	
	0.255 ± 0.020	(Ertuğrul et al., 2001b)	
	0.318 ± 0.016	*(Ximeng et al., 2001)*	
	0.248 ± 0.010	*(Çalışkan et al., 2002)*	
	0.255 ± 0.015	*(Baydaş, 2005)*	
	0.247 ± 0.005	(Demir and Şahin, 2007a)	
	0.248 ± 0.006	(Demir and Şahin, 2007a)	
	0.248 ± 0.006	(Demir and Şahin, 2007a)	
	0.2473 ± 0.005	(Demir and Şahin, 2007b)	
	0.2487 ± 0.006	(Demir and Şahin, 2007b)	
	0.2481 ± 0.006	(Demir and Şahin, 2007b)	
	0.2622 ± 0.005	(Ertuğral et al., 2007)	
	0.2622 ± 0.005	(Ertuğral, 2007)	
	0.244 ± 0.020	(Han et al., 2007)	
	0.215 ± 0.013	*(Han et al., 2008)*	
	0.217 ± 0.013	*(Han et al., 2008)*	
	0.215 ± 0.013	*(Han et al., 2008)*	
	0.217 ± 0.013	*(Han et al., 2008)*	
	0.213 ± 0.013	*(Han et al., 2008)*	
	0.215 ± 0.013	*(Han et al., 2008)*	
	0.2496 ± 0.007	(Sita Mahalakshmi et al., 2014)	

	0.2650 ± 0.019 0.2650 ± 0.0074 0.239 ± 0.014	(Akman et al., 2015) (Akman et al., 2016a) (Akman, 2016a)	
Z=65, Tb	*0.2485 ± 0.0050* 0.2644 ± 0.0117 *0.248 ± 0.029* 0.259 ± 0.003 0.258 ± 0.020 *0.303 ± 0.018* *0.303 ± 0.018* *0.258 ± 0.018* 0.2515 ± 0.007 *0.215 ± 0.013* *0.214 ± 0.013* *0.217 ± 0.013* *0.215 ± 0.013* *0.216 ± 0.013* *0.215 ± 0.013* 0.263 ± 0.013 0.290 ± 0.015 0.291 ± 0.015 0.2618 ± 0.0089 0.247 ± 0.014	*(Hansen et al., 1970b)* (Borowski et al., 1987) *(Durak and Özdemir, 2000)* (Ertuğrul et al., 2001a) (Ertuğrul et al., 2001b) *(Çalışkan et al., 2002)* *(Ertuğrul, 2002b)* *(Baydaş, 2005)* (Ertuğral et al., 2007) *(Han et al., 2008)* *(Han et al., 2008)* *(Han et al., 2008)* *(Han et al., 2008)* *(Han et al., 2008)* *(Han et al., 2008)* (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Demir and Şahin, 2013) (Akman et al., 2016a) (Akman, 2016a)	0.2530 ± 0.0020
Z=66, Dy	*0.2502 ± 0.0050* *0.2639 ± 0.0056* *0.255 ± 0.0077* 0.2549 ± 0.0051 0.2570 ± 0.0051 0.2565 ± 0.0051 0.2554 ± 0.0051 0.2555 ± 0.0051 0.247 ± 0.021 *0.249 ± 0.041* *0.28 ± 0.018* 0.263 ± 0.003 0.259 ± 0.020 *0.265 ± 0.013* *0.272 ± 0.010* *0.260 ± 0.018* 0.277 ± 0.030 0.278 ± 0.003 0.278 ± 0.003 0.2774 ± 0.030 0.2779 ± 0.003 0.2780 ± 0.003 0.2461 ± 0.009 0.246 ± 0.020 *0.205 ± 0.012* *0.206 ± 0.012* *0.207 ± 0.012* *0.205 ± 0.012* *0.203 ± 0.012* *0.203 ± 0.012* 0.2507 ± 0.008 0.2534 ± 0.0054 0.260 ± 0.017	*(Hansen et al., 1970b)* *(Mistry and Quarles, 1971b)* *(Mehta et al., 1986)* (Büyükkasap, 1997) (Büyükkasap, 1997) (Büyükkasap, 1997) (Büyükkasap, 1997) (Büyükkasap, 1997) (Durak and Özdemir, 1998) *(Durak and Özdemir, 2000)* *(Hajivaliei et al., 2000)* (Ertuğrul et al., 2001a) (Ertuğrul et al., 