Cross Sections for *K*-shell X-ray Production by Hydrogen and Helium Ions in Elements from Beryllium to Uranium

G. Lapicki

Department of Physics, East Carolina University, Greenville, North Carolina 27858

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Experimental cross sections for *K*-shell x-ray production by hydrogen and helium ions ($Z_1 = 1,2$) in target atoms from beryllium to uranium ($Z_2 = 4$–92) are tabulated as compiled (7418 cross sections) from the literature (161 references were found) with the search for the data terminated in January 1988. These cross sections are compared with predictions of the first Born approximation and ECPSSR theory for inner-shell ionization. The ECPSSR accounts for the energy loss (E) and Coulomb deflection (C) of the projectile ion as well as for the perturbed stationary state (PSS) and relativistic (R) nature of the target's inner-shell electron. While the first Born approximation generally overestimates the data by orders of magnitude, the ECPSSR theory is confirmed to be, on the average, in agreement with the experiment to within 10%–20%. For light and heavy target atoms, however, systematic and opposite deviations are found in the low projectile-velocity regime. These deviations are associated with the influence of multiple outer-shell ionizations on the fluorescence yields of light elements, particularly in ionization by helium ions, and with the inaccuracy of the ECPSSR theory in the reproduction of relativistic calculations for ionization of heavy elements. The remaining discrepancies at moderate projectile velocities are *prima facie* attributed to inadequacies of a screened hydrogenic description for the *K*-shell electron.

Key words: *K*-shell x-ray production cross sections; *K*-shell ionization; Born approximation; ECPSSR theory; H ions; He ions.

CONTENTS

List of Tables

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List of Figures

1. Introduction

Fifteen years ago, Rutledge and Watson[1] originated extensive tabulations of inner-shell cross sections by ionic projectiles in target atoms which cover most of the periodic table. Their compilation was restricted to *K*-shell ionization by H and He ions and reported some 600 x-ray production cross sections in 1973. In a 1978 sequel to it, Gardner and Gray[2] extended this compilation to ~1200 x-ray production cross sections by H and He ions. This extension covered *K*-shell ionization cross sections by heavier ions than helium as well; compilations of *L*-shell ionization data also exist.[3]

One could hence speculate that the number of *K*-shell x-ray production cross sections by H and He as reported in the literature doubled in a five-year period. To an extent that a constant fraction of all publications on inner-shell ionization phenomena contains such data, we could confirm this speculation. A histogram of publications cited in a 1975 thesis[4] on inner-shell ionization showed an exponential increase in these articles per annum since 1960; the growth rate was constant and indeed such that the number of publications per year has doubled every half of a decade.

Continued updates of these data, as carried almost single-handedly by Paul and co-workers[5–14] since 1978, appear also to be characterized by a rapid increase in their amount. In his 1984 analysis,[8] Paul uses some 3200 cross sections from the literature for protons alone. In an attempt to unravel systematic trends in such a mass of experimantal data, Paul *et al.*[5–14] normalize the data to theoretical predictions of the ECPSSR theory for direct *K*-shell ionization.[15] The ECPSSR theory for both direct ionizaton[15] and electron capture[16] accounts for the energy loss (E) and Coulomb deflection (C) of the projectile, and for the perturbed stationary state (PSS) and relativistic (R) changes in the description of the inner-shell electron that undergoes ionization. In our original analysis,[15] we scaled ~2600 *K*-shell x-ray production cross sections to the results of this theory. The deviations of experiment from the ECPSSR theory[15] were found to be within 10% once all the data were considered equally and averaged in the preselected equal intervals of the effective projectile energy-loss variable. Such discrepancies, being comparable to experimental uncertainties, appeared to be acceptable. Analyses[5–14] analogous to the analysis of Ref. 15 subsequently revealed, however, that the ECPSSR theory systematically overestimates the data in the slow collision regime after the proton measurements from 21 out of 77 references were rejected. Similar deviations were observed for deuteron and helium data[8] after the data from 22 out of 55 references were discarded according to the adopted rejection criterion.[6,7] This finding was confirmed with an updated 1986 compilation[12] that contains almost 4000 proton cross sections from 101 references and nearly 1800 alpha particle cross sections from 47 references.

Previous authors either reported compiled cross sections in a tabular form without theoretical scrutiny[1–3] or analyzed them, without listing of the data, through graphical comparisons with the predictions of theories.[5–14] In this work, both a compilation (Sec. 2 and Tables) and an analysis (Sec. 3 and Figs.) are given. Two motivating goals for the present article are: (i) the need for an update of the last tabular report of the data[2] because the number of available cross sections has multiplied sixfold since then, (ii) the desire for an evaluation of the ECPSSR theory vis-à-vis an expanded data base; this evaluation, being independent and methodologically slightly different than critical analyses by Paul *et al.*,[5–15] might be of interest to those who choose to compare the ECPSSR theory with experiment. Also, brief comments that go beyond raw data presentation and their conventional evaluation in the framework of chosen theories are made; the data growth is a good indicator of the dynamic evolution in the field of inner-shell ionization. Such a discussion could offer a useful glimpse at the changing status of this field to those readers who may not be directly involved in it and might be even of vital interest to the researchers who are immersed in this field.

2. Experimental data base

2.1. Search procedures

All compiled cross sections were taken from the tables from referenced articles or privately communicated by authors of the article. When the tables and authors were not available, the data were read off graphs with the accuracy of two significant figures. All cross sections are reported in this work in a three-digit format even though occasionally original sources published them in larger formats. Uncertainties of the order of 10% in the modern day measurements of these cross sections restrict their significance to, at most, a three-digit accuracy. Errors, found in the original literature by Paul and Muhr,[12] were corrected prior to the accumulation of present data base. All compiled data were stored on disk files in the chronological order for easy updates. These files were spot checked against source papers for possible misprints in transfer to computer files; a few coauthors of source references have kindly provided this author with a check of his printout of their data. The last update of the data was made during the summer of 1988 with January 1988 terminating the data search.

2.2. Summary of data base

2.2.a. Compiled *K*-shell x-ray production cross sections

Table 1 gives a summary of the distribution of 7418 compiled cross sections with respect to the target atomic number Z_2 for each of the the projectiles (protons, deuterons, ^{3}He, ^{4}He) separately as well as, cumulatively, for all projectiles ($Z_1 = 1,2$). It allows a global assessment of the availability of the data for a specific projectile-target combination as well as for a given target and all projectiles. In particular, this table identifies (by contrast with the bold print used for the Z_2 targets that appear in the compilation) the 15 elements for which no data were found in the $4 \leqslant Z_2 \leqslant 92$ range and it singles out copper as the most often (9% of all data) used target for *K*-shell x-ray measurements by H and He ions. *K*-shell x-ray production cross sections induced by protons, deuterons, ^{3}He, and ^{4}He ions are compiled in Tables 2–5, respectively. They are listed with the increasing atomic number Z_2 of the target atom which is also identified by name. For each element, the data appear according to the chronological order of the reference of their origin and, for each reference, they are listed with the increasing energy[17] of the projectile.

Tables 2–5 contain 7418 cross sections of which 63% are by protons, 26% by ^{4}He, 7% by deuterons, and 4% by ^{3}He. The data are from 161 references that are listed chronologically in a separate reference section which lists these source references (see Sec. 6.2). A contact between the references and Table 1, which provides only a summary of the data base content, is made in Table 6. Table 1 shows a distribution of all compiled cross sections with respect to the projectile and target atoms. Table 6 presents this information by identifying the reference from which the data were obtained; the correlation of the number of reported cross sections for a given projectile-target system with the reference number serves a twofold purpose: (1) to exhibit the rate of growth in accumulation of the data with time since references are arranged chronologically and (2) to find all references pertaining to the given projectile-target combination. This overview of data distribution gives a quick perspective on the dynamics with which the data appear in the literature for a selected projectile-target combination. It offers a detailed look at the regions of the periodic table that remain almost uncharted to experimental studies of *K* x-ray production by light ions; references identify the researchers who pioneered investigations in these nearly *tabula rasa* regions.

This article ends with an author index (see Sec. 6.3), which is keyed to the reference numbers appearing in Tables 2–6 so that an easy reference exists to the names of all of those who reported the compiled data. The reference numbers which follow given names of particular authors place their research activity in a historical context since the references are ordered chronologically. Anyone interested in contributions of a particular author to the compiled data can trace them easily with the aid of Table 6.

2.2.b. Units

In Tables 2–5, each data set from a given reference consists of pairs: the energy of the projectile in MeV (1.6×10^{-13} J) and the experimental x-ray production cross section in barn (10^{-28} m^2). The conventional units of the accelerator-based physics are used to report the data in these Tables because such units are employed in the source literature (SI equivalents of these units are stated in the parentheses). Velocities of the projectile and of the target *K*-shell electron are calculated in terms of $v_0 = e^2/\hbar$, the Bohr velocity (2.2×10^6 m/s) of the electron in the ground state of the H atom. In this atomic unit of velocity, the target *K*-shell electrons orbit at $v_{2K} = Z_{2K}$ where $Z_{2K} = Z_2 - 0.3$ is the electric charge, in units of 1 because one is the magnitude of the electron charge in atomic units, of the target nucleus diminished by Slater's screening constant. In Figs. 3–11, the choice of units is immaterial because dimensionless ratios are plotted along each axis. The parameters that define ξ_K^R/ζ_K, the scaling variable of the ECPSSR theory, are dimensionless (See Sec. 3.2.a. and Figs. 10 and 11).

2.3. Growth and decline in annual publication of data

Figure 1 shows a histogram of the data compiled in this article: the annual number of cross sections published in a given year is shown. It appears that the rapid rate of growth of the 1960s and early 1970s rose to a maximum in the late 1970's. The annual rate at which the cross sections were reported in the current decade is on the decline. If this trend continues, the total cumulative number of cross sections is destined to reach a saturated value of some 10 000.

This forecast does not mean that the research on inner-shell ionization processes slides down toward its nadir; the annual number of publications in this field continues to double every five years. Rather it is the specialized area of inner-shell ionization research, as measured by the amount of new *K*-shell x-ray production cross sections by light ions, that shrinks. Experimental and theoretical interests shift now toward problems of inner-shell ionization in which Z_1/Z_2, the ratio of projectile-to-target atomic numbers, approaches 1. Also, as investigations of the *K* shell in very asymmetric ($Z_1/Z_2 \ll 1$) collisions become less fashionable, the current research on such collisions gives more prominence to studies of *L*- and *M*-shell ionizations.

3. Data analysis

No attempt is made here to report the experimental errors as stated in the original papers. Often estimates of such errors are not consistent, ranging from 5% to 35% amongst various experimental groups even though the experiments were performed apparently under similar conditions. Less often, but most shockingly, the data for the identical collision systems are found to differ by a significantly larger margin of error than the claimed experimental uncertainties would imply[18]; in rare instances such data disagree by even more than a factor of 2. Hence, although, justifiably due to constant improvements in data gathering techniques, 25% uncertainties are quoted in older references and 10% uncertainties are claimed in recent articles, we assign equal weights to all data at the outset of our analysis.

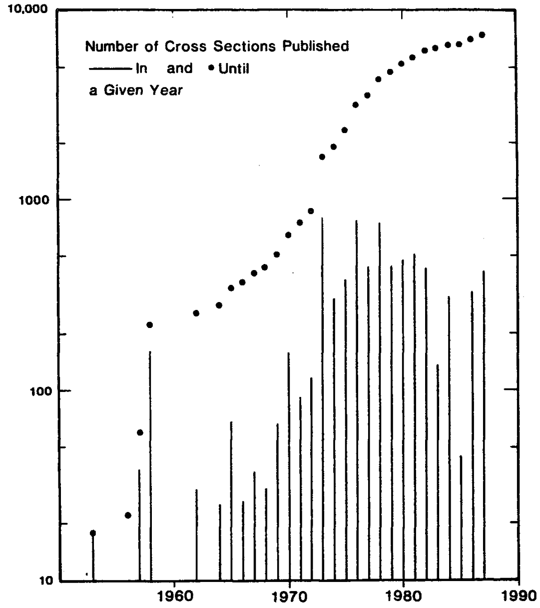

FIG. 1. Histogram of data for *K*-shell x-ray production by H and He ions (see Sec. 2.3). The vertical lines indicate the annual number of published cross sections as compiled in this work; the solid circles correspond to the cumulative number of these cross sections as they appeared up to a given year.

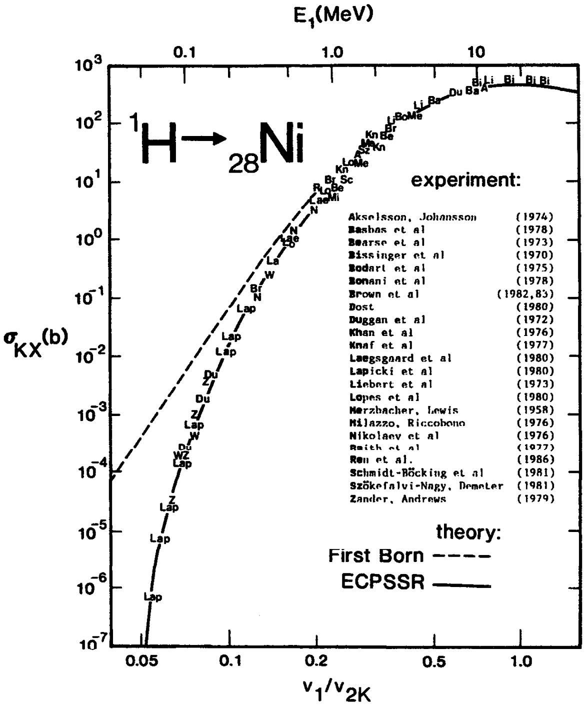

FIG. 2. *K*-shell x-ray production in nickel by protons as a function of the projectile's velocity scaled by the electron velocity in *K*-shell orbit of the target. Data are from Refs. 5, 20, 36, 47, 52, 55, 57, 69, 73, 76, 77, 84, 89, 94, 97, 108, 113, 114, 115, 120, 122, 132, 137, and 151 from the list of source references (see Sec. 6.2). The curves are based on the first Born (Refs. 20 and 21: dashed curve) and the ECPSSR (Refs. 15 and 16 :solid curve) theories.

Figure 2 shows the cross sections for protons on nickel, one of the most often used materials in the *K*-shell x-ray production measurements. These cross sections increase by as much as nine orders of magnitude with the projectile energy, labeled at the top of the figure in MeV. They exhibit a general trend of all data in that the cross sections peak where the velocity of the projectile v_1, matches approximately the orbital velocity of the *K*-shell electron in the target atom $v_{2K} = Z_{2K} = Z_2 - 0.3$.

3.1. Ionization cross sections

3.1.a. Conversion of ionization cross section to x-ray production cross section

Experimental x-ray production cross sections $\sigma_{KX}^{\text{Exper.}}$ can be compared with theoretical x-ray production cross sections σ_{KX}, after the ionization cross section σ_K is multiplied by the fluorescence yield ω_K, i.e., $\sigma_{KX} = \sigma_K \omega_K$. Throughout this work we use the single-vacancy fluorescence yields and employ for them the values as recommended by Krause[19] and listed in Tables 2–5. Multiple ionizations increase ω_K with the increasing Z_1/v_1. They do this, however, insignificantly (less than a percent) in K-shell ionization of heavier elements by light (hydrogen, helium) ions, in which $Z_1/v_1 \cong (Z_1/Z_2)/(v_1/v_{2K})$ is small even at low projectile velocities. Only small fluorescence yields ($\omega_K < 0.02$ for $Z_2 < 10$) are appreciably altered due to multiple ionization, more so in ionization by helium ($Z_1 = 2$) ions for which the condition of, say, $Z_1/Z_2 \geqslant 0.15$ covers twice as large a range of light elements. For such collision systems, theoretical x-ray production cross sections will be somewhat underestimated because the use of single-hole ω_K values. It should be noted that even single-hole fluorescence yields are in 10%–40% error for these relatively light target atoms.[19] The deviations become dramatic with increasing Z_1/Z_2 so that comparison of the theoretical predictions with the ${}_2$He on ${}_4$Be data ($Z_1/Z_2 = 1/2$) is the most problematic.

3.1.b. Ionization, as the sum of direct ionization and electron capture, in the first Born and ECPSSR theories

Ionization cross sections are obtained according to the first Born approximation[20,21] [$\sigma_K^{\rm FBORN}$, as shown by dashed curve in Fig. 2, consists of direct ionization and electron capture calculated in the plane wave Born approximation (PWBA)[20] and the Oppenheimer-Brinkman-Kramers treatment,[21] respectively], and the ECPSSR theory[15,16] ($\sigma_K^{\rm ECPSSR}$, solid curve in Fig. 2). In both calculations, ionization cross sections σ_K are taken as a sum of the cross sections for direct ionization to the target atom continuum plus electron capture to all bound states on the projectile. Although electron capture gives an additional contribution to ionization, the confusion in the literature exists because many authors still refer to ionization cross sections when only direct ionization cross sections are calculated. This unfortunate error of terminology can be found in particular in the most recent references to ECPSSR calculations.[12,13,22,23] We define and, as a matter of principle, calculate the ECPSSR ionization cross sections always as a sum of the direct ionization[15] and electron capture[16] cross sections, i.e.,

$$\sigma_K^{\rm ECPSSR} = \sigma_K^{\rm ECPSSR}(\text{DIRECT IONIZATION}) + \sigma_K^{\rm ECPSSR}(\text{ELECTRON CAPTURE}). \quad (1)$$

Although electron capture has negligible contribution to ionization when Z_1/Z_2 is small, we evaluate the ECPSSR ionization cross sections using Eq. (1) for all Z_1/Z_2 projectile-target combinations. Table 7 states the percentage contributions of electron capture to ionization as calculated in the ECPSSR theory.[15,16] Electron capture can contribute more than 1% when $Z_1/Z_2 \geqslant 1/15$ and the projectile energy per its mass is below 10 MeV/u. Table 7 lists these percentages only for protons and alpha particles because the electron capture contributions are essentially independent of the isotope nature of the projectile at a given velocity. The projectile is assumed to be fully stripped in these calculations (all its states are unoccupied and there are no electrons to screen it); this represents the condition under which most of the data were gathered. Some data were specifically reported for He$^+$; in many articles, however, the charge was unspecified. Contribution of electron capture to total ionization cross sections is calculated in the ECPSSR theory to be at most 5% when $Z_1/Z_2 \leqslant 0.15$ and for fully stripped projectiles, and it would be approximately one-half of that if the projectile were assumed to carry an electron into the collision. Hence, calculations which always presume a fully stripped projectile overestimate the ionization process by no more than a few percents if $Z_1/Z_2 \leqslant 0.15$. For protons on nickel ($Z_1/Z_2 = 0.036$) data of Fig. 2 electron capture contributes less than 0.1% to ionization. For $Z_1/Z_2 > 0.15$ collision systems, theoretical x-ray production cross sections used in this work are underestimated because single-hole ω_K values were employed and, sometimes, these cross sections are overestimated because a fully stripped projectile was always assumed. These deviations become dramatic with the increasing Z_1/Z_2 so that the comparison of the theoretical predictions with the ${}_2$He on ${}_4$Be data ($Z_1/Z_2 = \frac{1}{2}$) is the most problematic. We assume, however, that the ignored effect of multiple ionization and an overestimated[16,24] contribution of electron capture at $Z_1/Z_2 \rightarrow \frac{1}{2}$ tend to cancel each other to a great extent.

3.2. Choice of the ECPSSR for theoretical analysis of the data

Figure 2 demonstrates that, while the first Born approximation $\sigma_{KX}^{\rm FBORN}$ overestimates the proton on nickel data by as much as three orders of magnitude at lowest proton velocities, $\sigma_{KX}^{\rm ECPSSR}$ appears to be in good agreement with the measured cross sections. To exhibit these findings in a more refined way, unobscured by the artifact of a log–log graphical comparison, we plot the same data as the ratios of experimental cross sections $\sigma_{KX}^{\rm Exper.}$ to theoretical predictions in Fig. 3 for the first Born approximation and in Fig. 4 for the ECPSSR theory. To make a complete and compact comparison with all compiled data, the data are grouped in equal (0.1 in length) intervals on the $\log(v_1/v_{2K})$ scale. An arithmetic average of all cross sections in each group so defined is calculated, all data within the group that differ from this average by more than a factor of 2 are rejected, a new average for the group is found, and the rejection is made again from all the data in the group (including previously eliminated data) on the basis of the same criterion. Typically in two but no more than three iterations of this procedure the averages converge to constant values which are plotted in Figs. 3 and 4 for our example of K-shell x-ray production by protons in just one target element.

The success and relative ease in the implementation[23] of the ECPSSR theory, lead to its adoption as a theoretical benchmark for further analysis of the compiled data. A self-contained and critical[25] review of this theory is in order; development, scaling properties, and current status of the ECPSSR theory with alternative treatments is presented to justify a selection of this particular approach to inner-shell ionizations. The ECPSSR theory is reviewed *vis à vis* the first Born approximation and more *ab initio* theoretical approaches to inner-shell ionization.

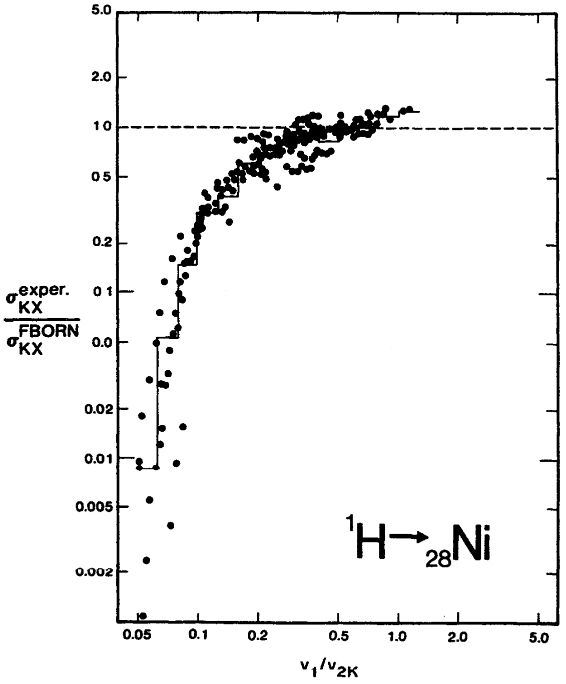

FIG. 3. Ratios of experimental cross sections to the first Born approximation for protons incident on nickel. Each step in the staircase curve represents the arithmetic average of all ratios found in the corresponding interval of v_1/v_{2K}.

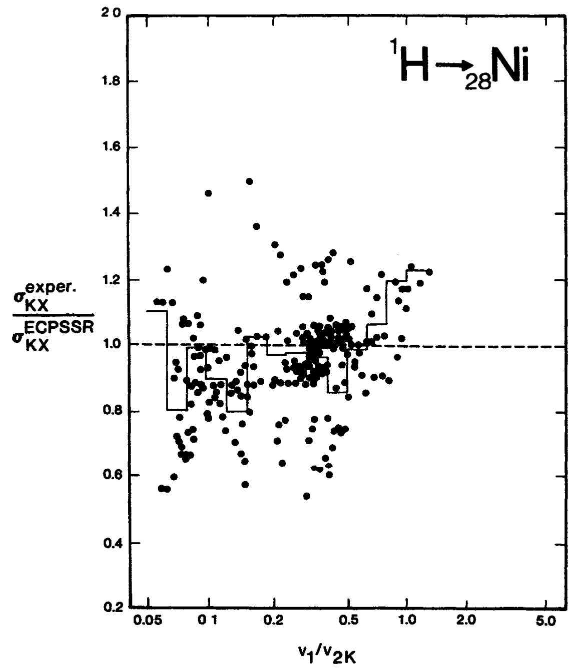

FIG. 4. Ratios of experimental cross sections to the ECPSSR for protons incident on nickel. Each step in the solid curve represents the arithmetic average of all ratios found in the corresponding interval of v_1/v_{2K}; the mean value for all proton on nickel ratios is 0.96.

3.2.a. Review and general scaling of the ECPSSR

A reduction of the discrepancies between the first Born approximation and the experiment occurs because the ECPSSR theory accounts for the binding effect that, being important at low projectile velocities and for large Z_1/Z_2, inhibits ionization and results in lower cross sections than the first Born approximation. Also, the ECPSSR approach corrects for the Coulomb-deflection of the projectile from a straight-line trajectory and considers the projectile energy loss exactly in the minimum momentum transfer; both corrections lead to smaller cross sections. The underestimation of the data in the first Born approximation for ionization of heavy target elements (large Z_2's mean small Z_1/Z_2) stems from its nonrelativistic treatment of the K-shell electron. The ECPSSR theory attempts to remedy this shortcoming by accounting for the relativistic effect and indeed by bringing the calculations in closer agreement with the data.

The ECPSSR theory originates with the work of Brandt, Laubert, and Sellin[26] who accounted for the increased binding and Coulomb-deflection effects in K-shell ionization. An extension of this work to the L shell was made[27] and subsequently, after a theoretical basis for the perturbed stationary-state (PSS) approach was established,[28] polarization[29,30] and relativistic[30] effects were included in the CPSSR theory[30] as a precursor of the ECPSSR approach[15] which also accounts for the projectile-energy loss. This theory was developed for electron capture in Ref. 16 in a similar manner as for direct ionization in Ref. 15. The ECPSSR theory for K- and L-shell ionization has been also extended to the M shell.[31]

In the slow collision limit, the calculations of the first Born approximation—for direct ionization which generally dominates over electron capture—scales with $\xi_K = 2v_1/v_{2K}\theta_K$ where θ_K is defined as the observed binding energy in terms of screened hydrogenic value $\frac{1}{2}Z_{2K}^2$. In the ECPSSR theory,[15] ξ_K is replaced by ξ_K^R/ζ_K to correct[30] the first Born approximation for the relativistic and perturbed stationary-state effects; ξ_K is replaced with $\xi_K^R = [m_K^R(\xi_K/\zeta_K)]^{\frac{1}{2}}\xi_K$ to simulate the relativistic effect[32] and ζ_K accounts for the PSS effect according to Eq. (20) of Ref. 30. After the analytically known[15] functions that correct for the projectile's energy loss and Coulomb deflection are factored out, all cross sections are reduced[27,33] in the slow collision limit to F_K, a universal function of ξ_K^R/ζ_K. For $\xi_K^R/\zeta_K > 1$, F_K diverges from this form depending on $\zeta_K\theta_K$. However, to the extent that $\zeta_K\theta_K$ does not (except for very light targets) vary significantly, the ionization cross section remains to a good approximation a universal function of ξ_K^R/ζ_K in all collisional regimes. This enables us to group K-shell x-ray production cross sections according to the ξ_K^R/ζ_K parameter for a comprehensive analysis of the compiled data against the predictions of the ECPSSR theory.

3.2.b. Current status, alternatives, advantages and shortcomings of the ECPSSR

The strength of the ECPSSR calculations lies in the relative ease with which this approach allows to incorporate analytically relevant physical effects into formulas of the first Born approximation for the ionization cross section; the role that these effects play can be recognized without being entangled in intricacies of the second or distorted Born approximation which requires a considerable numerical effort. Nevertheless, as an approximate description of an inelastic collision process, the ECPSSR theory is yet to be fully tested by more involved numerical procedures. It is hoped that with the phenomenal progress in computerized techniques such procedures will emerge as an penultimate check of the ECPSSR theory as well as its sophisticated replacements. The ultimate test for any theory will be in comparison of its predictions with experimental results.

Coulomb-deflection and PSS factors derived in the ECPSSR treatment have been utilized to modify first-order perturbation theories such as the binary encounter approximation (BEA).[34] We have stated previously[4,35] that the incorporation of the essentially quantum-mechanically derived correction factors into the BEA cross section, which equals the PWBA cross section under very restrictive conditions,[36] is not proper. Even in semiclassical and quantum approximations a selective use of just one of the ECPSSR factors might be questioned, especially when corrections for other effects are made on the basis of older[26,27,29,30] or different[14,37–39] accountings for the C, PSS, and R effects. An obvious example of misapplication[40] of the ECPSSR theory has been discussed elsewhere.[41] The Coulomb-deflection factor of the ECPSSR approach has been extensively used by Chen and Crasemann[22,43–45] in calculations that employ the united atom binding energy to simulate the PSS effect but take the energy loss and relativistic effects into account *ab initio*. These numerical calculations allow for exact limits for the momentum transfers and use relativistic wavefunctions based on the screened hydrogenic[42] or Hartree-Slater[22,43–45] potential. The *K*- and *L*-shell direct ionization calculations[22,43] were extended to the *M* shell[44] and even to the *N* shell.[45] The ECPSSR theory has been utilized in numerous comparisons with experimental inner-shell ionization cross sections. Predictions of the ECPSSR approach and its predecessors[26,27,29,30] were also used in (i) generation of proton-induced x-ray emission (PIXE) spectra,[46] (ii) calculation of relative *L*-shell x-ray intensities,[47] (iii) absolute calibration of the efficiency for semiconductor detectors,[48] (iv) alignment studies,[49] (v) semiempirical extraction of *L*-shell fluorescence yields,[50] and (vi) discussion of the feasibility of an antiproton detector.[51] The ECPSSR theory was employed in the determination of semiempirical formulas for *K*-shell ionization.[14,52]

In this work we calculate the ECPSSR ionization cross sections as stated in Refs. 15 and 16, although some improvements have been suggested since these references were published. Rigorous, numerical *ab initio* calculations and comprehensive comparisons with all inner-shell ionization data will decide whether nonadiabatic extentions[53] of the PSS approach are warranted. Coupled-state calculations are still in development. Their reliance always hinges on a clever choice of a set of basis states. Optimal selections have to be large enough to account for the physics of a collision and yet sufficiently small to be computationally manageable. A coupled-state calculation by Reading *et al.*[54] that utilizes the so-called forced impulse approximation and claims to conquer the slow collision regime has been carried out only at the first Born approximation level.

Unfortunately, the suggestion[10] that one should "investigate various effects theoretically since it is much easier to turn an effect on or off in a computer experiment than in nature" cannot be as yet carried out in practice. A "highly sophisticated computer program"[10] that could control all ECPSSR effects *ab initio* in any collision regime does not exist. While some calculations from the outset incorporate the E and R effects[22,42–45] and also account semiclassically for the Coulomb deflection,[55,56] they treat the PSS effect using sometimes[55] the old prescription of Ref. 26 or making[56] the united atom approximation which applies only in the strict limit of low projectile velocities. While other schemes[57] perform admirably to test the E, C and PSS effects, they were implemented only with nonrelativistic wave functions. Perhaps the closest to rigorous numerical test of all E, C, PSS, and R factors are the codes of Trautmann and co-workers[58]; they still, however, make ad hoc modifications to simulate the PSS effect. This effect is clearly seen in the *ab initio* coupled-state calculation Mehler *et al.*[59] that uses relativistic wave functions and offers promise; however, it is difficult to judge the outcome of this scheme because only one graph for *K*-shell ionization of silver by 0.9-MeV protons was presented[59] and in the subsequent paper only the probability for *K*-shell ionization is reported.[60] In accounting for PSS effects, this calculation gives a 20% reduction of the direct-ionization cross section as opposed to the ECPSSR approach that predicts only a few percent decrease of σ_K for the analyzed collision. This would be in agreement with Kocbach, who has concluded[61] that the ECPSSR treatment underestimates the role of the binding effect.[26] Mukoyama and Lin,[62] with an expansion of the relativistic wave function into Slater-type orbitals, have evaluated cross sections for *K*-shell ionization of copper by 0.5–2 MeV protons. These calculations, just as those of Refs. 59 and 60, lie ~15% below the ECPSSR results. Anholt *et al.*[63] have recommended that the cutoff impact parameter below which binding occurs be doubled; this would lower the ECPSSR cross sections, especially around their maxima, and thus would bring them in agreement with Refs. 59–62.

Sarkadi,[64] accounting for the nonadiabaticity of PSS states, finds contrary to Anholt's recipe[63] that the binding effect should have been deemphasized outside the slow collision regime; when v_1 approches v_{2K}, the *K*-shell does not adjust adiabatically and hence the binding effect should not be as large as the ECPSSR has it. This would increase the ECPSSR cross section around its peak, and thus widen the existing disagreement with Refs. 59–62. The coupled-state calculations of Mehler *et al.*[59,60] explain an enhancement of ionization, which counters the effect of the increased binding, as an effect of interaction among the continuum states, while the approach of Brandt *et al.*[29,30] traces the increase in ionization cross sections to the polarization of the bound state. A variational PSS description[65] of the polarization effect[29,30] determines that the ECPSSR underestimates as well this antibinding effect. Modifications suggested in Refs. 61

and 65 appear to cancel each other and thus they mask possible overall inadequacies in the ECPSSR treatment of the PSS (combined account for binding and polarization) effect. We now turn to the ultimate test of any theory, i.e., a broad comparison of its predictions with experimental observations.

3.3. Comparison of experimental and ECPSSR cross sections

In the pursuit of systematic discrepancies between the data and the predictions of the ECPSSR theory as Z_2-dependent deviations, we classify somewhat arbitrarily all elements as: light ($4\leqslant Z_2\leqslant 13$), medium ($14\leqslant Z_2\leqslant 66$), and heavy ($67\leqslant Z_2\leqslant 92$). Note that this classification assigns $Z_1/Z_2>0.15$ for the light atoms and $Z_1/Z_2<0.03$ for the heavy atoms bombarded by helium ions. The ratios of $\sigma_{KX}^{\text{Exper.}}$ to σ_K^{BORN} or $\sigma_{KX}^{\text{ECPSSR}}$ exhibit a substantial and erratic dependence on Z_2 for the lightest target atoms ($4\leqslant Z_2\leqslant 9$) which lack a fully filled L shell. Fluorescence yields for these elements could be uncertain by more than 40%.[19] These small K-shell x-ray fluorescence yields are indeed greatly affected by multiple ionizations. They are also changed by chemical and morphological changes in the incomplete L shell depending on the molecular composition and physical phase of the target. Finally, even in monatomic gas targets, the ionization cross section in itself is affected by relatively strong correlation effects in the very structure of the lightest atoms; the screened hydrogenic wave functions, on which our calculations are based, or even Hartree–Slater schemes become inappropriate because the independent electron model of an atom breaks down. For the lightest atoms, the experiment-to-theory ratios are not shown at all in Fig. 5 since their erratic behavior detracts from the main impression that this figure conveys, e.g., predictions of first Born approximation can be as much as three orders of magnitude above the data. The erratic behavior among the lightest atoms can be easily observed in Figs. 6, 7, and 9, where ratios for the $4\leqslant Z_2\leqslant 9$ elements are displayed separately with every element identified by its atomic number. We exclude these lightest target atoms from further statistical analysis: the rejection criterion will be applied to some 7000 data only in the $10\leqslant Z_2\leqslant 92$ range of elements.

Figures 5–9 show the experimental-to-theoretical cross section ratios as horizontal bars for all data with $10\leqslant Z_2\leqslant 92$ and as circles for three groups of data in the preselected Z_2 ranges. For moderately light ($10\leqslant Z_2\leqslant 13$) elements, which are predominantly (81%) based on aluminum cross sections, these ratios are drawn as the open circles. The half-open circles represent similar ratios for medium elements of which titanium, chromium, iron, cobalt, nickel, copper, silver, and tin amount to nearly a one-half of all data in the $14\leqslant Z_2\leqslant 66$ range. The solid circles are drawn for heavy elements ($67\leqslant Z_2\leqslant 92$) of which tantalum, gold, and lead are most typical, accounting for almost a one-half of all data in the $67\leqslant Z_2\leqslant 92$ range. Aluminum and gold were chosen, in fact, as representative of light and heavy elements by Chadwick,[66] after the 1912 discovery of x rays from iron bombard-

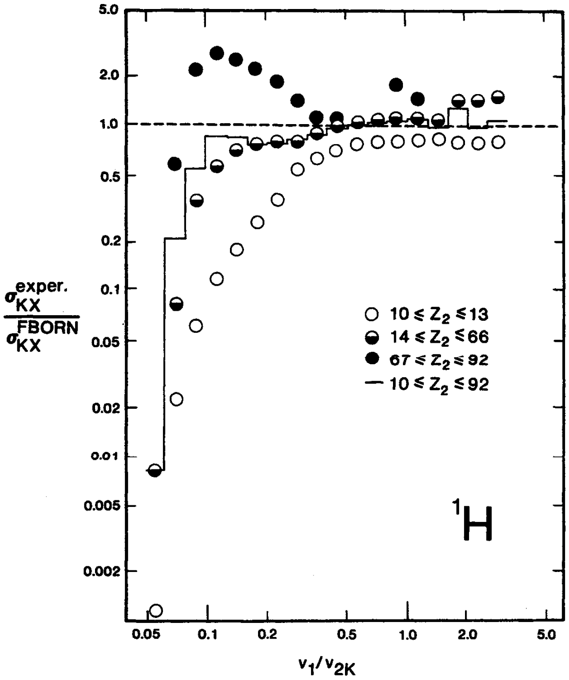

FIG. 5. Averaged [within the 0.1 intervals of $\log(v_1/v_{2K})$] ratios of experimental cross sections to the first Born calculations for the relatively light ($10\leqslant Z_2\leqslant 13$: open circles), medium ($14\leqslant Z_2\leqslant 66$: half-open circles), and heavy ($67\leqslant Z_2\leqslant 92$: closed circles) target elements bombarded by protons. The solid curve is based on the averaged ratios for the $10\leqslant Z_2\leqslant 92$ targets.

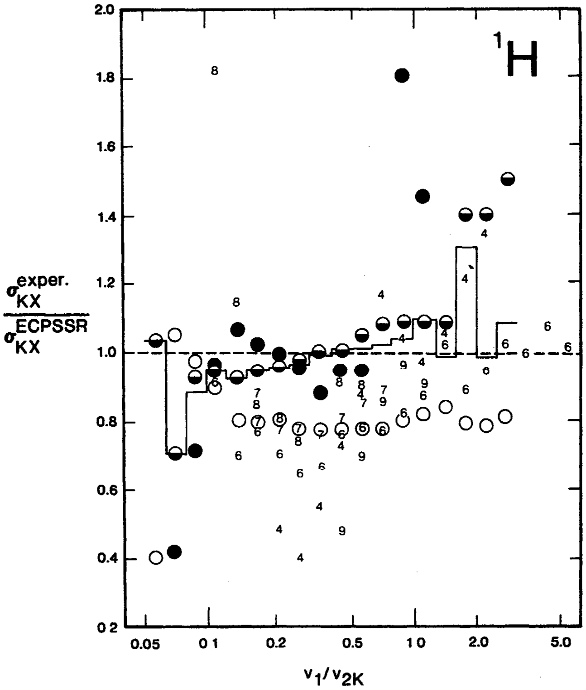

FIG. 6. Averaged [within the 0.1 intervals of $\log(v_1/v_{2K})$] ratios of experimental cross sections to the ECPSSR predictions for relatively light (open circles), medium (half-open circles), and heavy (closed circles) target elements bombarded by protons. The solid curve is based on the averaged ratios for the $10\leqslant Z_2\leqslant 92$ targets; ratios for the $4\leqslant Z_2\leqslant 9$ elements are identified by the atomic numbers of these targets. The mean value of the solid curve is 0.96.

ed by alpha particles. The trends of Fig. 2, the failure of the first Born approximation (illustrated in Fig. 5 for protons only since these trends are similar for other projectiles) and the relative success of the ECPSSR theory, are confirmed and well documented by Figs. 6–9.

The rejected data, i.e., the measurements which differ by more than a factor of 2 from other experimental cross sections in comparable collision regimes, are listed in Tables 2–5 in the bold print for easy recognition. Their identification may serve as a guide for experimentalists into trouble areas in which more measurements would be needed and worthwhile. Our criterion rejects 227 cross sections out of 7007 data. Such a large rejection would be anticipated if the standard deviation σ in the normal distribution of these data was such that 2.14σ were comparable to the measured cross sections. Experimental uncertainties, however, rarely exceed 25%. The ratios, which are more than a factor of 2 different from the mean values, typically lie no less than 4σ from these averages: at most five such ratios would be statistically expected in a sample of 7000 data, while 98% of all rejected ratios is most probably due to truly bad experiments.

In addition, new information emerges from this comprehensive and detailed experiment-to-theory comparison. The first Born approximation overestimates the data by orders of magnitude for the elements in the middle of the periodic table when projectiles are slow. It does it even more dramatically for light elements where Z_1/Z_2 is relatively large. On the other hand, when Z_1/Z_2 is small the first Born

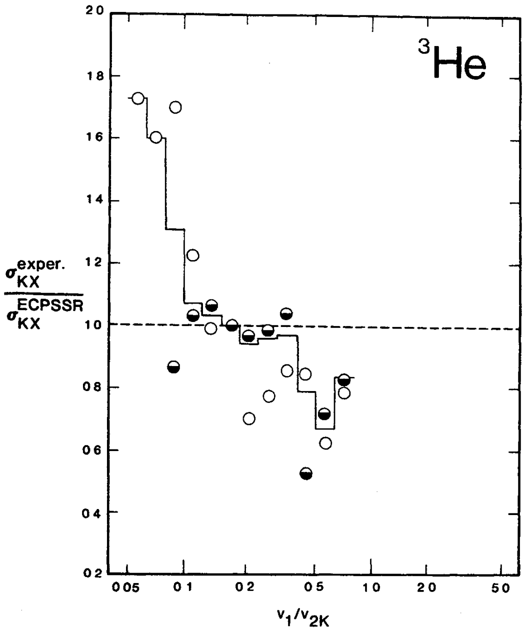

FIG. 8. Averaged [within the 0.1 intervals of $\log(v_1/v_{2K})$] ratios of experimental cross sections to the ECPSSR predictions for aluminum (open circles) and medium (half-open circles) target elements bombarded by ^{3}He ions. The solid curve is based on the averaged ratios for the $13 \leqslant Z_2 \leqslant 47$ targets. The mean value of the solid curve is 1.01.

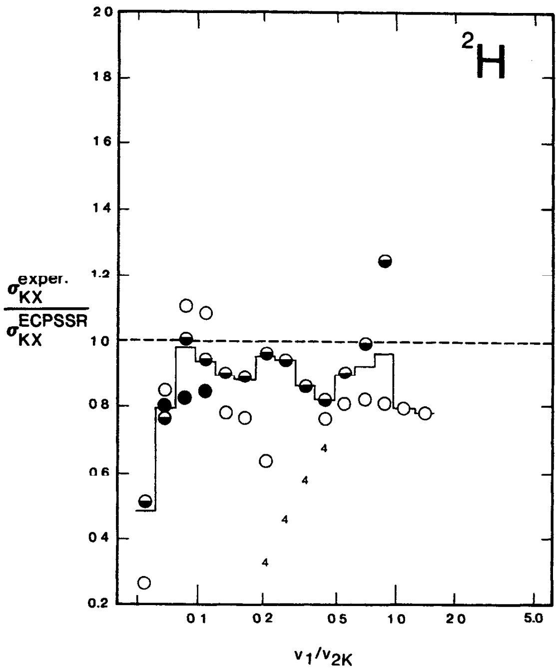

FIG. 7. Averaged [within the 0.1 intervals of $\log(v_1/v_{2K})$] ratios of experimental cross sections to the ECPSSR predictions for relatively light (open circles), medium (half-open circles), and heavy (closed circles) target elements bombarded by deuterons. The solid curve is based on the averaged ratios for the $11 \leqslant Z_2 \leqslant 79$ targets; ratios for beryllium are identified by its atomic number. The mean value of the solid curve is 0.92.

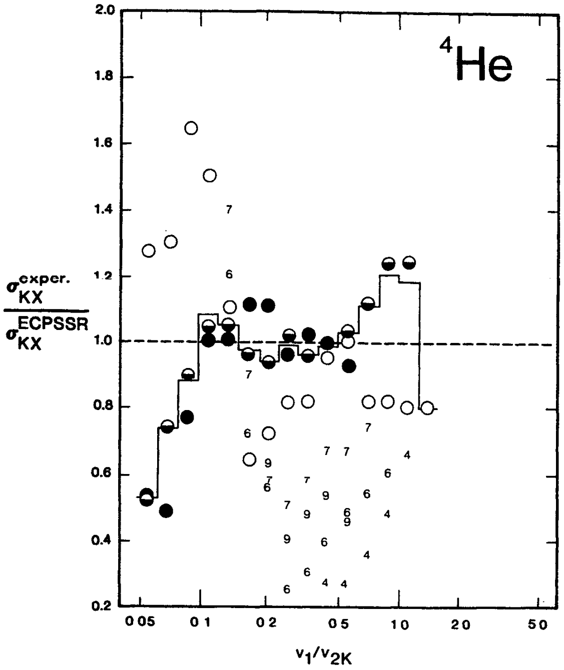

FIG. 9. Averaged [within the 0.1 intervals of $\log(v_1/v_{2K})$] ratios of experimental cross sections to the ECPSSR predictions for light (open circles), medium (half-open circles), and heavy (closed circles) target elements bombarded by ^{4}He ions. The solid curve is based on the averaged ratios for the $10 \leqslant Z_2 \leqslant 92$ targets; ratios for the $4 \leqslant Z_2 \leqslant 9$ elements identified by the atomic numbers of these targets. The mean value of the solid curve is 1.00.

approximation on the average underestimates the data by nearly a factor of 3 when $v_1/v_{2K} \simeq 0.1$. The ECPSSR removes these discrepancies so that the average ratios of experiment to theory are within 20% of the ideal ratio of 1 for protons. A similar conclusion was made in Ref. 15 for identical (protons and targets with $10 \leqslant Z_2 \leqslant 92$) collision systems but merely a one-half of the current data base for proton-induced x-ray production cross sections. For deuterons the agreement is within 25%, except at the lowest projectile velocities where ECPSSR overestimates the measured cross sections by a factor of 2.

For ^{3}He ions, the discrepancies are much more pronounced. They are, however, less significant due to the relatively small (4% of all compiled cross sections) and limited (to $13 \leqslant Z_2 \leqslant 47$ targets) amount of data that is available. As opposed to general trends at small v_1/v_{2K} for any other target-projectile combination, the experimental K x-ray production cross section from aluminum bombarded by ^{3}He is up to 70% larger then the ECPSSR predictions; these data, however, are from only a few references. The agreement of ECPSSR with the compiled ^{4}He data is comparable to its concord with the proton data on the average. Yet the divergence in agreement with the light versus heavy target data is more evident in helium-induced cross sections because Z_1/Z_2 is twice as large.

Experiment-to-theory comparisons, such as presented in this work and most recently by Paul and his collaborators,[5–14] are interpreted as tests of theories to be gauged by massive empirical collections of data. It is amusing to recall Cork[67] who, in a reversal of this procedure, argued that his experiment was acceptable because its deviation from the theory was comparable to theoretical uncertainties. Cork concluded that the measured cross section for K-shell x-ray production in iron by deuterons was "10 to 100 times greater than the theoretical value, but the difference could not be regarded as outside the limit of error in the calculation." Ironically, this particular calculation agrees (well within a factor of 2) with the predictions of current theories for σ_{KX} in iron by 10-MeV deuterons.

We continue to use our latest formulation of the ECPSSR theory.[15,16] Residual deviations of this theory from the data are present and are indeed statistically significant. While the data for moderately heavy and light target elements are in basic agreement with the averages for all data, the cross sections for the lightest and heaviest target atoms oscillate in opposite directions around these averages. In the slow collision limit, the measured cross sections are overpredicted when Z_1/Z_2 is small but they appear to be underpredicted when Z_1/Z_2 is large. Similar trends are noticed in recent work of Paul *et al.*[8–14] The overprediction of the experimental cross sections in heaviest targets is connected with a crude way in which the ECPSSR theory accounts for the relativistic effect; this theory indeed overestimates the importance of the relativistic treatment of the K-shell electron as proven[42] by numerical calculations that use the Dirac wave functions. The underprediction of the data for $Z_1/Z_2 > 0.15$ has been discussed above in terms of the influence of multiple ionizations on σ_K. This underprediction seems to contradict the pronouncements[59–61] that the

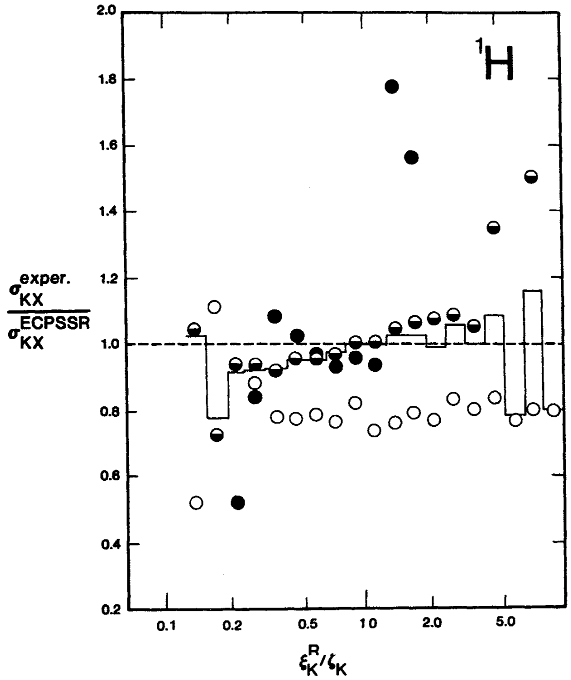

FIG. 10. Same as Fig. 6 but vs the variable ξ_K^R/ζ_K according to which the ECPSSR ionization cross sections scale in the slow collision regime. Correspondingly, the averages are within the 0.1 intervals of $\log(\xi_K^R/\zeta_K)$.

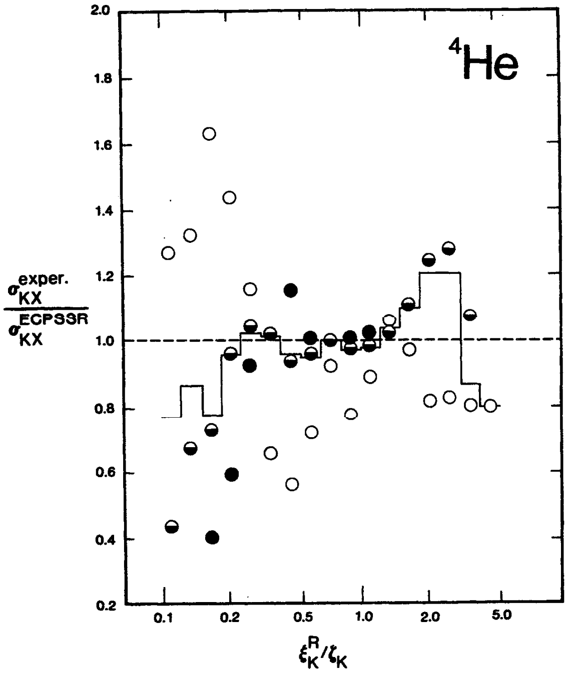

FIG. 11. Same as Fig. 9 but vs the variable ξ_K^R/ζ_K according to which the ECPSSR ionization cross sections scale in the slow collision regime. Correspondingly, the averages are within the 0.1 intervals of $\log(\xi_K^R/\zeta_K)$.

ECPSSR theory underestimates the PSS effect, smaller ionization cross sections that Refs. 59 and 61 suggest would accentuate the discrepancy with experiments. On the other hand, revised accounts for the binding[64] or for the polarization[65] effects could perhaps remove some of this discrepancy. As discussed in Sec. 3.2.a, the ECPSSR theory exhibits a nearly universal scaling with respect to ξ_K^R/ζ_K. Hence the ratios of Figs. 6 (for protons) and 9 (for ^{4}He) are, respectively, replotted as Figs. 10 and 11 in terms of this variable; the deuteron and ^{3}He ratios remain essentially the same because their relative scarcity prevents a statistically meaningful differentiation. Since ξ_K^R/ζ_K is more natural than v_1/v_{2K} in the scaling of the ECPSSR calculations, the replotted ratios are somewhat smoother and, especially at low velocities, the dichotomy between the light and heavy targets is more evident. Also, for large Z_1/Z_2, the discrepancy between the theory and the data is larger in Figs. 10 and 11. The deviations detected in Figs. 6 and 9 are now seen in the sharpest focus; they still persist and a fortiori reflect on real discrepancies between experiment and the ECPSSR theory.

4. Conclusions

This analysis supports the main conclusions of Ref. 15: for the $10 \leqslant Z_2 \leqslant 92$ targets, theory and experiment agree, on the average, to within ± 10% to 20%. With one standard deviation of ± 0.20, the mean ratio of $\sigma_{KX}^{\text{Exper.}}/\sigma_{KX}^{\text{ECPSSR}}$ for these targets and all projectiles equals 0.97. For ^{1}H, ^{2}H, ^{3}He, and ^{4}He, this ratio is, respectively, 0.96 ± 0.19, 0.92 ± 0.19, 1.01 ± 0.24, and 1.00 ± 0.23. The residual deviations are nevertheless genuine and systematic. Only a comprehensive survey of all the data allows to isolate these deviations as a fine structure superimposed on the billionfold change of cross sections with the projectile velocity.

Perhaps the Coulomb deflection factor of the ECPSSR theory should be reconsidered.[68] A quantum mechanical derivation[69] of this factor might be fundamentally more correct.[70] The ECPSSR could be faulty in its treatment of PSS effects. The discrepancy between it and multistate calculations[59,60,62], however, might reflect differences in the description of the K shell rather than inadequacies in the PSS formulation. The calculations of Refs. 59, 60, and 62 span a short interval of v_1/v_{2K} from 0.12 to 0.31; an extension of this interval with calculations that employ and do not employ a screened Coulomb potential for the K-shell electron would be of interest.

For now, the deviations found in our analysis are attributed primarily to inadequacies of a screened hydrogenic description of the target electron on which the ionization calculations[15,16,20,21] rest; this explanation of the observed deviations seems to be particularly valid when K shells of relatively light targets are considered. The ratios of the cross section based on Hartree–Slater wave functions[22,29,71] to the cross section evaluated with the screened hydrogenic wave functions show (see Fig. 3 of Ref. 15) remarkable resemblance to the ratios displayed in Figs. 10 and 11. Hence, we speculate that, provided the relativistic effect will be better accounted for in the theory and the multiple-ionization effect considered, almost perfect agreement with the data would result if the ECPSSR cross sections were calculated with better wavefunctions for atomic K shells.

Known disagreements between the ECPSSR predictions and L-subshell data appear to make this conclusion very speculative indeed. Attempts have been made to explain some of these discrepancies in terms of a two-step mechanism in which a vacancy decay in an ionized subshell is followed by intrashell transitions during the same collision.[72] These corrections have been made, however, in terms of the second order transition probabilities (instead of amplitudes) that were evaluated using the straight-line approximation and without account for PSS effects. An inclusion of PSS effects in the second Born approximation has been advocated by Sarkadi.[73] Strong inter-subshell couplings influence L-subshell ionization probabilities[74] and affect ionization cross sections.[75] It is hoped that rigorous numerical calculations—which extend beyond the first Born approximation, treat the E, C, PSS, and R effects concomitantly, and are *ab initio* in all collisional regimes—will become available in a near future. Ultimately, comprehensive compilations and analyses of the L- and M-shell data are needed to convert our tentative deductions, on the shortcomings of the ECPSSR treatment of K-shell ionization in particular, to more firm conclusions on inadequacies of this theory in general.

Aside from open questions of theoretical interpretation of the compiled data, the present compilation appears to have its own merits as an assessment of worthwhile experiments and, perhaps, as a stimulant for further measurements. It identifies the target elements for which K-shell x-ray productions cross sections have never or seldom been measured with light ion bombardment. It points to the projectiles for which more measurements would be desirable. The compiled data exhibit particularly large scatter among the deuteron and ^{3}He induced cross sections; possible bad measurements cannot be reliably recognized because of the relatively small (11% of all compiled cross sections) amount of these data. All helium-induced x-ray production cross sections should be reported with the He charge state; especially, for light target elements and at low-projectile velocities where electron capture contributes significantly to K-shell ionization (see Table 7). An extension of proton measurements at relatively high velocities, $v_1 > v_{2K}$, to other fast projectiles would be beneficial in understanding of relatively large discrepancies between lighter and heavier elements that appear (see Figs. 6 and 10) in the proton data at high velocities. It remains to be seen whether experimentalists will be prompted to a revival of K-shell x-ray measurements in asymmetric collisions. Such a resurgence could slow down the current rapid decline in the rate with which new data are reported (see Fig. 1) and it might force a quantitative revision of our present forecast about the total number of compiled cross sections saturating at 10 000.

5. Acknowledgments

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TABLE 1. Distribution of compiled K-shell x-ray production cross sections, for each target of atomic number $Z2=4$–92, with respect to the type of projectile ($Z1=1,2$: ions of H-1, H-2, He-3, He-4). $Z2$ of the elements, for which data are listed in Tables 2–5, is highlighted in the bold print. A summary of the compiled data for all target elements appears at the bottom of this table

$Z2$	Protons	+	Deuterons	+	He-3	+	He-4	=	All Ions
4	43		7		0		22		72
5	0		0		0		0		0
6	164		0		0		52		216
7	21		0		0		18		39
8	54		0		0		0		54
9	18		0		0		12		30
10	22		0		0		12		34
11	8		3		0		0		11
12	41		0		0		12		53
13	200		45		70		104		419
14	16		2		7		6		31
15	29		13		10		0		52
16	34		13		0		4		51
17	31		13		0		19		63
18	37		0		10		5		52
19	32		13		0		4		49
20	87		6		0		37		130
21	86		14		0		9		109
22	286		42		33		169		530
23	110		10		0		63		183
24	162		6		32		61		261
25	98		6		0		35		139
26	267		38		0		110		415
27	126		10		23		56		215
28	222		45		14		89		370
29	420		38		19		178		655
30	162		0		0		32		194
31	34		13		0		11		58
32	73		4		23		51		151
33	16		0		0		9		25
34	56		0		13		54		123
35	14		0		0		4		18
36	23		0		0		0		23
37	31		10		0		26		67
38	21		11		0		0		32
39	53		0		0		30		83
40	38		10		9		12		69
41	32		8		8		27		75
42	118		0		0		51		169
43	0		0		0		0		0
44	1		0		0		0		1
45	10		0		0		16		26
46	44		0		11		13		68
47	268		18		8		82		376
48	54		10		0		24		88

TABLE 1. Distribution of compiled *K*–shell x–ray production cross sections, for each target of atomic number $Z2=4–92$, with respect to the type of projectile ($Z1=1,2$: ions of H-1, H-2, He-3, He-4). $Z2$ of the elements, for which data are listed in Tables 2–5, is highlighted in the bold print. A summary of the compiled data for all target elements appears at the bottom of this table — Continued

Z2	Protons	+	Deuterons	+	He-3	+	He-4	=	All Ions
49	70		8		0		7		85
50	120		8		0		83		211
51	31		16		0		16		63
52	17		0		0		10		27
53	39		0		0		10		49
54	2		0		0		0		2
55	15		0		0		4		19
56	40		0		0		8		48
57	12		0		0		0		12
58	44		5		0		7		56
59	17		0		0		7		24
60	59		0		0		9		68
61	1		0		0		0		1
62	58		0		0		12		70
63	12		0		0		0		12
64	28		11		0		26		65
65	25		0		0		0		25
66	0		0		0		0		0
67	57		0		0		21		78
68	0		0		0		0		0
69	26		0		0		22		48
70	10		0		0		0		10
71	0		0		0		5		5
72	6		0		0		7		13
73	66		11		0		18		95
74	32		15		0		23		70
75	6		0		0		6		12
76	0		0		0		0		0
77	0		0		0		0		0
78	8		0		0		12		20
79	90		14		0		39		143
80	0		0		0		0		0
81	0		0		0		0		0
82	56		0		0		31		87
83	7		0		0		16		23
84	0		0		0		0		0
85	0		0		0		0		0
86	0		0		0		0		0
87	0		0		0		0		0
88	0		0		0		0		0
89	0		0		0		0		0
90	26		0		0		21		47
91	0		0		0		0		0
92	45		0		0		6		51

Z2=4-92	Protons	Deuterons	He-3	He-4	All Data
Targets	4687(63%)	496(7%)	290(4%)	1945(26%)	**7418**

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
4	Beryllium		Fluorescence yield = 0.00033						
1.50-2	8.70+0	4.76-1	2.00-2	3.00+1	4.71-1	2.50-2	7.50+1	5.02-1	35
3.00-2	1.60+2	5.83-1	4.00-2	4.00+2	6.60-1	5.00-2	6.50+2	6.64-1	
6.00-2	1.00+3	7.50-1	7.00-2	1.30+3	7.91-1	8.00-2	1.60+3	8.42-1	
9.00-2	1.80+3	8.54-1	1.00-1	2.00+3	8.82-1	1.20-1	2.30+3	9.24-1	
1.40-1	2.70+3	1.03+0	1.60-1	3.00+3	1.13+0	1.80-1	3.20+3	1.20+0	
2.00-1	3.40+3	1.28+0							
5.00-1	1.51+3	7.72-1	7.50-1	1.43+3	9.08-1	1.00+0	1.32+3	9.96-1	71
1.20+0	1.23+3	1.12+0	1.40+0	1.14+3	1.15+0	1.60+0	1.07+3	1.17+0	
1.80+0	1.01+3	1.20+0	2.00+0	9.78+2	1.24+0				
3.00-1	2.53+3	1.04+0	5.00-1	2.26+3	1.16+0	7.00-1	2.00+3	1.22+0	92
1.00+0	1.68+3	1.27+0	1.20+0	1.61+3	1.47+0	1.50+0	1.52+3	1.60+0	
1.80+0	1.42+3	1.68+0							
1.00-2	3.17-1	1.25-1	1.20-2	8.69-1	1.37-1	1.50-2	2.78+0	1.52-1	119
2.00-2	1.16+1	1.82-1	2.50-2	3.33+1	2.23-1	3.00-2	7.49+1	2.73-1	
4.00-2	2.23+2	3.68-1	5.00-2	4.47+2	4.56-1	6.00-2	7.33+2	5.50-1	
8.00-2	1.28+3	6.74-1	1.00-1	1.84+3	8.12-1	1.20-1	2.17+3	8.72-1	
6	Carbon		Fluorescence yield = 0.0028						
1.50+0	3.00+3	1.37+0							10
1.50-2	5.76-2	1.03-1	2.00-2	2.00-1	9.24-2	2.50-2	5.58-1	9.55-2	11
3.00-2	1.83+0	1.45-1	4.00-2	6.33+0	1.60-1	5.00-2	1.53+1	1.74-1	
6.00-2	3.40+1	2.13-1	7.00-2	5.94+1	2.36-1	8.00-2	1.17+2	3.25-1	
9.00-2	1.66+2	3.46-1	1.00-1	2.07+2	3.41-1	1.10-1	2.74+2	3.71-1	
4.99-1	2.17+3	7.65-1	5.95-1	2.24+3	7.87-1	6.98-1	2.28+3	8.11-1	
7.75-1	2.28+3	8.26-1	9.10-1	2.29+3	8.61-1	1.02+0	2.24+3	8.73-1	
1.10+0	2.18+3	8.70-1	1.20+0	2.17+3	8.95-1	1.27+0	2.10+3	8.88-1	
1.36+0	2.09+3	9.10-1	1.51+0	2.02+3	9.21-1	1.66+0	1.94+3	9.28-1	
1.91+0	1.89+3	9.73-1							
2.00-2	9.50-1	4.39-1	3.00-2	4.30+0	3.40-1	4.00-2	2.00+1	5.07-1	16
5.00-2	4.40+1	5.00-1	6.00-2	8.20+1	5.15-1	7.00-2	1.20+2	4.77-1	
8.00-2	2.20+2	6.11-1							
1.50-2	4.80-1	8.58-1	2.00-2	1.80+0	8.31-1	2.50-2	5.40+0	9.25-1	23
3.00-2	1.10+1	8.70-1	3.50-2	2.10+1	8.90-1	4.00-2	3.60+1	9.12-1	
5.00-2	8.10+1	9.20-1							

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
2.00-2	1.70+0	7.85-1	2.50-2	5.00+0	8.56-1	3.00-2	1.20+1	9.49-1	26
4.00-2	3.60+1	9.12-1	5.00-2	7.60+1	8.64-1	6.00-2	1.30+2	8.16-1	
7.00-2	2.00+2	7.95-1	8.00-2	2.80+2	7.78-1	9.00-2	3.70+2	7.72-1	
1.00-1	4.70+2	7.75-1	1.20-1	6.60+2	7.59-1	1.40-1	9.10+2	8.07-1	
1.60-1	1.20+3	8.76-1	1.80-1	1.30+3	8.18-1	2.00-1	1.50+3	8.40-1	
2.00+0	7.60+2	4.01-1	3.00+0	8.60+2	5.79-1	4.00+0	8.40+2	6.85-1	37
6.00+0	7.20+2	7.84-1	1.00+1	4.60+2	7.35-1	1.20+1	2.80+2	5.15-1	
1.40+1	3.30+2	6.85-1							
2.80-2	7.56+0	7.97-1	3.70-2	2.02+1	6.89-1	4.80-2	5.54+1	7.24-1	46
5.80-2	9.94+1	6.94-1	6.80-2	1.55+2	6.69-1	7.70-2	2.44+2	7.49-1	
8.70-2	3.32+2	7.51-1	9.70-2	4.40+2	7.75-1	1.06-1	5.42+2	7.90-1	
1.16-1	6.67+2	8.15-1	1.26-1	7.82+2	8.24-1	1.35-1	8.99+2	8.44-1	
1.45-1	1.03+3	8.66-1							
1.00-1	3.50+2	5.77-1	1.10-1	5.00+2	6.78-1	1.20-1	6.00+2	6.90-1	50
1.30-1	7.00+2	7.00-1	1.40-1	7.50+2	6.65-1	1.50-1	8.00+2	6.39-1	
1.60-1	1.00+3	7.30-1	1.70-1	1.10+3	7.43-1	2.00-1	1.20+3	6.72-1	
2.50-1	1.50+3	6.89-1	3.00-1	1.60+3	6.55-1	4.00-1	2.00+3	7.31-1	
5.00-1	2.10+3	7.40-1	6.00-1	2.10+3	7.38-1	7.00-1	2.00+3	7.11-1	
8.00-1	2.00+3	7.28-1	9.00-1	1.90+3	7.12-1	1.00+0	1.80+3	6.97-1	
1.00-2	7.00-2	1.01+0	1.25-2	1.80-1	7.97-1	1.50-2	4.00-1	7.15-1	51
1.75-2	7.80-1	6.67-1	2.00-2	1.30+0	6.00-1	2.50-2	3.30+0	5.65-1	
3.00-2	6.90+0	5.46-1	3.50-2	1.30+1	5.51-1	4.00-2	2.20+1	5.57-1	
4.50-2	3.20+1	5.26-1	5.00-2	5.10+1	5.80-1				
1.00+0	2.97+3	1.15+0	2.00+0	2.04+3	1.08+0	3.00+0	1.65+3	1.11+0	70
4.00+0	1.34+3	1.09+0	6.00+0	1.04+3	1.13+0	8.00+0	8.40+2	1.13+0	
1.00+1	7.00+2	1.12+0	1.20+1	6.20+2	1.14+0	1.40+1	5.60+2	1.16+0	
1.60+1	4.50+2	1.04+0	1.80+1	4.20+2	1.07+0				
2.90-1	2.21+3	9.21-1	5.20-1	2.80+3	9.83-1	7.20-1	2.77+3	9.90-1	81
1.02+0	2.45+3	9.54-1	2.00+0	2.01+3	1.06+0	3.00+0	1.46+3	9.83-1	
4.00+0	1.23+3	1.00+0	5.00+0	1.08+3	1.03+0	6.00+0	9.30+2	1.01+0	
7.00+0	8.30+2	1.01+0	8.00+0	8.10+2	1.09+0	9.00+0	7.20+2	1.06+0	
1.00+1	6.70+2	1.07+0	1.10+1	6.50+2	1.12+0	1.20+1	6.30+2	1.16+0	
1.30+1	5.50+2	1.08+0	1.40+1	5.30+2	1.10+0	1.50+1	5.30+2	1.16+0	
1.60+1	5.80+2	1.34+0							
1.00-1	4.15+2	6.84-1	1.25-1	6.50+2	6.94-1	1.50-1	9.10+2	7.27-1	82
1.75-1	1.15+3	7.48-1	2.00-1	1.36+3	7.62-1	2.50-1	1.77+3	8.14-1	
3.00-1	2.04+3	8.35-1	4.00-1	2.22+3	8.11-1	5.00-1	2.33+3	8.21-1	
6.00-1	2.35+3	8.26-1	7.00-1	2.28+3	8.11-1	8.00-1	2.09+3	7.61-1	
1.00+0	2.10+3	8.13-1							
1.80+1	4.28+2	1.09+0	1.90+1	3.79+2	1.00+0	2.00+1	3.69+2	1.02+0	85
2.10+1	3.59+2	1.03+0	2.20+1	3.39+2	1.01+0	2.30+1	3.30+2	1.02+0	
2.40+1	3.10+2	9.92-1	2.50+1	3.10+2	1.03+0	2.60+1	3.10+2	1.06+0	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
6.00-1	2.45+3	8.61-1	8.00-1	2.34+3	8.52-1	1.00+0	2.27+3	8.78-1	157
1.20+0	2.19+3	9.05-1	1.40+0	2.12+3	9.35-1	1.60+0	2.02+3	9.49-1	
1.80+0	1.97+3	9.83-1	2.00+0	1.91+3	1.01+0				
7 Nitrogen			Fluorescence yield = 0.0052						
2.80-2	2.69+0	1.06+0	3.70-2	7.18+0	8.78-1	4.80-2	1.81+1	7.97-1	46
5.80-2	3.38+1	7.47-1	6.80-2	5.91+1	7.59-1	7.70-2	9.19+1	7.95-1	
8.70-2	1.26+2	7.56-1	9.70-2	1.68+2	7.43-1	1.06-1	2.20+2	7.71-1	
1.16-1	2.73+2	7.66-1	1.26-1	3.26+2	7.58-1	1.35-1	3.84+2	7.67-1	
1.45-1	4.28+2	7.38-1							
1.25-1	3.17+2	7.51-1	1.50-1	4.70+2	7.56-1	1.75-1	6.42+2	7.82-1	82
2.00-1	8.21+2	8.08-1	2.50-1	1.09+3	7.97-1	3.00-1	1.36+3	8.20-1	
4.00-1	1.81+3	8.74-1	5.00-1	2.05+3	8.86-1				
8 Oxygen			Fluorescence yield = 0.0083						
2.00-2	1.86-1	1.08+0	2.50-2	4.60-1	9.14-1	3.00-2	9.40-1	8.14-1	18
3.50-2	1.72+0	7.62-1	4.00-2	2.90+0	7.34-1	4.50-2	4.70+0	7.36-1	
5.00-2	7.00+0	7.23-1	5.50-2	1.01+1	7.24-1	6.00-2	1.40+1	7.25-1	
6.50-2	1.88+1	7.28-1	7.00-2	2.44+1	7.26-1	7.50-2	3.10+1	7.27-1	
8.00-2	3.86+1	7.29-1	8.50-2	4.75+1	7.36-1	9.00-2	5.70+1	7.37-1	
9.50-2	6.70+1	7.34-1	1.00-1	7.90+1	7.39-1				
1.50-1	2.40+2	7.64-1							29
2.00-2	5.70-1	3.32+0	2.50-2	1.10+0	2.19+0	3.00-2	2.10+0	1.82+0	33
3.50-2	2.90+0	1.28+0	4.00-2	4.50+0	1.14+0	4.50-2	6.70+0	1.05+0	
5.00-2	1.00+1	1.03+0	5.50-2	1.50+1	1.07+0	6.00-2	2.00+1	1.04+0	
6.50-2	2.40+1	9.29-1	7.00-2	3.00+1	8.93-1	7.50-2	4.20+1	9.85-1	
8.00-2	5.50+1	1.04+0							
5.00-2	7.00+0	7.23-1	6.00-2	1.40+1	7.25-1	7.00-2	2.40+1	7.14-1	34
8.00-2	4.00+1	7.55-1	9.00-2	6.00+1	7.76-1	1.00-1	8.00+1	7.48-1	
1.50-1	2.30+2	7.32-1	2.00-1	4.50+2	7.86-1	2.50-1	7.00+2	8.39-1	
3.00-1	9.30+2	8.64-1	3.50-1	1.20+3	9.30-1	4.00-1	1.30+3	8.82-1	
2.00-2	1.80-1	1.05+0	2.50-2	4.60-1	9.14-1	3.00-2	9.50-1	8.23-1	51
3.50-2	1.65+0	7.31-1	4.00-2	3.00+0	7.59-1	4.50-2	4.70+0	7.36-1	
5.00-2	7.00+0	7.23-1	5.50-2	1.00+1	7.17-1	6.00-2	1.40+1	7.25-1	
6.50-2	1.90+1	7.36-1	7.00-2	2.50+1	7.44-1				
9 Fluorine			Fluorescence yield = 0.013						
5.00-1	1.10+3	8.29-1	8.45-1	1.45+3	7.72-1	1.00+0	1.50+3	7.53-1	110
3.00-1	3.14+2	4.48-1	3.50-1	4.15+2	4.72-1	4.00-1	5.14+2	4.92-1	116
5.00-1	7.54+2	5.68-1	6.00-1	1.02+3	6.60-1	7.00-1	1.27+3	7.41-1	
8.00-1	1.49+3	8.12-1	9.00-1	1.68+3	8.72-1	1.00+0	1.87+3	9.39-1	
1.10+0	1.94+3	9.51-1	1.20+0	2.02+3	9.76-1	1.40+0	2.06+3	9.82-1	
1.60+0	2.02+3	9.66-1	1.80+0	1.92+3	9.27-1	2.00+0	1.83+3	8.98-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
10 Neon			Fluorescence yield = 0.018						
4.80-2	1.41+0	1.13+0	5.80-2	2.67+0	9.73-1	6.80-2	4.68+0	9.11-1	46
7.70-2	7.83+0	9.50-1	9.70-2	1.79+1	9.45-1	1.16-1	3.29+1	9.51-1	
1.35-1	5.40+1	9.66-1							
5.00+0	1.40+3	1.00+0							58
1.25-1	3.20+1	7.27-1	1.50-1	5.70+1	7.47-1	2.00-1	1.25+2	7.50-1	82
2.50-1	2.09+2	7.47-1	3.00-1	3.18+2	7.86-1	4.00-1	5.63+2	8.56-1	
5.00-1	7.04+2	7.94-1	6.00-1	8.37+2	7.74-1	7.00-1	9.60+2	7.72-1	
8.00-1	1.05+3	7.64-1	9.00-1	1.20+3	8.10-1	1.00+0	1.30+3	8.31-1	
1.10+0	1.42+3	8.73-1	1.20+0	1.50+3	8.92-1				
11 Sodium			Fluorescence yield = 0.023						
2.00-2	8.00-3	1.72+0	2.50-2	2.50-2	1.38+0	3.00-2	6.00-2	1.21+0	101
4.00-2	1.20-1	5.79-1	5.00-2	2.50-1	4.39-1	5.50-2	6.00-1	6.97-1	
6.00-2	8.50-1	6.86-1	6.50-2	1.30+0	7.54-1				
12 Magnesium			Fluorescence yield = 0.03						
6.00-2	3.50-1	6.64-1	1.00-1	2.80+0	6.78-1	1.50-1	1.20+1	6.95-1	9
2.00-1	2.80+1	6.58-1	3.00-1	9.40+1	7.44-1	4.00-1	1.80+2	7.57-1	
5.00-1	2.30+2	6.38-1							
2.50-2	4.31-3	7.40-1	3.00-2	1.53-2	8.80-1	4.00-2	7.34-2	9.12-1	11
5.00-2	2.27-1	9.71-1	6.00-2	4.45-1	8.44-1	7.00-2	8.52-1	8.41-1	
8.00-2	1.85+0	1.06+0	9.00-2	2.41+0	8.71-1	1.00-1	3.46+0	8.38-1	
6.02-1	4.25+2	8.81-1	6.86-1	4.49+2	7.77-1	8.00-1	5.06+2	7.29-1	
9.00-1	5.77+2	7.35-1	1.00+0	6.42+2	7.42-1	1.10+0	7.27+2	7.77-1	
1.20+0	7.73+2	7.75-1	1.31+0	8.79+2	8.33-1	1.40+0	9.46+2	8.64-1	
1.50+0	1.03+3	9.08-1	1.60+0	1.07+3	9.16-1	1.70+0	1.14+3	9.55-1	
1.25-1	8.30+0	8.95-1	1.50-1	1.50+1	8.69-1	1.75-1	2.60+1	9.17-1	12
2.00-1	4.00+1	9.40-1							
3.00+0	1.10+3	8.39-1							94
2.00-2	6.00-4	4.70-1	2.50-2	4.00-3	6.87-1	3.00-2	1.20-2	6.90-1	101
3.50-2	3.00-2	7.40-1	4.00-2	6.00-2	7.46-1	4.50-2	1.00-1	7.00-1	
5.00-2	2.00-1	8.56-1	6.00-2	5.00-1	9.48-1				
13 Aluminum			Fluorescence yield = 0.039						
6.00-2	1.70-1	7.05-1	1.00-1	1.50+0	7.31-1	1.32-1	3.90+0	6.74-1	9
1.50-1	5.60+0	6.17-1	2.00-1	1.50+1	6.42-1	3.00-1	5.50+1	7.34-1	
4.00-1	1.20+2	7.97-1	5.00-1	2.30+2	9.64-1				
1.50+0	1.00+3	1.07+0							10
2.50-2	1.43-3	7.43-1	3.00-2	5.01-3	7.87-1	4.00-2	2.98-2	8.98-1	11
5.00-2	9.19-2	8.93-1	6.00-2	2.11-1	8.75-1	7.00-2	4.09-1	8.58-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
8.00-2	6.97-1	8.31-1	9.00-2	1.06+0	7.83-1	1.00-1	1.54+0	7.50-1	
4.84-1	1.92+2	8.58-1	5.98-1	2.72+2	8.24-1	7.00-1	3.44+2	8.14-1	
8.00-1	4.17+2	8.19-1	9.00-1	4.86+2	8.24-1	1.00+0	5.46+2	8.23-1	
1.10+0	6.17+2	8.45-1	1.20+0	6.66+2	8.43-1	1.30+0	7.19+2	8.53-1	
1.40+0	7.66+2	8.60-1	1.50+0	8.28+2	8.87-1	1.60+0	8.80+2	9.07-1	
1.70+0	9.24+2	9.21-1							
3.00-2	1.30-2	**2.04+0**	5.00-2	1.20-1	1.17+0	8.00-2	7.40-1	8.83-1	12
1.00-1	1.50+0	7.31-1	1.25-1	4.80+0	1.01+0	1.50-1	7.80+0	8.60-1	
1.75-1	1.60+1	1.05+0	2.00-1	2.90+1	1.24+0				
4.80-2	8.00-2	9.49-1	5.00-2	8.60-2	8.36-1	6.00-2	2.00-1	8.29-1	13
6.00-2	2.20-1	9.12-1	7.00-2	4.00-1	8.39-1	7.20-2	4.20-1	7.81-1	
8.00-2	6.50-1	7.75-1	8.40-2	7.70-1	7.52-1	9.00-2	1.00+0	7.38-1	
9.60-2	1.11+0	6.35-1	1.00-1	1.54+0	7.50-1				
2.50-2	2.00-3	1.04+0	3.00-2	6.10-3	9.58-1	4.00-2	3.10-2	9.34-1	17
5.00-2	1.20-1	1.17+0	6.00-2	2.20-1	9.12-1	7.00-2	4.40-1	9.23-1	
8.00-2	7.60-1	9.06-1	9.00-2	1.20+0	8.86-1	1.20-1	3.60+0	8.80-1	
1.40-1	6.20+0	8.69-1	1.80-1	1.00+1	5.98-1	1.90-1	1.40+1	7.04-1	
2.00-1	1.90+1	8.13-1							
8.00-2	5.60-1	6.68-1	9.00-2	8.40-1	6.20-1	1.00-1	1.40+0	6.82-1	22
1.10-1	2.00+0	6.76-1	1.20-1	2.80+0	6.84-1	1.30-1	4.00+0	7.31-1	
1.40-1	4.60+0	6.45-1	1.50-1	6.00+0	6.61-1	1.60-1	7.20+0	6.37-1	
1.70-1	8.00+0	5.77-1	1.80-1	1.00+1	5.98-1	1.90-1	1.20+1	6.03-1	
2.00-1	1.40+1	5.99-1							
9.00-2	1.05+0	7.75-1	1.00-1	1.49+0	7.26-1	1.40-1	4.67+0	6.55-1	25
1.80-1	1.06+1	6.34-1							
1.75-2	1.55-4	**1.45+0**	2.00-2	4.60-4	1.32+0	2.50-2	2.02-3	1.05+0	45
3.00-2	6.54-3	1.03+0	3.50-2	1.61-2	1.01+0	4.00-2	3.26-2	9.82-1	
5.00-2	1.07-1	1.04+0	6.00-2	2.27-1	9.41-1	7.00-2	4.33-1	9.08-1	
8.00-2	7.33-1	8.74-1	9.00-2	1.14+0	8.42-1	1.00-1	1.68+0	8.19-1	
1.10-1	2.35+0	7.95-1	1.20-1	3.46+0	8.46-1	1.40-1	6.44+0	9.03-1	
1.53-1	7.42+0	7.64-1	1.60-1	9.14+0	8.08-1	1.79-1	1.22+1	7.43-1	
2.00-1	1.79+1	7.66-1	2.04-1	1.84+1	7.40-1	2.50-1	3.11+1	6.82-1	
2.55-1	3.28+1	6.81-1	3.06-1	5.34+1	6.77-1	3.57-1	7.81+1	6.74-1	
4.08-1	9.81+1	6.23-1	4.59-1	1.38+2	6.84-1	5.10-1	1.70+2	6.86-1	
6.12-1	2.34+2	6.82-1	7.14-1	2.95+2	6.78-1	8.16-1	3.50+2	6.69-1	
9.18-1	4.01+2	6.64-1	1.02+0	4.46+2	6.59-1	1.12+0	4.84+2	6.52-1	
1.22+0	5.21+2	6.51-1	1.33+0	5.48+2	6.39-1	1.43+0	5.76+2	6.37-1	
1.53+0	6.04+2	6.39-1	1.63+0	6.27+2	6.39-1	1.73+0	6.50+2	6.42-1	
1.84+0	6.70+2	6.42-1	1.94+0	6.89+2	6.45-1	2.04+0	7.05+2	6.49-1	
2.14+0	7.23+2	6.54-1	2.24+0	7.39+2	6.59-1	2.35+0	7.54+2	6.62-1	
2.45+0	7.68+2	6.69-1	2.55+0	7.81+2	6.74-1	2.65+0	7.96+2	6.82-1	
2.75+0	8.09+2	6.89-1	2.85+0	8.23+2	6.98-1	2.96+0	8.37+2	7.07-1	
2.00-2	4.60-4	1.32+0	2.25-2	1.20-3	1.35+0	2.50-2	2.30-3	1.20+0	51
2.75-2	4.60-3	1.25+0	3.00-2	7.50-3	1.18+0	3.25-2	1.20-2	1.16+0	
3.50-2	1.50-2	9.42-1	4.00-2	3.80-2	1.14+0	4.50-2	7.00-2	1.14+0	
5.00-2	1.20-1	1.17+0	5.50-2	1.70-1	1.05+0				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
7.50-1	2.96+2	6.34-1	1.00+0	4.78+2	7.21-1	1.25+0	6.16+2	7.54-1	75
1.50+0	6.98+2	7.48-1	2.00+0	8.10+2	7.50-1	2.50+0	9.47+2	8.21-1	
3.00+0	9.93+2	8.38-1	3.50+0	9.98+2	8.37-1	4.00+0	9.73+2	8.24-1	
2.00-1	2.28+1	9.75-1							88
3.00+0	1.09+3	9.18-1							94
2.50+0	9.55+2	8.28-1	3.00+0	9.88+2	8.33-1	5.00+0	9.16+2	8.05-1	97
7.50+0	7.80+2	7.81-1	9.00+0	7.19+2	7.81-1	9.75+0	6.83+2	7.72-1	
1.50-2	8.00-6	3.58-1	1.60-2	2.00-5	4.51-1	1.70-2	5.00-5	6.16-1	101
1.80-2	9.00-5	6.47-1	1.90-2	1.60-4	7.10-1	2.00-2	3.50-4	1.00+0	
2.20-2	9.00-4	1.20+0	2.60-2	1.80-3	7.13-1	2.80-2	3.70-3	8.94-1	
3.00-2	6.00-3	9.42-1	3.50-2	1.20-2	7.54-1	4.00-2	2.40-2	7.23-1	
4.50-2	3.70-2	6.05-1	5.00-2	6.50-2	6.32-1	5.50-2	1.20-1	7.41-1	
6.00-2	2.00-1	8.29-1							
3.26-1	9.43+1	1.02+0	3.60-1	1.20+2	1.02+0	3.85-1	1.40+2	1.01+0	110
5.00-1	2.44+2	1.02+0	1.00+0	6.67+2	1.01+0				
7.50-1	2.96+2	6.34-1	1.00+0	4.78+2	7.21-1	1.25+0	6.16+2	7.54-1	117
1.50+0	6.98+2	7.48-1	2.00+0	8.10+2	7.50-1	2.50+0	9.47+2	8.21-1	
2.99+0	9.69+2	8.18-1	3.00+0	9.93+2	8.38-1	3.94+0	9.92+2	8.39-1	
6.07+0	8.79+2	8.14-1	9.13+0	7.33+2	8.02-1	1.22+1	6.13+2	7.83-1	
1.83+1	4.69+2	7.69-1	2.40+1	3.94+2	7.81-1	3.01+1	3.42+2	8.00-1	
3.56+1	2.97+2	7.86-1	3.96+1	2.77+2	7.94-1				
3.00-1	6.85+1	9.14-1	6.00-1	3.00+2	9.04-1	1.00+0	6.05+2	9.12-1	149
14 Silcon			Fluorescence yield = 0.05						
7.50-1	2.47+2	7.31-1	1.00+0	3.95+2	7.79-1	1.25+0	4.85+2	7.47-1	75
1.50+0	6.35+2	8.31-1	2.00+0	7.68+2	8.31-1	2.50+0	8.61+2	8.48-1	
3.00+0	9.34+2	8.75-1	3.50+0	9.55+2	8.75-1	4.00+0	9.60+2	8.74-1	
3.00+0	1.00+3	9.37-1							94
2.50-2	3.00-4	4.91-1	3.00-2	1.30-3	5.60-1	3.50-2	5.00-3	7.97-1	101
4.00-2	1.40-2	1.01+0	5.00-2	6.00-2	1.29+0	6.00-2	1.40-1	1.23+0	
15 Phosphorus			Fluorescence yield = 0.063						
1.40+0	5.27+2	9.12-1	1.50+0	5.51+2	8.91-1	1.60+0	6.12+2	9.32-1	122
1.70+0	6.33+2	9.15-1	1.80+0	6.70+2	9.25-1	1.90+0	6.95+2	9.22-1	
2.00+0	7.25+2	9.28-1							
6.00-1	1.59+2	1.01+0	8.00-1	3.49+2	1.29+0	1.00+0	4.56+2	1.19+0	123
1.20+0	5.59+2	1.15+0	1.40+0	6.72+2	1.16+0	1.60+0	7.92+2	1.21+0	
1.80+0	9.12+2	1.26+0	2.00+0	9.24+2	1.18+0	2.20+0	9.72+2	1.17+0	
2.40+0	9.66+2	1.11+0	2.60+0	9.28+2	1.03+0				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
1.00+0	4.81+2	1.25+0	1.30+0	6.50+2	1.22+0	1.90+0	8.46+2	1.12+0	156
2.25+0	8.54+2	1.02+0	2.55+0	9.73+2	1.09+0	2.80+0	1.01+3	1.09+0	
3.00+0	1.00+3	1.05+0	3.50+0	9.69+2	9.80-1	4.00+0	1.09+3	1.08+0	
4.50+0	1.13+3	1.11+0	5.00+0	1.13+3	1.11+0				
16	Sulfur		Fluorescence yield = 0.078						
8.30-1	1.80+2	8.50-1	1.58+0	5.40+2	1.02+0	2.56+0	7.50+2	9.64-1	66
3.28+0	1.08+3	1.24+0							
3.00+0	8.46+2	1.00+0							94
1.40+0	4.62+2	1.00+0	1.50+0	4.56+2	9.12-1	1.60+0	4.91+2	9.17-1	122
1.70+0	5.26+2	9.24-1	1.80+0	5.58+2	9.29-1	1.90+0	5.65+2	8.97-1	
2.00+0	5.97+2	9.08-1							
6.00-1	1.55+2	1.41+0	8.00-1	2.95+2	1.49+0	1.00+0	4.04+2	1.39+0	123
1.20+0	5.30+2	1.39+0	1.40+0	6.43+2	1.39+0	1.60+0	7.45+2	1.39+0	
1.80+0	8.09+2	1.35+0	2.00+0	8.77+2	1.33+0	2.20+0	9.68+2	1.37+0	
2.40+0	9.84+2	1.31+0	2.60+0	1.03+3	1.31+0				
1.00+0	3.14+2	1.08+0	1.30+0	4.57+2	1.08+0	1.90+0	6.76+2	1.07+0	156
2.25+0	7.28+2	1.01+0	2.55+0	8.23+2	1.06+0	2.80+0	8.17+2	1.00+0	
3.00+0	8.98+2	1.07+0	3.50+0	9.17+2	1.03+0	4.00+0	1.02+3	1.11+0	
4.50+0	1.12+3	1.19+0	5.00+0	1.13+3	1.19+0				
17	Chlorine		Fluorescence yield = 0.097						
9.50-1	2.60+2	1.27+0							76
3.00+0	6.95+2	9.21-1							94
1.40+0	3.63+2	9.69-1	1.50+0	3.74+2	9.14-1	1.60+0	4.02+2	9.09-1	122
1.70+0	4.23+2	8.92-1	1.80+0	5.25+2	1.04+0	1.90+0	5.15+2	9.66-1	
2.00+0	5.34+2	9.54-1							
8.00-1	1.63+2	1.11+0	1.00+0	2.64+2	1.18+0	1.20+0	2.80+2	9.31-1	123
1.40+0	3.31+2	8.84-1	1.60+0	4.18+2	9.45-1	1.80+0	4.80+2	9.52-1	
2.00+0	5.32+2	9.51-1	2.20+0	5.46+2	8.97-1	2.40+0	5.33+2	8.17-1	
2.60+0	5.71+2	8.26-1	2.80+0	5.53+2	7.63-1				
1.00+0	2.69+2	1.20+0	1.30+0	4.00+2	1.18+0	1.90+0	6.09+2	1.14+0	156
2.25+0	6.63+2	1.07+0	2.55+0	7.22+2	1.06+0	2.80+0	7.62+2	1.05+0	
3.00+0	8.08+2	1.07+0	3.50+0	8.42+2	1.04+0	4.00+0	9.35+2	1.10+0	
4.50+0	9.86+2	1.12+0	5.00+0	1.02+3	1.14+0				
18	Argon		Fluorescence yield = 0.118						
1.50+0	2.80+2	8.53-1	2.00+0	4.20+2	8.98-1	2.50+0	5.20+2	9.00-1	40
3.00+0	6.10+2	9.22-1	3.50+0	6.80+2	9.38-1	4.00+0	6.90+2	8.95-1	
4.50+0	7.60+2	9.47-1							