2001b) *(Ximeng et al., 2001)* *(Çalışkan et al., 2002)* *(Baydaş, 2005)* (Demir and Şahin, 2007a) (Demir and Şahin, 2007a) (Demir and Şahin, 2007a) (Demir and Şahin, 2007b) (Demir and Şahin, 2007b) (Demir and Şahin, 2007b) (Ertuğral et al., 2007) (Han et al., 2007) *(Han et al., 2008)* *(Han et al., 2008)* *(Han et al., 2008)* *(Han et al., 2008)* *(Han et al., 2008)* *(Han et al., 2008)* (Sita Mahalakshmi et al., 2014) (Akman et al., 2016a) (Akman, 2016a)	0.2646 ± 0.0010
Z=67, Ho	*0.2511 ± 0.0050* **0.2609 ± 0.0068** *0.2551 ± 0.0052* *0.252 ± 0.015*	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** *(Mistry and Quarles, 1971b)* *(Deconninck and Longree, 1977)*	0.2586 ± 0.0008

	0.2608 ± 0.0012	*(Kasagi et al., 1986)*	
	0.2609 ± 0.0052	(Büyükkasap, 1997)	
	0.2594 ± 0.0052	(Büyükkasap, 1997)	
	0.2598 ± 0.0052	(Büyükkasap, 1997)	
	0.2566 ± 0.0051	(Büyükkasap, 1997)	
	0.2586 ± 0.0052	(Büyükkasap, 1997)	
	0.250 ± 0.019	(Durak and Özdemir, 1998)	
	0.250 ± 0.032	*(Durak and Özdemir, 2000)*	
	0.260 ± 0.002	(Ertuğrul et al., 2001a)	
	0.260 ± 0.021	(Ertuğrul et al., 2001b)	
	0.267 ± 0.013	*(Ximeng et al., 2001)*	
	0.273 ± 0.014	*(Çalışkan et al., 2002)*	
	0.265 ± 0.019	*(Baydaş, 2005)*	
	0.259 ± 0.013	(Demir and Şahin, 2007a)	
	0.262 ± 0.004	(Demir and Şahin, 2007a)	
	0.261 ± 0.004	(Demir and Şahin, 2007a)	
	0.2596 ± 0.013	(Demir and Şahin, 2007b)	
	0.2616 ± 0.004	(Demir and Şahin, 2007b)	
	0.2613 ± 0.004	(Demir and Şahin, 2007b)	
	0.2609 ± 0.008	(Ertuğral et al., 2007)	
	0.247 ± 0.020	(Han et al., 2007)	
	0.206 ± 0.012	*(Han et al., 2008)*	
	0.205 ± 0.012	*(Han et al., 2008)*	
	0.205 ± 0.012	*(Han et al., 2008)*	
	0.206 ± 0.012	*(Han et al., 2008)*	
	0.205 ± 0.012	*(Han et al., 2008)*	
	0.206 ± 0.012	*(Han et al., 2008)*	
	0.2525 ± 0.008	(Sita Mahalakshmi et al., 2014)	
	0.2575 ± 0.0037	(Akman et al., 2016a)	
Z=68, Er	**0.2564 ± 0.0077**	**(Slivinsky and Ebert, 1969)**	0.2529 ± 0.0015
	0.2521 ± 0.0050	*(Hansen et al., 1970b)*	
	0.2538 ± 0.0064	*(Mistry and Quarles, 1971b)*	
	0.256 ± 0.0077	*(Slivinsky and Ebert, 1972b)*	
	0.263 ± 0.007	(Rao et al., 1987)	
	0.262 ± 0.007	*(Rao et al., 1987)*	
	0.2420 ± 0.0043	*(Chand et al., 1988)*	
	0.251 ± 0.011	*(Chand et al., 1989)*	
	0.251 ± 0.023	(Durak and Özdemir, 1998)	
	0.251 ± 0.038	*(Durak and Özdemir, 2000)*	
	0.28 ± 0.018	*(Hajivaliei et al., 2000)*	
	0.261 ± 0.003	(Ertuğrul et al., 2001a)	
	0.262 ± 0.021	(Ertuğrul et al., 2001b)	
	0.294 ± 0.015	*(Ximeng et al., 2001)*	
	0.266 ± 0.008	*(Çalışkan et al., 2002)*	