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
6.80-2	1.85-2	1.37+0	7.70-2	3.01-2	1.14+0	8.70-2	5.54-2	1.12+0	46
9.70-2	1.04-1	1.25+0	1.06-1	1.48-1	1.17+0	1.16-1	2.27-1	1.20+0	
1.26-1	3.05-1	1.13+0	1.35-1	4.01-1	1.10+0				
1.50+0	3.19+2	9.72-1	2.00+0	4.57+2	9.77-1	2.50+0	5.53+2	9.58-1	48
3.00+0	6.38+2	9.64-1	3.50+0	7.25+2	1.00+0	4.00+0	7.61+2	9.87-1	
4.50+0	7.99+2	9.96-1	5.00+0	8.68+2	1.05+0				
3.00+0	7.03+2	1.06+0							65
2.00+0	5.23+2	1.12+0							74
1.25-1	3.12-1	1.19+0	1.50-1	5.92-1	1.05+0	2.00-1	1.59+0	9.20-1	82
2.50-1	3.57+0	9.21-1	3.00-1	6.51+0	9.03-1	4.00-1	1.58+1	8.83-1	
5.00-1	3.00+1	8.83-1	6.00-1	4.79+1	8.72-1	7.00-1	6.85+1	8.58-1	
8.00-1	9.35+1	8.68-1	9.00-1	1.18+2	8.56-1	1.00+0	1.40+2	8.29-1	
19	Potassium		Fluorescence yield = 0.14						
9.50-1	1.21+2	1.06+0							76
3.00+0	5.35+2	9.38-1							94
1.40+0	2.20+2	9.46-1	1.50+0	2.27+2	8.75-1	1.60+0	2.48+2	8.69-1	122
1.70+0	2.70+2	8.68-1	1.80+0	3.43+2	1.02+0	1.90+0	3.55+2	9.86-1	
2.00+0	3.72+2	9.70-1							
6.00-1	4.04+1	1.06+0	8.00-1	8.65+1	1.11+0	1.00+0	1.23+2	9.73-1	123
1.20+0	1.79+2	1.00+0	1.40+0	2.46+2	1.06+0	1.60+0	2.98+2	1.04+0	
1.80+0	3.41+2	1.02+0	2.00+0	4.31+2	1.12+0	2.20+0	5.22+2	1.22+0	
2.40+0	5.56+2	1.19+0	2.60+0	5.73+2	1.13+0	2.80+0	6.04+2	1.12+0	
1.00+0	1.57+2	1.24+0	1.30+0	2.45+2	1.19+0	1.90+0	3.93+2	1.09+0	156
2.25+0	4.62+2	1.05+0	2.55+0	5.26+2	1.06+0	2.80+0	5.66+2	1.05+0	
3.00+0	6.30+2	1.11+0	3.50+0	6.75+2	1.06+0	4.00+0	7.24+2	1.06+0	
4.50+0	7.90+2	1.09+0	5.00+0	8.34+2	1.11+0				
20	Calcium		Fluorescence yield = 0.163						
2.00+0	2.34+2	7.54-1	3.00+0	3.95+2	8.17-1	4.00+0	4.94+2	8.25-1	20
5.00+0	5.76+2	8.58-1	6.00+0	5.93+2	8.34-1	7.00+0	6.32+2	8.60-1	
8.00+0	6.29+2	8.44-1	9.00+0	6.35+2	8.51-1	1.00+1	6.12+2	8.25-1	
1.10+1	6.17+2	8.42-1	1.20+1	6.18+2	8.58-1	1.30+1	6.17+2	8.71-1	
1.65+1	5.39+2	8.19-1	2.00+1	5.46+2	8.96-1	2.50+1	4.49+2	8.21-1	
3.00+0	4.85+2	1.00+0	5.00+0	7.47+2	1.11+0	7.00+0	8.12+2	1.10+0	94
9.00+0	7.95+2	1.07+0	1.10+1	7.76+2	1.06+0				
5.00-1	1.09+1	6.91-1	5.50-1	1.58+1	7.59-1	6.00-1	1.95+1	7.33-1	98
6.50-1	2.55+1	7.72-1	7.00-1	3.16+1	7.89-1	7.50-1	3.77+1	7.87-1	
8.00-1	4.36+1	7.78-1	8.50-1	5.07+1	7.82-1	9.00-1	5.87+1	7.93-1	
9.50-1	6.61+1	7.91-1	1.00+0	7.50+1	8.02-1	1.05+0	8.41+1	8.11-1	
1.10+0	9.47+1	8.29-1	1.15+0	1.01+2	8.09-1	1.20+0	1.10+2	8.10-1	
1.25+0	1.17+2	7.99-1	1.30+0	1.29+2	8.20-1	1.35+0	1.38+2	8.19-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
1.40+0	1.44+2	8.00-1	1.45+0	1.55+2	8.11-1	1.50+0	1.67+2	8.26-1	
1.55+0	1.75+2	8.21-1	1.60+0	1.89+2	8.42-1	1.65+0	1.97+2	8.35-1	
1.70+0	2.00+2	8.11-1	1.75+0	2.16+2	8.39-1	1.80+0	2.23+2	8.31-1	
1.85+0	2.25+2	8.06-1	1.90+0	2.46+2	8.50-1	1.95+0	2.51+2	8.37-1	
2.00+0	2.66+2	8.58-1							
2.00-1	6.30-1	9.51-1	2.25-1	8.10-1	7.73-1	2.50-1	1.32+0	8.47-1	106
2.75-1	1.71+0	7.75-1	3.00-1	2.38+0	7.91-1	3.25-1	3.16+0	7.96-1	
3.50-1	3.72+0	7.29-1	3.75-1	5.00+0	7.80-1	4.00-1	5.88+0	7.43-1	
4.25-1	7.62+0	7.95-1	4.50-1	8.86+0	7.73-1	4.75-1	1.10+1	8.14-1	
5.00-1	1.28+1	8.12-1							
6.00-1	2.64+1	9.92-1	8.00-1	5.66+1	1.01+0	1.00+0	9.16+1	9.79-1	123
1.20+0	1.40+2	1.03+0	1.40+0	1.81+2	1.01+0	1.60+0	2.23+2	9.93-1	
1.80+0	2.61+2	9.73-1	2.00+0	2.93+2	9.45-1	2.20+0	3.73+2	1.07+0	
2.40+0	4.24+2	1.10+0	2.60+0	4.24+2	1.00+0	2.80+0	4.56+2	1.00+0	
1.00+0	1.16+2	1.24+0	1.30+0	2.18+2	1.39+0	1.90+0	3.19+2	1.10+0	156
2.25+0	3.85+2	1.07+0	2.55+0	4.43+2	1.07+0	2.80+0	4.81+2	1.06+0	
3.00+0	5.09+2	1.05+0	3.50+0	5.69+2	1.04+0	4.00+0	6.47+2	1.08+0	
4.50+0	7.01+2	1.10+0	5.00+0	7.47+2	1.11+0				
21	Scandium		Fluorescence yield = 0.188						
6.67-1	2.37+1	9.44-1	1.00+0	6.83+1	9.84-1	1.33+0	1.29+2	1.01+0	64
1.67+0	2.14+2	1.13+0	2.00+0	2.68+2	1.07+0	2.33+0	3.17+2	1.03+0	
2.67+0	3.79+2	1.05+0	3.00+0	4.44+2	1.09+0	3.33+0	4.85+2	1.08+0	
3.67+0	5.97+2	1.22+0	4.00+0	5.76+2	1.10+0	4.33+0	6.05+2	1.10+0	
4.67+0	6.37+2	1.11+0	5.00+0	6.69+2	1.12+0	5.33+0	6.81+2	1.11+0	
5.67+0	6.99+2	1.11+0							
8.30-1	4.20+1	9.43-1	1.58+0	1.79+2	1.04+0	2.56+0	3.21+2	9.30-1	66
3.28+0	4.71+2	1.06+0							
5.00-1	9.88+0	9.11-1	5.50-1	1.32+1	9.13-1	6.00-1	1.72+1	9.23-1	98
6.50-1	2.14+1	9.16-1	7.00-1	2.62+1	9.15-1	7.50-1	3.13+1	9.13-1	
8.00-1	3.72+1	9.19-1	8.50-1	4.33+1	9.17-1	9.00-1	4.97+1	9.17-1	
9.50-1	5.70+1	9.24-1	1.00+0	6.56+1	9.46-1	1.05+0	7.33+1	9.47-1	
1.10+0	8.27+1	9.64-1	1.15+0	8.98+1	9.53-1	1.20+0	9.71+1	9.43-1	
1.25+0	1.06+2	9.48-1	1.30+0	1.15+2	9.52-1	1.35+0	1.22+2	9.38-1	
1.40+0	1.32+2	9.50-1	1.45+0	1.40+2	9.45-1	1.50+0	1.48+2	9.40-1	
1.55+0	1.57+2	9.40-1	1.60+0	1.65+2	9.34-1	1.65+0	1.69+2	9.10-1	
1.70+0	1.80+2	9.23-1	1.75+0	1.89+2	9.25-1	1.80+0	1.99+2	9.30-1	
1.85+0	2.06+2	9.22-1	1.90+0	2.15+2	9.26-1	1.95+0	2.26+2	9.37-1	
2.00+0	2.30+2	9.19-1							
2.00-1	3.60-1	8.62-1	2.25-1	5.70-1	8.53-1	2.50-1	9.70-1	9.66-1	106
2.75-1	1.32+0	9.19-1	3.00-1	1.87+0	9.48-1	3.25-1	2.15+0	8.20-1	
3.50-1	3.20+0	9.43-1	3.75-1	4.17+0	9.71-1	4.00-1	4.07+0	7.64-1	
4.25-1	5.13+0	7.90-1	4.50-1	6.24+0	8.00-1	4.75-1	7.33+0	7.92-1	
5.00-1	9.82+0	9.06-1							

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	σ^{Exper} / σ^{ECPSSR}	E_1 (MeV)	σ^{Exper} (barn)	σ^{Exper} / σ^{ECPSSR}	E_1 (MeV)	σ^{Exper} (barn)	σ^{Exper} / σ^{ECPSSR}	Ref.
2.00-1	3.76-1	9.00-1	3.00-1	1.82+0	9.22-1	4.00-1	4.98+0	9.35-1	121
5.00-1	9.96+0	9.19-1	6.00-1	1.74+1	9.34-1	7.00-1	2.62+1	9.15-1	
8.00-1	3.53+1	8.72-1	9.00-1	4.81+1	8.88-1				
5.00-1	9.65+0	8.90-1	6.00-1	1.71+1	9.18-1	7.00-1	2.70+1	9.43-1	137
8.00-1	3.91+1	9.66-1	1.00+0	6.73+1	9.70-1	1.20+0	1.01+2	9.81-1	
1.40+0	1.39+2	1.00+0	1.60+0	1.72+2	9.73-1	1.80+0	2.07+2	9.68-1	
2.00+0	2.78+2	1.11+0	2.20+0	2.85+2	9.98-1	2.30+0	3.06+2	1.01+0	
2.40+0	3.14+2	9.83-1	2.50+0	3.27+2	9.74-1				
22	Titanium		Fluorescence yield = 0.214						
1.60+0	1.70+2	1.23+0	1.80+0	2.20+2	1.29+0	2.10+0	2.60+2	1.20+0	5
2.30+0	3.30+2	1.33+0	2.70+0	3.90+2	1.28+0	2.80+0	4.40+2	1.38+0	
3.20+0	5.10+2	1.38+0	3.50+0	5.80+2	1.44+0	3.70+0	6.40+2	1.51+0	
3.90+0	6.80+2	1.54+0							
2.30-1	1.10-1	**2.32-1**	3.25-1	4.70-1	**2.67-1**	4.20-1	1.20+0	**2.80-1**	7
4.54-1	1.63+0	**2.94-1**	5.10-1	2.10+0	**2.62-1**				
1.50+0	1.10+2	8.93-1							10
2.00+0	2.21+2	1.10+0	3.00+0	3.69+2	1.07+0	4.00+0	4.90+2	1.08+0	20
5.00+0	5.53+2	1.05+0	6.00+0	6.26+2	1.08+0	7.00+0	6.63+2	1.08+0	
8.00+0	6.95+2	1.10+0	9.00+0	6.97+2	1.08+0	1.00+1	7.17+2	1.10+0	
1.10+1	6.92+2	1.06+0	1.20+1	6.75+2	1.04+0	1.30+1	6.44+2	1.00+0	
1.65+1	6.94+2	1.14+0	2.00+1	6.12+2	1.06+0	2.50+1	5.76+2	1.10+0	
9.00-2	5.65-3	1.07+0	1.10-1	1.88-2	1.15+0	1.30-1	4.54-2	1.19+0	25
1.50-1	9.01-2	1.19+0	1.70-1	1.65-1	1.24+0				
1.00-1	9.00-3	9.27-1	1.25-1	2.60-2	8.25-1	1.50-1	6.40-2	8.46-1	36
1.50+0	1.50+2	1.22+0	2.00+0	2.30+2	1.14+0	2.50+0	3.25+2	1.17+0	38
3.00+0	4.40+2	1.28+0	3.50+0	5.00+2	1.24+0	4.00+0	5.80+2	1.28+0	
4.50+0	6.40+2	1.30+0	5.00+0	6.10+2	1.16+0	5.50+0	6.70+2	1.21+0	
7.00-1	6.31+0	**3.07-1**	9.00-1	1.13+1	**2.83-1**	1.10+0	2.03+1	**3.15-1**	44
1.30+0	2.48+1	**2.68-1**	1.50+0	3.11+1	**2.53-1**	1.70+0	3.55+1	**2.30-1**	
1.90+0	4.28+1	**2.30-1**	2.10+0	4.68+1	**2.15-1**				
1.00+0	3.70+1	7.16-1	2.25+0	1.85+2	7.70-1	3.00+0	2.92+2	8.49-1	47
1.50+0	1.30+2	1.06+0	2.00+0	2.15+2	1.07+0	2.50+0	3.12+2	1.13+0	55
3.00+0	3.83+2	1.11+0	4.96+0	5.82+2	1.11+0	5.96+0	6.55+2	1.13+0	
6.96+0	7.08+2	1.16+0	8.94+0	7.48+2	1.16+0	1.09+1	7.62+2	1.17+0	
1.30-1	2.68-2	7.00-1	1.50-1	5.31-2	7.02-1	1.95-1	1.75-1	7.28-1	57
2.50-1	4.74-1	7.21-1	2.95-1	8.15-1	6.60-1	3.30-1	1.26+0	6.78-1	
3.60-1	1.70+0	6.72-1	3.80-1	1.90+0	6.23-1	4.15-1	2.26+0	5.49-1	
4.00-1	4.60+0	1.27+0	5.00-1	9.40+0	1.25+0	6.00-1	1.60+1	1.21+0	69
7.00-1	2.50+1	1.22+0	8.00-1	3.70+1	1.25+0	9.00-1	4.80+1	1.20+0	
1.00+0	6.40+1	1.24+0	1.10+0	8.00+1	1.24+0	1.20+0	9.70+1	1.24+0	

TABLE 2. K-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
1.30+0	1.13+2	1.22+0	1.40+0	1.33+2	1.24+0	1.50+0	1.57+2	1.27+0	
1.60+0	1.82+2	1.32+0	1.70+0	1.94+2	1.26+0	1.80+0	2.22+2	1.30+0	
1.90+0	2.38+2	1.28+0	2.00+0	2.59+2	1.28+0	2.10+0	2.74+2	1.26+0	
2.20+0	3.03+2	1.30+0	2.30+0	3.20+2	1.29+0				
6.00-1	1.30+1	9.86-1	7.00-1	2.10+1	1.02+0	8.00-1	3.20+1	1.08+0	72
9.00-1	4.50+1	1.13+0	1.00+0	6.10+1	1.18+0	1.50+0	1.40+2	1.14+0	
2.00+0	2.10+2	1.04+0	2.50+0	3.10+2	1.12+0	3.00+0	4.00+2	1.16+0	
1.50-1	8.30-2	1.10+0	2.00-1	2.98-1	1.11+0	2.50-1	6.20-1	9.43-1	73
3.00-1	1.24+0	9.44-1	3.50-1	2.00+0	8.74-1	4.00-1	2.80+0	7.70-1	
4.50-1	3.80+0	7.06-1	5.50-1	6.60+0	6.51-1	6.50-1	1.09+1	6.54-1	
7.50-1	1.83+1	7.36-1	8.50-1	2.63+1	7.62-1	9.50-1	3.68+1	8.05-1	
1.05+0	4.14+1	7.14-1							
1.00+0	5.45+1	1.06+0	1.10+0	6.83+1	1.06+0	1.20+0	8.37+1	1.07+0	77
1.30+0	1.02+2	1.10+0	1.40+0	1.18+2	1.10+0	1.50+0	1.36+2	1.10+0	
1.60+0	1.55+2	1.12+0	1.70+0	1.74+2	1.13+0	1.80+0	1.93+2	1.13+0	
1.90+0	2.08+2	1.12+0	2.00+0	2.30+2	1.14+0	2.10+0	2.50+2	1.15+0	
2.20+0	2.67+2	1.15+0	2.30+0	2.85+2	1.15+0	2.40+0	3.00+2	1.14+0	
2.50+0	3.18+2	1.15+0	2.60+0	3.31+2	1.14+0	2.70+0	3.46+2	1.13+0	
2.80+0	3.59+2	1.13+0	2.90+0	3.72+2	1.12+0	3.00+0	3.85+2	1.12+0	
1.00-1	7.45-3	7.67-1	1.10-1	1.45-2	8.89-1	1.20-1	2.64-2	1.03+0	79
1.30-1	4.58-2	1.20+0	1.40-1	7.63-2	1.39+0	1.50-1	1.23-1	1.63+0	
1.00+0	3.70+1	7.16-1	2.00+0	1.54+2	7.63-1	5.00+0	5.20+2	9.86-1	84
3.00+0	3.70+2	1.08+0							94
5.00-1	6.65+0	8.82-1	5.50-1	9.80+0	9.66-1	6.00-1	1.32+1	1.00+0	98
6.50-1	1.63+1	9.79-1	7.00-1	1.99+1	9.68-1	7.50-1	2.32+1	9.33-1	
8.00-1	2.82+1	9.55-1	8.50-1	3.30+1	9.57-1	9.00-1	3.78+1	9.46-1	
9.50-1	4.41+1	9.65-1	1.00+0	4.89+1	9.47-1	1.05+0	5.43+1	9.36-1	
1.10+0	6.11+1	9.47-1	1.15+0	6.77+1	9.50-1	1.20+0	7.34+1	9.37-1	
1.25+0	8.06+1	9.44-1	1.30+0	8.97+1	9.68-1	1.35+0	9.61+1	9.59-1	
1.40+0	1.05+2	9.75-1	1.45+0	1.12+2	9.71-1	1.50+0	1.18+2	9.58-1	
1.55+0	1.27+2	9.72-1	1.60+0	1.34+2	9.69-1	1.65+0	1.41+2	9.65-1	
1.70+0	1.49+2	9.66-1	1.75+0	1.55+2	9.54-1	1.80+0	1.61+2	9.45-1	
1.85+0	1.72+2	9.66-1	1.90+0	1.78+2	9.58-1	1.95+0	1.90+2	9.81-1	
2.00+0	1.96+2	9.71-1							
3.80-2	4.00-6	1.11+0	4.00-2	1.00-5	1.49+0	4.50-2	2.50-5	1.02+0	101
5.00-2	6.00-5	8.64-1	5.50-2	1.40-4	8.60-1	6.00-2	3.00-4	9.00-1	
7.00-2	1.00-3	9.50-1							
4.00+0	4.80+2	1.06+0	6.00+0	6.81+2	1.18+0	8.00+0	7.16+2	1.13+0	105
1.00+1	7.56+2	1.16+0	1.20+1	7.40+2	1.14+0	1.40+1	7.16+2	1.13+0	
1.60+1	6.70+2	1.09+0	1.80+1	6.13+2	1.03+0	2.00+1	5.93+2	1.03+0	
2.20+1	5.65+2	1.02+0							
2.00-1	2.70-1	1.01+0	2.25-1	3.90-1	9.00-1	2.50-1	6.20-1	9.43-1	106
2.75-1	8.20-1	8.65-1	3.00-1	1.32+0	1.01+0	3.25-1	1.43+0	8.13-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
3.50-1	2.01+0	8.78-1	3.75-1	2.48+0	8.51-1	4.00-1	3.17+0	8.72-1	
4.25-1	3.63+0	8.15-1	4.50-1	4.56+0	8.48-1	4.75-1	5.57+0	8.69-1	
5.00-1	6.64+0	8.80-1							
6.00-2	2.09-4	6.27-1	7.00-2	6.16-4	5.85-1	8.00-2	1.57-3	6.08-1	108
9.00-2	3.57-3	6.75-1	1.00-1	7.45-3	7.67-1	1.10-1	1.45-2	8.89-1	
1.20-1	2.64-2	1.03+0	1.30-1	4.58-2	1.20+0	1.40-1	7.63-2	1.39+0	
1.50-1	1.23-1	1.63+0							
1.00+0	5.28+1	1.02+0	1.25+0	8.53+1	9.99-1	1.50+0	1.30+2	1.06+0	112
1.75+0	1.68+2	1.03+0	2.00+0	2.11+2	1.05+0	2.25+0	2.48+2	1.03+0	
2.50+0	2.88+2	1.04+0	2.75+0	3.33+2	1.07+0	3.00+0	3.71+2	1.08+0	
2.00-1	2.74-1	1.02+0	3.00-1	1.48+0	1.13+0	4.00-1	3.99+0	1.10+0	113
5.00-1	8.00+0	1.06+0	6.00-1	1.32+1	1.00+0	8.00-1	3.00+1	1.02+0	
1.00+0	5.15+1	9.97-1	1.20+0	8.12+1	1.04+0	1.60+0	1.43+2	1.03+0	
2.00+0	2.15+2	1.07+0	2.40+0	2.72+2	1.04+0				
1.00-1	3.77-3	**3.88-1**	1.25-1	1.56-2	4.95-1	1.50-1	4.34-2	5.73-1	118
1.75-1	9.50-2	6.29-1	2.00-1	1.77-1	6.61-1	3.00-1	9.57-1	7.29-1	
4.00-1	2.89+0	7.95-1	5.00-1	6.08+0	8.06-1	6.00-1	1.08+1	8.19-1	
7.00-1	1.70+1	8.27-1	8.00-1	2.50+1	8.47-1				
3.00-1	1.20+0	9.14-1	4.00-1	3.37+0	9.27-1	5.00-1	7.10+0	9.41-1	132
6.00-1	1.26+1	9.55-1	7.00-1	1.90+1	9.24-1	8.00-1	2.87+1	9.72-1	
1.00+0	4.88+1	9.45-1	1.20+0	7.67+1	9.79-1	1.40+0	1.08+2	1.00+0	
1.60+0	1.38+2	9.98-1	1.80+0	1.73+2	1.02+0	2.00+0	2.08+2	1.03+0	
2.20+0	2.36+2	1.02+0	2.40+0	2.69+2	1.02+0				
5.00-1	6.88+0	9.12-1	6.00-1	1.24+1	9.40-1	7.00-1	1.94+1	9.44-1	137
8.00-1	2.80+1	9.49-1	1.00+0	4.88+1	9.45-1	1.20+0	7.29+1	9.31-1	
1.40+0	1.02+2	9.47-1	1.60+0	1.32+2	9.54-1	1.80+0	1.65+2	9.69-1	
2.00+0	1.97+2	9.76-1	2.20+0	2.26+2	9.72-1	2.30+0	2.50+2	1.01+0	
2.40+0	2.61+2	9.95-1	2.50+0	2.76+2	9.97-1				
1.50+0	8.95+1	7.27-1	2.10+0	2.13+2	9.80-1	2.60+0	2.85+2	9.78-1	148
3.10+0	3.64+2	1.02+0	3.60+0	4.40+2	1.07+0				
1.00+0	4.94+1	9.57-1							149
23	Vanadium		Fluorescence yield = 0.243						
1.00-1	5.50-3	9.90-1	1.25-1	1.70-2	8.93-1	1.50-1	4.30-2	9.10-1	36
2.25+0	1.43+2	7.27-1							47
4.00-1	3.00+0	1.19+0	5.00-1	6.30+0	1.19+0	6.00-1	1.60+1	1.70+0	69
7.00-1	1.73+1	1.16+0	8.00-1	2.60+1	1.20+0	9.00-1	3.50+1	1.18+0	
1.00+0	4.50+1	1.16+0	1.10+0	5.80+1	1.19+0	1.20+0	7.00+1	1.17+0	
1.30+0	8.70+1	1.22+0	1.40+0	1.00+2	1.19+0	1.50+0	1.18+2	1.22+0	
1.60+0	1.34+2	1.22+0	1.70+0	1.47+2	1.20+0	1.80+0	1.69+2	1.25+0	
1.90+0	1.81+2	1.21+0	2.00+0	1.97+2	1.21+0	2.10+0	2.13+2	1.21+0	
2.20+0	2.19+2	1.15+0	2.30+0	2.44+2	1.20+0				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
1.50-1	5.80-2	1.23+0	2.00-1	1.65-1	9.51-1	2.50-1	4.30-1	9.84-1	73
3.00-1	8.80-1	9.93-1	3.50-1	1.20+0	7.66-1	4.00-1	2.30+0	9.14-1	
4.50-1	3.00+0	7.98-1	5.50-1	5.00+0	6.94-1	6.50-1	8.80+0	7.33-1	
7.50-1	1.60+1	8.81-1	8.50-1	1.78+1	6.96-1	9.50-1	2.55+1	7.49-1	
9.50-1	2.27+1	6.66-1							76
1.00+0	3.52+1	9.07-1	1.10+0	4.38+1	8.96-1	1.30+0	6.63+1	9.27-1	86
1.50+0	8.60+1	8.92-1	1.70+0	1.11+2	9.06-1	1.90+0	1.37+2	9.17-1	
2.00+0	1.51+2	9.26-1	2.10+0	1.64+2	9.30-1	2.30+0	1.90+2	9.35-1	
2.50+0	2.14+2	9.34-1	2.70+0	2.35+2	9.24-1	2.80+0	2.45+2	9.19-1	
2.90+0	2.53+2	9.08-1	3.00+0	2.63+2	9.06-1				
5.00-1	4.80+0	9.03-1	5.50-1	6.92+0	9.60-1	6.00-1	8.75+0	9.28-1	98
6.50-1	1.13+1	9.41-1	7.00-1	1.40+1	9.39-1	7.50-1	1.66+1	9.15-1	
8.00-1	2.06+1	9.49-1	8.50-1	2.52+1	9.85-1	9.00-1	2.92+1	9.85-1	
9.50-1	3.39+1	9.95-1	1.00+0	3.84+1	9.89-1	1.05+0	4.29+1	9.80-1	
1.10+0	4.72+1	9.66-1	1.15+0	5.43+1	1.00+0	1.20+0	5.91+1	9.87-1	
1.25+0	6.57+1	1.00+0	1.30+0	7.17+1	1.00+0	1.35+0	7.79+1	1.00+0	
1.40+0	8.35+1	9.98-1	1.45+0	9.05+1	1.01+0	1.50+0	9.48+1	9.83-1	
1.55+0	1.05+2	1.02+0	1.60+0	1.10+2	1.01+0	1.65+0	1.16+2	9.99-1	
1.70+0	1.23+2	1.00+0	1.75+0	1.28+2	9.92-1	1.80+0	1.34+2	9.88-1	
1.85+0	1.40+2	9.82-1	1.90+0	1.45+2	9.70-1	1.95+0	1.56+2	9.97-1	
2.00+0	1.56+2	9.57-1							
2.00-1	1.45-1	8.36-1	2.25-1	2.42-1	8.49-1	2.50-1	3.61-1	8.26-1	106
2.75-1	4.71-1	7.41-1	3.00-1	7.80-1	8.80-1	3.25-1	1.09+0	9.11-1	
3.50-1	1.42+0	9.06-1	3.75-1	1.90+0	9.48-1	4.00-1	2.23+0	8.86-1	
4.25-1	2.82+0	9.11-1	4.50-1	3.31+0	8.81-1	4.75-1	4.30+0	9.57-1	
5.00-1	5.17+0	9.73-1							
5.00-1	5.63+0	1.06+0	6.00-1	1.10+1	1.17+0	8.00-1	2.04+1	9.40-1	113
1.00+0	4.00+1	1.03+0	1.20+0	5.75+1	9.60-1	1.60+0	1.10+2	1.01+0	
2.00+0	1.54+2	9.45-1	2.40+0	2.21+2	1.02+0				
1.00+0	4.13+1	1.06+0	1.20+0	6.20+1	1.04+0	1.40+0	8.40+1	1.00+0	137
1.60+0	1.09+2	9.96-1	1.80+0	1.35+2	9.95-1	2.00+0	1.71+2	1.05+0	
2.20+0	1.89+2	9.95-1							
24	Chromium		Fluorescence yield = 0.275						
1.00-1	2.80-3	8.78-1	1.25-1	1.00-2	8.65-1	1.50-1	2.70-2	9.08-1	36
5.00-1	4.90+0	1.29+0	6.00-1	8.70+0	1.28+0	7.00-1	1.37+1	1.26+0	69
8.00-1	2.09+1	1.30+0	9.00-1	2.70+1	1.21+0	1.00+0	3.60+1	1.23+0	
1.10+0	4.70+1	1.26+0	1.20+0	5.50+1	1.20+0	1.30+0	6.80+1	1.23+0	
1.40+0	8.20+1	1.26+0	1.50+0	9.40+1	1.24+0	1.60+0	1.08+2	1.25+0	
1.70+0	1.24+2	1.27+0	1.80+0	1.35+2	1.24+0	1.90+0	1.49+2	1.24+0	
2.00+0	1.67+2	1.27+0	2.10+0	1.77+2	1.23+0	2.20+0	1.98+2	1.28+0	
2.00-1	6.80-2	5.97-1	2.50-1	2.10-1	7.15-1	3.00-1	4.10-1	6.77-1	73
3.50-1	7.80-1	7.19-1	4.00-1	1.13+0	6.42-1	4.50-1	1.62+0	6.10-1	
5.50-1	2.80+0	5.41-1	6.50-1	4.90+0	5.61-1	7.50-1	8.20+0	6.14-1	
8.50-1	1.16+1	6.09-1	9.50-1	1.80+1	7.00-1	1.05+0	2.15+1	6.48-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\frac{\sigma^{\text{Exper}}}{\sigma^{\text{ECPSSR}}}$	E_1 (MeV)	σ^{Exper} (barn)	$\frac{\sigma^{\text{Exper}}}{\sigma^{\text{ECPSSR}}}$	E_1 (MeV)	σ^{Exper} (barn)	$\frac{\sigma^{\text{Exper}}}{\sigma^{\text{ECPSSR}}}$	Ref.
9.50-1	1.73+1	6.73-1							76
1.00-1	3.60-3	1.13+0	1.10-1	6.20-3	1.10+0	1.20-1	1.07-2	1.16+0	79
1.30-1	1.80-2	1.26+0	1.40-1	2.80-2	1.33+0	1.50-1	4.00-2	1.35+0	
9.00-1	1.55+1	6.96-1	9.50-1	1.73+1	6.73-1	1.00+0	2.50+1	8.54-1	80
1.10+0	2.73+1	7.31-1	1.20+0	3.60+1	7.83-1	1.30+0	4.17+1	7.52-1	
1.40+0	5.13+1	7.85-1	1.60+0	6.06+1	7.00-1	1.70+0	7.19+1	7.36-1	
1.80+0	8.46+1	7.75-1	1.90+0	8.18+1	6.80-1	2.00+0	8.60+1	6.53-1	
2.10+0	1.20+2	8.35-1	2.20+0	1.13+2	7.28-1	2.30+0	1.28+2	7.68-1	
2.40+0	1.37+2	7.68-1	2.50+0	1.71+2	9.00-1	2.60+0	1.54+2	7.66-1	
2.70+0	1.68+2	7.91-1	2.80+0	1.69+2	7.56-1	3.00+0	2.07+2	8.46-1	
3.40+0	2.50+2	8.76-1	3.60+0	2.65+2	8.71-1	3.80+0	2.79+2	8.65-1	
4.00+0	3.53+2	1.04+0							
3.00+0	2.81+2	1.15+0	5.00+0	4.86+2	1.18+0	7.00+0	6.19+2	1.22+0	94
9.00+0	6.63+2	1.20+0	1.10+1	6.78+2	1.19+0				
5.00-1	3.52+0	9.30-1	5.50-1	4.84+0	9.36-1	6.00-1	6.57+0	9.64-1	98
6.50-1	8.19+0	9.38-1	7.00-1	1.02+1	9.35-1	7.50-1	1.24+1	9.28-1	
8.00-1	1.49+1	9.27-1	8.50-1	1.79+1	9.40-1	9.00-1	2.07+1	9.30-1	
9.50-1	2.38+1	9.26-1	1.00+0	2.80+1	9.56-1	1.05+0	3.13+1	9.44-1	
1.10+0	3.60+1	9.65-1	1.15+0	3.87+1	9.31-1	1.20+0	4.40+1	9.57-1	
1.25+0	4.92+1	9.72-1	1.30+0	5.29+1	9.53-1	1.35+0	5.77+1	9.57-1	
1.40+0	6.31+1	9.66-1	1.45+0	6.74+1	9.55-1	1.50+0	7.26+1	9.58-1	
1.55+0	7.82+1	9.64-1	1.60+0	8.49+1	9.81-1	1.65+0	8.93+1	9.69-1	
1.70+0	9.46+1	9.69-1	1.75+0	1.00+2	9.68-1	1.80+0	1.06+2	9.71-1	
1.85+0	1.13+2	9.86-1	1.90+0	1.17+2	9.73-1	1.95+0	1.22+2	9.69-1	
2.00+0	1.28+2	9.72-1							
2.00-1	1.07-1	9.39-1	2.25-1	1.69-1	8.93-1	2.50-1	2.77-1	9.44-1	106
2.75-1	4.05-1	9.39-1	3.00-1	5.80-1	9.57-1	3.25-1	7.80-1	9.48-1	
3.50-1	1.02+0	9.40-1	3.75-1	1.31+0	9.38-1	4.00-1	1.68+0	9.55-1	
4.25-1	2.02+0	9.28-1	4.50-1	2.47+0	9.31-1	4.75-1	2.98+0	9.34-1	
5.00-1	3.66+0	9.66-1							
7.00+0	3.80+2	7.51-1							114
7.00+0	3.95+2	7.81-1							125
3.00-1	6.37-1	1.05+0	4.00-1	1.71+0	9.72-1	5.00-1	3.86+0	1.02+0	132
6.00-1	6.97+0	1.02+0	7.00-1	1.05+1	9.62-1	8.00-1	1.59+1	9.89-1	
1.00+0	2.85+1	9.73-1	1.20+0	4.48+1	9.74-1	1.40+0	6.37+1	9.75-1	
1.60+0	8.46+1	9.77-1	1.80+0	1.09+2	9.99-1	2.00+0	1.27+2	9.64-1	
2.20+0	1.52+2	9.79-1	2.40+0	1.78+2	9.98-1				
8.00-1	1.50+1	9.33-1	1.00+0	2.76+1	9.42-1	1.20+0	4.31+1	9.37-1	137
1.40+0	6.18+1	9.46-1	1.60+0	8.29+1	9.57-1	1.80+0	1.08+2	9.90-1	
2.00+0	1.29+2	9.79-1	2.20+0	1.48+2	9.53-1	2.30+0	1.61+2	9.66-1	
2.40+0	1.72+2	9.64-1	2.50+0	1.79+2	9.42-1				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}$ / $\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}$ / $\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}$ / $\sigma^{\rm ECPSSR}$	Ref.
1.00+0	2.83+1	9.66-1	1.10+0	3.79+1	1.02+0	1.20+0	4.90+1	1.07+0	152
1.30+0	5.74+1	1.03+0	1.40+0	7.27+1	1.11+0	1.50+0	8.83+1	1.16+0	
1.60+0	9.93+1	1.15+0	1.70+0	1.18+2	1.21+0	1.80+0	1.40+2	1.28+0	
1.90+0	1.64+2	1.36+0	2.00+0	1.82+2	1.38+0	2.10+0	2.09+2	1.46+0	
2.20+0	2.17+2	1.40+0	2.30+0	2.41+2	1.45+0	2.40+0	2.70+2	1.51+0	
2.50+0	3.03+2	1.59+0	2.60+0	3.34+2	1.66+0	2.70+0	3.57+2	1.68+0	
2.80+0	3.82+2	1.71+0	2.90+0	4.30+2	1.84+0	3.00+0	4.53+2	1.85+0	
25	Manganese		Fluorescence yield = 0.308						
1.00-1	1.10-3	6.02-1	1.25-1	4.30-3	6.13-1	1.50-1	1.30-2	6.94-1	36
2.50+0	1.56+2	9.99-1	3.00+0	2.26+2	1.10+0	4.50+0	3.56+2	1.08+0	52
6.00+0	4.46+2	1.07+0	6.50+0	4.37+2	9.98-1	7.00+0	5.19+2	1.14+0	
8.00+0	5.28+2	1.09+0	8.50+0	5.97+2	1.20+0	9.00+0	5.68+2	1.12+0	
1.00+1	5.47+2	1.05+0	1.05+1	5.64+2	1.07+0	1.10+1	6.19+2	1.16+0	
1.20+1	6.56+2	1.22+0							
1.30-1	8.20-3	9.39-1	1.50-1	1.23-2	6.57-1	1.95-1	5.39-2	8.07-1	57
2.50-1	1.65-1	8.33-1	3.00-1	2.70-1	6.49-1	3.30-1	3.64-1	6.04-1	
3.60-1	5.13-1	6.12-1	3.85-1	7.02-1	6.53-1	4.15-1	8.15-1	5.77-1	
4.00-1	1.55+0	1.25+0	5.00-1	3.20+0	1.18+0	6.00-1	5.70+0	1.15+0	69
7.00-1	9.30+0	1.16+0	8.00-1	1.45+1	1.22+0	9.00-1	1.98+1	1.19+0	
1.00+0	2.60+1	1.17+0	1.10+0	3.40+1	1.20+0	1.20+0	4.10+1	1.16+0	
1.30+0	5.10+1	1.19+0	1.40+0	6.00+1	1.18+0	1.50+0	6.90+1	1.16+0	
1.60+0	8.20+1	1.20+0	1.70+0	9.30+1	1.20+0	1.80+0	1.06+2	1.22+0	
1.90+0	1.19+2	1.23+0	2.00+0	1.33+2	1.25+0	2.10+0	1.40+2	1.21+0	
2.20+0	1.59+2	1.26+0	2.30+0	1.71+2	1.25+0				
3.00+0	2.18+2	1.06+0							94
5.00-1	2.64+0	9.76-1	5.50-1	3.64+0	9.78-1	6.00-1	4.72+0	9.56-1	98
6.50-1	6.12+0	9.62-1	7.00-1	7.44+0	9.30-1	7.50-1	9.14+0	9.28-1	
8.00-1	1.11+1	9.32-1	8.50-1	1.32+1	9.31-1	9.00-1	1.55+1	9.31-1	
9.50-1	1.81+1	9.37-1	1.00+0	2.10+1	9.47-1	1.05+0	2.38+1	9.45-1	
1.10+0	2.68+1	9.45-1	1.15+0	3.00+1	9.45-1	1.20+0	3.35+1	9.48-1	
1.25+0	3.75+1	9.61-1	1.30+0	4.03+1	9.42-1	1.35+0	4.43+1	9.47-1	
1.40+0	4.83+1	9.48-1	1.45+0	5.37+1	9.75-1	1.50+0	5.62+1	9.47-1	
1.55+0	6.12+1	9.60-1	1.60+0	6.58+1	9.62-1	1.65+0	7.04+1	9.67-1	
1.70+0	7.29+1	9.41-1	1.75+0	7.93+1	9.65-1	1.80+0	8.29+1	9.53-1	
1.85+0	8.69+1	9.47-1	1.90+0	9.13+1	9.45-1	1.95+0	9.92+1	9.77-1	
2.00+0	1.03+2	9.68-1							
2.00-1	4.80-2	6.40-1	2.25-1	8.90-2	7.05-1	2.50-1	1.55-1	7.82-1	106
2.75-1	2.21-1	7.53-1	3.00-1	3.45-1	8.29-1	3.25-1	4.60-1	8.09-1	
3.50-1	6.60-1	8.75-1	3.75-1	8.50-1	8.71-1	4.00-1	1.11+0	8.98-1	
4.25-1	1.43+0	9.30-1	4.50-1	1.73+0	9.20-1	4.75-1	2.15+0	9.47-1	
5.00-1	2.60+0	9.61-1							
5.00-1	2.37+0	8.76-1	6.00-1	4.24+0	8.59-1	8.00-1	1.08+1	9.07-1	113
1.00+0	2.18+1	9.83-1	1.20+0	3.52+1	9.96-1	1.60+0	6.63+1	9.70-1	
2.00+0	1.03+2	9.68-1	2.40+0	1.59+2	1.09+0				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
26	Iron		Fluorescence yield = 0.34						
1.55+0	4.40+1	8.82-1	3.90+0	2.70+2	1.12+0				2
1.40-1	7.40-3	9.16-1	1.50-1	1.10-2	9.37-1	1.60-1	1.40-2	8.49-1	6
1.80-1	2.50-2	8.39-1	2.00-1	4.00-2	8.12-1	2.20-1	5.80-2	7.60-1	
2.40-1	8.30-2	7.41-1	2.60-1	1.10-1	6.97-1	2.80-1	1.50-1	6.96-1	
3.00-1	2.00-1	7.01-1	3.20-1	2.50-1	6.76-1	3.40-1	3.00-1	6.40-1	
3.60-1	3.80-1	6.50-1	4.00-1	5.70-1	6.56-1	4.40-1	8.00-1	6.50-1	
7.40-1	3.60+0	5.17-1	9.35-1	6.80+0	4.91-1	1.04+0	1.10+1	5.92-1	
1.20+0	1.40+1	5.20-1	1.30+0	1.70+1	5.16-1				
4.54-1	5.53-1	**4.02-1**							7
1.50+0	3.80+1	8.21-1							10
7.00-1	2.96+0	5.05-1	9.00-1	6.21+0	5.00-1	1.10+0	1.13+1	5.24-1	27
1.30+0	1.59+1	**4.82-1**	1.50+0	2.22+1	**4.80-1**	1.70+0	2.61+1	**4.28-1**	
1.90+0	3.31+1	**4.30-1**	2.10+0	4.19+1	**4.48-1**	2.30+0	4.92+1	**4.47-1**	
2.50+0	6.42+1	5.03-1							
1.60+2	2.29+2	1.51+0							30
1.00-1	1.20-3	1.17+0	1.25-1	4.90-3	1.16+0	1.50-1	1.20-2	1.02+0	36
1.00+0	1.40+1	8.39-1	1.50+0	4.40+1	9.51-1	2.00+0	8.10+1	9.52-1	38
2.50+0	1.20+2	9.40-1	3.00+0	1.85+2	1.09+0	3.50+0	2.20+2	1.04+0	
4.00+0	2.50+2	1.00+0	4.50+0	2.80+2	9.88-1	5.00+0	3.10+2	9.86-1	
5.50+0	3.30+2	9.65-1							
1.00+0	1.10+1	6.59-1	2.25+0	7.40+1	6.98-1	3.00+0	1.25+2	7.33-1	47
2.50+0	1.19+2	9.32-1	3.00+0	1.77+2	1.04+0	4.00+0	2.68+2	1.08+0	52
4.50+0	2.75+2	9.70-1	5.00+0	3.12+2	9.93-1	6.00+0	4.05+2	1.11+0	
6.50+0	3.86+2	9.95-1	7.00+0	4.29+2	1.05+0	8.00+0	4.49+2	1.03+0	
8.50+0	4.91+2	1.09+0	9.00+0	5.00+2	1.09+0	1.00+1	4.90+2	1.03+0	
1.05+1	4.86+2	1.01+0	1.10+1	4.99+2	1.02+0	1.20+1	4.94+2	9.92-1	
5.00-1	1.40+0	7.25-1	6.00-1	4.40+0	1.23+0	7.00-1	7.20+0	1.23+0	53
8.00-1	9.50+0	1.08+0	9.00-1	1.42+1	1.14+0	1.00+0	1.69+1	1.01+0	
1.10+0	2.40+1	1.11+0	1.20+0	2.96+1	1.10+0	1.30+0	3.44+1	1.04+0	
1.40+0	3.92+1	9.96-1	1.50+0	5.02+1	1.08+0	1.60+0	5.69+1	1.06+0	
1.70+0	6.57+1	1.08+0	1.80+0	6.92+1	1.01+0	1.90+0	7.27+1	9.45-1	
2.00+0	7.65+1	8.99-1							
1.50+0	4.66+1	1.01+0	2.00+0	8.68+1	1.02+0	2.50+0	1.32+2	1.03+0	55
3.00+0	1.75+2	1.03+0	4.97+0	3.24+2	1.04+0	5.96+0	3.88+2	1.06+0	
6.94+0	4.39+2	1.09+0	6.96+0	4.32+2	1.07+0	8.94+0	4.95+2	1.08+0	
1.09+1	5.29+2	1.08+0							
1.30-1	8.00-3	1.51+0	1.50-1	1.56-2	1.33+0	1.95-1	4.45-2	1.02+0	57
2.55-1	1.12-1	7.70-1	3.00-1	1.86-1	6.51-1	3.30-1	2.76-1	6.61-1	
3.60-1	3.46-1	5.92-1	3.90-1	4.22-1	5.34-1	4.15-1	5.26-1	5.28-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
8.30-1	8.10+0	8.25-1	1.58+0	5.90+1	1.13+0	2.56+0	1.34+2	1.01+0	66
3.28+0	2.27+2	1.17+0							
4.00-1	1.24+0	1.43+0	5.00-1	2.30+0	1.19+0	6.00-1	4.20+0	1.17+0	69
7.00-1	6.70+0	1.14+0	8.00-1	1.05+1	1.19+0	9.00-1	1.39+1	1.12+0	
1.00+0	1.87+1	1.12+0	1.10+0	2.50+1	1.16+0	1.20+0	3.10+1	1.15+0	
1.30+0	3.90+1	1.18+0	1.40+0	4.70+1	1.19+0	1.50+0	5.40+1	1.17+0	
1.60+0	6.10+1	1.14+0	1.70+0	7.00+1	1.15+0	1.80+0	8.20+1	1.19+0	
1.90+0	9.30+1	1.21+0	2.00+0	9.90+1	1.16+0	2.10+0	1.11+2	1.19+0	
2.20+0	1.20+2	1.18+0	2.30+0	1.28+2	1.16+0				
2.00-1	2.80-2	5.68-1	2.50-1	9.40-2	7.04-1	3.00-1	1.90-1	6.65-1	73
3.50-1	3.50-1	6.67-1	4.00-1	5.40-1	6.22-1	4.50-1	8.90-1	6.67-1	
5.50-1	1.88+0	7.02-1	6.50-1	3.26+0	7.04-1	7.50-1	5.50+0	7.59-1	
8.50-1	8.80+0	8.35-1	9.50-1	1.35+1	9.32-1	1.05+0	1.40+1	7.34-1	
9.50-1	9.30+0	6.42-1							76
1.00-1	4.73-4	4.61-1	1.10-1	9.95-4	5.14-1	1.20-1	1.96-3	5.93-1	79
1.30-1	3.66-3	6.89-1	1.40-1	6.50-3	8.05-1	1.50-1	1.11-2	9.45-1	
1.00+0	1.26+1	7.55-1	2.00+0	6.37+1	7.48-1	5.00+0	2.37+2	7.54-1	84
1.00+0	1.49+1	8.93-1	1.20+0	2.32+1	8.61-1	1.50+0	3.90+1	8.43-1	86
1.80+0	5.92+1	8.60-1	2.00+0	7.39+1	8.68-1	2.30+0	9.71+1	8.81-1	
2.50+0	1.12+2	8.78-1	2.80+0	1.29+2	8.42-1	2.90+0	1.34+2	8.27-1	
3.00+0	1.76+2	1.03+0							94
5.00-1	2.04+0	1.06+0	5.50-1	2.82+0	1.05+0	6.00-1	3.48+0	9.74-1	98
6.50-1	4.48+0	9.67-1	7.00-1	6.62+0	1.13+0	7.50-1	6.83+0	9.43-1	
8.00-1	8.47+0	9.62-1	8.50-1	1.13+1	1.07+0	9.00-1	1.21+1	9.74-1	
9.50-1	1.40+1	9.67-1	1.00+0	1.57+1	9.40-1	1.05+0	1.81+1	9.50-1	
1.10+0	2.19+1	1.01+0	1.15+0	2.49+1	1.03+0	1.20+0	2.71+1	1.01+0	
1.25+0	3.02+1	1.01+0	1.30+0	3.23+1	9.80-1	1.35+0	3.67+1	1.02+0	
1.40+0	4.10+1	1.04+0	1.45+0	4.36+1	1.02+0	1.50+0	4.51+1	9.75-1	
1.55+0	4.77+1	9.56-1	1.60+0	5.22+1	9.76-1	1.65+0	5.53+1	9.67-1	
1.70+0	6.02+1	9.86-1	1.75+0	6.26+1	9.63-1	1.80+0	6.60+1	9.59-1	
1.85+0	6.94+1	9.53-1	1.90+0	7.53+1	9.79-1	1.95+0	7.79+1	9.61-1	
2.00+0	8.31+1	9.76-1							
4.00+0	2.67+2	1.07+0	6.00+0	4.00+2	1.09+0	8.00+0	5.00+2	1.14+0	105
1.00+1	5.48+2	1.15+0	1.20+1	6.04+2	1.21+0	1.40+1	5.69+2	1.12+0	
1.60+1	5.86+2	1.16+0	1.80+1	6.18+2	1.23+0	2.00+1	5.83+2	1.18+0	
2.20+1	5.34+2	1.11+0							
2.50-1	1.02-1	7.63-1	2.75-1	1.93-1	9.65-1	3.00-1	2.44-1	8.55-1	106
3.25-1	3.47-1	8.82-1	3.50-1	4.70-1	8.96-1	3.75-1	6.60-1	9.67-1	
4.00-1	7.90-1	9.10-1	4.25-1	1.03+0	9.49-1	4.50-1	1.26+0	9.45-1	
4.75-1	1.46+0	9.04-1	5.00-1	1.83+0	9.47-1				
7.00-2	2.85-5	**4.76-1**	8.00-2	8.16-5	4.24-1	9.00-2	2.06-4	4.27-1	108
1.00-1	4.73-4	4.61-1	1.10-1	9.95-4	5.14-1	1.20-1	1.96-3	5.93-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
1.30-1	3.66-3	6.89-1	1.40-1	6.50-3	8.05-1	1.50-1	1.11-2	9.45-1	
5.00-1	1.94+0	1.00+0	6.00-1	3.82+0	1.07+0	8.00-1	9.23+0	1.05+0	113
1.00+0	1.68+1	1.01+0	1.20+0	2.74+1	1.02+0	1.60+0	5.00+1	9.35-1	
2.00+0	8.57+1	1.01+0	2.40+0	1.13+2	9.51-1				
1.00-1	3.09-4	**3.01-1**	1.25-1	1.67-3	**3.96-1**	1.50-1	5.71-3	4.86-1	118
1.75-1	1.44-2	5.55-1	2.00-1	2.98-2	6.05-1	2.50-1	9.15-2	6.85-1	
3.00-1	2.13-1	7.46-1	4.00-1	7.21-1	8.30-1	5.00-1	1.56+0	8.07-1	
7.00-1	4.86+0	8.30-1	8.00-1	7.31+0	8.30-1				
2.00-1	5.78-2	1.17+0	2.50-1	1.46-1	1.09+0	3.00-1	3.09-1	1.08+0	121
4.00-1	8.96-1	1.03+0	5.00-1	2.05+0	1.06+0	6.00-1	3.73+0	1.04+0	
7.00-1	5.99+0	1.02+0	8.00-1	9.10+0	1.03+0	9.00-1	1.27+1	1.02+0	
1.00+0	1.76+1	1.05+0	1.10+0	2.05+1	9.50-1	1.20+0	2.76+1	1.02+0	152
1.30+0	3.11+1	9.43-1	1.40+0	3.81+1	9.68-1	1.50+0	4.25+1	9.18-1	
1.60+0	5.19+1	9.71-1	1.70+0	5.86+1	9.60-1	1.80+0	6.50+1	9.44-1	
1.90+0	6.77+1	8.80-1	2.00+0	6.86+1	8.06-1	2.10+0	7.41+1	7.93-1	
2.20+0	7.76+1	7.62-1	2.30+0	9.02+1	8.19-1	2.40+0	9.76+1	8.22-1	
2.50+0	1.03+2	8.07-1	2.60+0	1.05+2	7.70-1	2.70+0	1.10+2	7.60-1	
2.80+0	1.18+2	7.70-1	2.90+0	1.23+2	7.59-1	3.00+0	1.29+2	7.57-1	
27	Cobalt		Fluorescence yield = 0.373						
1.00-1	5.00-4	8.70-1	1.25-1	2.30-3	9.03-1	1.50-1	6.80-3	9.19-1	36
1.00+0	7.60+0	6.03-1	1.50+0	4.20+1	1.16+0	2.00+0	7.80+1	1.15+0	38
2.50+0	1.10+2	1.06+0	3.00+0	1.50+2	1.06+0	3.50+0	1.90+2	1.07+0	
4.00+0	2.10+2	9.92-1	4.50+0	2.40+2	9.86-1	5.00+0	2.70+2	9.91-1	
5.50+0	3.10+2	1.04+0	6.00+0	3.20+2	9.94-1				
5.00-1	1.60+0	1.15+0	6.00-1	2.70+0	1.04+0	7.00-1	4.20+0	9.74-1	53
8.00-1	6.40+0	9.78-1	9.00-1	9.50+0	1.02+0	1.00+0	1.27+1	1.01+0	
1.10+0	1.65+1	1.00+0	1.20+0	1.99+1	9.60-1	1.30+0	2.47+1	9.73-1	
1.40+0	2.79+1	9.12-1	1.50+0	3.34+1	9.25-1	1.60+0	3.91+1	9.32-1	
1.70+0	4.42+1	9.18-1	1.80+0	4.60+1	8.43-1	1.90+0	5.35+1	8.73-1	
2.00+0	5.93+1	8.71-1							
1.50+0	3.72+1	1.03+0	2.00+0	7.02+1	1.03+0	2.50+0	1.09+2	1.05+0	55
3.00+0	1.46+2	1.04+0	4.96+0	2.67+2	9.89-1	5.96+0	3.20+2	1.00+0	
6.94+0	3.66+2	1.02+0	6.96+0	3.64+2	1.01+0	8.94+0	4.25+2	1.02+0	
1.09+1	4.61+2	1.03+0							
5.00-1	1.90+0	1.37+0	6.00-1	3.50+0	1.34+0	7.00-1	5.70+0	1.32+0	69
8.00-1	9.20+0	1.41+0	9.00-1	1.21+1	1.30+0	1.00+0	1.66+1	1.32+0	
1.10+0	2.10+1	1.28+0	1.20+0	2.60+1	1.25+0	1.30+0	3.20+1	1.26+0	
1.40+0	3.90+1	1.28+0	1.50+0	4.50+1	1.25+0	1.60+0	5.20+1	1.24+0	
1.70+0	5.90+1	1.22+0	1.80+0	6.70+1	1.23+0	1.90+0	8.00+1	1.30+0	
2.00+0	8.60+1	1.26+0	2.10+0	9.60+1	1.28+0	2.20+0	1.03+2	1.25+0	
2.30+0	1.10+2	1.23+0							
2.00-1	3.10-2	9.50-1	2.50-1	8.70-2	9.56-1	3.00-1	1.60-1	8.08-1	73
3.50-1	3.10-1	8.42-1	4.00-1	5.70-1	9.25-1	4.50-1	7.20-1	7.55-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
2.00+0	5.13+1	7.54-1	5.00+0	1.99+2	7.31-1				84
3.00+0	1.35+2	9.57-1							94
2.00-1	3.57-2	1.09+0	2.50-1	9.94-2	1.09+0	3.00-1	2.06-1	1.04+0	115
3.50-1	3.75-1	1.02+0	4.00-1	6.29-1	1.02+0	4.50-1	9.94-1	1.04+0	
5.00-1	1.35+0	9.70-1	6.00-1	2.57+0	9.87-1	7.00-1	4.04+0	9.37-1	
8.00-1	6.02+0	9.20-1	9.00-1	8.57+0	9.20-1	1.00+0	1.13+1	8.96-1	
1.10+0	1.48+1	9.01-1	1.20+0	1.88+1	9.07-1	1.30+0	2.34+1	9.22-1	
1.40+0	2.78+1	9.09-1	1.50+0	3.22+1	8.92-1	1.60+0	3.68+1	8.77-1	
1.70+0	4.27+1	8.86-1	1.80+0	4.84+1	8.87-1	1.90+0	5.52+1	9.00-1	
2.00+0	6.25+1	9.18-1							
3.00-1	2.03-1	1.03+0	4.00-1	6.21-1	1.01+0	5.00-1	1.41+0	1.01+0	132
6.00-1	2.64+0	1.01+0	7.00-1	4.34+0	1.01+0	8.00-1	6.48+0	9.90-1	
1.00+0	1.25+1	9.91-1	1.20+0	2.08+1	1.00+0	1.40+0	3.05+1	9.97-1	
1.60+0	4.31+1	1.03+0	1.80+0	5.67+1	1.04+0	2.00+0	6.82+1	1.00+0	
2.20+0	8.38+1	1.02+0	2.30+0	8.99+1	1.00+0	2.40+0	9.79+1	1.01+0	
6.00-1	2.48+0	9.52-1	7.00-1	4.11+0	9.53-1	8.00-1	6.25+0	9.55-1	137
1.00+0	1.23+1	9.75-1	1.20+0	2.00+1	9.65-1	1.40+0	2.93+1	9.58-1	
1.60+0	4.08+1	9.72-1	1.80+0	5.30+1	9.72-1	2.00+0	6.59+1	9.68-1	
2.20+0	8.00+1	9.73-1							
1.00+0	1.21+1	9.60-1	1.20+0	1.63+1	7.87-1	1.40+0	2.69+1	8.80-1	152
1.60+0	3.32+1	7.91-1	1.80+0	4.28+1	7.85-1	2.00+0	5.86+1	8.61-1	
2.20+0	6.51+1	7.92-1	2.40+0	8.06+1	8.33-1	2.60+0	8.49+1	7.63-1	
2.80+0	1.04+2	8.22-1	3.00+0	1.16+2	8.23-1				
28	Nickel		Fluorescence yield = 0.406						
1.50+0	2.00+1	7.11-1	1.70+0	2.40+1	6.34-1	1.80+0	2.70+1	6.25-1	5
1.90+0	3.20+1	6.58-1	2.30+0	4.40+1	6.09-1	2.40+0	5.00+1	6.38-1	
2.50+0	5.90+1	6.96-1	2.80+0	7.60+1	7.34-1	3.10+0	9.20+1	7.49-1	
3.50+0	1.10+2	7.41-1	3.70+0	1.20+2	7.47-1				
5.00+0	2.94+2	1.26+0	8.00+0	4.09+2	1.17+0	1.00+1	4.77+2	1.21+0	20
1.40+1	5.24+2	1.21+0	1.70+1	5.17+2	1.17+0	2.00+1	5.46+2	1.24+0	
2.40+1	5.10+2	1.19+0	2.80+1	5.06+2	1.23+0				
1.00-1	2.50-4	7.90-1	1.25-1	1.40-3	9.15-1	1.50-1	4.50-3	9.71-1	36
1.00+0	7.20+0	7.56-1	2.25+0	5.40+1	7.81-1	3.00+0	9.20+1	7.88-1	47
2.50+0	7.89+1	9.31-1	3.00+0	1.23+2	1.05+0	4.00+0	1.82+2	1.02+0	52
4.50+0	2.12+2	1.02+0	5.00+0	2.49+2	1.06+0	6.00+0	2.67+2	9.50-1	
6.50+0	2.56+2	8.50-1	7.00+0	3.53+2	1.11+0	8.00+0	3.18+2	9.09-1	
8.50+0	4.18+2	1.15+0	9.00+0	3.62+2	9.67-1	1.00+1	4.06+2	1.03+0	
1.05+1	4.55+2	1.13+0	1.10+1	4.54+2	1.11+0	1.20+1	4.93+2	1.17+0	
1.50+0	2.75+1	9.78-1	2.00+0	5.52+1	1.02+0	2.50+0	8.64+1	1.02+0	55
2.98+0	1.14+2	9.88-1	3.00+0	1.20+2	1.03+0	4.97+0	2.33+2	1.00+0	
5.96+0	2.82+2	1.01+0	6.94+0	3.21+2	1.01+0	6.95+0	3.23+2	1.02+0	
8.94+0	3.84+2	1.03+0	1.09+1	4.17+2	1.02+0				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
9.00-2	1.22-4	9.00-1	1.00-1	2.27-4	7.17-1	1.10-1	4.19-4	6.54-1	57
1.20-1	7.75-4	6.63-1	1.30-1	1.47-3	7.47-1	1.40-1	2.73-3	8.85-1	
1.50-1	5.07-3	1.09+0	2.00-1	2.01-2	9.33-1	2.50-1	5.12-2	8.27-1	
2.95-1	9.36-2	7.34-1	3.30-1	1.43-1	7.02-1	3.60-1	1.92-1	6.64-1	
3.90-1	2.55-1	6.44-1	4.15-1	2.68-1	5.33-1				
5.00-1	1.50+0	1.50+0	6.00-1	2.60+0	1.37+0	7.00-1	4.30+0	1.35+0	69
8.00-1	6.20+0	1.27+0	9.00-1	8.30+0	1.19+0	1.00+0	1.16+1	1.22+0	
1.10+0	1.53+1	1.22+0	1.20+0	1.82+1	1.15+0	1.30+0	2.40+1	1.22+0	
1.40+0	2.70+1	1.14+0	1.50+0	3.50+1	1.24+0	1.60+0	4.10+1	1.25+0	
1.70+0	4.70+1	1.24+0	1.80+0	5.30+1	1.23+0	1.90+0	5.80+1	1.19+0	
2.00+0	6.80+1	1.25+0	2.10+0	7.70+1	1.28+0				
2.00-1	2.10-2	9.75-1	2.50-1	5.40-2	8.73-1	3.00-1	1.08-1	7.89-1	73
3.50-1	2.20-1	8.52-1	4.00-1	3.90-1	8.93-1	4.50-1	5.20-1	7.63-1	
5.50-1	1.20+0	8.53-1	6.50-1	2.14+0	8.59-1	7.50-1	3.16+0	7.96-1	
8.50-1	4.20+0	7.15-1							
9.50-1	5.30+0	6.46-1							76
1.00+0	1.00+1	1.05+0	1.10+0	1.28+1	1.02+0	1.20+0	1.60+1	1.01+0	77
1.30+0	1.97+1	1.00+0	1.40+0	2.38+1	1.01+0	1.50+0	2.84+1	1.01+0	
1.60+0	3.35+1	1.02+0	1.70+0	3.90+1	1.03+0	1.80+0	4.47+1	1.03+0	
1.90+0	5.09+1	1.05+0	2.00+0	5.71+1	1.05+0	2.10+0	6.33+1	1.05+0	
2.20+0	7.02+1	1.06+0	2.30+0	7.61+1	1.05+0	2.40+0	8.23+1	1.05+0	
2.50+0	8.82+1	1.04+0	2.60+0	9.36+1	1.03+0	2.70+0	9.81+1	1.01+0	
2.80+0	1.03+2	9.95-1	2.90+0	1.06+2	9.63-1	3.00+0	1.09+2	9.34-1	
1.00+0	7.38+0	7.74-1	2.00+0	4.06+1	7.47-1	5.00+0	1.98+2	8.46-1	84
1.25+0	9.50+0	5.37-1							89
3.00+0	1.19+2	1.02+0							94
2.50+0	7.55+1	8.91-1	3.00+0	1.02+2	8.74-1	5.00+0	2.12+2	9.05-1	97
7.50+0	3.07+2	9.15-1	9.00+0	3.43+2	9.16-1	9.75+0	3.48+2	8.94-1	
8.00-2	2.67-5	5.61-1	9.00-2	7.59-5	5.60-1	1.00-1	1.93-4	6.10-1	108
1.10-1	4.48-4	6.99-1	1.20-1	9.63-4	8.24-1	1.30-1	1.95-3	9.90-1	
1.40-1	3.72-3	1.21+0	1.50-1	6.81-3	1.47+0				
5.00-1	9.85-1	9.82-1	6.00-1	1.81+0	9.51-1	8.00-1	4.35+0	8.93-1	113
1.00+0	9.03+0	9.48-1	1.20+0	1.51+1	9.52-1	1.40+0	2.18+1	9.22-1	
1.60+0	3.05+1	9.28-1	1.80+0	4.05+1	9.37-1	2.00+0	5.01+1	9.22-1	
2.20+0	6.17+1	9.34-1	2.40+0	7.33+1	9.35-1				
7.00+0	3.10+2	9.71-1							114
2.00-1	2.13-2	9.89-1	2.50-1	6.09-2	9.84-1	3.00-1	1.30-1	9.49-1	115
3.50-1	2.50-1	9.68-1	4.00-1	3.82-1	8.75-1	4.50-1	6.29-1	9.22-1	
5.00-1	8.90-1	8.87-1	6.00-1	1.69+0	8.88-1	7.00-1	2.85+0	8.96-1	
8.00-1	4.30+0	8.83-1	9.00-1	6.17+0	8.84-1	1.00+0	8.40+0	8.81-1	
1.10+0	1.11+1	8.89-1	1.20+0	1.42+1	8.95-1	1.30+0	1.78+1	9.07-1	

TABLE 2. K-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
1.40+0	2.10+1	8.88-1	1.50+0	2.48+1	8.82-1	1.60+0	2.98+1	9.07-1	
1.70+0	3.37+1	8.90-1	1.80+0	3.81+1	8.82-1	1.90+0	4.43+1	9.11-1	
2.00+0	4.97+1	9.15-1							
5.50-2	7.10-7	1.13+0	6.00-2	2.30-6	1.13+0	6.50-2	6.70-6	1.24+0	120
7.00-2	1.40-5	1.13+0	7.50-2	2.40-5	9.43-1	8.00-2	4.40-5	9.25-1	
9.00-2	1.40-4	1.03+0	1.00-1	3.40-4	1.07+0	1.10-1	6.80-4	1.06+0	
1.20-1	1.20-3	1.03+0	1.30-1	1.90-3	9.65-1	1.40-1	3.20-3	1.04+0	
1.50-1	4.30-3	9.28-1	1.60-1	5.70-3	8.53-1	1.80-1	1.10-2	8.73-1	
2.00-1	1.70-2	7.89-1	2.20-1	2.90-2	8.47-1	2.40-1	4.30-2	8.36-1	
2.60-1	6.10-2	8.27-1	2.80-1	8.80-2	8.63-1	3.00-1	1.30-1	9.49-1	
1.40+0	2.54+1	1.07+0	1.50+0	3.00+1	1.07+0	1.60+0	3.30+1	1.00+0	122
1.70+0	3.99+1	1.05+0	1.80+0	4.33+1	1.00+0	1.90+0	4.88+1	1.00+0	
2.00+0	5.40+1	9.94-1							
3.00-1	1.44-1	1.05+0	4.00-1	4.43-1	1.01+0	5.00-1	1.01+0	1.01+0	132
6.00-1	1.97+0	1.04+0	7.00-1	3.28+0	1.03+0	8.00-1	5.13+0	1.05+0	
1.00+0	9.69+0	1.02+0	1.20+0	1.64+1	1.03+0	1.40+0	2.41+1	1.02+0	
1.60+0	3.35+1	1.02+0	1.80+0	4.39+1	1.02+0	2.00+0	5.55+1	1.02+0	
2.20+0	6.75+1	1.02+0	2.30+0	7.37+1	1.02+0	2.40+0	7.95+1	1.01+0	
1.00+0	9.00+0	9.44-1	1.20+0	1.49+1	9.39-1	1.40+0	2.27+1	9.60-1	137
1.60+0	3.13+1	9.52-1	1.80+0	4.22+1	9.76-1	2.00+0	5.22+1	9.61-1	
2.20+0	6.29+1	9.52-1							
1.60+0	3.53+1	1.07+0	1.80+0	4.21+1	9.74-1	2.00+0	5.48+1	1.01+0	151
2.20+0	7.23+1	1.09+0	2.40+0	8.09+1	1.03+0				
29	Copper		Fluorescence yield = 0.44						
2.00-1	4.50-3	**3.13-1**	2.50-1	1.00-2	**2.35-1**	3.00-1	2.10-2	**2.19-1**	3
3.50-1	4.00-2	**2.18-1**	4.00-1	8.50-2	**2.71-1**	4.60-1	2.00-1	**3.73-1**	
7.00-1	2.00+0	8.46-1	1.00+0	8.60+0	1.19+0	1.22+0	1.60+1	1.27+0	
4.00-1	1.59-1	5.07-1	5.00-1	3.28-1	**4.49-1**	6.00-1	6.84-1	4.89-1	4
7.00-1	1.07+0	**4.53-1**	8.00-1	1.71+0	**4.68-1**	9.00-1	3.01+0	5.71-1	
1.00+0	4.36+0	6.02-1							
1.40-1	1.90-3	9.87-1	1.50-1	2.80-3	9.59-1	1.60-1	4.50-3	1.05+0	6
1.80-1	8.20-3	9.94-1	2.00-1	1.40-2	9.75-1	2.20-1	2.20-2	9.51-1	
2.40-1	3.20-2	9.11-1	2.60-1	4.60-2	9.04-1	2.80-1	6.60-2	9.30-1	
3.00-1	9.00-2	9.39-1	3.20-1	1.20-1	9.51-1	3.40-1	1.60-1	9.83-1	
3.60-1	2.00-1	9.73-1	3.80-1	3.00-1	1.17+0	4.00-1	3.10-1	9.89-1	
4.40-1	3.80-1	8.40-1	6.00-1	1.20+0	8.57-1	7.40-1	2.20+0	7.75-1	
9.35-1	4.50+0	7.59-1	1.04+0	6.30+0	7.75-1	1.14+0	7.80+0	7.46-1	
1.20+0	9.40+0	7.69-1							
2.30-1	2.10-2	7.32-1	3.25-1	7.10-2	5.27-1	4.20-1	1.90-1	5.02-1	7
4.54-1	2.88-1	5.65-1	5.10-1	4.70-1	5.99-1				
1.50-1	3.00-3	1.03+0	2.00-1	1.30-2	9.05-1	3.00-1	8.80-2	9.18-1	9
4.00-1	3.10-1	9.89-1	5.00-1	6.30-1	8.63-1				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
1.50+0	2.00+1	9.10-1							10
6.40+0	2.75+2	1.06+0	6.70+0	2.85+2	1.05+0	7.00+0	3.00+2	1.07+0	21
7.50+0	3.10+2	1.04+0	7.80+0	3.25+2	1.06+0	8.20+0	3.35+2	1.06+0	
8.40+0	3.40+2	1.06+0	8.50+0	3.50+2	1.08+0	8.80+0	3.60+2	1.09+0	
9.00+0	3.65+2	1.09+0	9.20+0	3.70+2	1.09+0	9.40+0	3.75+2	1.09+0	
9.60+0	3.75+2	1.08+0	9.90+0	3.70+2	1.05+0				
7.00-1	1.77+0	7.49-1	9.00-1	4.09+0	7.76-1	1.10+0	7.11+0	7.44-1	27
1.30+0	1.09+1	7.18-1	1.50+0	1.47+1	6.69-1	1.70+0	1.80+1	6.01-1	
1.90+0	2.29+1	5.91-1	2.10+0	3.09+1	6.40-1	2.30+0	3.64+1	6.23-1	
2.50+0	4.79+1	6.94-1							
1.60+2	2.20+2	1.50+0							30
1.25-1	9.50-4	1.04+0	1.50-1	3.10-3	1.06+0				36
1.00+0	8.80+0	1.21+0	2.00+0	5.10+1	1.17+0				39
1.00+0	5.40+0	7.45-1	2.25+0	4.20+1	7.52-1	3.00+0	7.50+1	7.81-1	47
2.50+0	6.64+1	9.63-1	3.00+0	9.81+1	1.02+0	4.00+0	1.56+2	1.03+0	52
4.50+0	1.80+2	1.02+0	5.00+0	1.86+2	9.24-1	6.00+0	2.53+2	1.03+0	
6.50+0	2.46+2	9.31-1	7.00+0	2.99+2	1.06+0	8.00+0	2.90+2	9.31-1	
8.50+0	3.46+2	1.07+0	9.00+0	3.25+2	9.67-1	1.00+1	3.79+2	1.07+0	
1.05+1	3.62+2	9.95-1	1.10+1	4.05+2	1.09+0	1.20+1	4.25+2	1.11+0	
5.00-1	5.00-1	6.85-1	6.00-1	1.00+0	7.14-1	7.00-1	1.80+0	7.61-1	53
8.00-1	2.80+0	7.67-1	9.00-1	4.10+0	7.77-1	1.00+0	6.00+0	8.28-1	
1.10+0	8.00+0	8.37-1	1.20+0	1.07+1	8.76-1	1.30+0	1.34+1	8.82-1	
1.40+0	1.63+1	8.82-1	1.50+0	1.98+1	9.01-1	1.60+0	2.34+1	9.06-1	
1.70+0	2.68+1	8.95-1	1.80+0	3.22+1	9.42-1	1.90+0	3.59+1	9.26-1	
2.00+0	3.92+1	9.03-1							
1.50+0	2.14+1	9.74-1	2.00+0	4.27+1	9.83-1	2.50+0	6.87+1	9.96-1	55
3.00+0	9.51+1	9.90-1	4.96+0	2.06+2	1.03+0	5.96+0	2.52+2	1.04+0	
6.96+0	2.97+2	1.06+0	8.94+0	3.55+2	1.06+0	1.09+1	3.98+2	1.07+0	
1.30-1	1.14-3	9.56-1	1.50-1	2.35-3	8.05-1	2.00-1	1.28-2	8.91-1	57
2.50-1	4.54-2	1.07+0	2.95-1	7.21-2	8.08-1	3.30-1	9.81-2	6.83-1	
3.60-1	1.26-1	6.13-1	3.85-1	1.46-1	5.42-1	4.15-1	1.72-1	4.76-1	
3.00+0	8.70+1	9.06-1	5.00+0	1.80+2	8.94-1				59
6.67-1	2.00+0	9.94-1	1.00+0	7.30+0	1.01+0	1.33+0	1.54+1	9.48-1	64
1.67+0	2.79+1	9.75-1	2.00+0	4.26+1	9.81-1	2.33+0	5.45+1	9.07-1	
2.67+0	7.46+1	9.56-1	3.00+0	9.05+1	9.42-1	3.33+0	1.16+2	1.01+0	
3.67+0	1.34+2	1.00+0	4.00+0	1.44+2	9.55-1	4.33+0	1.85+2	1.10+0	
4.67+0	1.99+2	1.07+0	5.00+0	2.13+2	1.06+0	5.33+0	2.31+2	1.06+0	
5.67+0	2.47+2	1.07+0							

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
8.30-1	4.30+0	1.05+0	1.58+0	2.90+1	1.16+0	2.56+0	6.80+1	9.42-1	66
3.28+0	1.23+2	1.10+0							
5.00-1	9.00-1	1.23+0	6.00-1	1.80+0	1.29+0	7.00-1	2.90+0	1.23+0	69
8.00-1	4.70+0	1.29+0	9.00-1	6.40+0	1.21+0	1.00+0	8.70+0	1.20+0	
1.10+0	1.16+1	1.21+0	1.20+0	1.44+1	1.18+0	1.30+0	1.82+1	1.20+0	
1.40+0	2.20+1	1.19+0	1.50+0	2.60+1	1.18+0	1.60+0	3.20+1	1.24+0	
1.70+0	3.60+1	1.20+0	1.80+0	4.10+1	1.20+0	1.90+0	4.80+1	1.24+0	
2.00+0	5.30+1	1.22+0	2.10+0	5.70+1	1.18+0	2.20+0	6.00+1	1.12+0	
2.30+0	6.60+1	1.13+0							
2.00+0	2.30+1	5.30-1							74
9.50-1	4.20+0	6.76-1							76
1.00+0	7.17+0	9.89-1	1.20+0	1.21+1	9.90-1	1.40+0	1.88+1	1.02+0	77
1.50+0	2.27+1	1.03+0	1.60+0	2.69+1	1.04+0	1.80+0	3.62+1	1.06+0	
2.00+0	4.63+1	1.07+0	2.20+0	5.61+1	1.05+0	2.40+0	6.50+1	1.02+0	
2.50+0	6.94+1	1.01+0	2.60+0	7.30+1	9.82-1	2.80+0	7.97+1	9.36-1	
3.00+0	8.41+1	8.75-1							
9.00-1	5.05+0	9.58-1	1.00+0	7.89+0	1.09+0	1.10+0	1.27+1	1.33+0	80
1.20+0	1.75+1	1.43+0	1.30+0	1.85+1	1.22+0	1.40+0	2.08+1	1.13+0	
1.50+0	2.24+1	1.02+0	1.60+0	2.80+1	1.08+0	1.70+0	3.30+1	1.10+0	
1.80+0	3.54+1	1.04+0	1.90+0	4.44+1	1.15+0	2.00+0	4.63+1	1.07+0	
2.10+0	4.62+1	9.57-1	2.20+0	5.38+1	1.01+0	2.30+0	6.10+1	1.04+0	
2.40+0	7.42+1	1.17+0	2.50+0	6.95+1	1.01+0	2.60+0	6.04+1	8.13-1	
2.70+0	8.95+1	1.12+0	2.80+0	8.90+1	1.04+0	2.90+0	7.49+1	8.27-1	
3.00+0	8.15+1	8.48-1	3.10+0	1.17+2	1.15+0	3.20+0	1.24+2	1.15+0	
3.30+0	1.25+2	1.11+0	3.40+0	1.15+2	9.71-1	3.50+0	1.16+2	9.36-1	
3.60+0	1.29+2	9.97-1	3.70+0	1.22+2	9.03-1	3.80+0	2.22+2	1.58+0	
3.90+0	2.14+2	1.47+0	4.00+0	2.20+2	1.46+0				
3.00+0	9.72+1	1.01+0	5.00+0	2.12+2	1.05+0	7.00+0	2.98+2	1.06+0	94
9.00+0	3.57+2	1.06+0	1.10+1	3.92+2	1.06+0				
2.49-1	4.68-2	1.12+0	3.00-1	1.08-1	1.13+0	3.53-1	2.11-1	1.11+0	99
4.03-1	3.51-1	1.09+0	4.84-1	6.77-1	1.05+0	5.52-1	1.06+0	1.02+0	
6.35-1	1.66+0	9.75-1	7.20-1	2.44+0	9.40-1	8.10-1	3.47+0	9.14-1	
9.00-1	4.70+0	8.91-1	1.10+0	8.18+0	8.56-1	1.31+0	1.30+1	8.38-1	
1.52+0	1.91+1	8.41-1	1.72+0	2.61+1	8.48-1	1.91+0	3.40+1	8.67-1	
1.50-1	1.46-3	5.00-1	2.00-1	9.46-3	6.59-1	3.00-1	7.58-2	7.90-1	103
4.00-1	2.77-1	8.84-1	5.00-1	6.60-1	9.04-1	6.00-1	1.26+0	9.00-1	
7.00-1	2.20+0	9.31-1	8.00-1	3.48+0	9.53-1				
2.20+1	4.47+2	1.09+0	3.10+1	3.91+2	1.02+0	4.40+1	3.28+2	9.84-1	104
4.00+0	1.56+2	1.03+0	6.00+0	2.80+2	1.14+0	8.00+0	3.69+2	1.18+0	105
1.00+1	4.09+2	1.15+0	1.20+1	4.49+2	1.17+0	1.40+1	4.81+2	1.20+0	
1.60+1	4.72+2	1.15+0	1.80+1	4.94+2	1.20+0	2.00+1	4.85+2	1.18+0	
2.20+1	4.76+2	1.16+0							