	0.271 ± 0.016	*(Baydaş, 2005)*	
	0.2549 ± 0.007	(Ertuğral et al., 2007)	
	0.247 ± 0.020	(Han et al., 2007)	
	0.213 ± 0.012	*(Han et al., 2008)*	
	0.205 ± 0.012	*(Han et al., 2008)*	
	0.216 ± 0.013	*(Han et al., 2008)*	
	0.209 ± 0.013	*(Han et al., 2008)*	
	0.215 ± 0.013	*(Han et al., 2008)*	
	0.218 ± 0.013	*(Han et al., 2008)*	
	0.2555 ± 0.0053	(Akman et al., 2016a)	
	0.272 ± 0.017	(Akman, 2016a)	
Z=69, Tm	*0.2535 ± 0.0051*	*(Hansen et al., 1970b)*	0.2611 ± 0.0010
	0.274 ± 0.014	*(Deconninck and Longree, 1977)*	
	0.2611 ± 0.0012	*(Kasagi et al., 1986)*	
	0.248 ± 0.0074	*(Mehta et al., 1986)*	
	0.253 ± 0.026	*(Ertuğrul et al., 1997)*	

	0.266 ± 0.003 0.264 ± 0.020 0.2609 ± 0.005 0.256 ± 0.010	(Ertuğrul et al., 2001a) (Ertuğrul et al., 2001b) (Ertuğral et al., 2007) (Kaya et al., 2007)	
Z=70, Yb	**0.2681 ± 0.0080** *0.2550 ± 0.0051* **0.2651 ± 0.0074** *0.2703 ± 0.0058* *0.268 ± 0.0080* *0.256 ± 0.022* 0.255 ± 0.022 *0.28 ± 0.018* 0.2589 ± 0.005 0.270 ± 0.014	**(Slivinsky and Ebert, 1969)** *(Hansen et al., 1970b)* **(McCrary et al., 1971)** *(Mistry and Quarles, 1971b)* *(Slivinsky and Ebert, 1972b)* *(Ertuğrul et al., 1997)* (Durak and Özdemir, 1998) *(Hajivaliei et al., 2000)* (Ertuğral et al., 2007) (Kaya et al., 2007)	0.2630 ± 0.0024
Z=71, Lu	*0.2572 ± 0.0051* *0.276 ± 0.014* *0.2636 ± 0.0012* 0.2483 ± 0.0049 *0.259 ± 0.019* 0.2669 ± 0.009 0.260 ± 0.013	*(Hansen et al., 1970b)* *(Deconninck and Longree, 1977)* *(Kasagi et al., 1986)* (Borowski et al., 1987) *(Ertuğrul et al., 1997)* (Ertuğral et al., 2007) (Kaya et al., 2007)	0.2626 ± 0.0011
Z=72, Hf	**0.2688 ± 0.0081** *0.2593 ± 0.0052* *0.269 ± 0.0081* 0.307 ± 0.0138 0.2658 ± 0.008 0.268 ± 0.009 0.250 ± 0.003	**(Slivinsky and Ebert, 1969)** *(Hansen et al., 1970b)* *(Slivinsky and Ebert, 1972b)* (Aylikci et al., 2007) (Ertuğral et al., 2007) (Kaya et al., 2007) (Bennal et al., 2010)	0.2580 ± 0.0022
Z=73, Ta	*0.2615 ± 0.0052* **0.2648 ± 0.0073** *0.252 ± 0.020* *0.2682 ± 0.0017* 0.268 ± 0.007 *0.268 ± 0.007* *0.265 ± 0.021* 0.261 ± 0.018 0.251 ± 0.004 0.271 ± 0.012 0.2704 ± 0.005 0.273 ± 0.011 0.251 ± 0.004	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** *(Deconninck and Longree, 1977)* *(Kasagi et al., 1986)* (Rao et al., 1987) *(Rao et al., 1987)* *(Ertuğrul et al., 1997)* (Durak and Özdemir, 1998) (Bennal and Badiger, 2006) (Çevik et al., 2007) (Ertuğral et al., 2007) (Kaya et al., 2007) (Bennal et al., 2010)	0.2644 ± 0.0013