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	Ref.
1.00+0	7.25+0	1.00+0	1.25+0	1.38+1	1.01+0	1.50+0	2.40+1	1.09+0	112
1.75+0	3.41+1	1.06+0	2.00+0	4.49+1	1.03+0	2.25+0	5.83+1	1.04+0	
2.50+0	7.03+1	1.02+0	2.75+0	8.68+1	1.05+0	3.00+0	1.03+2	1.07+0	
5.00-1	7.65-1	1.05+0	6.00-1	1.46+0	1.04+0	8.00-1	3.80+0	1.04+0	113
1.00+0	7.12+0	9.83-1	1.20+0	1.16+1	9.49-1	1.40+0	1.79+1	9.68-1	
1.60+0	2.51+1	9.72-1	1.80+0	3.31+1	9.68-1	2.00+0	4.28+1	9.85-1	
2.20+0	5.03+1	9.43-1	2.40+0	6.19+1	9.73-1				
7.00+0	3.10+2	1.10+0							114
2.00-1	1.65-2	1.15+0	2.50-1	4.45-2	1.05+0	3.00-1	9.52-2	9.93-1	115
3.50-1	1.78-1	9.70-1	4.00-1	3.03-1	9.67-1	4.50-1	4.81-1	9.76-1	
5.00-1	6.81-1	9.33-1	6.00-1	1.38+0	9.86-1	7.00-1	2.30+0	9.73-1	
8.00-1	3.59+0	9.84-1	9.00-1	5.12+0	9.71-1	1.00+0	7.48+0	1.03+0	
1.10+0	9.79+0	1.02+0	1.20+0	1.21+1	9.90-1	1.30+0	1.48+1	9.74-1	
1.40+0	1.78+1	9.63-1	1.50+0	2.15+1	9.78-1	1.60+0	2.51+1	9.72-1	
1.70+0	2.92+1	9.75-1	1.80+0	3.35+1	9.80-1	1.90+0	3.78+1	9.75-1	
2.00+0	4.24+1	9.76-1							
5.00-1	6.99-1	9.58-1	6.25-1	1.35+0	8.38-1	7.50-1	2.47+0	8.33-1	117
8.75-1	3.95+0	8.17-1	1.00+0	6.01+0	8.29-1	1.25+0	1.19+1	8.71-1	
1.50+0	1.93+1	8.78-1	1.75+0	2.92+1	9.12-1	2.00+0	3.95+1	9.09-1	
2.25+0	5.47+1	9.79-1	2.50+0	6.85+1	9.93-1	2.75+0	8.41+1	1.02+0	
3.00+0	9.70+1	1.01+0	2.99+0	9.22+1	9.68-1	3.94+0	1.45+2	9.81-1	
6.07+0	2.46+2	9.93-1	9.13+0	3.50+2	1.03+0	1.22+1	4.06+2	1.05+0	
1.83+1	4.23+2	1.02+0	2.40+1	4.12+2	1.02+0	3.01+1	3.96+2	1.03+0	
3.56+1	3.74+2	1.03+0	3.96+1	3.56+2	1.02+0				
1.25-1	3.34-4	3.65-1	1.50-1	1.33-3	4.56-1	1.75-1	4.02-3	5.68-1	118
2.00-1	8.89-3	6.19-1	2.50-1	2.98-2	7.01-1	3.00-1	7.30-2	7.61-1	
4.00-1	2.68-1	8.55-1	5.00-1	6.42-1	8.80-1	6.00-1	1.24+0	8.86-1	
7.00-1	2.09+0	8.84-1	8.00-1	3.24+0	8.88-1				
1.40+0	1.98+1	1.07+0	1.50+0	2.16+1	9.83-1	1.60+0	2.51+1	9.72-1	122
1.70+0	2.94+1	9.82-1	1.80+0	3.40+1	9.94-1	1.90+0	3.58+1	9.24-1	
2.00+0	4.15+1	9.55-1							
7.00+0	3.29+2	1.17+0							125
1.00-1	1.37-4	7.87-1	1.20-1	5.92-4	8.57-1	1.40-1	1.69-3	8.78-1	126
1.60-1	3.82-3	8.95-1	1.80-1	7.60-3	9.22-1	2.00-1	1.33-2	9.26-1	
2.50-1	3.91-2	9.20-1	3.00-1	8.48-2	8.84-1				
5.00-1	7.65-1	1.05+0	7.07-1	2.54+0	1.04+0	1.00+0	7.16+0	9.88-1	130
1.41+0	1.84+1	9.71-1	2.00+0	4.23+1	9.74-1	2.50+0	6.55+1	9.50-1	
3.00-1	9.40-2	9.80-1	4.00-1	3.16-1	1.01+0	5.00-1	7.57-1	1.04+0	132
6.00-1	1.44+0	1.03+0	7.00-1	2.30+0	9.73-1	8.00-1	3.67+0	1.01+0	
1.00+0	7.25+0	1.00+0	1.20+0	1.22+1	9.99-1	1.40+0	1.86+1	1.01+0	
1.60+0	2.64+1	1.02+0	1.80+0	3.50+1	1.02+0	2.00+0	4.26+1	9.81-1	
2.20+0	5.34+1	1.00+0	2.30+0	5.74+1	9.83-1	2.40+0	6.32+1	9.93-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
2.80-1	9.20-2	1.30+0	3.30-1	1.70-1	1.18+0	3.70-1	2.50-1	1.09+0	135
4.20-1	3.70-1	9.77-1	5.00-1	6.60-1	9.04-1	5.60-1	8.80-1	8.01-1	
6.10-1	1.10+0	7.42-1	6.50-1	1.30+0	7.05-1	6.90-1	1.60+0	7.10-1	
7.40-1	1.90+0	6.69-1	7.90-1	2.40+0	6.84-1	8.30-1	2.80+0	6.83-1	
8.70-1	3.30+0	6.94-1	9.10-1	4.40+0	8.06-1	1.01+0	5.70+0	7.64-1	
1.11+0	7.90+0	8.05-1	1.21+0	9.70+0	7.76-1	1.31+0	1.30+1	8.38-1	
1.41+0	1.60+1	8.50-1	1.51+0	1.90+1	8.50-1	1.61+0	2.20+1	8.39-1	
1.71+0	2.40+1	7.90-1	1.81+0	3.00+1	8.66-1				
5.00-1	6.76-1	9.26-1	6.00-1	1.32+0	9.43-1	7.00-1	2.31+0	9.77-1	137
8.00-1	3.54+0	9.70-1	1.00+0	6.90+0	9.52-1	1.20+0	1.15+1	9.41-1	
1.40+0	1.74+1	9.41-1	1.60+0	2.44+1	9.45-1	1.80+0	3.25+1	9.50-1	
2.00+0	4.15+1	9.55-1	2.20+0	5.07+1	9.50-1				
1.50+0	2.06+1	9.37-1	2.00+0	4.61+1	1.06+0	2.25+0	5.57+1	9.97-1	143
2.50+0	6.88+1	9.98-1	2.75+0	7.99+1	9.68-1	3.00+0	9.68+1	1.01+0	
1.00+0	6.96+0	9.60-1	2.00+0	4.26+1	9.81-1				149
1.60+0	2.61+1	1.01+0	1.80+0	3.46+1	1.01+0	2.00+0	4.55+1	1.05+0	151
2.20+0	5.58+1	1.05+0	2.40+0	6.57+1	1.03+0				
30	Zinc		Fluorescence yield = 0.47						
7.00-1	1.49+0	8.49-1	9.00-1	3.54+0	8.91-1	1.10+0	5.33+0	7.31-1	27
1.30+0	8.31+0	7.09-1	1.50+0	1.41+1	8.20-1	1.70+0	1.73+1	7.36-1	
1.90+0	2.54+1	8.27-1	2.10+0	2.75+1	7.12-1	2.30+0	3.01+1	6.40-1	
2.50+0	3.45+1	6.18-1							
2.50+0	5.34+1	9.56-1	3.00+0	7.80+1	9.86-1	4.00+0	1.34+2	1.05+0	52
4.50+0	1.52+2	1.01+0	5.00+0	1.71+2	9.93-1	6.00+0	2.12+2	1.00+0	
6.50+0	2.17+2	9.43-1	7.00+0	2.51+2	1.02+0	8.00+0	2.81+2	1.02+0	
8.50+0	3.23+2	1.12+0	9.00+0	3.03+2	1.01+0	1.00+1	3.37+2	1.06+0	
1.05+1	3.39+2	1.03+0	1.10+1	3.58+2	1.07+0	1.20+1	3.82+2	1.10+0	
4.50-1	3.00-1	8.44-1	5.60-1	5.00-1	6.22-1	6.60-1	1.60+0	1.12+0	53
7.70-1	2.60+0	1.08+0	8.70-1	3.60+0	1.01+0	9.70-1	5.30+0	1.06+0	
1.08+0	7.00+0	1.01+0	1.20+0	9.10+0	9.71-1	1.30+0	1.14+1	9.72-1	
1.40+0	1.40+1	9.77-1	1.50+0	1.66+1	9.66-1	1.60+0	1.94+1	9.60-1	
1.70+0	2.22+1	9.44-1	1.80+0	2.52+1	9.30-1	1.90+0	2.87+1	9.35-1	
2.00+0	3.19+1	9.23-1							
7.00-1	2.63+0	1.50+0	1.00+0	6.42+0	1.17+0	1.40+0	1.57+1	1.10+0	56
1.60+0	2.00+1	9.89-1	1.80+0	2.67+1	9.85-1	2.00+0	3.31+1	9.58-1	
2.20+0	4.25+1	9.95-1	2.40+0	5.32+1	1.03+0	2.60+0	6.47+1	1.07+0	
2.80+0	7.62+1	1.09+0	3.00+0	8.72+1	1.10+0	3.20+0	1.01+2	1.14+0	
3.40+0	1.11+2	1.13+0	3.60+0	1.23+2	1.14+0	3.80+0	1.36+2	1.16+0	
4.00+0	1.54+2	1.21+0	4.20+0	1.66+2	1.22+0	4.40+0	1.78+2	1.22+0	
1.50-1	1.72-3	9.39-1	1.95-1	7.35-3	8.86-1	2.55-1	2.90-2	9.09-1	57
3.00-1	5.39-2	8.05-1	3.35-1	7.63-2	7.08-1	3.60-1	9.87-2	6.77-1	
3.90-1	1.15-1	5.69-1	4.15-1	1.53-1	5.90-1				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
2.00-1	1.40-2	1.47+0	2.50-1	3.80-2	1.31+0	3.00-1	7.80-2	1.17+0	73
3.50-1	1.50-1	1.16+0	4.00-1	2.80-1	1.25+0	4.50-1	3.90-1	1.10+0	
1.00+0	5.60+0	1.02+0	1.10+0	7.50+0	1.03+0	1.20+0	9.70+0	1.03+0	86
1.40+0	1.50+1	1.05+0	1.60+0	2.16+1	1.07+0	1.80+0	2.92+1	1.08+0	
2.00+0	3.78+1	1.09+0	2.20+0	4.68+1	1.10+0	2.40+0	5.56+1	1.08+0	
2.60+0	6.42+1	1.06+0	2.80+0	7.14+1	1.02+0	3.00+0	7.76+1	9.80-1	
1.00-1	6.08-5	6.51-1	1.10-1	1.34-4	6.51-1	1.20-1	2.74-4	6.84-1	108
1.30-1	5.30-4	7.45-1	1.40-1	9.73-4	8.28-1	1.50-1	1.72-3	9.39-1	
7.00+0	2.30+2	9.33-1							114
2.00-1	1.30-2	1.37+0	2.50-1	3.41-2	1.17+0	3.00-1	7.71-2	1.15+0	115
3.50-1	1.41-1	1.09+0	4.00-1	2.34-1	1.05+0	4.50-1	3.83-1	1.08+0	
5.00-1	5.70-1	1.07+0	6.00-1	9.63-1	9.36-1	7.00-1	1.61+0	9.18-1	
8.00-1	2.49+0	9.12-1	9.00-1	3.61+0	9.08-1	1.00+0	5.13+0	9.33-1	
1.10+0	7.38+0	1.01+0	1.20+0	9.25+0	9.87-1	1.30+0	1.20+1	1.02+0	
1.40+0	1.38+1	9.63-1	1.50+0	1.60+1	9.31-1	1.60+0	1.84+1	9.10-1	
1.70+0	2.21+1	9.40-1	1.80+0	2.61+1	9.63-1	1.90+0	2.95+1	9.61-1	
2.00+0	3.33+1	9.63-1							
7.00+0	2.06+2	8.35-1							125
3.00-1	6.37-2	9.52-1	4.00-1	2.23-1	9.97-1	5.00-1	5.22-1	9.84-1	132
6.00-1	1.01+0	9.82-1	7.00-1	1.69+0	9.63-1	8.00-1	2.68+0	9.82-1	
1.00+0	5.46+0	9.93-1	1.20+0	9.24+0	9.86-1	1.40+0	1.43+1	9.98-1	
1.60+0	2.03+1	1.00+0	1.80+0	2.78+1	1.03+0	2.00+0	3.47+1	1.00+0	
2.20+0	4.28+1	1.00+0	2.30+0	4.93+1	1.05+0	2.40+0	5.17+1	1.01+0	
5.00-1	4.84-1	9.13-1	6.00-1	9.48-1	9.21-1	7.00-1	1.62+0	9.23-1	137
8.00-1	2.52+0	9.23-1	1.00+0	5.27+0	9.59-1	1.20+0	8.77+0	9.35-1	
1.40+0	1.35+1	9.42-1	1.60+0	1.96+1	9.70-1	1.80+0	2.55+1	9.41-1	
2.00+0	3.27+1	9.46-1	2.20+0	4.06+1	9.50-1				
1.00+0	5.31+0	9.66-1	1.10+0	7.31+0	1.00+0	1.20+0	8.34+0	8.90-1	152
1.30+0	1.02+1	8.70-1	1.40+0	1.25+1	8.72-1	1.50+0	1.53+1	8.90-1	
1.60+0	1.78+1	8.81-1	1.70+0	1.97+1	8.38-1	1.80+0	2.35+1	8.67-1	
1.90+0	2.66+1	8.66-1	2.00+0	2.77+1	8.01-1	2.10+0	3.24+1	8.38-1	
2.20+0	3.64+1	8.52-1	2.30+0	4.01+1	8.53-1	2.40+0	4.13+1	8.03-1	
2.50+0	4.31+1	7.72-1	2.60+0	4.68+1	7.75-1	2.70+0	4.95+1	7.61-1	
2.80+0	5.44+1	7.80-1	2.90+0	5.98+1	8.03-1	3.00+0	6.20+1	7.83-1	
31	Gallium		Fluorescence yield = 0.507						
5.00-1	3.00-1	7.79-1	6.00-1	6.00-1	7.93-1	7.00-1	1.10+0	8.46-1	53
8.00-1	1.80+0	8.81-1	9.00-1	2.70+0	9.01-1	1.00+0	4.10+0	9.84-1	
1.10+0	5.30+0	9.53-1	1.20+0	7.60+0	1.06+0	1.30+0	8.90+0	9.85-1	
1.40+0	1.11+1	1.00+0	1.50+0	1.36+1	1.02+0	1.60+0	1.61+1	1.02+0	
1.70+0	1.88+1	1.02+0	1.80+0	2.19+1	1.03+0	1.90+0	2.48+1	1.02+0	
2.00+0	2.83+1	1.03+0							

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
1.00+0	4.00+0	9.60-1	1.20+0	6.40+0	8.90-1	1.40+0	9.20+0	8.29-1	86
1.60+0	1.28+1	8.08-1	1.80+0	1.74+1	8.18-1	2.00+0	2.29+1	8.34-1	
2.20+0	2.89+1	8.45-1	2.40+0	3.47+1	8.40-1	2.60+0	3.94+1	8.05-1	
2.80+0	4.21+1	7.41-1	3.00+0	4.21+1	6.50-1				
1.40+0	1.03+1	9.28-1	1.50+0	1.22+1	9.12-1	1.60+0	1.50+1	9.46-1	122
1.70+0	1.74+1	9.43-1	1.80+0	2.01+1	9.45-1	1.90+0	2.25+1	9.25-1	
2.00+0	2.48+1	9.03-1							
32	Germanium		Fluorescence yield = 0.535						
1.00+0	2.80+0	8.92-1	1.50+0	1.00+1	9.68-1	2.00+0	2.10+1	9.72-1	38
2.50+0	3.50+1	9.71-1	3.00+0	5.40+1	1.03+0	3.50+0	7.00+1	1.00+0	
4.00+0	9.70+1	1.10+0	4.50+0	1.05+2	9.92-1	5.00+0	1.20+2	9.74-1	
5.50+0	1.50+2	1.07+0	6.00+0	1.60+2	1.03+0				
1.00+0	2.30+0	7.33-1	2.25+0	2.20+1	7.72-1	3.00+0	4.00+1	7.61-1	47
5.00-1	3.00-1	1.08+0	6.00-1	5.00-1	9.04-1	7.00-1	9.00-1	9.36-1	53
8.00-1	1.40+0	9.21-1	9.00-1	2.00+0	8.92-1	1.00+0	2.80+0	8.92-1	
1.10+0	3.70+0	8.78-1	1.20+0	4.80+0	8.77-1	1.30+0	6.00+0	8.68-1	
1.40+0	7.20+0	8.43-1	1.50+0	8.70+0	8.42-1	1.60+0	1.10+1	8.95-1	
1.70+0	1.22+1	8.46-1	1.80+0	1.41+1	8.47-1	1.90+0	1.60+1	8.41-1	
2.00+0	1.85+1	8.56-1							
3.00+0	5.44+1	1.04+0							94
2.00-1	3.66-3	8.93-1	3.00-1	3.07-2	9.48-1	3.50-1	5.56-2	8.59-1	115
4.00-1	1.08-1	9.47-1	4.50-1	1.71-1	9.28-1	5.00-1	2.67-1	9.57-1	
6.00-1	5.45-1	9.85-1	7.00-1	9.07-1	9.43-1	8.00-1	1.43+0	9.41-1	
9.00-1	2.10+0	9.36-1	1.00+0	2.94+0	9.37-1	1.10+0	3.97+0	9.42-1	
1.20+0	5.17+0	9.45-1	1.30+0	6.37+0	9.21-1	1.40+0	8.10+0	9.49-1	
1.50+0	1.02+1	9.88-1	1.60+0	1.18+1	9.60-1	1.70+0	1.38+1	9.58-1	
1.80+0	1.59+1	9.55-1	1.90+0	1.83+1	9.61-1	2.00+0	2.06+1	9.53-1	
3.30-1	8.30-2	1.66+0	3.70-1	1.20-1	1.46+0	4.20-1	1.70-1	1.22+0	135
4.60-1	2.10-1	1.04+0	5.20-1	3.40-1	1.05+0	5.60-1	4.30-1	1.00+0	
6.00-1	5.30-1	9.58-1	6.50-1	6.40-1	8.66-1	7.10-1	9.10-1	9.01-1	
7.50-1	1.10+0	9.02-1	7.90-1	1.30+0	8.92-1	9.10-1	1.80+0	7.75-1	
1.01+0	2.30+0	7.10-1	1.11+0	3.40+0	7.85-1	1.21+0	4.60+0	8.20-1	
1.31+0	5.40+0	7.64-1	1.41+0	7.50+0	8.61-1	1.51+0	8.60+0	8.18-1	
1.61+0	1.10+1	8.80-1	1.71+0	1.20+1	8.20-1	1.81+0	1.40+1	8.29-1	
33	Arsenic		Fluorescence yield = 0.562						
4.70-1	1.00-1	6.32-1	5.70-1	3.00-1	8.95-1	6.80-1	5.00-1	7.79-1	53
7.80-1	9.00-1	8.66-1	8.90-1	1.40+0	8.63-1	9.90-1	2.10+0	9.15-1	
1.10+0	2.80+0	8.74-1	1.20+0	3.80+0	9.09-1	1.30+0	4.80+0	9.05-1	
1.40+0	6.00+0	9.12-1	1.50+0	7.40+0	9.26-1	1.60+0	8.80+0	9.22-1	
1.70+0	1.04+1	9.26-1	1.80+0	1.22+1	9.35-1	1.90+0	1.41+1	9.42-1	
2.00+0	1.59+1	9.36-1							
34	Selenium		Fluorescence yield = 0.589						

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
1.00+0	2.00+0	1.11+0	2.00+0	1.50+1	1.11+0				39
4.00-1	7.16-2	1.22+0	6.00-1	2.91-1	9.70-1	8.00-1	8.49-1	9.97-1	61
1.00+0	1.86+0	1.03+0	1.20+0	2.81+0	8.77-1	1.40+0	4.41+0	8.68-1	
1.60+0	6.54+0	8.80-1	1.80+0	8.57+0	8.37-1	2.00+0	1.15+1	8.54-1	
3.00+0	3.42+1	9.92-1							94
1.00+1	2.26+2	1.17+0	1.20+1	2.74+2	1.24+0	1.40+1	2.80+2	1.16+0	
1.60+1	2.98+2	1.17+0	1.80+1	3.22+2	1.22+0	2.00+1	3.28+2	1.21+0	
2.20+1	3.10+2	1.12+0							
6.00-1	3.19-1	1.06+0	8.00-1	8.28-1	9.72-1	1.00+0	1.79+0	9.93-1	113
1.20+0	3.18+0	9.92-1	1.40+0	4.89+0	9.62-1	1.60+0	7.21+0	9.70-1	
1.80+0	1.04+1	1.02+0	2.00+0	1.34+1	9.95-1	2.20+0	1.62+1	9.52-1	
2.40+0	1.90+1	9.04-1							
7.00+0	1.50+2	1.10+0							114
2.00-1	2.08-3	1.19+0	2.50-1	6.20-3	9.97-1	3.00-1	1.44-2	9.16-1	115
3.50-1	3.59-2	1.11+0	4.00-1	5.86-2	1.00+0	4.50-1	9.12-2	9.48-1	
5.00-1	1.52-1	1.03+0	6.00-1	3.06-1	1.02+0	7.00-1	5.46-1	1.03+0	
8.00-1	8.70-1	1.02+0	9.00-1	1.28+0	1.01+0	1.00+0	1.79+0	9.93-1	
1.10+0	2.39+0	9.78-1	1.20+0	3.15+0	9.83-1	1.30+0	4.02+0	9.84-1	
1.40+0	5.05+0	9.94-1	1.50+0	5.88+0	9.48-1	1.60+0	7.39+0	9.94-1	
1.70+0	8.46+0	9.63-1	1.80+0	9.83+0	9.60-1	1.90+0	1.13+1	9.57-1	
2.00+0	1.28+1	9.51-1							
7.00+0	1.54+2	1.13+0							125
35 Bromine			Fluorescence yield = 0.615						
6.00-1	3.34-1	1.50+0	8.00-1	7.93-1	1.24+0	1.00+0	1.56+0	1.14+0	61
1.20+0	2.71+0	1.10+0	1.40+0	4.47+0	1.13+0	1.60+0	6.03+0	1.04+0	
1.80+0	8.31+0	1.03+0	2.00+0	1.04+1	9.75-1				
1.50+0	4.00+0	8.29-1	2.00+0	9.95+0	9.33-1	2.25+0	1.29+1	9.00-1	143
2.50+0	1.74+1	9.37-1	2.75+0	2.18+1	9.45-1	3.00+0	2.95+1	1.05+0	
36 Krypton			Fluorescence yield = 0.643						
1.50+0	5.90+0	1.56+0	2.00+0	1.30+1	1.54+0	2.50+0	2.10+1	1.41+0	40
3.00+0	4.30+1	1.89+0	3.50+0	4.70+1	1.48+0	4.00+0	6.20+1	1.50+0	
4.50+0	7.70+1	1.50+0							
1.50+0	6.23+0	1.65+0	2.00+0	1.32+1	1.56+0	2.50+0	2.25+1	1.51+0	48
3.00+0	3.66+1	1.61+0	3.50+0	4.74+1	1.49+0	4.00+0	6.38+1	1.55+0	
4.50+0	7.92+1	1.55+0	5.00+0	1.02+2	1.67+0				
3.00+0	3.15+1	1.38+0							65
5.00-1	7.10-2	8.88-1	8.16-1	5.20-1	9.97-1	9.15-1	7.00-1	8.99-1	68
1.00+0	1.00+0	9.50-1	1.29+0	2.20+0	9.20-1	1.63+0	4.30+0	8.95-1	
2.00+0	6.80+0	8.03-1							

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
37 Rubidium			Fluorescence yield = 0.667						
1.00+0	5.80-1	7.19-1	2.25+0	7.50+0	8.17-1	3.00+0	1.50+1	8.12-1	47
4.00-1	2.77-2	1.25+0	6.00-1	1.24-1	9.99-1	8.00-1	4.08-1	1.11+0	61
1.00+0	9.27-1	1.15+0	1.20+0	1.32+0	8.95-1	1.40+0	2.37+0	9.90-1	
1.60+0	3.62+0	1.01+0	1.80+0	4.47+0	8.91-1	2.00+0	5.43+0	8.08-1	
1.00+0	8.00-1	9.92-1	1.50+0	2.90+0	9.83-1	2.00+0	6.90+0	1.03+0	72
2.50+0	1.10+1	9.20-1	3.00+0	2.00+1	1.08+0				
2.20+1	2.21+2	1.05+0	3.10+1	2.08+2	9.49-1	4.40+1	2.09+2	9.90-1	104
3.50-1	5.75-3	4.86-1	4.00-1	1.15-2	5.18-1	4.50-1	2.32-2	6.16-1	111
5.00-1	3.51-2	5.94-1	6.00-1	8.00-2	6.44-1	7.00-1	1.70-1	7.55-1	
1.50+0	2.67+0	9.05-1	2.10+0	7.41+0	9.68-1	2.60+0	1.23+1	9.35-1	148
3.10+0	1.89+1	9.50-1	3.60+0	2.45+1	8.90-1				
38 Strontium			Fluorescence yield = 0.69						
6.00-1	7.97-2	8.56-1	8.00-1	3.64-1	1.30+0	1.00+0	7.02-1	1.13+0	61
1.20+0	1.18+0	1.03+0	1.40+0	1.81+0	9.68-1	1.60+0	2.69+0	9.58-1	
1.80+0	3.94+0	9.94-1	2.00+0	5.28+0	9.90-1				
3.00+0	1.23+1	8.18-1							94
4.00-1	9.88-3	6.11-1	4.50-1	2.21-2	7.99-1	5.00-1	3.42-2	7.81-1	111
6.00-1	7.39-2	7.93-1	7.00-1	1.44-1	8.45-1	8.00-1	2.06-1	7.33-1	
9.00-1	3.32-1	7.73-1	1.00+0	5.19-1	8.36-1	1.10+0	7.26-1	8.47-1	
1.20+0	1.03+0	9.01-1	1.40+0	1.52+0	8.13-1	1.50+0	1.81+0	7.83-1	
39 Yttrium			Fluorescence yield = 0.71						
2.50+0	7.44+0	9.62-1	3.00+0	1.25+1	1.03+0	4.00+0	2.54+1	1.10+0	52
4.50+0	3.20+1	1.09+0	5.00+0	3.56+1	9.92-1	6.00+0	5.22+1	1.06+0	
6.50+0	6.09+1	1.09+0	7.00+0	5.84+1	9.36-1	8.00+0	7.27+1	9.67-1	
8.50+0	9.60+1	1.18+0	9.00+0	9.50+1	1.09+0	1.00+1	1.10+2	1.12+0	
1.05+1	1.02+2	9.84-1	1.10+1	1.11+2	1.02+0	1.20+1	1.03+2	8.73-1	
3.00+0	9.30+0	7.66-1	5.00+0	2.80+1	7.81-1				59
6.00-1	7.20-2	1.03+0	8.00-1	2.20-1	1.03+0	1.00+0	4.80-1	1.01+0	61
1.20+0	8.81-1	9.93-1	1.40+0	1.43+0	9.80-1	1.60+0	2.11+0	9.56-1	
1.80+0	3.09+0	9.87-1	2.00+0	3.94+0	9.30-1				
1.00+0	4.10-1	8.59-1	1.20+0	7.70-1	8.68-1	1.40+0	1.30+0	8.91-1	86
1.60+0	1.90+0	8.61-1	1.80+0	2.80+0	8.95-1	2.00+0	3.70+0	8.74-1	
2.20+0	4.70+0	8.53-1	2.40+0	5.80+0	8.34-1	2.60+0	7.00+0	8.18-1	
2.80+0	8.10+0	7.89-1	3.00+0	9.20+0	7.58-1				

TABLE 2. K-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
5.00-1	3.60-2	1.11+0	7.50-1	1.80-1	1.07+0	1.00+0	5.50-1	1.15+0	95
1.25+0	1.20+0	1.18+0	1.50+0	2.20+0	1.22+0	2.00+0	5.20+0	1.23+0	
2.50+0	9.20+0	1.19+0							
4.00+0	2.13+1	9.20-1	6.00+0	5.69+1	1.16+0	8.00+0	8.53+1	1.13+0	105
1.00+1	1.14+2	1.16+0	1.20+1	1.49+2	1.26+0	1.40+1	1.56+2	1.16+0	
1.60+1	1.85+2	1.26+0	1.80+1	1.92+2	1.22+0	2.00+1	2.13+2	1.29+0	
2.20+1	2.06+2	1.20+0							
40	Zirconium		Fluorescence yield = 0.73						
2.30-1	1.20-4	**3.33-1**	3.25-1	1.00-3	**3.39-1**	4.20-1	4.00-3	**3.68-1**	7
4.54-1	8.75-3	5.59-1	5.10-1	1.20-2	**4.55-1**				
1.60+2	1.35+2	1.39+0							30
1.00+0	3.10-1	8.38-1	2.25+0	3.60+0	7.66-1	3.00+0	7.50+0	7.59-1	47
4.00-1	3.51-3	**4.09-1**	4.50-1	5.69-3	**3.79-1**	5.00-1	1.75-2	7.23-1	111
7.00-1	6.28-2	6.40-1	9.00-1	2.10-1	8.28-1	1.00+0	3.24-1	8.76-1	
1.10+0	4.56-1	8.85-1	1.20+0	5.88-1	8.50-1	1.30+0	7.74-1	8.59-1	
1.40+0	9.49-1	8.28-1	1.50+0	1.28+0	8.98-1				
1.00+0	3.77-1	1.02+0	2.00+0	3.34+0	9.89-1				113
7.00+0	6.00+1	1.13+0							114
2.75-1	5.69-4	5.03-1	3.00-1	1.15-3	6.09-1	3.50-1	2.91-3	6.65-1	118
3.80-1	4.38-3	6.57-1	4.00-1	6.34-3	7.38-1	5.00-1	1.88-2	7.77-1	
6.00-1	4.26-2	8.09-1	7.00-1	8.03-2	8.19-1	8.00-1	1.35-1	8.24-1	
7.00+0	6.35+1	1.19+0							125
1.50+0	1.15+0	8.07-1	2.10+0	3.20+0	8.25-1	2.60+0	5.39+0	7.80-1	148
3.10+0	8.67+0	8.11-1	3.60+0	1.14+1	7.52-1				
41	Niobium		Fluorescence yield = 0.74						
9.00-1	8.60-1	**4.40+0**	1.10+0	1.60+0	**3.99+0**	1.30+0	3.10+0	**4.39+0**	44
1.50+0	5.20+0	**4.63+0**	1.70+0	1.10+1	**6.63+0**	1.90+0	1.30+1	**5.61+0**	
2.10+0	1.50+1	**4.84+0**	2.30+0	1.70+1	**4.25+0**	2.50+0	2.50+1	**4.98+0**	
1.13+0	3.60-1	8.18-1	1.34+0	6.50-1	8.32-1	1.55+0	1.00+0	8.03-1	87
1.76+0	1.60+0	8.67-1	1.97+0	2.10+0	8.15-1	2.18+0	3.00+0	8.71-1	
2.39+0	3.60+0	8.10-1	2.60+0	4.50+0	8.07-1	2.70+0	4.80+0	7.80-1	
3.00+0	6.80+0	8.45-1							94
2.00-1	7.07-5	8.49-1	2.40-1	3.15-4	9.75-1	2.80-1	9.61-4	1.10+0	126
3.20-1	2.14-3	1.11+0	3.60-1	4.28-3	1.17+0	4.00-1	7.65-3	1.22+0	
4.50-1	1.39-2	1.25+0	5.00-1	2.32-2	1.28+0				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
1.50+0	9.38-1	8.35-1	2.10+0	2.59+0	8.36-1	2.60+0	4.50+0	8.07-1	148
3.10+0	7.18+0	8.25-1	3.60+0	1.04+1	8.35-1				
42	Molybdenum		Fluorescence yield = 0.765						
2.40+0	8.00+0	**2.20+0**							1
2.50-1	1.90-4	6.55-1	3.00-1	5.50-4	5.86-1	3.50-1	1.60-3	7.01-1	3
4.00-1	3.30-3	7.14-1	7.00-1	6.50-2	1.13+0	1.00+0	2.30-1	1.03+0	
1.22+0	4.40-1	9.92-1	1.61+0	1.20+0	1.08+0				
2.40-1	5.50-4	**2.53+0**	2.60-1	8.20-4	**2.16+0**	2.80-1	1.20-3	**1.95+0**	6
3.00-1	1.80-3	**1.92+0**	3.20-1	2.50-3	1.82+0	3.40-1	3.60-3	1.85+0	
3.60-1	4.70-3	1.77+0	3.80-1	6.30-3	1.78+0	4.00-1	8.10-3	1.75+0	
4.40-1	1.30-2	1.75+0	6.00-1	3.40-2	1.12+0	7.40-1	8.50-2	1.18+0	
9.35-1	2.10-1	1.20+0	1.03+0	2.90-1	1.17+0	1.20+0	5.30-1	1.25+0	
4.54-1	5.62-3	6.50-1							7
1.60+2	1.18+2	1.34+0							30
2.50+0	3.13+0	7.70-1	3.00+0	5.38+0	8.18-1	4.00+0	1.00+1	7.66-1	52
4.50+0	1.31+1	7.76-1	5.00+0	1.71+1	8.15-1	6.00+0	2.36+1	7.96-1	
6.50+0	2.17+1	6.38-1	7.00+0	2.21+1	5.74-1	8.00+0	3.80+1	8.01-1	
8.50+0	4.12+1	7.94-1	9.00+0	3.73+1	6.65-1	1.00+1	5.34+1	8.29-1	
1.05+1	4.67+1	6.84-1	1.10+1	6.35+1	8.79-1	1.20+1	7.11+1	8.95-1	
4.00-1	4.72-3	1.02+0	6.00-1	2.94-2	9.68-1	8.00-1	9.68-2	9.95-1	61
1.00+0	2.18-1	9.74-1	1.20+0	4.02-1	9.46-1	1.40+0	6.79-1	9.52-1	
1.60+0	1.13+0	1.03+0	1.80+0	1.48+0	9.39-1	2.00+0	2.05+0	9.49-1	
1.00+0	2.35-1	1.05+0	1.20+0	4.21-1	9.90-1	1.40+0	6.95-1	9.75-1	77
1.50+0	8.71-1	9.77-1	1.60+0	1.10+0	1.00+0	1.80+0	1.58+0	1.00+0	
2.00+0	2.20+0	1.02+0	2.20+0	2.92+0	1.03+0	2.40+0	3.68+0	1.01+0	
2.50+0	4.06+0	9.98-1	2.60+0	4.42+0	9.78-1	2.80+0	5.07+0	9.21-1	
3.00+0	5.52+0	8.40-1							
5.00-1	1.40-2	1.03+0	7.50-1	7.50-2	9.91-1	1.00+0	2.30-1	1.03+0	95
1.25+0	5.20-1	1.06+0	1.50+0	9.90-1	1.11+0	2.00+0	2.40+0	1.11+0	
2.50+0	4.50+0	1.11+0							
7.00+0	3.64+1	9.45-1							125
3.90-1	4.10-3	1.01+0	4.30-1	6.80-3	1.02+0	4.80-1	1.10-2	9.78-1	135
5.50-1	1.90-2	9.12-1	6.00-1	2.90-2	9.55-1	6.60-1	3.70-2	8.19-1	
7.10-1	5.00-2	8.21-1	7.70-1	6.90-2	8.23-1	8.00-1	9.90-2	1.02+0	
8.50-1	1.10-1	8.95-1	9.00-1	1.40-1	9.20-1	1.01+0	2.20-1	9.48-1	
1.11+0	3.10-1	9.55-1	1.21+0	4.30-1	9.83-1	1.31+0	5.40-1	9.45-1	
1.41+0	6.80-1	9.32-1	1.51+0	7.70-1	8.46-1	1.61+0	1.10+0	9.85-1	
1.71+0	1.20+0	8.90-1	1.81+0	1.50+0	9.36-1				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	Ref.
5.00-1	1.31-2	9.65-1	6.00-1	3.17-2	1.04+0	7.00-1	6.01-2	1.05+0	144
8.00-1	1.04-1	1.07+0	9.00-1	1.56-1	1.03+0	1.00+0	2.39-1	1.07+0	
1.20+0	4.54-1	1.07+0	1.40+0	7.52-1	1.05+0	1.60+0	1.16+0	1.06+0	
1.80+0	1.64+0	1.04+0	2.00+0	2.24+0	1.04+0	2.20+0	2.98+0	1.05+0	
2.40+0	3.73+0	1.03+0	2.60+0	4.63+0	1.02+0	2.80+0	5.62+0	1.02+0	
3.00+0	6.66+0	1.01+0	3.20+0	7.80+0	1.01+0	3.50+0	9.64+0	1.01+0	
4.00+0	1.32+1	1.01+0	4.50+0	1.68+1	9.95-1	5.00+0	2.16+1	1.03+0	
5.50+0	2.52+1	9.98-1	6.00+0	3.01+1	1.02+0				
1.50+0	7.09-1	7.95-1	2.10+0	1.97+0	7.91-1	2.60+0	3.40+0	7.52-1	148
3.10+0	5.55+0	7.77-1							
44 Ruthenium			Fluorescence yield = 0.794						
7.00+0	2.63+1	9.43-1							125
45 Rhodium			Fluorescence yield = 0.808						
1.60+2	1.16+2	1.54+0							30
1.03+0	1.00-1	8.29-1	1.24+0	2.10-1	8.92-1	1.45+0	3.40-1	8.46-1	87
1.66+0	5.20-1	8.29-1	1.87+0	7.70-1	8.42-1	2.07+0	1.10+0	8.81-1	
2.29+0	1.50+0	8.89-1	2.50+0	1.90+0	8.75-1	2.70+0	2.20+0	8.16-1	
46 Palladium			Fluorescence yield = 0.82						
6.00-1	8.12-3	7.76-1	8.00-1	3.28-2	9.17-1	1.00+0	7.14-2	8.35-1	61
1.20+0	1.52-1	9.11-1	1.40+0	2.49-1	8.71-1	1.60+0	3.86-1	8.64-1	
1.80+0	5.41-1	8.27-1	2.00+0	7.55-1	8.29-1				
2.15-1	8.50-6	5.19-1	2.30-1	1.90-5	6.33-1	2.45-1	4.20-5	8.22-1	120
2.60-1	6.50-5	7.93-1	2.75-1	9.70-5	7.74-1	3.00-1	1.70-4	7.30-1	
5.00-1	4.12-3	9.32-1	6.00-1	1.07-2	1.02+0	7.00-1	2.12-2	1.03+0	144
8.00-1	3.85-2	1.08+0	9.00-1	6.10-2	1.07+0	1.00+0	9.27-2	1.08+0	
1.20+0	1.84-1	1.10+0	1.40+0	3.14-1	1.10+0	1.60+0	4.86-1	1.09+0	
1.80+0	7.06-1	1.08+0	2.00+0	9.76-1	1.07+0	2.20+0	1.31+0	1.08+0	
2.40+0	1.69+0	1.07+0	2.60+0	2.10+0	1.06+0	2.80+0	2.53+0	1.04+0	
3.00+0	3.09+0	1.05+0	3.20+0	3.55+0	1.01+0	3.50+0	4.53+0	1.02+0	
4.00+0	6.37+0	1.04+0	4.50+0	8.36+0	1.03+0	5.00+0	1.06+1	1.03+0	
5.50+0	1.30+1	1.03+0	6.00+0	1.53+1	1.01+0				
1.50+0	2.99-1	8.28-1	2.10+0	8.58-1	8.12-1	2.60+0	1.70+0	8.58-1	148
3.10+0	2.43+0	7.55-1	3.60+0	4.11+0	8.65-1	3.70+0	4.46+0	8.77-1	
3.80+0	4.51+0	8.30-1							
47 Silver			Fluorescence yield = 0.831						
1.70+0	5.30-1	1.21+0	1.92+0	1.00+0	1.54+0	2.17+0	1.60+0	1.69+0	1
2.40+0	2.30+0	1.79+0	2.64+0	3.30+0	**1.95+0**	2.88+0	6.30+0	**2.91+0**	
6.00-1	3.20-3	**3.97-1**	7.00-1	7.83-3	4.89-1	8.00-1	1.35-2	4.81-1	4
9.00-1	2.58-2	5.72-1	1.00+0	3.58-2	5.29-1				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\frac{\sigma^{\mathrm{Exper}}}{\sigma^{\mathrm{ECPSSR}}}$	E_1 (MeV)	σ^{Exper} (barn)	$\frac{\sigma^{\mathrm{Exper}}}{\sigma^{\mathrm{ECPSSR}}}$	E_1 (MeV)	σ^{Exper} (barn)	$\frac{\sigma^{\mathrm{Exper}}}{\sigma^{\mathrm{ECPSSR}}}$	Ref.
1.80+0	4.40-1	8.32-1	2.00+0	4.90-1	6.64-1	2.10+0	5.70-1	6.64-1	5
2.10+0	7.50-1	8.74-1	2.30+0	8.50-1	7.52-1	2.40+0	9.20-1	7.17-1	
2.40+0	1.00+0	7.79-1	2.60+0	1.20+0	7.41-1	2.70+0	1.40+0	7.76-1	
2.80+0	1.60+0	8.00-1	2.90+0	2.10+0	9.52-1	3.20+0	2.70+0	9.36-1	
3.40+0	3.00+0	8.86-1	3.60+0	3.40+0	8.65-1				
2.60-1	1.30-4	**2.34+0**	2.80-1	2.00-4	**2.03+0**	3.00-1	3.30-4	**2.02+0**	6
3.20-1	4.90-4	**1.92+0**	3.40-1	7.40-4	**1.96+0**	3.60-1	1.10-3	**2.03+0**	
3.80-1	1.50-3	**2.00+0**	4.00-1	2.10-3	**2.07+0**	6.00-1	1.10-2	1.36+0	
7.40-1	2.40-2	1.18+0	9.35-1	6.60-2	1.26+0	1.04+0	9.90-2	1.26+0	
1.20+0	1.70-1	1.28+0							
1.60+2	1.09+2	1.61+0							30
2.00+0	8.10-1	1.10+0	3.00+0	2.60+0	1.07+0	4.00+0	6.10+0	1.19+0	32
5.00+0	1.00+1	1.16+0	6.00+0	1.40+1	1.10+0	7.00+0	1.90+1	1.10+0	
8.00+0	2.40+1	1.10+0	9.00+0	2.90+1	1.09+0	1.00+1	3.60+1	1.15+0	
1.10+1	3.90+1	1.08+0	1.20+1	4.40+1	1.09+0	1.30+1	5.00+1	1.12+0	
1.40+1	5.70+1	1.17+0	1.50+1	5.90+1	1.12+0	1.70+1	7.40+1	1.24+0	
1.80+1	8.20+1	1.30+0	1.90+1	7.90+1	1.20+0	2.00+1	7.90+1	1.15+0	
2.10+1	8.60+1	1.21+0	2.20+1	9.80+1	1.33+0	2.30+1	9.80+1	1.29+0	
2.40+1	8.40+1	1.08+0	2.50+1	8.50+1	1.06+0	2.60+1	9.50+1	1.16+0	
2.70+1	9.60+1	1.15+0	2.80+1	9.50+1	1.12+0	3.00+1	9.20+1	1.05+0	
1.50+0	3.50-1	1.21+0	2.00+0	1.10+0	1.49+0	2.50+0	1.70+0	1.18+0	38
3.00+0	3.10+0	1.28+0	3.50+0	4.30+0	1.18+0	4.00+0	5.50+0	1.08+0	
4.50+0	7.80+0	1.15+0	5.00+0	9.50+0	1.10+0	5.50+0	1.10+1	1.03+0	
1.00+0	8.00-2	1.18+0	2.00+0	8.10-1	1.10+0				39
1.00+0	6.50-2	9.60-1	2.25+0	1.00+0	9.45-1	3.00+0	2.30+0	9.50-1	47
2.50+0	1.07+0	7.40-1	3.00+0	1.88+0	7.76-1	4.00+0	4.18+0	8.17-1	52
4.50+0	5.49+0	8.10-1	5.00+0	6.81+0	7.90-1	6.00+0	8.88+0	6.97-1	
6.50+0	1.25+1	8.36-1	7.00+0	1.41+1	8.18-1	8.00+0	1.88+1	8.58-1	
8.50+0	2.05+1	8.46-1	9.00+0	2.14+1	8.04-1	1.00+1	2.60+1	8.30-1	
1.05+1	2.45+1	7.28-1	1.10+1	3.09+1	8.57-1	1.20+1	3.69+1	9.13-1	
1.50+0	2.85-1	9.83-1	2.00+0	7.52-1	1.02+0	2.50+0	1.44+0	9.96-1	55
2.98+0	2.19+0	9.21-1	3.00+0	2.42+0	9.99-1	4.97+0	7.68+0	9.03-1	
5.96+0	1.12+1	8.92-1	6.94+0	1.54+1	9.08-1	6.96+0	1.48+1	8.68-1	
8.94+0	2.36+1	8.97-1	1.09+1	3.22+1	9.02-1				
6.00-1	6.70-3	8.31-1	8.00-1	2.70-2	9.63-1	1.00+0	6.40-2	9.45-1	63
1.20+0	1.30-1	9.77-1	1.40+0	2.20-1	9.60-1	1.60+0	3.40-1	9.45-1	
1.80+0	4.70-1	8.89-1	2.00+0	6.70-1	9.08-1				
1.00+0	7.06-2	1.04+0	1.10+0	9.88-2	1.02+0	1.20+0	1.34-1	1.01+0	77
1.30+0	1.78-1	1.01+0	1.40+0	2.32-1	1.01+0	1.50+0	2.96-1	1.02+0	
1.60+0	3.70-1	1.03+0	1.70+0	4.57-1	1.04+0	1.80+0	5.54-1	1.05+0	
1.90+0	6.63-1	1.06+0	2.00+0	7.82-1	1.06+0	2.10+0	9.13-1	1.06+0	
2.20+0	1.05+0	1.06+0	2.30+0	1.20+0	1.06+0	2.40+0	1.34+0	1.04+0	
2.50+0	1.49+0	1.03+0	2.60+0	1.63+0	1.01+0	2.70+0	1.77+0	9.81-1	
2.80+0	1.89+0	9.45-1	2.90+0	2.00+0	9.07-1	3.00+0	2.10+0	8.67-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
4.00-1	9.00-4	8.88-1	6.00-1	9.40-3	1.17+0	8.00-1	3.30-2	1.18+0	87
1.00+0	7.90-2	1.17+0	1.20+0	1.40-1	1.05+0	1.40+0	2.30-1	1.00+0	
1.60+0	3.60-1	1.00+0	1.80+0	5.20-1	9.84-1	2.00+0	7.50-1	1.02+0	
2.20+0	9.90-1	1.00+0	2.40+0	1.30+0	1.01+0				
3.00+0	1.93+0	7.97-1							94
5.00-1	2.80-3	8.34-1	7.50-1	1.80-2	8.38-1	1.00+0	6.30-2	9.30-1	95
1.25+0	1.50-1	9.74-1	1.50+0	3.00-1	1.03+0	2.00+0	7.90-1	1.07+0	
2.50+0	1.70+0	1.18+0							
2.49-1	1.76-5	4.53-1	3.00-1	9.84-5	6.02-1	3.53-1	4.09-4	8.53-1	99
4.03-1	9.34-4	8.83-1	4.84-1	2.37-3	8.33-1	5.52-1	4.51-3	8.27-1	
6.35-1	8.93-3	8.56-1	7.20-1	1.54-2	8.52-1	8.10-1	2.58-2	8.74-1	
9.00-1	4.02-2	8.92-1	1.10+0	8.60-2	8.88-1	1.52+0	2.64-1	8.70-1	
1.72+0	4.15-1	9.09-1	1.91+0	5.80-1	9.08-1				
4.00+0	5.00+0	9.77-1	7.50+0	1.69+1	8.64-1	8.00+0	1.83+1	8.35-1	100
9.00+0	2.24+1	8.42-1	1.00+1	2.62+1	8.36-1	1.10+1	3.24+1	8.99-1	
1.20+1	3.58+1	8.86-1	1.30+1	3.93+1	8.79-1	1.40+1	4.29+1	8.79-1	
1.50+1	4.87+1	9.26-1							
4.00-1	3.22-4	**3.18-1**	5.00-1	1.62-3	4.82-1	6.00-1	4.64-3	5.75-1	103
7.00-1	9.58-3	5.98-1	8.00-1	1.93-2	6.88-1				
2.20+1	7.22+1	9.80-1	3.10+1	8.20+1	9.25-1	4.40+1	8.34+1	8.64-1	104
3.50-1	3.30-4	7.26-1	4.00-1	8.17-4	8.06-1	5.00-1	3.00-3	8.93-1	113
6.00-1	7.50-3	9.30-1	8.00-1	2.77-2	9.88-1	1.00+0	7.08-2	1.05+0	
1.20+0	1.38-1	1.04+0	1.40+0	2.40-1	1.05+0	1.60+0	3.70-1	1.03+0	
1.80+0	5.23-1	9.89-1	2.00+0	7.52-1	1.02+0	2.20+0	1.00+0	1.01+0	
3.50-1	1.45-4	**3.19-1**	3.75-1	2.53-4	**3.65-1**	4.00-1	4.42-4	**4.36-1**	118
4.50-1	9.89-4	5.09-1	5.00-1	1.87-3	5.57-1	6.00-1	5.10-3	6.32-1	
7.00-1	1.06-2	6.62-1	8.00-1	1.93-2	6.88-1				
2.00-1	2.80-6	5.60-1	2.15-1	5.50-6	5.31-1	2.30-1	1.00-5	5.13-1	120
2.45-1	1.90-5	5.60-1	2.60-1	3.50-5	6.31-1	2.75-1	5.90-5	6.86-1	
3.00-1	1.40-4	8.57-1							
2.50-1	1.89-5	4.70-1	3.00-1	1.05-4	6.43-1	3.50-1	3.26-4	7.17-1	121
4.00-1	7.01-4	6.92-1	5.00-1	2.46-3	7.33-1	6.00-1	6.62-3	8.21-1	
7.00-1	1.36-2	8.49-1	8.00-1	2.40-2	8.56-1	9.00-1	4.05-2	8.98-1	
1.00+0	6.18-2	9.13-1							
7.00+0	1.70+1	9.86-1							125
2.50-1	1.96-5	4.87-1	3.00-1	1.16-4	7.10-1	3.50-1	3.75-4	8.25-1	126
4.00-1	1.00-3	9.87-1	4.50-1	2.10-3	1.08+0	5.00-1	3.64-3	1.08+0	
5.50-1	6.08-3	1.13+0	6.00-1	9.57-3	1.19+0				
7.07-1	1.70-2	1.02+0	1.00+0	7.30-2	1.08+0	1.41+0	2.40-1	1.01+0	130
2.00+0	7.50-1	1.02+0	2.50+0	1.50+0	1.04+0				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
4.20-1	1.60-3	1.20+0	4.60-1	2.80-3	1.28+0	5.10-1	4.30-3	1.16+0	135
5.50-1	6.50-3	1.21+0	6.00-1	9.10-3	1.13+0	6.40-1	1.20-2	1.11+0	
6.90-1	1.70-2	1.13+0	7.40-1	2.20-2	1.08+0	8.20-1	3.20-2	1.03+0	
8.80-1	4.40-2	1.07+0	1.01+0	7.60-2	1.08+0	1.11+0	1.20-1	1.20+0	
1.21+0	1.50-1	1.09+0	1.31+0	1.90-1	1.05+0	1.41+0	2.60-1	1.11+0	
1.51+0	3.20-1	1.08+0	1.61+0	4.00-1	1.09+0	1.71+0	4.60-1	1.03+0	
1.81+0	5.90-1	1.10+0							
1.50+0	2.62-1	9.04-1	2.10+0	6.68-1	7.78-1	2.60+0	1.21+0	7.47-1	148
3.10+0	1.95+0	7.36-1	3.30+0	2.44+0	7.79-1	3.60+0	3.06+0	7.79-1	
3.80+0	3.57+0	7.92-1							
1.60+0	3.66-1	1.02+0	1.80+0	5.72-1	1.08+0	2.00+0	7.15-1	9.69-1	151
2.20+0	1.07+0	1.08+0	2.40+0	1.32+0	1.03+0				
48 Cadmium			Fluorescence yield = 0.843						
2.50+0	9.07-1	7.65-1	3.00+0	1.65+0	8.26-1	4.00+0	3.86+0	9.05-1	52
4.50+0	4.31+0	7.61-1	5.00+0	5.44+0	7.49-1	6.00+0	8.70+0	8.06-1	
6.50+0	8.53+0	6.71-1	7.00+0	1.17+1	7.96-1	8.00+0	1.49+1	7.92-1	
8.50+0	1.82+1	8.71-1	9.00+0	1.77+1	7.71-1	1.00+1	2.20+1	8.08-1	
1.05+1	2.12+1	7.25-1	1.10+1	2.70+1	8.62-1	1.20+1	2.99+1	8.46-1	
6.00-1	4.80-3	7.68-1	8.00-1	1.80-2	8.13-1	1.00+0	4.90-2	9.09-1	63
1.20+0	1.00-1	9.38-1	1.40+0	1.70-1	9.21-1	1.60+0	2.70-1	9.27-1	
1.80+0	3.90-1	9.09-1	2.00+0	5.40-1	8.99-1				
1.00+0	4.60-2	8.53-1	1.20+0	9.00-2	8.44-1	1.40+0	1.60-1	8.67-1	86
1.60+0	2.50-1	8.58-1	1.80+0	3.80-1	8.85-1	2.00+0	5.30-1	8.82-1	
2.20+0	7.10-1	8.79-1	2.40+0	9.00-1	8.57-1	2.60+0	1.10+0	8.27-1	
2.80+0	1.30+0	7.90-1	3.00+0	1.60+0	8.01-1				
3.00+0	1.47+0	7.36-1							94
6.00-1	2.27-3	**3.63-1**	7.00-1	6.14-3	4.90-1	8.00-1	1.57-2	7.10-1	111
9.00-1	2.52-2	7.06-1	1.00+0	3.46-2	6.42-1	1.10+0	5.46-2	7.05-1	
1.20+0	7.90-2	7.41-1	1.30+0	1.08-1	7.60-1	1.40+0	1.40-1	7.59-1	
1.50+0	1.70-1	7.27-1	1.60+0	2.25-1	7.73-1	1.70+0	2.73-1	7.67-1	
1.80+0	3.18-1	7.41-1	1.90+0	3.97-1	7.78-1	2.00+0	4.74-1	7.89-1	
2.10+0	5.25-1	7.50-1	2.20+0	6.33-1	7.84-1	2.30+0	6.62-1	7.16-1	
7.00+0	1.32+1	8.98-1							125
49 Indium			Fluorescence yield = 0.853						
3.00+0	1.51+0	9.16-1	5.00+0	5.20+0	8.53-1				59
9.00-1	3.74-2	1.32+0	1.00+0	6.12-2	1.42+0	1.10+0	9.35-2	1.51+0	80
1.20+0	1.28-1	1.50+0	1.30+0	1.70-1	1.49+0	1.40+0	2.30-1	1.55+0	
1.50+0	2.55-1	1.35+0	1.60+0	3.40-1	1.44+0	1.70+0	3.91-1	1.35+0	
1.80+0	4.08-1	1.17+0	1.90+0	5.10-1	1.23+0	2.00+0	4.34-1	8.87-1	
2.10+0	6.89-1	1.21+0	2.20+0	7.06-1	1.07+0	2.30+0	9.86-1	1.30+0	
2.40+0	1.31+0	1.52+0	2.50+0	1.49+0	1.53+0				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
1.00+0	3.60-2	8.37-1	1.20+0	7.30-2	8.53-1	1.40+0	1.30-1	8.74-1	86
1.60+0	2.00-1	8.49-1	1.80+0	3.10-1	8.89-1	2.00+0	4.30-1	8.78-1	
2.20+0	5.90-1	8.94-1	2.40+0	7.60-1	8.83-1	2.60+0	9.00-1	8.24-1	
2.80+0	1.10+0	8.12-1	3.00+0	1.30+0	7.89-1				
6.00-1	5.50-3	1.13+0	8.00-1	1.90-2	1.09+0	1.00+0	5.00-2	1.16+0	87
1.20+0	8.50-2	9.93-1	1.40+0	1.50-1	1.01+0	1.60+0	2.30-1	9.76-1	
1.80+0	3.50-1	1.00+0	2.00+0	5.00-1	1.02+0	2.20+0	6.60-1	1.00+0	
2.40+0	8.50-1	9.87-1							
3.00+0	1.12+0	6.80-1	5.00+0	3.62+0	5.94-1	7.00+0	9.20+0	7.34-1	94
9.00+0	1.62+1	8.18-1	1.10+1	2.30+1	8.45-1				
6.00-1	1.73-3	**3.57-1**	7.00-1	4.25-3	**4.32-1**	8.00-1	8.50-3	4.86-1	111
9.00-1	1.88-2	6.63-1	1.00+0	2.64-2	6.14-1	1.10+0	3.90-2	6.30-1	
1.20+0	5.70-2	6.66-1	1.30+0	7.23-2	6.32-1	1.40+0	9.27-2	6.23-1	
1.50+0	1.22-1	6.45-1	1.60+0	1.49-1	6.32-1	1.70+0	1.98-1	6.85-1	
1.80+0	2.39-1	6.86-1	1.90+0	2.53-1	6.08-1	2.00+0	3.03-1	6.19-1	
2.10+0	3.71-1	6.49-1							
3.00-1	3.36-5	4.19-1	3.50-1	1.32-4	5.49-1	4.00-1	3.47-4	6.23-1	129
5.00-1	1.46-3	7.48-1	6.00-1	3.77-3	7.78-1	7.00-1	8.26-3	8.40-1	
8.00-1	1.50-2	8.58-1	9.00-1	2.48-2	8.75-1	1.00+0	3.77-2	8.76-1	
50	Tin		Fluorescence yield = 0.862						
2.60-1	5.70-5	**3.39+0**	2.80-1	9.70-5	**3.03+0**	3.20-1	2.10-4	**2.29+0**	6
3.60-1	5.20-4	**2.47+0**	3.80-1	7.70-4	**2.58+0**	4.00-1	1.10-3	**2.66+0**	
4.40-1	2.00-3	**2.73+0**	4.50-1	2.30-3	**2.76+0**	6.00-1	5.60-3	1.49+0	
7.40-1	1.40-2	1.42+0	9.35-1	3.80-2	1.44+0	1.04+0	5.90-2	1.47+0	
1.60+2	9.41+1	1.63+0							30
1.00+0	3.20-2	9.29-1	2.25+0	5.50-1	9.48-1	3.00+0	1.30+0	9.54-1	47
1.80+0	3.13-1	1.10+0	2.20+0	5.82-1	1.08+0	2.60+0	9.19-1	1.02+0	60
3.00+0	1.32+0	9.69-1	3.20+0	1.71+0	1.05+0	3.60+0	2.25+0	9.99-1	
4.00+0	3.31+0	1.11+0	4.40+0	4.03+0	1.07+0				
6.00-1	3.20-3	8.50-1	8.00-1	8.20-3	5.92-1	1.00+0	3.20-2	9.29-1	63
1.20+0	5.80-2	8.41-1	1.40+0	1.00-1	8.30-1	1.60+0	1.60-1	8.36-1	
1.80+0	2.40-1	8.45-1	2.00+0	3.20-1	7.99-1				
2.33+0	6.10-1	9.41-1	2.67+0	9.41-1	9.70-1	3.00+0	1.38+0	1.01+0	64
3.33+0	1.76+0	9.64-1	3.67+0	2.39+0	1.01+0	4.00+0	2.96+0	9.96-1	
4.33+0	3.69+0	1.01+0	4.67+0	4.40+0	1.01+0	5.00+0	5.25+0	1.02+0	
5.33+0	6.05+0	1.01+0	5.67+0	7.03+0	1.03+0				
1.00+0	2.60-2	7.55-1	1.20+0	5.60-2	8.12-1	1.40+0	1.00-1	8.30-1	86
1.60+0	1.60-1	8.36-1	1.80+0	2.40-1	8.45-1	2.00+0	3.40-1	8.49-1	
2.20+0	4.50-1	8.31-1	2.40+0	5.80-1	8.20-1	2.60+0	7.30-1	8.12-1	
2.80+0	9.00-1	8.05-1	2.90+0	1.00+0	8.08-1	3.00+0	1.20+0	8.81-1	
3.00+0	9.40-1	6.90-1							94

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
5.00-1	1.00-3	6.71-1	7.50-1	8.00-3	7.63-1	1.00+0	2.90-2	8.42-1	95
1.25+0	7.30-2	9.12-1	1.50+0	1.50-1	9.78-1	2.00+0	4.00-1	9.99-1	
2.50+0	7.60-1	9.50-1							
8.00-1	4.50-3	**3.25-1**	9.00-1	1.00-2	**4.43-1**	1.00+0	1.67-2	4.85-1	111
1.10+0	2.31-2	4.65-1	1.20+0	3.55-2	5.15-1	1.30+0	5.11-2	5.53-1	
1.40+0	6.45-2	5.36-1	1.50+0	8.00-2	5.22-1	1.60+0	9.80-2	5.12-1	
1.70+0	1.21-1	5.15-1	1.80+0	1.60-1	5.63-1	1.90+0	1.91-1	5.63-1	
2.00+0	2.18-1	5.45-1	2.10+0	2.68-1	5.74-1				
7.00+0	1.07+1	1.00+0							125
4.20-1	8.60-4	1.55+0	5.10-1	1.80-3	1.09+0	6.00-1	3.00-3	7.97-1	135
7.00-1	5.70-3	7.38-1	7.50-1	7.80-3	7.44-1	7.90-1	1.00-2	7.62-1	
8.30-1	1.50-2	9.27-1	8.80-1	2.10-2	1.02+0	1.01+0	3.40-2	9.49-1	
1.11+0	4.80-2	9.33-1	1.21+0	6.80-2	9.56-1	1.31+0	9.50-2	1.00+0	
1.41+0	1.30-1	1.05+0	1.51+0	1.60-1	1.02+0	1.61+0	1.90-1	9.72-1	
1.71+0	2.10-1	8.76-1	1.81+0	2.70-1	9.33-1				
5.00-1	1.36-3	9.12-1	6.00-1	3.59-3	9.53-1	7.00-1	7.63-3	9.87-1	144
8.00-1	1.46-2	1.05+0	9.00-1	2.43-2	1.08+0	1.00+0	3.70-2	1.07+0	
1.10+0	5.44-2	1.09+0	1.20+0	7.50-2	1.09+0	1.30+0	1.00-1	1.08+0	
1.40+0	1.32-1	1.10+0	1.60+0	2.12-1	1.11+0	1.80+0	3.14-1	1.11+0	
2.00+0	4.37-1	1.09+0	2.20+0	5.92-1	1.09+0	2.40+0	7.62-1	1.08+0	
2.60+0	9.74-1	1.08+0	2.80+0	1.19+0	1.06+0	3.00+0	1.46+0	1.07+0	
3.20+0	1.72+0	1.05+0	3.50+0	2.22+0	1.06+0	4.00+0	3.11+0	1.05+0	
4.50+0	4.17+0	1.04+0	5.00+0	5.26+0	1.03+0	5.50+0	6.64+0	1.04+0	
6.00+0	7.93+0	1.02+0							
51 Antimony			Fluorescence yield = 0.87						
1.00+0	2.60-2	9.41-1	2.25+0	5.40-1	1.13+0	3.00+0	1.20+0	1.06+0	47
6.00-1	1.40-3	4.77-1	8.00-1	1.00-2	9.09-1	1.00+0	2.60-2	9.41-1	63
1.20+0	5.50-2	9.88-1	1.40+0	1.00-1	1.02+0	1.60+0	1.60-1	1.03+0	
1.80+0	2.30-1	9.90-1	2.00+0	3.40-1	1.04+0				
3.00-1	1.86-5	4.77-1	3.50-1	7.25-5	5.77-1	4.00-1	2.03-4	6.62-1	126
4.50-1	5.49-4	8.73-1	5.00-1	1.12-3	9.82-1	5.50-1	1.82-3	9.62-1	
6.00-1	3.00-3	1.02+0	6.50-1	4.77-3	1.10+0				
3.50-1	7.50-5	5.96-1	4.00-1	1.92-4	6.26-1	5.00-1	8.93-4	7.83-1	129
6.00-1	2.28-3	7.77-1	7.00-1	5.12-3	8.41-1	8.00-1	8.93-3	8.12-1	
9.00-1	1.48-2	8.20-1	1.00+0	2.57-2	9.31-1				
2.10+0	3.15-1	8.21-1	2.60+0	6.06-1	8.17-1	3.10+0	9.55-1	7.70-1	148
3.30+0	1.32+0	8.93-1							
52 Tellurium			Fluorescence yield = 0.877						
6.00-1	2.20-3	9.60-1	8.00-1	9.00-3	1.03+0	1.00+0	1.90-2	8.55-1	63
1.20+0	3.30-2	7.32-1	1.40+0	5.90-2	7.42-1	1.60+0	9.20-2	7.22-1	
1.80+0	1.20-1	6.31-1	2.00+0	1.80-1	6.68-1				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
7.00+0	7.06+0	9.05-1							125
1.60+0	6.14-2	4.82-1	1.80+0	8.26-2	**4.34-1**	2.00+0	1.25-1	**4.64-1**	138
2.20+0	1.79-1	4.89-1	2.40+0	2.42-1	5.03-1	2.60+0	2.82-1	**4.59-1**	
2.80+0	4.17-1	5.44-1	3.00+0	5.19-1	5.54-1				
53	Iodine		Fluorescence yield = 0.884						
6.00-1	1.50-3	8.36-1	8.00-1	6.20-3	8.85-1	1.00+0	1.40-2	7.80-1	87
1.20+0	3.20-2	8.73-1	1.40+0	5.90-2	9.08-1	1.60+0	9.20-2	8.81-1	
1.80+0	1.50-1	9.59-1	2.00+0	2.10-1	9.45-1	2.20+0	3.00-1	9.92-1	
2.40+0	3.60-1	9.05-1							
3.00+0	5.50-1	7.04-1	5.00+0	2.36+0	7.64-1	7.00+0	5.14+0	7.71-1	94
9.00+0	8.70+0	7.91-1	1.10+1	1.18+1	7.57-1				
6.11-1	2.01-3	1.02+0	8.11-1	6.01-3	8.07-1	1.02+0	1.62-2	8.37-1	127
1.20+0	3.32-2	9.05-1	1.40+0	5.79-2	8.91-1	1.60+0	9.60-2	9.19-1	
1.80+0	1.34-1	8.56-1	2.00+0	1.96-1	8.82-1	2.20+0	2.70-1	8.92-1	
2.40+0	3.58-1	9.00-1	2.60+0	4.78-1	9.39-1	2.80+0	5.48-1	8.60-1	
3.00+0	6.23-1	7.97-1	3.20+0	7.52-1	7.99-1	3.40+0	9.45-1	8.46-1	
3.60+0	1.11+0	8.47-1	3.80+0	1.32+0	8.68-1	3.85+0	1.36+0	8.64-1	
1.50+0	8.07-2	9.69-1	2.00+0	2.02-1	9.09-1	2.25+0	2.95-1	9.08-1	143
2.50+0	4.56-1	1.01+0	2.75+0	4.82-1	7.98-1	3.00+0	7.88-1	1.01+0	
54	Xenon		Fluorescence yield = 0.891						
4.50+0	4.73+0	**2.36+0**	5.00+0	6.64+0	**2.54+0**				48
55	Cesium		Fluorescence yield = 0.897						
1.13+0	1.60-2	8.26-1	1.34+0	2.80-2	7.52-1	1.55+0	5.00-2	7.90-1	87
1.76+0	7.80-2	7.89-1	1.97+0	1.10-1	7.60-1	2.18+0	1.70-1	8.41-1	
2.39+0	2.10-1	7.73-1	2.60+0	2.90-1	8.21-1	2.70+0	3.00-1	7.56-1	
1.50+0	5.96-2	1.06+0	2.00+0	1.66-1	1.09+0	2.25+0	2.26-1	1.01+0	143
2.50+0	3.56-1	1.14+0	2.75+0	4.34-1	1.03+0	3.00+0	6.06-1	1.11+0	
56	Barium		Fluorescence yield = 0.902						
1.60+2	4.22+1	1.02+0							30
1.00+0	8.40-3	8.70-1	1.20+0	1.40-2	6.96-1	1.40+0	2.00-2	5.54-1	63
1.60+0	3.00-2	5.12-1	1.80+0	4.40-2	4.97-1	2.00+0	4.90-2	**3.87-1**	
7.00+0	3.75+0	8.92-1							125
1.50+0	4.65-2	1.00+0	2.00+0	1.07-1	8.45-1	2.25+0	2.05-1	1.10+0	143
2.50+0	3.26-1	1.25+0	2.75+0	4.04-1	1.15+0	3.00+0	5.71-1	1.25+0	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
6.00-1	7.64-4	8.78-1	7.00-1	1.72-3	8.93-1	8.00-1	3.50-3	9.62-1	144
9.00-1	6.29-3	1.02+0	1.00+0	1.03-2	1.07+0	1.10+0	1.52-2	1.07+0	
1.20+0	2.18-2	1.08+0	1.30+0	2.94-2	1.08+0	1.40+0	3.93-2	1.09+0	
1.50+0	5.06-2	1.09+0	1.60+0	6.67-2	1.14+0	1.70+0	8.22-2	1.13+0	
1.80+0	9.65-2	1.09+0	2.00+0	1.42-1	1.12+0	2.20+0	1.90-1	1.10+0	
2.40+0	2.57-1	1.12+0	2.60+0	3.27-1	1.11+0	2.80+0	4.10-1	1.10+0	
3.00+0	4.98-1	1.09+0	3.20+0	6.09-1	1.10+0	3.50+0	7.96-1	1.11+0	
4.00+0	1.16+0	1.11+0	4.50+0	1.53+0	1.07+0	5.00+0	2.00+0	1.06+0	
5.50+0	2.56+0	1.07+0	6.00+0	3.07+0	1.04+0				
57	Lanthanum		Fluorescence yield = 0.907						
8.00-1	2.70-3	9.17-1	1.00+0	7.40-3	9.37-1	1.20+0	1.40-2	8.45-1	63
1.40+0	2.50-2	8.37-1	1.60+0	3.10-2	6.37-1	1.80+0	3.90-2	5.29-1	
2.00+0	5.20-2	4.92-1							
2.00+0	1.21-1	1.14+0	2.25+0	1.96-1	1.25+0	2.50+0	2.47-1	1.13+0	143
2.75+0	3.57-1	1.21+0	3.00+0	4.93-1	1.28+0				
58	Cerium		Fluorescence yield = 0.912						
6.00-1	3.20-4	5.89-1	8.00-1	1.70-3	7.12-1	1.00+0	5.10-3	7.86-1	87
1.20+0	1.10-2	8.03-1	1.40+0	2.10-2	8.46-1	1.60+0	3.10-2	7.63-1	
1.80+0	5.60-2	9.08-1	2.00+0	7.40-2	8.36-1	2.20+0	1.10-1	9.04-1	
2.40+0	1.40-1	8.66-1							
7.00+0	2.64+0	8.50-1							125
5.00-1	9.57-5	5.26-1	6.00-1	3.43-4	6.31-1	7.00-1	8.82-4	7.11-1	129
8.00-1	1.97-3	8.25-1	9.00-1	3.87-3	9.44-1	1.00+0	5.69-3	8.77-1	
6.00-1	4.38-4	8.06-1	6.50-1	6.89-4	8.18-1	7.00-1	1.06-3	8.55-1	144
8.00-1	2.23-3	9.34-1	9.00-1	4.01-3	9.78-1	1.00+0	6.51-3	1.00+0	
1.10+0	1.00-2	1.04+0	1.20+0	1.46-2	1.07+0	1.30+0	2.02-2	1.08+0	
1.40+0	2.70-2	1.09+0	1.50+0	3.48-2	1.08+0	1.60+0	4.48-2	1.10+0	
1.70+0	5.62-2	1.11+0	1.80+0	6.87-2	1.11+0	2.00+0	9.94-2	1.12+0	
2.20+0	1.34-1	1.10+0	2.40+0	1.82-1	1.13+0	2.60+0	2.34-1	1.12+0	
2.80+0	2.93-1	1.11+0	3.00+0	3.62-1	1.11+0	3.20+0	4.40-1	1.12+0	
3.50+0	5.73-1	1.12+0	4.00+0	8.30-1	1.11+0	4.50+0	1.14+0	1.10+0	
5.00+0	1.50+0	1.10+0	5.50+0	1.90+0	1.09+0	6.00+0	2.34+0	1.08+0	
59	Praseodymium		Fluorescence yield = 0.917						
6.00-1	2.90-4	6.72-1	8.00-1	1.31-3	6.74-1	1.00+0	3.70-3	6.92-1	87
1.20+0	8.30-3	7.30-1	1.40+0	1.60-2	7.72-1	1.60+0	2.70-2	7.94-1	
1.80+0	3.90-2	7.54-1	2.00+0	5.70-2	7.66-1	2.20+0	8.10-2	7.90-1	
2.40+0	1.00-1	7.33-1							
5.00-1	3.80-5	**2.70-1**	7.50-1	6.20-4	**4.37-1**	1.00+0	3.30-3	6.17-1	95
1.25+0	9.20-3	6.88-1	1.50+0	1.90-2	7.08-1	2.00+0	6.40-2	8.60-1	
2.50+0	1.50-1	9.65-1							
60	Neodymium		Fluorescence yield = 0.921						
3.00+0	2.10-1	8.99-1	5.00+0	8.40-1	8.35-1				59

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
6.00-1	2.10-4	6.13-1	8.00-1	1.10-3	6.94-1	1.00+0	3.40-3	7.68-1	87
1.20+0	8.10-3	8.55-1	1.40+0	1.60-2	9.22-1	1.60+0	2.60-2	9.11-1	
1.80+0	3.90-2	8.96-1	2.00+0	5.30-2	8.44-1	2.20+0	7.50-2	8.65-1	
2.40+0	9.70-2	8.41-1							
7.00-1	6.83-4	8.47-1	8.00-1	1.50-3	9.46-1	9.00-1	2.66-3	9.62-1	144
1.00+0	4.43-3	1.00+0	1.10+0	6.86-3	1.03+0	1.20+0	1.02-2	1.08+0	
1.30+0	1.41-2	1.08+0	1.40+0	1.91-2	1.10+0	1.50+0	2.49-2	1.11+0	
1.60+0	3.19-2	1.12+0	1.80+0	4.92-2	1.13+0	2.00+0	7.06-2	1.12+0	
2.20+0	9.95-2	1.15+0	2.40+0	1.30-1	1.13+0	2.60+0	1.69-1	1.13+0	
2.80+0	2.11-1	1.12+0	3.00+0	2.63-1	1.13+0	3.20+0	3.23-1	1.14+0	
3.50+0	4.21-1	1.13+0	4.00+0	6.06-1	1.11+0	4.50+0	8.32-1	1.10+0	
5.00+0	1.09+0	1.08+0	5.50+0	1.41+0	1.09+0	6.00+0	1.73+0	1.08+0	
1.00+0	1.86-3	**4.20-1**	1.20+0	5.61-3	5.92-1	1.40+0	1.27-2	7.32-1	154
1.60+0	2.34-2	8.20-1	1.80+0	3.96-2	9.10-1	2.00+0	5.61-2	8.93-1	
2.20+0	8.19-2	9.45-1	2.40+0	1.10-1	9.53-1	2.60+0	1.42-1	9.51-1	
2.60+0	1.55-1	1.04+0	2.80+0	1.79-1	9.48-1	3.00+0	2.43-1	1.04+0	155
3.20+0	3.04-1	1.07+0	3.40+0	3.73-1	1.09+0	3.60+0	4.23-1	1.05+0	
2.70+0	1.35-1	8.02-1	3.00+0	2.13-1	9.12-1	4.00+0	5.02-1	9.20-1	159
4.50+0	7.95-1	1.05+0	4.90+0	1.05+0	1.10+0	5.40+0	1.26+0	1.03+0	
6.00+0	1.84+0	1.15+0	6.50+0	2.14+0	1.10+0				
61 Promethium		Fluorescence yield = 0.925							
7.00+0	1.74+0	8.65-1							125
62 Samarium		Fluorescence yield = 0.929							
1.60+2	4.55+1	1.54+0							30
7.50-1	4.30-4	5.63-1	1.00+0	2.10-3	6.89-1	1.25+0	6.30-3	8.04-1	95
1.50+0	1.40-2	8.77-1	2.00+0	4.30-2	9.54-1	2.50+0	8.90-2	9.35-1	
7.00-1	3.97-4	7.52-1	8.00-1	9.25-4	8.70-1	9.00-1	1.74-3	9.23-1	144
1.00+0	2.96-3	9.71-1	1.10+0	4.69-3	1.02+0	1.20+0	7.06-3	1.06+0	
1.30+0	9.85-3	1.08+0	1.40+0	1.36-2	1.11+0	1.50+0	1.77-2	1.11+0	
1.60+0	2.30-2	1.13+0	1.70+0	2.99-2	1.18+0	1.80+0	3.57-2	1.15+0	
2.00+0	5.08-2	1.13+0	2.20+0	7.12-2	1.14+0	2.40+0	9.57-2	1.15+0	
2.60+0	1.24-1	1.15+0	2.80+0	1.57-1	1.15+0	3.00+0	1.95-1	1.15+0	
3.20+0	2.34-1	1.13+0	3.50+0	3.11-1	1.15+0	4.00+0	4.51-1	1.13+0	
4.50+0	6.27-1	1.12+0	5.00+0	8.22-1	1.10+0	5.50+0	1.05+0	1.10+0	
6.00+0	1.32+0	1.10+0							
8.00-1	5.66-4	5.33-1	1.00+0	2.22-3	7.28-1	1.20+0	5.24-3	7.89-1	154
1.40+0	1.05-2	8.57-1	1.60+0	1.75-2	8.62-1	1.80+0	2.88-2	9.25-1	
2.00+0	4.36-2	9.67-1	2.20+0	6.12-2	9.82-1	2.40+0	8.37-2	1.00+0	
2.60+0	1.10-1	1.02+0							
2.60+0	1.24-1	1.15+0	2.80+0	1.54-1	1.13+0	3.00+0	1.82-1	1.07+0	155
3.20+0	2.39-1	1.15+0	3.40+0	2.81-1	1.13+0	3.60+0	3.45-1	1.17+0	
3.80+0	3.87-1	1.12+0							