Z=74, W	**0.2710 ± 0.0081** *0.2632 ± 0.0052* *0.271 ± 0.0081* *0.284 ± 0.014* *0.2723 ± 0.0018* *0.267 ± 0.024* 0.264 ± 0.017 0.274 ± 0.012 0.2710 ± 0.005 0.266 ± 0.012 **0.265 ± 0.016**	**(Slivinsky and Ebert, 1969)** *(Hansen et al., 1970b)* *(Slivinsky and Ebert, 1972b)* *(Deconninck and Longree, 1977)* *(Kasagi et al., 1986)* *(Ertuğrul et al., 1997)* (Durak and Özdemir, 1998) (Çevik et al., 2007) (Ertuğral et al., 2007) (Kaya et al., 2007) **(Cengiz et al., 2011)**	0.2712 ± 0.0015
Z=75, Re	*0.2653 ± 0.0053* *0.261 ± 0.019* 0.2684 ± 0.009 0.274 ± 0.015 **0.258 ± 0.015**	*(Hansen et al., 1970b)* *(Ertuğrul et al., 1997)* (Ertuğral et al., 2007) (Kaya et al., 2007) **(Cengiz et al., 2011)**	0.2658 ± 0.0041
Z=76, Os	*0.2671 ± 0.0053* *0.259 ± 0.0078* 0.2710 ± 0.008	*(Hansen et al., 1970b)* *(Mehta et al., 1986)* (Ertuğral et al., 2007)	0.2668 ± 0.0037

	0.275 ± 0.017 **0.272 ± 0.016**	(Kaya et al., 2007) **(Cengiz et al., 2011)**	
Z=77, Ir	*0.2693 ± 0.0054* **0.2738 ± 0.0079** 0.2724 ± 0.005	*(Hansen et al., 1970b)* **(McCrary et al., 1971)** (Ertuğral et al., 2007)	0.2715 ± 0.0033
Z=78, Pt	*0.2705 ± 0.0054* *0.265 ± 0.021* *0.270 ± 0.0081* 0.2682 ± 0.005 **0.259 ± 0.016** 0.260 ± 0.006	*(Hansen et al., 1970b)* *(Deconninck and Longree, 1977)* *(Mehta et al., 1986)* (Ertuğral et al., 2007) **(Cengiz et al., 2011)** (Anand et al., 2014)	0.2669 ± 0.0028
Z=79, Au	**0.2786 ± 0.0084** *0.2734 ± 0.0055* **0.268 ± 0.016** **0.2721 ± 0.0079** *0.279 ± 0.0084* *0.280 ± 0.017* *0.252 ± 0.025* *0.2758 ± 0.028* *0.29 ± 0.03* *0.2770 ± 0.0023* *0.2755 ± 0.0012* *0.269 ± 0.024* 0.262 ± 0.003 0.2680 ± 0.005 0.262 ± 0.003 0.280 ± 0.020 0.264 ± 0.010	**(Slivinsky and Ebert, 1969)** *(Hansen et al., 1970b)* **(de Pinho, 1971)** **(McCrary et al., 1971)** *(Slivinsky and Ebert, 1972b)* *(Deconninck and Longree, 1977)* *(Kamal et al., 1980)* *(Kamal et al., 1980)* *(Kamal et al., 1980)* *(Kasagi et al., 1986)* *(Dasmahapatra and Mukherjee, 1995)* *(Ertuğrul et al., 1997)* (Bennal and Badiger, 2006) (Ertuğral et al., 2007) (Bennal et al., 2010) (Cengiz et al., 2010b) (Anand et al., 2014)	0.2729 ± 0.0009
Z=80, Hg	*0.2755 ± 0.0055* **0.276 ± 0.016** *0.2794 ± 0.0086* *0.2743 ± 0.0055* *0.2786 ± 0.0022* *0.276 ± 0.018* 0.272 ± 0.025 0.2794 ± 0.003 0.2553 ± 0.0006 0.2772 ± 0.0007	*(Hansen et al., 1970b)* **(de Pinho, 1971)** *(Chand et al., 1989)* *(Chand et al., 1989)* *(Dasmahapatra and Mukherjee, 1995)* *(Ertuğrul et al., 1997)* (Durak and Özdemir, 1998) (Ertuğral et al., 2007) (Yalçin, 2007) (Yalçin, 2007)	0.2656 ± 0.0004