TABLE 2. K-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
2.70+0	1.14-1	9.35-1	3.00+0	1.71-1	1.01+0	4.00+0	4.25-1	1.06+0	159
4.50+0	5.68-1	1.02+0	5.00+0	7.48-1	1.01+0	5.50+0	1.01+0	1.06+0	
6.00+0	1.27+0	1.06+0	6.50+0	1.52+0	1.04+0	7.00+0	1.90+0	1.09+0	
63 Europium			Fluorescence yield = 0.932						
8.00-1	8.50-4	9.74-1	1.00+0	2.00-3	7.88-1	1.20+0	4.50-3	8.07-1	87
1.40+0	9.10-3	8.80-1	1.60+0	1.40-2	8.15-1	1.80+0	2.30-2	8.70-1	
2.00+0	3.30-2	8.61-1	2.20+0	4.40-2	8.29-1	2.40+0	5.90-2	8.30-1	
2.20+1	1.26+1	9.87-1	3.10+1	1.65+1	8.83-1	4.40+1	2.00+1	8.15-1	104
64 Gadolinium			Fluorescence yield = 0.935						
8.00-1	7.10-4	9.89-1	1.00+0	2.20-3	1.04+0	1.20+0	4.90-3	1.04+0	87
1.40+0	8.60-3	9.83-1	1.60+0	1.50-2	1.03+0	1.80+0	2.10-2	9.33-1	
2.00+0	3.30-2	1.01+0	2.20+0	4.40-2	9.70-1	2.40+0	5.60-2	9.22-1	
7.00+0	9.90-1	7.50-1	8.00+0	1.48+0	8.19-1	9.00+0	1.85+0	7.82-1	100
1.00+1	2.48+0	8.37-1	1.10+1	3.06+0	8.47-1	1.20+1	3.75+0	8.75-1	
1.30+1	4.10+0	8.22-1	1.40+1	4.94+0	8.65-1	1.50+1	5.68+0	8.83-1	
4.75+0	2.88-1	5.98-1							107
9.00-1	5.60-4	**4.33-1**	1.20+0	3.18-3	6.77-1	1.40+0	7.01-3	8.01-1	139
1.60+0	1.31-2	8.97-1	1.80+0	2.05-2	9.11-1	2.00+0	3.15-2	9.64-1	
2.20+0	4.56-2	1.00+0	2.40+0	6.24-2	1.03+0	2.60+0	8.00-2	1.01+0	
65 Terbium			Fluorescence yield = 0.938						
1.60+2	2.94+1	1.18+0							30
8.00-1	1.85-4	**3.13-1**	1.00+0	9.94-4	5.60-1	1.20+0	3.01-3	7.60-1	155
1.40+0	6.47-3	8.71-1	1.60+0	1.17-2	9.40-1	1.80+0	1.74-2	9.06-1	
2.00+0	2.77-2	9.91-1	2.20+0	3.90-2	1.00+0	2.40+0	5.26-2	1.01+0	
2.60+0	7.30-2	1.08+0	2.80+0	9.57-2	1.11+0	3.00+0	1.13-1	1.05+0	
3.20+0	1.43-1	1.09+0	3.40+0	1.60-1	1.01+0	3.60+0	1.96-1	1.05+0	
2.70+0	9.10-2	1.19+0	3.00+0	1.00-1	9.33-1	4.00+0	2.76-1	1.08+0	159
4.50+0	3.51-1	9.79-1	5.00+0	4.77-1	9.93-1	5.50+0	6.67-1	1.07+0	
6.00+0	1.04+0	1.33+0	6.50+0	1.06+0	1.11+0	7.00+0	1.56+0	1.36+0	
67 Holmium			Fluorescence yield = 0.944						
8.00-1	3.62-4	8.99-1	9.00-1	7.27-4	9.72-1	1.05+0	1.70-3	1.08+0	91
1.20+0	3.14-3	1.10+0	1.35+0	5.43-3	1.16+0	1.50+0	8.36-3	1.18+0	
1.60+0	1.08-2	1.19+0	1.80+0	1.67-2	1.18+0	2.00+0	2.42-2	1.17+0	
2.10+0	2.79-2	1.14+0	2.20+0	3.35-2	1.16+0	2.40+0	4.32-2	1.12+0	
2.60+0	5.56-2	1.10+0	2.80+0	7.21-2	1.12+0	3.00+0	8.99-2	1.12+0	
3.20+0	1.18-1	1.21+0	3.40+0	1.38-1	1.17+0	3.60+0	1.58-1	1.13+0	
3.80+0	1.85-1	1.12+0	4.00+0	2.06-1	1.07+0				
7.50-1	1.10-4	3.92-1	1.00+0	7.10-4	5.67-1	1.25+0	2.50-3	7.38-1	95
1.50+0	6.00-3	8.46-1	2.00+0	1.90-2	9.19-1	2.50+0	4.20-2	9.48-1	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
7.00+0	1.00+0	1.14+0							125
9.00-1	2.08-4	2.78-1	1.00+0	6.08-4	4.85-1	1.20+0	1.74-3	6.11-1	145
1.20+0	1.89-3	6.63-1	1.40+0	3.90-3	7.22-1	1.60+0	7.45-3	8.18-1	
1.60+0	7.92-3	8.70-1	1.80+0	1.30-2	9.20-1	2.00+0	1.97-2	9.53-1	
2.00+0	2.06-2	9.97-1	2.20+0	2.84-2	9.87-1	2.40+0	3.92-2	1.01+0	
2.40+0	3.95-2	1.02+0	2.60+0	5.32-2	1.05+0	2.60+0	4.95-2	9.81-1	
2.70+0	6.11-2	1.07+0	3.00+0	8.53-2	1.07+0	4.00+0	2.04-1	1.06+0	159
4.50+0	2.84-1	1.05+0	5.00+0	3.87-1	1.07+0	5.50+0	5.14-1	1.09+0	
6.00+0	6.47-1	1.09+0	6.50+0	8.96-1	1.23+0	7.00+0	9.87-1	1.12+0	
7.50+0	1.22+0	1.17+0	8.00+0	1.31+0	1.08+0	8.50+0	1.65+0	1.18+0	
9.00+0	1.96+0	1.23+0	9.50+0	2.01+0	1.12+0	1.00+1	2.47+0	1.22+0	
69	Thulium		Fluorescence yield = 0.949						
3.00+0	5.30-2	8.80-1	5.00+0	2.40-1	8.68-1				59
7.00+0	7.32-1	1.08+0							125
1.00+0	4.63-4	5.20-1	1.20+0	1.46-3	7.07-1	1.40+0	3.11-3	7.84-1	154
1.60+0	5.64-3	8.38-1	1.80+0	9.57-3	9.11-1	2.00+0	1.40-2	9.09-1	
2.20+0	2.27-2	1.05+0	2.40+0	2.85-2	9.82-1	2.60+0	4.58-2	1.21+0	
1.00+0	5.97-4	6.71-1	1.20+0	1.90-3	9.20-1	1.40+0	4.02-3	1.01+0	155
1.60+0	7.21-3	1.07+0	1.80+0	1.21-2	1.15+0	2.00+0	1.74-2	1.13+0	
2.20+0	2.82-2	1.31+0	2.40+0	3.56-2	1.23+0	2.60+0	4.63-2	1.22+0	
2.80+0	5.89-2	1.22+0	3.00+0	8.19-2	1.36+0	3.20+0	1.04-1	1.41+0	
3.40+0	1.31-1	1.47+0	3.60+0	1.43-1	1.35+0				
70	Ytterbium		Fluorescence yield = 0.951						
4.00+0	1.19-1	9.37-1	7.50+0	5.64-1	7.99-1	8.00+0	7.10-1	8.58-1	100
9.00+0	9.06-1	8.27-1	1.00+1	1.10+0	7.92-1	1.10+1	1.39+0	8.08-1	
1.20+1	1.74+0	8.44-1	1.30+1	2.04+0	8.38-1	1.40+1	2.35+0	8.36-1	
1.50+1	2.74+0	8.53-1							
72	Hafnium		Fluorescence yield = 0.955						
7.50-1	5.10-5	4.86-1	1.00+0	3.70-4	6.88-1	1.25+0	1.30-3	8.37-1	95
1.50+0	3.00-3	8.92-1	2.00+0	9.30-3	9.21-1	2.50+0	2.10-2	9.54-1	
73	Tantalum		Fluorescence yield = 0.957						
1.92+0	1.30-2	**1.71+0**	2.17+0	2.30-2	1.95+0	2.40+0	3.30-2	1.97+0	1
2.64+0	6.00-2	**2.59+0**	2.88+0	7.70-2	**2.50+0**	3.15+0	1.10-1	**2.68+0**	
1.80+0	3.10-3	5.19-1	2.00+0	3.80-3	**4.31-1**	2.20+0	6.00-3	**4.84-1**	5
2.30+0	8.00-3	5.52-1	2.40+0	9.70-3	5.78-1	2.60+0	1.10-2	**5.00-1**	
3.00+0	2.00-2	5.69-1	3.40+0	2.50-2	**4.79-1**	3.50+0	2.80-2	**4.90-1**	
3.70+0	3.50-2	**5.17-1**	3.90+0	4.50-2	5.67-1				

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
1.00+0	8.70-4	**1.91+0**	1.12+0	1.40-3	**1.74+0**	1.25+0	2.50-3	**1.87+0**	6
1.60+2	2.28+1	1.41+0							30
7.50-1	3.30-5	3.82-1	1.00+0	3.10-4	6.80-1	1.25+0	1.60-3	1.20+0	95
1.50+0	2.80-3	9.60-1	2.00+0	8.70-3	9.87-1	2.50+0	2.00-2	1.04+0	
7.00+0	3.27-1	8.04-1	8.00+0	5.00-1	8.77-1	9.00+0	6.62-1	8.72-1	100
1.00+1	8.17-1	8.42-1	1.10+1	9.94-1	8.29-1	1.20+1	1.41+0	9.69-1	
1.30+1	1.53+0	8.91-1	1.40+1	1.63+0	8.15-1	1.50+1	1.87+0	8.17-1	
7.00+0	4.57-1	1.12+0							125
1.10+0	4.40-4	5.98-1	1.30+0	1.01-3	6.35-1	1.50+0	2.24-3	7.68-1	158
1.70+0	4.28-3	8.93-1	1.90+0	6.84-3	9.35-1	2.10+0	1.08-2	1.03+0	
2.25+0	1.40-2	1.04+0	2.45+0	1.98-2	1.10+0	2.65+0	2.54-2	1.08+0	
2.80+0	3.47-2	1.23+0	3.00+0	4.14-2	1.18+0	3.20+0	5.13-2	1.19+0	
3.40+0	6.52-2	1.25+0	3.60+0	7.50-2	1.20+0	3.80+0	8.50-2	1.16+0	
2.70+0	2.80-2	1.12+0	3.00+0	3.92-2	1.11+0	3.30+0	5.24-2	1.10+0	159
3.60+0	7.11-2	1.14+0	4.00+0	9.76-2	1.14+0	4.50+0	1.38-1	1.14+0	
5.00+0	1.96-1	1.20+0	5.50+0	2.72-1	1.27+0	6.00+0	3.18-1	1.17+0	
6.50+0	3.81-1	1.14+0	7.00+0	4.93-1	1.21+0	7.50+0	5.98-1	1.23+0	
8.00+0	6.43-1	1.13+0	8.50+0	8.13-1	1.23+0				
74	Tungsten		Fluorescence yield = 0.958						
4.75+0	1.05-1	8.41-1							107
1.20+0	5.84-4	6.13-1	1.39+0	1.64-3	8.92-1	1.60+0	2.68-3	8.15-1	139
2.00+0	6.60-3	8.56-1	2.22+0	1.10-2	9.81-1	2.40+0	1.59-2	1.08+0	
2.60+0	1.91-2	9.90-1	2.80+0	2.44-2	9.88-1	3.20+0	3.89-2	1.02+0	
3.80+0	6.59-2	1.02+0	4.50+0	1.08-1	1.01+0	5.20+0	1.62-1	1.00+0	
6.00+0	2.14-1	8.95-1	6.90+0	3.03-1	8.75-1	8.00+0	4.32-1	8.56-1	
6.50-1	9.01-6	3.54-1	7.20-1	2.51-5	4.68-1	8.00-1	6.10-5	5.68-1	142
9.00-1	1.44-4	6.63-1	1.00+0	2.79-4	7.21-1	1.25+0	8.99-4	7.82-1	
1.50+0	2.01-3	7.94-1	1.75+0	3.80-3	8.13-1	2.00+0	6.57-3	8.52-1	
2.25+0	1.02-2	8.67-1	2.50+0	1.56-2	9.23-1	2.75+0	2.25-2	9.67-1	
3.00+0	3.18-2	1.03+0	3.25+0	4.27-2	1.07+0	3.50+0	5.29-2	1.05+0	
3.75+0	7.35-2	1.18+0							
75	Rhenium		Fluorescence yield = 0.959						
7.50-1	2.20-5	3.80-1	1.00+0	1.60-4	4.88-1	1.25+0	7.40-4	7.46-1	95
1.50+0	2.10-3	9.54-1	2.00+0	7.10-3	1.05+0	2.50+0	9.60-3	6.46-1	
78	Platinum		Fluorescence yield = 0.963						
1.60+2	1.82+1	1.48+0							30

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	Ref.
7.50-1	1.20-5	3.79-1	1.00+0	1.30-4	6.46-1	1.25+0	5.10-4	7.95-1	95
1.50+0	1.30-3	8.88-1	2.00+0	4.00-3	8.67-1	2.50+0	9.20-3	8.97-1	
7.00+0	2.72-1	1.22+0							125
79	Gold		Fluorescence yield = 0.964						
2.40+0	1.60-2	2.03+0							1
1.60+2	1.68+1	1.44+0							30
3.00+0	2.00-2	1.19+0	4.00+0	4.20-2	1.02+0	6.00+0	1.30-1	9.86-1	41
7.00+0	2.40-1	1.20+0	8.00+0	2.60-1	9.24-1	9.00+0	4.50-1	1.19+0	
1.00+1	5.80-1	1.19+0	1.10+1	6.50-1	1.07+0	1.20+1	8.20-1	1.11+0	
1.30+1	1.06+0	1.20+0	1.40+1	1.20+0	1.16+0	1.50+1	1.40+0	1.17+0	
1.00+0	9.47-5	5.54-1	1.10+0	1.88-4	6.49-1	1.20+0	3.07-4	6.75-1	91
1.30+0	4.96-4	7.40-1	1.40+0	7.61-4	8.06-1	1.50+0	1.03-3	8.04-1	
1.60+0	1.41-3	8.36-1	1.70+0	1.96-3	9.06-1	1.80+0	2.50-3	9.21-1	
1.90+0	3.16-3	9.43-1	2.00+0	4.04-3	9.91-1	2.10+0	4.95-3	1.01+0	
2.20+0	5.75-3	9.93-1	2.40+0	8.33-3	1.06+0	2.60+0	1.12-2	1.08+0	
2.80+0	1.47-2	1.10+0	3.00+0	1.89-2	1.13+0	3.20+0	2.36-2	1.15+0	
3.40+0	2.96-2	1.18+0	3.60+0	3.70-2	1.24+0	3.80+0	4.35-2	1.23+0	
4.00+0	4.83-2	1.17+0							
1.00+0	9.60-5	5.61-1	1.30+0	3.80-4	5.67-1	1.50+0	9.00-4	7.03-1	93
1.75+0	1.80-3	7.41-1	2.00+0	3.00-3	7.36-1	2.25+0	5.50-3	8.77-1	
2.50+0	7.50-3	8.25-1	2.75+0	1.00-2	7.96-1	2.80+0	1.30-2	9.75-1	
3.00+0	1.90-2	1.13+0	3.50+0	2.50-2	9.13-1	4.00+0	4.00-2	9.70-1	
5.00+0	7.00-2	8.83-1	6.00+0	1.10-1	8.34-1	7.00+0	1.80-1	9.03-1	
8.00+0	2.60-1	9.24-1							
7.50-1	7.70-6	2.99-1	1.00+0	9.40-5	5.50-1	1.25+0	3.90-4	7.02-1	95
1.50+0	9.60-4	7.49-1	2.00+0	3.20-3	7.85-1	2.50+0	7.50-3	8.25-1	
7.50+0	2.25-1	9.43-1	8.00+0	2.46-1	8.74-1	9.00+0	3.23-1	8.55-1	100
1.00+1	4.12-1	8.46-1	1.10+1	5.50-1	9.04-1	1.20+1	6.75-1	9.13-1	
1.30+1	8.03-1	9.12-1	1.40+1	9.41-1	9.09-1	1.50+1	1.16+0	9.72-1	
2.20+1	2.66+0	1.08+0	3.10+1	3.88+0	9.31-1	4.40+1	5.93+0	9.31-1	104
7.00+0	2.12-1	1.06+0							125
7.10-1	4.32-6	**2.57-1**	7.60-1	8.77-6	3.08-1	8.20-1	1.75-5	3.57-1	142
9.00-1	3.89-5	4.29-1	1.00+0	8.94-5	5.23-1	1.25+0	3.86-4	6.95-1	
1.50+0	1.05-3	8.20-1	1.75+0	2.21-3	9.10-1	2.00+0	3.95-3	9.69-1	
2.25+0	6.30-3	1.00+0	2.50+0	9.24-3	1.02+0	3.00+0	1.60-2	9.55-1	
3.50+0	2.70-2	9.86-1							
1.60+0	1.13-3	6.70-1	2.00+0	3.74-3	9.18-1	2.20+0	5.49-3	9.49-1	145
2.40+0	7.13-3	9.04-1	2.60+0	1.12-2	1.08+0	2.60+0	1.36-2	1.31+0	

TABLE 2. K-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
82	Lead		Fluorescence yield = 0.967						
1.92+0	3.60-3	1.49+0	2.17+0	5.90-3	1.53+0	2.40+0	1.05-2	1.89+0	1
2.88+0	3.05-2	**2.94+0**							
1.60+0	1.10-3	9.58-1	1.70+0	1.50-3	1.01+0	1.80+0	2.00-3	1.07+0	5
1.90+0	2.20-3	9.46-1	2.00+0	2.70-3	9.52-1	2.10+0	3.60-3	1.05+0	
2.20+0	4.30-3	1.06+0	2.30+0	4.50-3	9.43-1	2.40+0	5.10-3	9.18-1	
2.50+0	7.90-3	1.23+0	2.60+0	8.40-3	1.14+0	2.70+0	9.00-3	1.08+0	
2.70+0	9.90-3	1.18+0	2.90+0	1.10-2	1.04+0	3.00+0	1.30-2	1.09+0	
3.20+0	1.40-2	9.55-1	3.20+0	1.50-2	1.02+0	3.30+0	1.60-2	9.90-1	
3.40+0	1.70-2	9.57-1	3.60+0	1.80-2	8.47-1				
1.60+2	1.84+1	1.87+0							30
3.00+0	1.28-2	1.08+0	5.00+0	5.30-2	9.37-1				59
7.50-1	2.60-6	**1.90-1**	1.00+0	6.10-5	5.83-1	1.25+0	2.40-4	6.62-1	95
1.50+0	6.60-4	7.63-1	2.00+0	2.30-3	8.11-1	2.50+0	5.10-3	7.95-1	
4.00+0	4.07-2	1.39+0	7.50+0	1.57-1	9.18-1	8.00+0	1.86-1	9.22-1	100
9.00+0	2.41-1	8.87-1	1.00+1	2.98-1	8.49-1	1.10+1	3.99-1	9.07-1	
1.20+1	4.78-1	8.90-1	1.30+1	5.68-1	8.86-1	1.40+1	6.75-1	8.97-1	
1.50+1	8.00-1	9.16-1							
1.00+0	4.18-5	4.00-1	1.25+0	2.44-4	6.73-1	1.50+0	6.38-4	7.38-1	113
1.75+0	1.22-3	7.29-1	2.00+0	2.45-3	8.63-1	2.25+0	3.69-3	8.37-1	
3.00+0	9.87-3	8.31-1	4.00+0	2.61-2	8.89-1	5.00+0	5.37-2	9.49-1	
6.00+0	9.13-2	9.69-1	7.00+0	1.35-1	9.45-1	8.00+0	1.85-1	9.17-1	
7.00+0	1.78-1	1.25+0							125
83	Bismuth		Fluorescence yield = 0.968						
7.50-1	1.80-6	**1.63-1**	1.00+0	5.40-5	6.09-1	1.25+0	2.40-4	7.63-1	95
1.50+0	6.00-4	7.89-1	2.00+0	1.90-3	7.53-1	2.50+0	4.90-3	8.55-1	
7.00+0	1.50-1	1.17+0							125
90	Thorium		Fluorescence yield = 0.971						
7.00+0	7.02-2	1.12+0	8.00+0	1.06-1	1.19+0	9.00+0	1.28-1	1.07+0	100
1.00+1	1.61-1	1.03+0	1.10+1	2.02-1	1.03+0	1.20+1	2.38-1	9.91-1	
1.30+1	2.75-1	9.53-1	1.40+1	2.95-1	8.65-1	1.50+1	3.72-1	9.37-1	
4.75+0	3.02-2	1.41+0	6.80+0	5.75-2	9.88-1	7.20+0	7.69-2	1.14+0	107
8.80+0	1.07-1	9.43-1	1.01+1	1.95-1	1.22+0				
1.20+0	2.00-5	**2.21-1**	1.60+0	2.21-4	5.17-1	1.83+0	4.45-4	5.65-1	124
2.00+0	8.18-4	7.14-1	2.30+0	1.52-3	7.63-1	2.40+0	2.10-3	8.98-1	
2.80+0	3.60-3	8.87-1	2.81+0	3.64-3	8.86-1	3.30+0	7.38-3	1.05+0	
3.79+0	1.17-2	1.07+0	4.80+0	2.72-2	1.23+0	6.00+0	4.91-2	1.18+0	

TABLE 2. *K*-shell x-ray production by protons in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
92	Uranium		Fluorescence yield = 0.972						
2.25+0	1.50-3	1.01+0	3.75+0	9.20-3	1.05+0				2
2.50+0	5.80-4	**2.61-1**	2.70+0	8.40-4	**2.86-1**	2.90+0	1.00-3	**2.65-1**	5
3.10+0	1.20-3	**2.54-1**	3.30+0	1.50-3	**2.58-1**	3.60+0	2.00-3	**2.60-1**	
3.90+0	2.70-3	**2.74-1**	4.20+0	3.50-3	**2.83-1**	4.40+0	4.80-3	**3.38-1**	
4.60+0	5.80-3	**3.58-1**	5.00+0	7.30-3	**3.54-1**	5.60+0	9.50-3	**3.34-1**	
1.60+2	1.00+1	1.75+0							30
1.40+0	1.05-4	6.29-1	1.50+0	1.53-4	6.34-1	1.60+0	2.42-4	7.23-1	91
1.80+0	4.92-4	8.43-1	2.00+0	9.05-4	9.81-1	2.20+0	1.41-3	1.04+0	
2.40+0	2.04-3	1.07+0	2.60+0	2.82-3	1.10+0	2.80+0	4.28-3	1.28+0	
3.00+0	5.29-3	1.25+0	3.20+0	6.70-3	1.28+0	3.40+0	7.93-3	1.24+0	
3.60+0	8.50-3	1.11+0	3.80+0	1.13-2	1.24+0	4.00+0	1.41-2	1.32+0	
1.25+0	3.60-5	4.17-1	1.50+0	1.30-4	5.38-1	2.00+0	5.90-4	6.40-1	95
2.50+0	2.10-3	9.46-1							
4.75+0	1.46-2	8.21-1							107
1.10+0	1.67-5	4.46-1	1.20+0	3.12-5	4.67-1	1.30+0	5.35-5	4.89-1	142
1.40+0	8.59-5	5.15-1	1.60+0	1.93-4	5.76-1	1.80+0	3.80-4	6.51-1	
2.00+0	6.81-4	7.38-1	2.25+0	1.29-3	8.68-1	2.50+0	2.23-3	1.00+0	

[a] Cross sections and their ratios are printed in a compressed power of 10 notation, e.g. 4.76-1 means 4.76*10^{-1} .

[b] The ratios shown in **bold** print differ by more than a factor of 2 from the averaged ratios and were -- as described in the text -- rejected. This rejection criterion was applied only to the Z2 > 9 data.

TABLE 3. *K*-shell x-ray production by deuterons in target elements from beryllium to gold[a,b]

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
4 Beryllium			Fluorescence yield = 0.00033						
3.00-2	5.66+0	2.91-1	4.00-2	2.29+1	3.46-1	5.00-2	6.46+1	4.21-1	119
6.00-2	1.35+2	4.82-1	8.00-2	3.39+2	5.52-1	1.00-1	5.90+2	5.97-1	
1.20-1	8.95+2	6.66-1							
11 Sodium			Fluorescence yield = 0.023						
4.00-2	1.80-2	**1.61+0**	5.00-2	5.00-2	1.47+0	6.50-2	2.00-1	1.75+0	102
13 Aluminum			Fluorescence yield = 0.039						
1.80-1	1.18+0	7.46-1	2.00-1	1.68+0	7.16-1	2.80-1	5.06+0	6.53-1	25
3.60-1	1.12+1	6.33-1							
4.00-2	1.68-3	1.11+0	4.50-2	3.25-3	1.07+0	5.00-2	5.71-3	1.05+0	45
6.00-2	1.44-2	1.03+0	7.00-2	3.00-2	1.01+0	8.00-2	5.46-2	9.85-1	
9.00-2	9.00-2	9.57-1	1.00-1	1.39-1	9.35-1	1.10-1	2.02-1	9.06-1	
1.20-1	2.80-1	8.76-1	1.30-1	3.81-1	8.59-1	1.40-1	4.98-1	8.34-1	
1.60-1	8.05-1	7.98-1	1.80-1	1.22+0	7.71-1	2.00-1	1.79+0	7.63-1	
2.20-1	2.54+0	7.64-1	2.40-1	3.50+0	7.72-1	2.60-1	4.79+0	7.98-1	
2.80-1	6.42+0	8.29-1							
2.00+0	5.04+2	7.56-1	3.00+0	7.59+2	8.11-1	4.00+0	8.89+2	8.22-1	97
5.00+0	9.46+2	8.19-1	6.00+0	9.79+2	8.25-1	8.00+0	9.51+2	8.05-1	
1.00+1	9.07+2	7.97-1	1.20+1	8.46+2	7.81-1	1.40+1	8.08+2	7.87-1	
1.50+1	7.75+2	7.76-1	1.80+1	7.06+2	7.67-1	1.95+1	6.83+2	7.72-1	
2.40-2	7.00-6	**1.84-1**	2.80-2	2.50-5	**1.87-1**	3.00-2	7.00-5	3.12-1	102
3.20-2	1.30-4	3.65-1	3.40-2	3.00-4	5.57-1	3.80-2	7.00-4	6.33-1	
4.00-2	1.40-3	9.23-1	5.00-2	3.50-3	6.42-1	5.50-2	7.00-3	7.73-1	
6.00-2	1.20-2	8.55-1							
14 Silcon			Fluorescence yield = 0.05						
5.00-2	1.20-3	5.29-1	6.00-2	4.60-3	7.35-1				102
15 Phosphorus			Fluorescence yield = 0.063						
1.60+0	2.32+2	8.46-1	1.80+0	2.83+2	8.54-1	2.00+0	3.22+2	8.33-1	122
2.20+0	3.68+2	8.37-1	2.40+0	4.29+2	8.76-1	2.60+0	4.77+2	8.87-1	
2.80+0	5.20+2	8.95-1	3.00+0	5.46+2	8.78-1	3.20+0	6.13+2	9.29-1	
3.40+0	6.31+2	9.08-1	3.60+0	6.70+2	9.22-1	3.80+0	6.77+2	8.95-1	
4.00+0	7.04+2	8.98-1							

TABLE 3. *K*-shell x-ray production by deuterons in target elements from beryllium to gold[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
16	Sulfur		Fluorescence yield = 0.078						
1.60+0	1.64+2	8.19-1	1.80+0	2.15+2	8.70-1	2.00+0	2.68+2	9.12-1	122
2.20+0	2.84+2	8.37-1	2.40+0	3.25+2	8.49-1	2.60+0	3.59+2	8.45-1	
2.80+0	4.04+2	8.69-1	3.00+0	4.29+2	8.53-1	3.20+0	4.62+2	8.58-1	
3.40+0	5.10+2	8.92-1	3.60+0	5.34+2	8.85-1	3.80+0	5.55+2	8.78-1	
4.00+0	5.59+2	8.47-1							
17	Chlorine		Fluorescence yield = 0.097						
1.60+0	1.19+2	7.95-1	1.80+0	1.51+2	8.06-1	2.00+0	1.81+2	7.99-1	122
2.20+0	2.18+2	8.21-1	2.40+0	2.28+2	7.51-1	2.60+0	2.72+2	7.97-1	
2.80+0	2.99+2	7.92-1	3.00+0	3.31+2	8.03-1	3.20+0	3.41+2	7.66-1	
3.40+0	3.96+2	8.30-1	3.60+0	4.34+2	8.56-1	3.80+0	4.39+2	8.19-1	
4.00+0	4.57+2	8.13-1							
19	Potassium		Fluorescence yield = 0.14						
1.60+0	6.13+1	7.69-1	1.80+0	8.05+1	7.79-1	2.00+0	1.01+2	7.86-1	122
2.20+0	1.23+2	7.96-1	2.40+0	1.32+2	7.29-1	2.60+0	1.62+2	7.78-1	
2.80+0	1.80+2	7.66-1	3.00+0	2.04+2	7.79-1	3.20+0	2.13+2	7.40-1	
3.40+0	2.47+2	7.88-1	3.60+0	2.74+2	8.10-1	3.80+0	2.82+2	7.78-1	
4.00+0	3.01+2	7.80-1							
20	Calcium		Fluorescence yield = 0.163						
4.00-1	6.93-1	8.76-1	5.00-1	1.52+0	8.58-1	6.00-1	2.80+0	8.43-1	133
7.00-1	4.73+0	8.56-1	8.00-1	8.15+0	9.65-1	9.00-1	1.05+1	8.67-1	
21	Scandium		Fluorescence yield = 0.188						
4.00-1	4.73-1	9.24-1	6.00-1	1.98+0	8.95-1	8.00-1	5.19+0	9.03-1	121
1.00+0	1.04+1	9.07-1	1.20+0	1.78+1	9.15-1	1.40+0	2.62+1	8.84-1	
1.60+0	3.74+1	8.97-1	1.80+0	5.07+1	9.13-1				
4.00-1	4.45-1	8.69-1	5.00-1	1.01+0	8.68-1	6.00-1	1.92+0	8.68-1	133
7.00-1	3.25+0	8.74-1	8.00-1	5.19+0	9.03-1	9.00-1	7.33+0	8.81-1	
22	Titanium		Fluorescence yield = 0.214						
1.80-1	1.26-2	1.12+0	2.20-1	3.28-2	1.15+0	2.60-1	7.05-2	1.19+0	25
3.00-1	1.29-1	1.19+0	3.40-1	2.23-1	1.25+0				
6.00+0	3.70+2	1.07+0	1.25+1	6.80+2	1.15+0	1.50+1	7.80+2	1.25+0	31
1.00+0	7.68+0	9.55-1	2.00+0	5.19+1	9.81-1	2.50+0	8.85+1	1.02+0	131
3.00+0	1.25+2	1.00+0							
4.00-1	2.98-1	8.81-1	5.00-1	6.96-1	8.94-1	6.00-1	1.35+0	9.02-1	133
7.00-1	2.19+0	8.61-1	8.00-1	3.40+0	8.57-1	9.00-1	5.02+0	8.67-1	
2.00-1	2.42-2	1.31+0	2.50-1	6.79-2	1.35+0	3.00-1	1.40-1	1.30+0	153
3.50-1	2.52-1	1.26+0	4.00-1	4.17-1	1.23+0	4.50-1	6.50-1	1.23+0	

TABLE 3. *K*-shell x-ray production by deuterons in target elements from beryllium to gold[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
5.00-1	9.63-1	1.24+0	5.50-1	1.36+0	1.24+0	6.00-1	1.86+0	1.24+0	
6.50-1	2.46+0	1.24+0	7.00-1	3.16+0	1.24+0	7.50-1	3.98+0	1.24+0	
8.00-1	4.91+0	1.24+0	8.50-1	5.95+0	1.23+0	9.00-1	7.11+0	1.23+0	
1.00+0	9.80+0	1.22+0	1.10+0	1.30+1	1.21+0	1.20+0	1.67+1	1.21+0	
1.30+0	2.09+1	1.20+0	1.40+0	2.56+1	1.20+0	1.50+0	3.08+1	1.19+0	
1.60+0	3.65+1	1.20+0	1.80+0	4.94+1	1.20+0	2.00+0	6.42+1	1.21+0	
23	Vanadium		Fluorescence yield = 0.243						
1.00+0	5.44+0	9.52-1	2.00+0	4.07+1	1.02+0	2.50+0	6.91+1	1.03+0	131
3.00+0	1.01+2	1.03+0							
4.00-1	2.23-1	9.85-1	5.00-1	5.16-1	9.73-1	6.00-1	9.97-1	9.69-1	133
7.00-1	1.74+0	9.85-1	8.00-1	2.73+0	9.83-1	9.00-1	3.77+0	9.22-1	
24	Chromium		Fluorescence yield = 0.275						
4.00-1	1.53-1	9.92-1	5.00-1	3.54-1	9.69-1	6.00-1	6.79-1	9.47-1	133
7.00-1	1.20+0	9.66-1	8.00-1	1.84+0	9.35-1	9.00-1	2.63+0	9.01-1	
25	Manganese		Fluorescence yield = 0.308						
4.00-1	1.05-1	9.96-1	5.00-1	2.49-1	9.82-1	6.00-1	4.91-1	9.76-1	133
7.00-1	8.61-1	9.80-1	8.00-1	1.34+0	9.56-1	9.00-1	2.00+0	9.56-1	
26	Iron		Fluorescence yield = 0.34						
4.00-1	8.86-2	1.22+0	5.00-1	2.03-1	1.15+0	6.00-1	3.97-1	1.12+0	121
8.00-1	1.14+0	1.14+0	1.00+0	2.38+0	1.11+0	1.20+0	4.14+0	1.07+0	
1.40+0	6.67+0	1.07+0	1.60+0	9.85+0	1.06+0	1.80+0	1.33+1	1.02+0	
4.00-1	7.49-2	1.04+0	5.00-1	1.87-1	1.06+0	6.00-1	3.80-1	1.08+0	133
7.00-1	6.53-1	1.05+0	8.00-1	1.01+0	1.01+0	9.00-1	1.50+0	9.98-1	
2.50-1	1.19-2	1.31+0	3.00-1	2.83-2	1.34+0	3.50-1	5.42-2	1.31+0	153
4.00-1	9.27-2	1.28+0	4.50-1	1.47-1	1.26+0	5.00-1	2.21-1	1.25+0	
5.50-1	3.14-1	1.23+0	6.00-1	4.39-1	1.24+0	6.50-1	5.88-1	1.24+0	
7.00-1	7.66-1	1.23+0	7.50-1	9.77-1	1.23+0	8.00-1	1.22+0	1.22+0	
8.50-1	1.50+0	1.21+0	9.00-1	1.81+0	1.20+0	1.00+0	2.55+0	1.19+0	
1.10+0	3.46+0	1.18+0	1.20+0	4.52+0	1.17+0	1.30+0	5.77+0	1.16+0	
1.40+0	7.19+0	1.15+0	1.50+0	8.81+0	1.15+0	1.60+0	1.06+1	1.14+0	
1.80+0	1.49+1	1.15+0	2.00+0	2.00+1	1.15+0				
27	Cobalt		Fluorescence yield = 0.373						
1.00+0	1.52+0	9.74-1	2.00+0	1.34+1	1.02+0	2.50+0	2.34+1	9.85-1	131
3.00+0	3.71+1	1.00+0							
4.00-1	4.83-2	9.63-1	5.00-1	1.22-1	9.83-1	6.00-1	2.48-1	9.88-1	133
7.00-1	4.43-1	9.94-1	8.00-1	7.03-1	9.75-1	9.00-1	1.01+0	9.27-1	

TABLE 3. *K*-shell x-ray production by deuterons in target elements from beryllium to gold[a,b]—Continued

E_1	σ^{Exper}	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1	σ^{Exper}	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1	σ^{Exper}	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	
(MeV)	(barn)		(MeV)	(barn)		(MeV)	(barn)		Ref.
28 Nickel			Fluorescence yield = 0.406						
2.00+0	8.37+0	8.37-1	3.00+0	2.55+1	8.82-1	4.00+0	4.91+1	8.87-1	97
5.00+0	7.70+1	8.96-1	6.00+0	1.07+2	9.07-1	8.00+0	1.64+2	9.10-1	
1.00+1	2.16+2	9.17-1	1.20+1	2.58+2	9.14-1	1.40+1	2.96+2	9.24-1	
1.50+1	3.08+2	9.15-1	1.80+1	3.37+2	8.97-1	1.95+1	3.53+2	9.05-1	
1.00-1	4.20-6	4.77-1	1.10-1	8.70-6	4.23-1	1.20-1	1.90-5	4.52-1	120
1.30-1	4.30-5	5.55-1	1.40-1	7.50-5	5.67-1	1.50-1	1.30-4	6.13-1	
1.60-1	2.00-4	6.18-1	1.80-1	4.40-4	6.58-1	2.00-1	9.30-4	7.57-1	
2.20-1	1.60-3	7.73-1	2.40-1	2.60-3	7.96-1	2.60-1	4.00-3	8.18-1	
2.80-1	6.10-3	8.76-1	3.00-1	8.30-3	8.60-1				
1.60+0	5.13+0	9.86-1	1.80+0	6.77+0	9.17-1	2.00+0	9.65+0	9.65-1	122
2.20+0	1.26+1	9.67-1	2.40+0	1.59+1	9.65-1	2.60+0	1.94+1	9.56-1	
2.80+0	2.38+1	9.76-1	3.00+0	2.78+1	9.62-1	3.20+0	3.19+1	9.46-1	
3.40+0	3.64+1	9.39-1	3.60+0	4.19+1	9.48-1	3.80+0	4.80+1	9.68-1	
4.00+0	5.26+1	9.50-1							
4.00-1	3.27-2	9.40-1	5.00-1	8.32-2	9.52-1	6.00-1	1.74-1	9.75-1	133
7.00-1	3.16-1	9.89-1	8.00-1	5.22-1	1.00+0	9.00-1	7.99-1	1.01+0	
29 Copper			Fluorescence yield = 0.44						
6.00-1	8.59-2	6.68-1	7.00-1	1.70-1	7.33-1	8.00-1	3.46-1	9.09-1	4
9.00-1	4.73-1	8.14-1	1.00+0	7.06-1	8.40-1				
1.60+0	3.63+0	9.25-1	1.80+0	5.42+0	9.66-1	2.00+0	7.69+0	1.01+0	122
2.20+0	9.39+0	9.37-1	2.40+0	1.18+1	9.26-1	2.60+0	1.44+1	9.13-1	
2.80+0	1.79+1	9.36-1	3.00+0	2.07+1	9.13-1	3.20+0	2.43+1	9.15-1	
3.40+0	2.86+1	9.30-1	3.60+0	3.30+1	9.42-1	3.80+0	3.69+1	9.31-1	
4.00+0	3.98+1	8.97-1							
1.60-1	6.90-5	3.50-1	1.80-1	2.25-4	5.35-1	2.00-1	6.09-4	7.70-1	126
2.40-1	2.03-3	9.36-1	2.80-1	4.59-3	9.63-1	3.20-1	9.18-3	1.02+0	
3.60-1	1.63-2	1.06+0	4.00-1	2.58-2	1.06+0	5.00-1	6.59-2	1.06+0	
6.00-1	1.45-1	1.13+0							
1.00+0	7.73-1	9.20-1	2.00+0	7.69+0	1.01+0	2.50+0	1.44+1	1.01+0	131
3.00+0	2.33+1	1.03+0							
4.00-1	2.40-2	9.82-1	5.00-1	6.33-2	1.02+0	6.00-1	1.26-1	9.79-1	133
7.00-1	2.33-1	1.00+0	8.00-1	3.83-1	1.01+0	9.00-1	5.80-1	9.99-1	
31 Gallium			Fluorescence yield = 0.507						
1.60+0	2.14+0	9.59-1	1.80+0	3.10+0	9.60-1	2.00+0	4.16+0	9.36-1	122
2.20+0	5.46+0	9.27-1	2.40+0	7.15+0	9.46-1	2.60+0	9.00+0	9.52-1	
2.80+0	1.11+1	9.60-1	3.00+0	1.30+1	9.37-1	3.20+0	1.58+1	9.63-1	
3.40+0	1.78+1	9.35-1	3.60+0	2.08+1	9.50-1	3.80+0	2.27+1	9.08-1	
4.00+0	2.66+1	9.45-1							

TABLE 3. *K*-shell x-ray production by deuterons in target elements from beryllium to gold[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
32 Germanium			Fluorescence yield = 0.535						
1.00+0	3.16-1	9.38-1	2.00+0	3.45+0	1.02+0	2.50+0	6.78+0	1.04+0	131
3.00+0	1.08+1	1.00+0							
37 Rubidium			Fluorescence yield = 0.667						
8.00-1	1.89-2	5.69-1	1.00+0	5.13-2	6.50-1	1.20+0	1.06-1	6.83-1	111
1.40+0	1.92-1	7.13-1	1.60+0	3.27-1	7.65-1	1.80+0	4.61-1	7.25-1	
2.00+0	7.15-1	7.96-1	2.20+0	8.88-1	7.28-1	2.40+0	1.27+0	7.92-1	
2.60+0	1.62+0	7.90-1							
38 Strontium			Fluorescence yield = 0.69						
7.00-1	1.04-2	7.21-1	8.00-1	1.91-2	7.65-1	1.00+0	4.78-2	7.97-1	111
1.20+0	1.00-1	8.43-1	1.40+0	1.93-1	9.33-1	1.60+0	3.00-1	9.10-1	
1.80+0	4.38-1	8.90-1	2.00+0	6.23-1	8.93-1	2.20+0	7.95-1	8.37-1	
2.40+0	1.11+0	8.87-1	2.60+0	1.55+0	9.66-1				
40 Zirconium			Fluorescence yield = 0.73						
7.00-1	4.96-3	6.09-1	8.00-1	9.64-3	6.74-1	1.00+0	2.63-2	7.53-1	111
1.20+0	5.07-2	7.26-1	1.40+0	1.01-1	8.22-1	1.60+0	1.59-1	8.05-1	
1.80+0	2.34-1	7.88-1	2.00+0	3.60-1	8.49-1	2.40+0	5.91-1	7.69-1	
2.60+0	6.81-1	6.88-1							
41 Niobium			Fluorescence yield = 0.74						
3.20-1	5.09-5	4.92-1	4.00-1	4.63-4	1.17+0	4.80-1	1.35-3	1.28+0	126
5.60-1	3.02-3	1.35+0	6.40-1	5.60-3	1.35+0	7.20-1	1.03-2	1.48+0	
8.00-1	1.52-2	1.40+0	9.00-1	2.35-2	1.33+0				
47 Silver			Fluorescence yield = 0.831						
5.00-1	1.06-4	4.74-1	6.00-1	4.23-4	7.09-1	7.00-1	1.07-3	8.44-1	121
8.00-1	2.02-3	8.62-1	1.00+0	5.83-3	9.52-1	1.20+0	1.22-2	9.55-1	
1.40+0	2.18-2	9.43-1	1.60+0	3.63-2	9.57-1	1.80+0	5.54-2	9.52-1	
4.00-1	3.06-5	5.35-1	5.00-1	1.82-4	8.13-1	6.00-1	5.26-4	8.81-1	126
7.00-1	1.33-3	1.05+0	8.00-1	2.59-3	1.11+0	9.00-1	4.66-3	1.19+0	
1.00+0	6.64-3	1.08+0	1.10+0	1.09-2	1.21+0	1.20+0	1.64-2	1.28+0	
48 Cadmium			Fluorescence yield = 0.843						
9.00-1	1.01-3	**3.25-1**	1.00+0	2.35-3	**4.83-1**	1.20+0	6.89-3	6.75-1	111
1.40+0	1.05-2	5.66-1	1.60+0	2.41-2	7.89-1	1.80+0	3.09-2	6.59-1	
2.00+0	4.43-2	6.51-1	2.20+0	5.48-2	5.77-1	2.40+0	7.90-2	6.19-1	
2.60+0	1.00-1	5.99-1							

TABLE 3. *K*-shell x-ray production by deuterons in target elements from beryllium to gold[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	Ref.
49	Indium		Fluorescence yield = 0.853						
6.00-1	2.02-4	5.72-1	7.00-1	4.98-4	6.43-1	8.00-1	1.10-3	7.59-1	129
1.00+0	3.46-3	8.95-1	1.20+0	7.38-3	9.03-1	1.40+0	1.33-2	8.92-1	
1.60+0	2.30-2	9.33-1	1.80+0	3.61-2	9.54-1				
50	Tin		Fluorescence yield = 0.862						
1.20+0	1.94-3	**2.95-1**	1.40+0	5.03-3	**4.18-1**	1.60+0	9.54-3	**4.78-1**	111
1.80+0	1.38-2	**4.50-1**	2.00+0	1.78-2	**3.97-1**	2.20+0	2.65-2	**4.24-1**	
2.40+0	3.39-2	**4.01-1**	2.60+0	4.00-2	**3.61-1**				
51	Antimony		Fluorescence yield = 0.87						
5.00-1	4.54-5	6.29-1	6.00-1	1.71-4	8.13-1	7.00-1	4.27-4	8.99-1	126
8.00-1	8.40-4	9.26-1	9.00-1	1.63-3	1.05+0	1.00+0	2.82-3	1.14+0	
1.10+0	4.49-3	1.21+0	1.20+0	6.73-3	1.27+0	1.30+0	8.50-3	1.16+0	
7.00-1	3.12-4	6.57-1	8.00-1	6.74-4	7.43-1	1.00+0	1.83-3	7.39-1	129
1.20+0	4.41-3	8.32-1	1.40+0	8.27-3	8.48-1	1.60+0	1.47-2	9.07-1	
1.80+0	2.27-2	9.08-1							
58	Cerium		Fluorescence yield = 0.912						
1.00+0	3.94-4	6.75-1	1.20+0	1.02-3	7.74-1	1.40+0	2.30-3	9.18-1	129
1.60+0	4.19-3	9.86-1	1.80+0	6.72-3	1.01+0				
64	Gadolinium		Fluorescence yield = 0.935						
9.00-1	6.91-5	6.21-1	1.10+0	2.12-4	6.90-1	1.20+0	2.30-4	4.99-1	150
1.40+0	5.28-4	5.82-1	1.60+0	1.26-3	8.00-1	1.80+0	1.46-3	5.84-1	
2.00+0	3.75-3	1.01+0	2.20+0	4.64-3	8.77-1	2.40+0	6.72-3	9.30-1	
2.60+0	9.43-3	9.86-1	2.80+0	1.08-2	8.75-1				
73	Tantalum		Fluorescence yield = 0.957						
1.20+0	3.82-5	**3.43-1**	1.40+0	8.32-5	**3.51-1**	1.60+0	2.18-4	5.05-1	158
1.80+0	3.94-4	5.57-1	2.00+0	7.58-4	7.05-1	2.20+0	1.29-3	8.33-1	
2.40+0	2.19-3	1.03+0	2.60+0	2.72-3	9.57-1	2.80+0	3.24-3	8.80-1	
3.00+0	4.08-3	8.74-1	3.20+0	4.60-3	7.94-1				
74	Tungsten		Fluorescence yield = 0.958						
1.30+0	1.07-4	7.44-1	1.44+0	1.89-4	8.04-1	1.60+0	3.13-4	8.29-1	147
1.70+0	4.10-4	8.37-1	1.80+0	5.22-4	8.40-1	1.90+0	6.51-4	8.41-1	
2.00+0	7.93-4	8.36-1	2.25+0	1.22-3	8.20-1	2.50+0	1.79-3	8.19-1	
2.75+0	2.48-3	8.09-1	3.00+0	3.33-3	8.05-1	3.25+0	4.34-3	8.02-1	
3.50+0	5.54-3	8.01-1	3.75+0	6.96-3	8.04-1	4.00+0	8.72-3	8.19-1	

TABLE 3. *K*-shell x-ray production by deuterons in target elements from beryllium to gold[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
79 Gold			Fluorescence yield = 0.964						
1.42+0	8.15-5	7.35-1	1.52+0	1.20-4	7.74-1	1.64+0	1.77-4	8.00-1	147
1.80+0	2.73-4	8.17-1	1.90+0	3.43-4	8.15-1	2.00+0	4.22-4	8.12-1	
2.25+0	6.70-4	8.09-1	2.50+0	9.74-4	7.92-1	2.75+0	1.39-3	8.02-1	
3.00+0	1.91-3	8.14-1	3.25+0	2.57-3	8.34-1	3.50+0	3.40-3	8.64-1	
3.75+0	4.36-3	8.85-1	4.00+0	5.64-3	9.31-1				

[a] Cross sections and their ratios are printed in a compressed power of 10 notation, e.g. 9.31-1 means $9.31*10^{-1}$.