Z=81, Tl	*0.2795 ± 0.0056* **0.276 ± 0.013** 0.281 ± 0.006 *0.276 ± 0.008* *0.2779 ± 0.0023* *0.281 ± 0.027* 0.2695 ± 0.005 0.287 ± 0.026 0.287 ± 0.009	*(Hansen et al., 1970b)* **(de Pinho, 1971)** (Schmidt-Ott et al., 1972) *(Mehta et al., 1987b)* *(Dasmahapatra and Mukherjee, 1995)* *(Ertuğrul et al., 1997)* (Ertuğral et al., 2007) (Sreevidya et al., 2013) (Sreevidya et al., 2014)	0.2776 ± 0.0018
Z=82, Pb	**0.2710 ± 0.0081** *0.2810 ± 0.0056* **0.275 ± 0.015** **0.2712 ± 0.0079** *0.282 ± 0.0085* *0.269 ± 0.022* *0.2826 ± 0.0025* 0.279 ± 0.007 0.280 ± 0.007 *0.2832 ± 0.0022* *0.281 ± 0.033* 0.275 ± 0.021 0.268 ± 0.003	**(Slivinsky and Ebert, 1969)** *(Hansen et al., 1970b)* **(de Pinho, 1971)** **(McCrary et al., 1971)** *(Slivinsky and Ebert, 1972b)* *(Deconninck and Longree, 1977)* *(Kasagi et al., 1986)* (Rao et al., 1987) *(Rao et al., 1987)* *(Dasmahapatra and Mukherjee, 1995)* *(Ertuğrul et al., 1997)* (Durak and Özdemir, 1998) (Bennal and Badiger, 2006)	0.2769 ± 0.0011

	0.2822 ± 0.007 0.268 ± 0.003 0.262 ± 0.006	(Ertuğral et al., 2007) (Bennal et al., 2010) (Anand et al., 2014)	
Z=83, Bi	**0.279 ± 0.011** **0.2744 ± 0.0079** *0.272 ± 0.022* *0.283 ± 0.026* 0.295 ± 0.014 0.2896 ± 0.009	**(de Pinho, 1971)** **(McCrary et al., 1971)** *(Deconninck and Longree, 1977)* *(Ertuğrul et al., 1997)* (Çevik et al., 2007) (Ertuğral et al., 2007)	0.2819 ± 0.0047
Z=86, Rn	**0.278 ± 0.012** 0.2606 ± 0.0012 0.2847 ± 0.0013	**(de Pinho, 1971)** (Yalçin, 2007) (Yalçin, 2007)	0.2717 ± 0.0009
Z=88, Ra	**0.284 ± 0.012**	**(de Pinho, 1971)**	0.284 ± 0.012
Z=90, Th	**0.2899 ± 0.0087** **0.282 ± 0.011** **0.2857 ± 0.0080** *0.294 ± 0.0088* *0.287 ± 0.029* 0.3141 ± 0.010	**(Slivinsky and Ebert, 1969)** **(de Pinho, 1971)** **(McCrary et al., 1971)** *(Slivinsky and Ebert, 1972b)* *(Ertuğrul et al., 1997)* (Ertuğral et al., 2007)	0.2925 ± 0.0040
Z=92, U	**0.2933 ± 0.0088** **0.281 ± 0.010** **0.2762 ± 0.0079** 0.300 ± 0.006 *0.295 ± 0.0089* *0.286 ± 0.032* 0.3152 ± 0.009	**(Slivinsky and Ebert, 1969)** **(de Pinho, 1971)** **(McCrary et al., 1971)** (Schmidt-Ott et al., 1972) *(Slivinsky and Ebert, 1972b)* *(Ertuğrul et al., 1997)* (Ertuğral et al., 2007)	0.2941 ± 0.0033
Z=94, Pu	**0.2809 ± 0.0080** 0.308 ± 0.008	**(McCrary et al., 1971)** (Schmidt-Ott et al., 1972)	0.2945 ± 0.0057
Z=96, Cm	0.327 ± 0.010 0.310 ± 0.008	(Hansen *et al.,* 1970a) (Schmidt-Ott et al., 1972)	0.3166 ± 0.0062

Table 3. The fitting coefficients for the calculation of the semi-empirical Kβ/Kα intensity ratios according to the formulae (12) and (13).

Z-range ($11 \leq Z \leq 96$)	a_i , b_i	Values
g(Z)	a_0	-1.7575111808
	a_1	0.3504422304
	a_2	-0.0214052445
	a_3	$6.9992828731 \times 10^{-4}$
	a_4	$-1.3126925457 \times 10^{-5}$
	a_5	$1.4185391613 \times 10^{-7}$
	a_6	$-8.2251914276 \times 10^{-10}$
	a_7	$1.9839625574 \times 10^{-12}$
f(Z)	b_0	0.9594455466
	b_1	0.0011985327
	b_2	$-5.9831959854 \times 10^{-6}$
	b_3	$-3.798431556 \times 10^{-8}$

Table 4. The semi-empirical Kβ/Kα intensity ratios compared with the theoretical calculations, using the multiconfiguration Dirac-Fock (MCDF) method for elements with 11≤ *Z*≤ 96.

Z, Element	Semi-empirical calculation	Theoretical calculation	*Z*, Element	Semi-empirical calculation	Theoretical calculation
Z=11, Na	0.0050	-	*Z*=54, Xe	0.2305	-
Z=12, Mg	0.0122	-	*Z*=55, Cs	0.2332	-
Z=13, Al	0.0226	-	*Z*=56, Ba	0.2357	-
Z=14, Si	0.0352	-	*Z*=57, La	0.2381	-
Z=15, P	0.0489	-	*Z*=58, Ce	0.2403	-
Z=16, S	0.0628	0.0545	*Z*=59, Pr	0.2424	-
Z=17, Cl	0.0759	-	*Z*=60, Nd	0.2443	-
Z=18, Ar	0.0879	0.104	*Z*=61, Pm	0.2462	-
Z=19, K	0.0984	0.103	*Z*=62, Sm	0.2479	-
Z=20, Ca	0.1074	-	*Z*=63, Eu	0.2496	-
Z=21, Sc	0.1150	-	*Z*=64, Gd	0.2512	-
Z=22, Ti	0.1213	0.119	*Z*=65, Tb	0.2527	-
Z=23, V	0.1265	-	*Z*=66, Dy	0.2542	-
Z=24, Cr	0.1308	0.120	*Z*=67, Ho	0.2557	-
Z=25, Mn	0.1345	-	*Z*=68, Er	0.2572	-
Z=26, Fe	0.1375	0.134	*Z*=69, Tm	0.2587	-
Z=27, Co	0.1403	-	*Z*=70, Yb	0.2601	-
Z=28, Ni	0.1428	0.131	*Z*=71, Lu	0.2616	-
Z=29, Cu	0.1452	0.129	*Z*=72, Hf	0.2630	-
Z=30, Zn	0.1476	0.136	*Z*=73, Ta	0.2645	-
Z=31, Ga	0.1500	-	*Z*=74, W	0.2659	-
Z=32, Ge	0.1525	0.146	*Z*=75, Re	0.2673	-
Z=33, As	0.1552	0.148	*Z*=76, Re	0.2686	-
Z=34, Se	0.1580	0.154	*Z*=77, Ir	0.2699	-
Z=35, Br	0.1611	-	*Z*=78, Pt	0.2712	-
Z=36, Kr	0.1643	0.168	*Z*=79, Au	0.2723	-
Z=37, Rb	0.1677	-	*Z*=80, Hg	0.2734	0.276
Z=38, Sr	0.1713	-	*Z*=81, Tl	0.2744	-
Z=39, Y	0.1750	-	*Z*=82, Pb	0.2754	0.278
Z=40, Zr	0.1789	0.187	*Z*=83, Bi	0.2762	0.281
Z=41, Nb	0.1828	-	*Z*=84, Po	0.2770	-
Z=42, Mo	0.1868	-	*Z*=85, At	0.2777	-
Z=43, Tc	0.1909	-	*Z*=86, Rn	0.2785	0.285
Z=44, Ru	0.1950	-	*Z*=87, Fr	0.2793	-
Z=45, Rh	0.1990	-	*Z*=88, Ra	0.2802	-
Z=46, Pd	0.2030	-	*Z*=89, Ac	0.2814	-
Z=47, Ag	0.2069	-	*Z*=90, Th	0.2830	-
Z=48, Cd	0.2108	0.212	*Z*=91, Pa	0.2850	-
Z=49, In	0.2144	-	*Z*=92, U	0.2878	-
Z=50, Sn	0.2180	0.220	*Z*=93, Np	0.2915	-
Z=51, Sb	0.2214	-	*Z*=94, Pu	0.2964	-
Z=52, Te	0.2246	0.224	*Z*=95, Am	0.3029	-
Z=53, I	0.2277	-	*Z*=96, Cm	0.3113	-

Appendix

Table A: weighted average (W) and recommended weighted average (WR) Kβ to Kα intensity ratios for elements from $_{11}$Na to $_{96}$Cm.

***Z*, Symbol**	$(K\beta/K\alpha)_W \pm \varepsilon$	$(K\beta/K\alpha)_{WR} \pm \varepsilon$	***Z*, Symbol**	$(K\beta/K\alpha)_W \pm \varepsilon$	$(K\beta/K\alpha)_{WR} \pm \varepsilon$
Z=11, Na	0.00843 ± 0.0015	0.00843 ± 0.0015	*Z*=50, Sn	0.2174 ± 0.0006	0.2175 ± 0.0006
Z=12, Mg	0.01147 ± 0.0020	0.01147 ± 0.0020	*Z*=51, Sb	0.2141± 0.0029	0.2141± 0.0029
Z=13, Al	0.018 ± 0.00036	0.018 ± 0.00036	*Z*=52, Te	0.2284± 0.0022	0.2284± 0.0022
Z=14, Si	0.030 ± 0.00060	0.030 ± 0.00060	*Z*=53, I	0.2268± 0.0044	0.2268± 0.0044
Z=15, P	0.0380 ± 0.0007	0.0380 ± 0.0007	*Z*=54, Xe	0.2249± 0.0006	0.2249± 0.0006
Z=16, S	0.0579 ± 0.0009	0.0579 ± 0.0009	*Z*=55, Cs	0.2179± 0.0005	0.2179± 0.0005
Z=17, Cl	0.0854 ± 0.0014	0.0911 ± 0.0038	*Z*=56, Ba	0.2310± 0.0006	0.2310± 0.0006
Z=18, Ar	0.1032 ± 0.0067	0.1032 ± 0.0067	*Z*=57, La	0.2414± 0.0012	0.2414± 0.0012
Z=19, K	0.1189 ± 0.0016	0.1227 ± 0.0015	*Z*=58, Ce	0.2433± 0.0014	0.2433± 0.0014
Z=20, Ca	0.1240 ± 0.0014	0.1284 ± 0.0015	*Z*=59, Pr	0.2489± 0.0016	0.2489± 0.0016
Z=21, Sc	0.1255 ± 0.0013	0.1262 ± 0.0014	*Z*=60, Nd	0.2445± 0.0015	0.2445± 0.0015
Z=22, Ti	0.1277 ± 0.0003	0.1279 ± 0.0003	*Z*=62, Sm	0.2520 ± 0.0012	0.2515 ± 0.0012
Z=23, V	0.1380 ± 0.0002	0.1410 ± 0.0002	*Z*=63, Eu	0.2465± 0.0011	0.2465± 0.0011
Z=24, Cr	0.1306 ± 0.0002	0.1321 ± 0.0003	*Z*=64, Gd	0.2548± 0.0012	0.2548± 0.0012
Z=25, Mn	0.1278 ± 0.0003	0.1281 ± 0.0004	*Z*=65, Tb	0.2599 ± 0.0024	0.2583 ± 0.0025
Z=26, Fe	0.1308 ± 0.0002	0.1309 ± 0.0002	*Z*=66, Dy	0.2684± 0.0011	0.2684± 0.0011
Z=27, Co	0.1318 ± 0.0003	0.1318 ± 0.0003	*Z*=67, Ho	0.2598± 0.0011	0.2598± 0.0011
Z=28, Ni	0.1387 ± 0.0001	0.1387 ± 0.0001	*Z*=68, Er	0.2593± 0.0022	0.2593± 0.0022
Z=29, Cu	0.1354 ± 0.0003	0.1362 ± 0.0003	*Z*=69, Tm	0.2641± 0.0025	0.2641± 0.0025
Z=30, Zn	0.1304 ± 0.0004	0.1285 ± 0.0004	*Z*=70, Yb	0.2627± 0.0035	0.2627± 0.0035
Z=31, Ga	0.1427 ± 0.0022	0.1427 ± 0.0022	*Z*=71, Lu	0.2533± 0.0041	0.2533± 0.0041
Z=32, Ge	0.1492 ± 0.0009	0.1495 ± 0.0009	*Z*=72, Hf	0.2566 ± 0.0025	0.2549 ± 0.0025
Z=33, As	0.1427 ± 0.0022	0.1488 ± 0.0028	*Z*=73, Ta	0.2588 ± 0.0021	0.2588 ± 0.0021
Z=34, Se	0.1605 ± 0.0006	0.1611 ± 0.0006	*Z*=74, W	0.2702±0.0036	0.2702±0.0036
Z=35, Br	0.1605 ± 0.0017	0.1609 ± 0.0017	*Z*=75, Re	0.2674 ± 0.0069	0.2674 ± 0.0069
Z=36, Kr	0.1715 ± 0.0014	0.1715 ± 0.0014	*Z*=76, Os	0.2718 ± 0.0066	0.2718 ± 0.0066
Z=37, Rb	0.1757 ± 0.0016	0.1757 ± 0.0016	*Z*=77, Ir	0.2728 ± 0.0042	0.2728 ± 0.0042
Z=38, Sr	0.1806 ± 0.0015	0.1806 ± 0.0015	*Z*=78, Pt	0.2645 ± 0.0037	0.2645 ± 0.0037
Z=39, Y	0.1814 ± 0.0010	0.1814 ± 0.0010	*Z*=79, Au	0.2643 ± 0.0018	0.2643 ± 0.0018
Z=40, Zr	0.1823± 0.0013	0.1823± 0.0013	*Z*=80, Hg	0.2649 ± 0.0005	0.2649 ± 0.0005
Z=41, Nb	0.1858± 0.0014	0.1858± 0.0014	*Z*=81, Tl	0.2764 ± 0.0034	0.2764 ± 0.0034
Z=42, Mo	0.2027 ± 0.0004	0.2030 ± 0.0005	*Z*=82, Pb	0.2701 ± 0.0017	0.2701 ± 0.0017
Z=43, Tc	0.1816± 0.0015	0.1816± 0.0015	*Z*=83, Bi	0.2823 ± 0.0049	0.2823 ± 0.0049
Z=44, Ru	0.2063 ± 0.0004	0.2103 ± 0.0004	*Z*=86, Rn	0.2717 ± 0.0009	0.2717 ± 0.0009
Z=45, Rh	0.2077 ± 0.0005	0.2073 ± 0.0005	*Z*=88, Ra	0.2840 ± 0.0012	0.2840 ± 0.0012
Z=46, Pd	0.2115 ± 0.0005	0.2115 ± 0.0005	*Z*=90, Th	0.2923 ± 0.0046	0.2923 ± 0.0046
Z=47, Ag	0.2012 ± 0.0003	0.2012 ± 0.0003	*Z*=92, U	0.2941 ± 0.0036	0.2941 ± 0.0036
Z=48, Cd	0.2108 ± 0.0005	0.2110 ± 0.0005	*Z*=94, Pu	0.2945 ± 0.0057	0.2945 ± 0.0057
Z=49, In	0.2113 ± 0.0012	0.2120 ± 0.0012	*Z*=96, Cm	0.3166 ± 0.0062	0.3166 ± 0.0062