[b] The ratios shown in **bold** print differ by more than a factor of 2 from the averaged ratios and were -- as described in the text -- rejected. This rejection criterion was applied only to the Z2 > 9 data.

TABLE 4. *K*-shell x-ray production by helium-3 in target elements from aluminum to silver[a,b]

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
13	Aluminum		Fluorescence yield = 0.039						
1.00-1	3.80-2	1.98+0	1.25-1	1.30-1	2.08+0	1.50-1	2.60-1	1.67+0	12
1.75-1	4.40-1	1.36+0	2.00-1	6.80-1	1.13+0				
4.50-2	1.20-4	1.69+0	5.00-2	3.00-4	1.68+0	6.00-2	1.20-3	1.60+0	17
7.50-2	3.70-3	1.07+0	8.00-2	9.20-3	1.77+0	9.00-2	2.00-2	1.90+0	
1.00-1	3.10-2	1.62+0	1.20-1	7.10-2	1.40+0	1.50-1	1.50-1	9.66-1	
1.70-1	2.50-1	8.85-1	1.90-1	3.80-1	8.02-1	2.00-1	6.50-1	1.08+0	
1.50-1	1.72-1	1.11+0	1.80-1	3.69-1	9.99-1	2.10-1	7.29-1	9.75-1	28
2.40-1	1.22+0	9.02-1	2.70-1	2.08+0	9.20-1	3.00-1	3.17+0	8.93-1	
4.50-2	1.24-4	1.75+0	5.00-2	3.26-4	1.82+0	6.00-2	1.28-3	1.71+0	45
7.00-2	3.97-3	1.80+0	8.00-2	9.58-3	1.85+0	9.00-2	1.75-2	1.66+0	
1.00-1	3.29-2	1.72+0	1.10-1	5.12-2	1.59+0	1.20-1	7.55-2	1.49+0	
1.40-1	1.45-1	1.31+0	1.60-1	2.43-1	1.15+0	1.80-1	3.88-1	1.05+0	
2.00-1	5.96-1	9.94-1	4.08-1	8.28+0	6.56-1	5.10-1	1.95+1	6.45-1	
6.12-1	3.70+1	6.20-1	7.14-1	6.49+1	6.31-1	8.16-1	1.01+2	6.28-1	
1.02+0	2.11+2	6.60-1	1.12+0	2.80+2	6.70-1	1.22+0	3.62+2	6.88-1	
1.43+0	5.54+2	7.10-1	1.63+0	7.65+2	7.32-1	1.84+0	1.01+3	7.56-1	
2.04+0	1.27+3	7.86-1	2.24+0	1.57+3	8.31-1	2.45+0	1.90+3	8.76-1	
2.65+0	2.22+3	9.18-1	2.85+0	2.58+3	9.70-1	2.96+0	2.76+3	9.91-1	
2.25+0	8.08+2	**4.25-1**	3.00+0	1.45+3	5.12-1	3.75+0	2.08+3	5.85-1	75
4.50+0	2.66+3	6.49-1	6.00+0	3.68+3	7.77-1	7.50+0	4.35+3	8.63-1	
9.00+0	4.65+3	9.06-1							
6.00-1	4.46+1	8.03-1	7.50-1	9.58+1	7.87-1	9.00-1	1.94+2	8.85-1	161
1.05+0	3.43+2	9.87-1	1.20+0	4.36+2	8.67-1	1.35+0	6.77+2	9.96-1	
1.50+0	9.00+2	1.03+0	1.80+0	1.35+3	1.06+0	2.10+0	1.81+3	1.06+0	
2.40+0	2.31+3	1.10+0							
14	Silcon		Fluorescence yield = 0.05						
2.25+0	6.28+2	4.77-1	3.00+0	1.15+3	5.50-1	3.75+0	1.67+3	6.08-1	75
4.50+0	2.27+3	6.92-1	6.00+0	3.20+3	8.00-1	7.50+0	3.68+3	8.38-1	
9.00+0	3.91+3	8.51-1							

TABLE 4. *K*-shell x-ray production by helium-3 in target elements from aluminum to silver[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	Ref.
15	Phosphorus		Fluorescence yield = 0.063						
6.00-1	8.97+0	5.32-1	7.50-1	2.82+1	7.33-1	9.00-1	6.16+1	8.47-1	161
1.05+0	1.00+2	8.27-1	1.20+0	1.57+2	8.59-1	1.35+0	2.35+2	9.08-1	
1.50+0	3.64+2	1.05+0	1.80+0	5.94+2	1.08+0	2.10+0	7.32+2	9.38-1	
2.40+0	1.07+3	1.04+0							
18	Argon		Fluorescence yield = 0.118						
6.00-1	2.58+0	6.77-1	7.50-1	7.39+0	8.18-1	9.00-1	1.27+1	7.17-1	161
1.05+0	2.73+1	8.90-1	1.20+0	4.12+1	8.51-1	1.35+0	6.90+1	9.68-1	
1.50+0	9.05+1	9.10-1	1.80+0	1.77+2	1.04+0	2.10+0	2.49+2	9.53-1	
2.40+0	3.63+2	9.87-1							
22	Titanium		Fluorescence yield = 0.214						
5.25-1	4.27-1	1.16+0	6.00-1	6.75-1	1.04+0	6.75-1	1.13+0	1.07+0	160
7.50-1	1.61+0	1.00+0	9.00-1	3.13+0	9.57-1	1.05+0	5.52+0	9.44-1	
1.20+0	8.96+0	9.42-1	1.50+0	1.90+1	9.13-1	1.80+0	3.57+1	9.37-1	
2.10+0	5.89+1	9.50-1	2.40+0	8.78+1	9.50-1	2.70+0	1.25+2	9.70-1	
3.00+0	1.68+2	9.77-1	3.30+0	2.13+2	9.71-1	3.60+0	2.80+2	1.03+0	
3.90+0	3.29+2	1.00+0	4.20+0	4.07+2	1.05+0	4.50+0	4.62+2	1.03+0	
4.80+0	5.28+2	1.03+0							
6.00-1	6.83-1	1.05+0	7.50-1	1.80+0	1.12+0	9.00-1	3.06+0	9.36-1	161
1.05+0	5.71+0	9.77-1	1.20+0	9.67+0	1.02+0	1.35+0	1.42+1	9.83-1	
1.50+0	2.04+1	9.80-1	1.80+0	3.79+1	9.94-1	2.10+0	6.06+1	9.78-1	
2.40+0	8.56+1	9.26-1	2.70+0	1.36+2	1.06+0	3.00+0	1.91+2	1.11+0	
3.30+0	2.48+2	1.13+0	3.60+0	3.10+2	1.14+0				
24	Chromium		Fluorescence yield = 0.275						
5.25-1	1.85-1	1.12+0	6.00-1	3.30-1	1.11+0	6.75-1	5.50-1	1.13+0	160
7.50-1	7.84-1	1.04+0	9.00-1	1.60+0	1.03+0	1.05+0	2.79+0	9.87-1	
1.20+0	4.51+0	9.67-1	1.50+0	9.93+0	9.53-1	1.80+0	1.84+1	9.45-1	
2.10+0	2.99+1	9.26-1	2.40+0	4.54+1	9.25-1	2.70+0	6.68+1	9.55-1	
3.00+0	9.39+1	9.91-1	3.30+0	1.15+2	9.36-1	3.60+0	1.57+2	1.01+0	
3.90+0	1.89+2	9.95-1	4.20+0	2.26+2	9.90-1	4.50+0	2.68+2	9.99-1	
6.00-1	3.27-1	1.10+0	7.50-1	7.18-1	9.54-1	9.00-1	1.40+0	8.98-1	161
1.05+0	2.91+0	1.03+0	1.20+0	5.14+0	1.10+0	1.35+0	7.12+0	9.94-1	
1.50+0	1.02+1	9.79-1	1.80+0	1.92+1	9.86-1	2.10+0	3.12+1	9.66-1	
2.40+0	4.84+1	9.86-1	2.70+0	7.15+1	1.02+0	3.00+0	1.00+2	1.06+0	
3.30+0	1.25+2	1.02+0	3.60+0	1.49+2	9.59-1				
27	Cobalt		Fluorescence yield = 0.373						
6.00-1	1.12-1	1.16+0	7.50-1	3.06-1	1.19+0	9.00-1	6.32-1	1.16+0	160
1.05+0	1.17+0	1.16+0	1.20+0	1.86+0	1.10+0	1.50+0	3.96+0	1.02+0	
1.80+0	7.16+0	9.61-1	2.10+0	1.23+1	9.73-1	2.40+0	1.92+1	9.77-1	
6.00-1	1.39-1	1.44+0	7.50-1	2.98-1	1.16+0	9.00-1	7.75-1	1.42+0	161
1.05+0	1.41+0	1.40+0	1.20+0	2.49+0	1.47+0	1.35+0	3.74+0	1.42+0	

TABLE 4. *K*-shell x-ray production by helium-3 in target elements from aluminum to silver[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
1.50+0	5.51+0	1.42+0	1.80+0	1.00+1	1.34+0	2.10+0	1.54+1	1.22+0	
2.40+0	2.34+1	1.19+0	2.70+0	3.71+1	1.30+0	3.00+0	5.20+1	1.31+0	
3.30+0	6.83+1	1.30+0	3.60+0	8.60+1	1.27+0				
28	Nickel		Fluorescence yield = 0.406						
6.00-1	5.97-2	8.94-1	7.50-1	1.56-1	8.63-1	9.00-1	3.53-1	9.07-1	161
1.05+0	6.86-1	9.46-1	1.20+0	1.19+0	9.74-1	1.35+0	1.85+0	9.66-1	
1.50+0	2.67+0	9.42-1	1.80+0	5.32+0	9.72-1	2.10+0	9.34+0	1.00+0	
2.40+0	1.24+1	8.49-1	2.70+0	1.94+1	9.07-1	3.00+0	2.56+1	8.60-1	
3.30+0	3.27+1	8.22-1	3.60+0	5.44+1	1.06+0				
29	Copper		Fluorescence yield = 0.44						
5.25-1	2.60-2	1.06+0	6.00-1	5.00-2	1.07+0	6.75-1	9.00-2	1.12+0	160
7.50-1	1.05-1	8.15-1	9.00-1	3.12-1	1.11+0	1.05+0	5.74-1	1.09+0	
1.20+0	9.35-1	1.05+0	1.50+0	2.12+0	1.02+0	1.80+0	4.03+0	9.93-1	
2.10+0	6.81+0	9.78-1	2.40+0	1.08+1	9.85-1	2.70+0	1.57+1	9.73-1	
3.00+0	2.16+1	9.57-1	3.30+0	2.95+1	9.74-1	3.60+0	3.73+1	9.48-1	
3.90+0	4.81+1	9.68-1	4.20+0	5.83+1	9.51-1	4.50+0	6.72+1	9.06-1	
4.80+0	8.32+1	9.47-1							
32	**Germanium**		Fluorescence yield = 0.535						
6.00-1	1.81-2	1.14+0	7.50-1	5.46-2	1.18+0	9.00-1	1.15-1	1.10+0	160
1.05+0	2.31-1	1.14+0	1.20+0	3.95-1	1.13+0	1.50+0	9.03-1	1.08+0	
1.80+0	1.71+0	1.03+0	2.10+0	2.95+0	1.02+0	2.40+0	4.59+0	9.95-1	
6.00-1	1.22-2	7.68-1	7.50-1	3.83-2	8.26-1	9.00-1	8.56-2	8.17-1	161
1.05+0	2.08-1	1.03+0	1.20+0	3.68-1	1.06+0	1.35+0	5.67-1	1.02+0	
1.50+0	7.92-1	9.48-1	1.80+0	1.56+0	9.43-1	2.10+0	2.88+0	9.96-1	
2.40+0	4.14+0	8.97-1	2.70+0	6.53+0	9.48-1	3.00+0	8.40+0	8.60-1	
3.30+0	1.27+1	9.56-1	3.60+0	1.72+1	9.85-1				
34	Selenium		Fluorescence yield = 0.589						
6.00-1	2.78-3	**3.57-1**	7.50-1	1.35-2	5.71-1	1.05+0	9.54-2	8.85-1	161
1.20+0	1.55-1	8.22-1	1.35+0	2.83-1	9.32-1	1.50+0	4.45-1	9.68-1	
1.80+0	7.89-1	8.55-1	2.10+0	1.55+0	9.51-1	2.40+0	2.34+0	8.92-1	
2.70+0	3.49+0	8.84-1	3.00+0	5.27+0	9.34-1	3.30+0	7.07+0	9.15-1	
3.60+0	1.02+1	9.97-1							
40	Zirconium		Fluorescence yield = 0.73						
1.20+0	3.50-2	1.04+0	1.50+0	9.20-2	1.06+0	1.80+0	2.01-1	1.11+0	160
2.10+0	3.58-1	1.09+0	2.40+0	5.34-1	9.86-1	3.00+0	1.21+0	1.00+0	
3.30+0	2.37+0	1.41+0	4.20+0	3.77+0	9.98-1	4.80+0	5.76+0	9.94-1	
41	Niobium		Fluorescence yield = 0.74						
1.05+0	1.10-2	8.00-1	1.20+0	2.65-2	1.04+0	1.35+0	4.26-2	9.99-1	161
1.50+0	6.33-2	9.49-1	1.80+0	1.39-1	9.93-1	2.40+0	4.06-1	9.63-1	
3.00+0	8.89-1	9.39-1	3.30+0	1.31+0	9.91-1				

TABLE 4. K-shell x-ray production by helium-3 in target elements from aluminum to silver[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
46	Palladium		Fluorescence yield = 0.82						
1.05+0	1.85-3	**5.22-1**	1.20+0	3.84-3	5.62-1	1.35+0	8.69-3	7.31-1	161
1.50+0	1.51-2	7.91-1	1.80+0	3.51-2	8.44-1	2.10+0	7.64-2	9.85-1	
2.40+0	1.09-1	8.36-1	2.70+0	1.79-1	8.79-1	3.00+0	2.65-1	8.84-1	
3.30+0	3.52-1	8.31-1	3.60+0	5.01-1	8.71-1				
47	Silver		Fluorescence yield = 0.831						
1.50+0	1.41-2	9.40-1	1.80+0	2.99-2	9.08-1	2.10+0	6.14-2	9.93-1	160
2.40+0	1.00-1	9.58-1	3.00+0	2.26-1	9.37-1	3.30+0	4.48-1	1.32+0	
4.20+0	7.57-1	9.58-1	4.80+0	1.22+0	9.85-1				

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[a] Cross sections and their ratios are printed in a compressed power of 10 notation, e.g. 9.85-1 means $9.85*10^{-1}$.

[b] The ratios shown in **bold** print differ by more than a factor of 2 from the averaged ratios and were -- as described in the text -- rejected. This rejection criterion was applied only to the Z2 > 9 data.

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
4 Beryllium			Fluorescence yield = 0.00033						
5.00-1	4.06+3	1.43-1	7.50-1	5.43+3	2.26-1	1.00+0	6.29+3	3.20-1	71
1.25+0	6.88+3	4.22-1	1.50+0	7.15+3	5.17-1	1.75+0	7.11+3	5.91-1	
2.00+0	6.82+3	6.40-1							
2.50-1	6.09+3	2.58-1	3.00-1	7.28+3	2.73-1	5.00-1	1.10+4	3.87-1	92
8.00-1	1.10+4	4.76-1	1.00+0	1.07+4	5.44-1	1.20+0	1.02+4	6.04-1	
1.50+0	9.62+3	6.95-1	1.80+0	8.91+3	7.60-1	2.00+0	8.22+3	7.72-1	
4.00-2	1.90+1	2.64-1	5.00-2	3.75+1	1.59-1	6.00-2	6.54+1	1.14-1	119
8.00-2	1.59+2	8.29-2	1.00-1	3.28+2	7.88-2	1.20-1	5.44+2	7.74-2	
6 Carbon			Fluorescence yield = 0.0028						
4.00-2	2.70-1	4.14+0	5.00-2	3.70-1	1.63+0	6.00-2	6.00-1	9.74-1	16
7.00-2	8.40-1	5.92-1	8.00-2	1.30+0	4.49-1				
5.00-2	9.00-1	3.97+0	6.00-2	1.60+0	2.60+0	7.00-2	2.30+0	1.62+0	23
8.00-2	3.40+0	1.17+0	9.00-2	5.40+0	9.97-1	1.00-1	8.50+0	9.01-1	
1.10-1	1.10+1	7.09-1	1.20-1	1.80+1	7.41-1	1.30-1	2.80+1	7.67-1	
1.40-1	3.70+1	7.00-1	1.50-1	5.60+1	7.53-1	1.60-1	8.20+1	8.07-1	
1.70-1	1.00+2	7.37-1	1.80-1	1.20+2	6.77-1	1.90-1	1.70+2	7.49-1	
2.00-1	1.90+2	6.65-1							
5.00-2	5.60-1	2.47+0	6.00-2	9.50-1	1.54+0	7.00-2	1.60+0	1.13+0	26
8.00-2	2.40+0	8.28-1	9.00-2	3.80+0	7.01-1	1.00-1	5.80+0	6.15-1	
1.10-1	8.90+0	5.74-1	1.20-1	1.20+1	4.94-1	1.30-1	1.70+1	4.66-1	
1.40-1	2.40+1	4.54-1	1.50-1	3.50+1	4.71-1	1.60-1	4.30+1	4.23-1	
1.70-1	6.00+1	4.42-1	1.80-1	7.00+1	3.95-1	1.90-1	8.40+1	3.70-1	
2.00-1	1.10+2	3.85-1							
1.16-1	5.31+0	2.60-1	1.35-1	1.01+1	2.29-1				46
1.50-1	2.26+1	3.04-1	1.75-1	4.13+1	2.66-1	2.00-1	6.62+1	2.32-1	82
2.50-1	1.89+2	2.60-1	3.00-1	3.44+2	2.40-1	4.00-1	1.03+3	2.95-1	
6.00-1	3.09+3	3.67-1	8.00-1	5.24+3	4.19-1	1.00+0	6.89+3	4.58-1	
1.20+0	8.09+3	4.91-1	1.60+0	8.89+3	5.14-1	2.00+0	9.86+3	5.85-1	
2.40+0	9.82+3	6.14-1							

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
7 Nitrogen			Fluorescence yield = 0.0052						
9.70-2	2.11+0	1.40+0	1.16-1	4.27+0	1.15+0	1.35-1	8.34+0	1.06+0	46
1.25-1	4.65+0	8.66-1	1.50-1	1.06+1	8.03-1	1.75-1	1.90+1	6.83-1	82
2.00-1	3.14+1	6.00-1	2.50-1	8.03+1	5.59-1	3.00-1	1.48+2	4.77-1	
4.00-1	4.86+2	5.31-1	5.00-1	1.02+3	5.48-1	6.00-1	1.74+3	5.74-1	
7.00-1	2.71+3	6.29-1	8.00-1	3.70+3	6.62-1	1.00+0	5.33+3	6.72-1	
1.20+0	6.45+3	6.58-1	1.60+0	8.15+3	6.67-1	2.00+0	9.81+3	7.38-1	
9 Fluorine			Fluorescence yield = 0.013						
1.00+0	1.67+3	7.79-1	1.70+0	4.49+3	8.19-1	1.80+0	4.82+3	8.19-1	110
4.00-1	7.19+1	6.29-1	6.00-1	2.00+2	3.92-1	8.00-1	4.01+2	3.27-1	116
1.00+0	7.01+2	3.27-1	1.20+0	1.07+3	3.40-1	1.40+0	1.62+3	3.92-1	
1.60+0	1.98+3	3.92-1	1.80+0	2.52+3	4.28-1	2.00+0	3.05+3	4.61-1	
10 Neon			Fluorescence yield = 0.018						
9.70-2	1.36-1	2.06+0	1.16-1	3.51-1	2.17+0	1.35-1	6.13-1	1.82+0	46
2.00-1	1.38+0	6.57-1	2.50-1	3.66+0	6.39-1	3.00-1	7.10+0	5.58-1	82
4.00-1	2.19+1	5.11-1	5.00-1	5.40+1	5.19-1	6.00-1	1.12+2	5.46-1	
8.00-1	3.09+2	5.77-1	1.00+0	6.17+2	6.05-1	1.20+0	9.87+2	6.16-1	
12 Magnesium			Fluorescence yield = 0.03						
1.25-1	7.40-2	1.92+0	1.50-1	1.80-1	1.89+0	1.75-1	3.40-1	1.71+0	12
2.00-1	5.90-1	1.59+0							
1.00+0	2.88+2	1.23+0	1.50+0	5.00+2	6.71-1	2.50+0	1.73+3	8.13-1	19
3.00+0	2.39+3	8.58-1	3.50+0	3.15+3	9.37-1	4.00+0	3.55+3	9.21-1	
4.50+0	4.05+3	9.49-1	5.00+0	4.60+3	9.99-1				
13 Aluminum			Fluorescence yield = 0.039						
1.00-1	6.10-3	1.20+0	1.25-1	3.10-2	1.76+0	1.50-1	8.60-2	1.90+0	12
1.75-1	1.70-1	1.77+0	2.00-1	3.10-1	1.72+0				
2.90+0	2.40+2	**1.32-1**	3.55+0	3.50+2	**1.43-1**	3.90+0	4.40+2	**1.59-1**	15
4.45+0	5.70+2	**1.78-1**	4.80+0	6.60+2	**1.92-1**	5.30+0	8.30+2	**2.21-1**	
6.00-2	2.00-4	1.24+0	7.50-2	7.00-4	8.40-1	8.00-2	1.80-3	1.40+0	17
9.00-2	3.70-3	1.36+0	1.00-1	7.00-3	1.37+0	1.70-1	8.70-2	1.04+0	
1.90-1	1.50-1	1.06+0	2.00-1	2.20-1	1.22+0				
1.00+0	1.34+2	1.07+0	1.50+0	5.90+2	1.37+0	2.00+0	9.61+2	1.09+0	19
2.50+0	1.52+3	1.08+0	3.00+0	1.99+3	1.04+0	3.50+0	2.93+3	1.22+0	
4.00+0	4.10+3	1.44+0	4.50+0	4.81+3	1.49+0	5.00+0	5.08+3	1.42+0	

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
1.80-1	1.20-1	1.09+0	2.00-1	2.00-1	1.11+0	2.20-1	4.00-1	1.43+0	22
2.40-1	7.00-1	1.69+0	2.60-1	8.00-1	1.35+0	2.80-1	1.00+0	1.21+0	
3.00-1	1.60+0	1.44+0	3.20-1	2.00+0	1.36+0				
1.80-1	1.39-1	1.27+0	2.20-1	2.93-1	1.05+0	2.60-1	5.47-1	9.21-1	28
3.00-1	1.06+0	9.53-1	3.40-1	1.73+0	9.07-1				
6.00-2	2.10-4	1.30+0	7.00-2	7.35-4	1.43+0	8.00-2	1.75-3	1.36+0	45
9.00-2	4.06-3	1.50+0	1.00-1	7.65-3	1.50+0	1.20-1	2.10-2	1.48+0	
1.40-1	4.77-2	1.50+0	1.60-1	8.42-2	1.36+0	1.80-1	1.50-1	1.37+0	
2.00-1	2.41-1	1.34+0	4.08-1	3.25+0	7.91-1	5.10-1	6.60+0	6.46-1	
6.12-1	1.25+1	5.96-1	7.14-1	2.30+1	6.10-1	8.16-1	3.78+1	6.14-1	
1.02+0	8.47+1	6.35-1	1.12+0	1.17+2	6.46-1	1.22+0	1.54+2	6.53-1	
1.43+0	2.48+2	6.58-1	1.63+0	3.62+2	6.73-1	1.84+0	4.95+2	6.80-1	
2.04+0	6.46+2	7.01-1	2.24+0	8.20+2	7.26-1	2.35+0	9.15+2	7.37-1	
2.45+0	1.02+3	7.56-1	2.55+0	1.14+3	7.84-1	2.65+0	1.25+3	8.02-1	
2.85+0	1.49+3	8.43-1	2.96+0	1.59+3	8.46-1	3.06+0	1.68+3	8.47-1	
3.16+0	1.76+3	8.45-1	3.26+0	1.85+3	8.48-1	3.67+0	2.18+3	8.49-1	
4.08+0	2.44+3	8.37-1	4.69+0	2.76+3	8.18-1	5.51+0	3.10+3	8.01-1	
5.92+0	3.17+3	7.78-1							
1.00+0	1.00+2	8.00-1	1.50+0	4.41+2	1.02+0	2.00+0	9.42+2	1.07+0	54
2.50+0	1.57+3	1.12+0	3.00+0	2.19+3	1.14+0	3.50+0	2.89+3	1.20+0	
4.00+0	3.52+3	1.23+0	4.50+0	4.18+3	1.29+0	5.00+0	4.83+3	1.35+0	
2.50+0	1.10+3	7.84-1	3.20+0	1.80+3	8.49-1	3.25+0	2.00+3	9.21-1	96
4.00+0	2.39+3	8.38-1	4.90+0	2.60+3	7.40-1				
4.00+0	2.17+3	7.61-1	6.00+0	3.30+3	8.03-1	8.00+0	3.91+3	8.24-1	97
1.00+1	4.15+3	8.22-1	1.20+1	4.28+3	8.33-1	1.60+1	4.12+3	8.19-1	
2.00+1	3.93+3	8.20-1	2.40+1	3.58+3	7.92-1	2.80+1	3.38+3	7.95-1	
3.00+1	3.30+3	7.99-1							
1.00+0	1.13+2	9.04-1	1.80+0	6.64+2	9.61-1				110
14	Silcon		Fluorescence yield = 0.05						
2.90+0	1.40+2	**1.12-1**	3.55+0	2.00+2	**1.13-1**	3.90+0	2.50+2	**1.23-1**	15
4.45+0	3.10+2	**1.28-1**	4.80+0	3.50+2	**1.32-1**	5.30+0	4.10+2	**1.39-1**	
16	Sulfur		Fluorescence yield = 0.078						
1.10+1	4.20+3	1.22+0	1.60+1	4.82+3	1.24+0	2.10+1	4.45+3	1.12+0	109
2.70+1	4.18+3	1.08+0							
17	Chlorine		Fluorescence yield = 0.097						
1.20+1	3.45+3	1.08+0	2.50+1	4.60+3	1.22+0	3.00+1	4.46+3	1.21+0	31
4.00+1	3.69+3	1.07+0							
1.10+1	3.10+3	1.03+0	1.60+1	4.20+3	1.17+0	2.10+1	3.70+3	9.83-1	109
2.70+1	4.45+3	1.19+0							

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
8.00-1	1.24+1	1.92+0	1.00+0	2.80+1	1.87+0	1.20+0	4.72+1	1.63+0	123
1.40+0	7.56+1	1.53+0	1.60+0	1.04+2	1.36+0	1.80+0	1.52+2	1.37+0	
2.00+0	2.19+2	1.43+0	2.20+0	2.54+2	1.26+0	2.40+0	2.97+2	1.16+0	
2.60+0	4.55+2	1.43+0	2.80+0	5.04+2	1.32+0				
18	Argon		Fluorescence yield = 0.118						
3.00-1	4.15-2	6.65-1	5.00-1	4.59-1	7.58-1	8.00-1	3.11+0	7.69-1	82
1.00+0	6.60+0	6.97-1	1.20+0	1.20+1	6.51-1				
19	Potassium		Fluorescence yield = 0.14						
1.10+1	2.54+3	1.16+0	1.60+1	3.20+3	1.12+0	2.10+1	3.69+3	1.17+0	109
2.70+1	3.78+3	1.14+0							
20	Calcium		Fluorescence yield = 0.163						
1.50+0	2.00+1	1.16+0	2.00+0	5.00+1	1.10+0	3.00+0	1.80+2	1.16+0	38
4.00+0	3.70+2	1.13+0	5.00+0	6.40+2	1.18+0	6.00+0	8.60+2	1.11+0	
7.00+0	1.00+3	9.92-1	8.00+0	1.30+3	1.05+0	9.00+0	1.40+3	9.66-1	
1.00+1	1.60+3	9.72-1	1.10+1	1.80+3	9.85-1	1.20+1	1.90+3	9.55-1	
6.00+0	7.24+2	9.36-1	9.00+0	1.48+3	1.02+0	1.20+1	2.14+3	1.08+0	94
1.50+1	2.62+3	1.10+0	1.80+1	2.97+3	1.12+0				
8.00-1	2.41+0	1.47+0	1.00+0	5.00+0	1.28+0	1.20+0	1.00+1	1.30+0	123
1.40+0	1.76+1	1.30+0	1.60+0	2.90+1	1.34+0	1.80+0	4.27+1	1.32+0	
2.00+0	6.15+1	1.35+0	2.20+0	8.64+1	1.39+0	2.40+0	1.05+2	1.29+0	
2.60+0	1.41+2	1.37+0	2.80+0	1.70+2	1.33+0				
8.00-1	1.51+0	9.23-1	1.00+0	3.34+0	8.57-1	1.20+0	6.68+0	8.65-1	133
1.40+0	1.13+1	8.37-1	1.60+0	1.76+1	8.16-1	1.80+0	2.45+1	7.60-1	
2.00+1	3.18+3	1.14+0	2.40+1	3.36+3	1.14+0	2.80+1	3.50+3	1.15+0	136
21	Scandium		Fluorescence yield = 0.188						
8.00-1	1.07+0	1.00+0	1.00+0	2.53+0	9.85-1	1.20+0	4.62+0	9.02-1	133
1.40+0	8.49+0	9.41-1	1.60+0	1.38+1	9.51-1	1.80+0	2.03+1	9.30-1	
2.00+1	2.85+3	1.15+0	2.40+1	3.21+3	1.20+0	2.80+1	3.32+3	1.19+0	136
22	Titanium		Fluorescence yield = 0.214						
2.90+0	2.40+1	**3.39-1**	3.90+0	5.30+1	**3.24-1**	4.80+0	9.10+1	**3.29-1**	14
5.30+0	1.16+2	**3.34-1**							
1.20+1	1.41+3	1.01+0	2.50+1	2.89+3	1.19+0	3.00+1	3.17+3	1.23+0	31
4.00+1	3.40+3	1.27+0							
1.50+0	8.80+0	1.11+0	2.00+0	2.50+1	1.16+0	3.00+0	8.80+1	1.12+0	38
4.00+0	2.00+2	1.14+0	5.00+0	3.30+2	1.08+0	6.00+0	5.70+2	1.25+0	
7.00+0	6.60+2	1.07+0	8.00+0	8.50+2	1.09+0	9.00+0	8.80+2	9.31-1	
1.00+1	1.20+3	1.09+0	1.10+1	1.40+3	1.12+0	1.20+1	1.70+3	1.22+0	

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
2.00+1	2.40+3	1.10+0							42
5.00-1	1.21-1	1.25+0	6.00-1	2.61-1	1.21+0	7.00-1	4.91-1	1.19+0	67
8.00-1	8.48-1	1.19+0	9.00-1	1.33+0	1.17+0	1.00+0	2.00+0	1.16+0	
1.10+0	2.87+0	1.15+0	1.20+0	3.83+0	1.10+0	1.30+0	5.15+0	1.10+0	
1.40+0	6.57+0	1.07+0	1.50+0	8.42+0	1.07+0	1.60+0	1.03+1	1.04+0	
1.70+0	1.29+1	1.05+0	1.80+0	1.47+1	9.78-1	1.90+0	1.82+1	1.01+0	
2.00+0	2.17+1	1.01+0	2.10+0	2.40+1	9.46-1	2.20+0	2.85+1	9.62-1	
2.30+0	3.22+1	9.41-1	2.40+0	3.70+1	9.42-1				
5.00-1	1.10-1	1.14+0	6.00-1	2.70-1	1.26+0	7.00-1	5.00-1	1.21+0	72
8.00-1	7.00-1	9.83-1	9.00-1	8.50-1	7.45-1	1.00+0	1.30+0	7.53-1	
1.10+0	2.10+0	8.42-1	1.20+0	3.00+0	8.65-1	1.30+0	3.80+0	8.13-1	
1.40+0	5.10+0	8.30-1	1.50+0	6.50+0	8.23-1	1.60+0	8.50+0	8.55-1	
1.70+0	1.00+1	8.12-1	1.80+0	1.20+1	7.99-1	1.90+0	1.50+1	8.29-1	
2.00+0	1.90+1	8.81-1	2.10+0	2.20+1	8.67-1	2.20+0	2.60+1	8.78-1	
2.30+0	2.90+1	8.47-1	2.40+0	3.10+1	7.89-1	2.50+0	3.90+1	8.72-1	
1.00+0	2.63+0	1.52+0	1.10+0	3.37+0	1.35+0	1.30+0	5.43+0	1.16+0	78
1.50+0	7.80+0	9.88-1	1.70+0	1.15+1	9.34-1	1.90+0	1.83+1	1.01+0	
2.10+0	2.28+1	8.98-1	2.20+0	3.06+1	1.03+0	2.30+0	3.49+1	1.02+0	
2.40+0	4.02+1	1.02+0	2.50+0	4.51+1	1.01+0	2.60+0	4.67+1	9.23-1	
2.70+0	5.67+1	9.96-1	2.80+0	6.38+1	1.00+0	2.90+0	7.01+1	9.91-1	
3.00+0	7.75+1	9.90-1	3.10+0	8.45+1	9.79-1	3.20+0	9.08+1	9.60-1	
3.30+0	1.00+2	9.67-1	3.40+0	1.11+2	9.86-1	3.50+0	1.19+2	9.76-1	
3.60+0	1.23+2	9.34-1	3.70+0	1.34+2	9.45-1	3.80+0	1.46+2	9.58-1	
3.90+0	1.58+2	9.66-1	4.00+0	1.69+2	9.64-1	4.10+0	1.75+2	9.37-1	
4.20+0	1.90+2	9.57-1	4.30+0	2.04+2	9.68-1	4.40+0	2.03+2	9.09-1	
2.50+0	5.70+1	1.27+0	3.20+0	1.00+2	1.06+0	3.25+0	1.10+2	1.11+0	96
4.00+0	1.79+2	1.02+0	4.90+0	2.50+2	8.62-1				
1.00+1	1.03+3	9.34-1	1.20+1	1.38+3	9.92-1	1.40+1	1.64+3	9.98-1	105
1.60+1	1.86+3	1.00+0	1.80+1	2.21+3	1.09+0	2.00+1	2.32+3	1.07+0	
2.20+1	2.50+3	1.09+0	2.40+1	2.65+3	1.11+0	2.60+1	2.72+3	1.10+0	
2.80+1	2.80+3	1.11+0	3.00+1	2.96+3	1.15+0				
2.30-1	3.92-4	**2.23-1**	2.50-1	8.54-4	**2.95-1**	2.80-1	1.89-3	3.42-1	118
3.00-1	3.21-3	4.00-1	3.50-1	8.62-3	4.82-1	4.00-1	1.93-2	5.62-1	
5.00-1	6.57-2	6.81-1	6.00-1	1.59-1	7.40-1	7.00-1	3.15-1	7.64-1	
8.00-1	5.56-1	7.81-1							
8.00-1	7.80-1	1.09+0	1.00+0	1.81+0	1.05+0	1.20+0	3.34+0	9.63-1	133
1.40+0	5.72+0	9.31-1	1.60+0	9.15+0	9.20-1	1.80+0	1.33+1	8.85-1	
2.00+1	2.36+3	1.08+0	2.40+1	2.72+3	1.14+0	2.80+1	2.88+3	1.14+0	136
7.76-1	6.02-1	9.56-1	9.16-1	1.03+0	8.41-1	1.05+0	1.45+0	6.90-1	146
1.60+0	6.69+0	6.73-1							
1.50+0	4.66+0	5.90-1	2.02+0	1.88+1	8.43-1	2.50+0	3.24+1	7.24-1	148
3.00+0	5.56+1	7.10-1	3.50+0	9.01+1	7.39-1				

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
4.50-1	8.07-2	1.35+0	5.00-1	1.30-1	1.35+0	5.50-1	1.95-1	1.32+0	153
6.00-1	2.78-1	1.29+0	6.50-1	3.84-1	1.27+0	7.00-1	5.14-1	1.25+0	
7.50-1	6.73-1	1.23+0	8.00-1	8.64-1	1.21+0	8.50-1	1.09+0	1.20+0	
9.00-1	1.36+0	1.19+0	1.00+0	2.02+0	1.17+0	1.10+0	2.88+0	1.15+0	
1.20+0	3.97+0	1.14+0	1.30+0	5.31+0	1.14+0	1.40+0	6.93+0	1.13+0	
1.50+0	8.88+0	1.12+0	1.60+0	1.12+1	1.13+0	1.80+0	1.69+1	1.12+0	
2.00+0	2.45+1	1.14+0	2.20+0	3.42+1	1.15+0	2.40+0	4.65+1	1.18+0	
2.60+0	6.17+1	1.22+0	2.80+0	8.03+1	1.26+0	3.00+0	1.03+2	1.32+0	
7.00-1	4.82-1	1.17+0	8.00-1	8.23-1	1.16+0	9.00-1	1.21+0	1.06+0	160
1.00+0	1.83+0	1.06+0	1.20+0	3.57+0	1.03+0	1.40+0	6.29+0	1.02+0	
1.60+0	1.03+1	1.04+0	2.00+0	2.09+1	9.70-1	2.40+0	3.72+1	9.47-1	
23	Vanadium		Fluorescence yield = 0.243						
1.00+0	1.47+0	1.24+0	1.25+0	2.60+0	9.31-1	1.50+0	4.30+0	7.83-1	54
1.75+0	7.00+0	7.34-1	2.00+0	9.79+0	6.45-1	2.50+0	1.62+1	5.08-1	
3.00+0	2.73+1	4.83-1	3.50+0	4.00+1	**4.48-1**	4.00+0	5.82+0	**4.50-2**	
4.50+0	7.59+0	**4.29-2**							
5.00-1	7.40-2	1.16+0	6.00-1	1.81-1	1.26+0	7.00-1	3.36-1	1.21+0	67
8.00-1	5.83-1	1.21+0	9.00-1	9.47-1	1.22+0	1.00+0	1.39+0	1.17+0	
1.10+0	2.07+0	1.21+0	1.20+0	2.69+0	1.12+0	1.30+0	3.66+0	1.13+0	
1.40+0	4.90+0	1.15+0	1.50+0	6.02+0	1.10+0	1.60+0	7.59+0	1.09+0	
1.70+0	9.34+0	1.08+0	1.80+0	1.13+1	1.07+0	1.90+0	1.37+1	1.08+0	
2.00+0	1.62+1	1.07+0	2.10+0	1.90+1	1.06+0	2.20+0	2.13+1	1.02+0	
2.30+0	2.60+1	1.07+0	2.40+0	2.87+1	1.03+0				
1.00+0	1.21+0	1.02+0	2.20+0	1.97+1	9.39-1	2.30+0	2.26+1	9.30-1	78
2.40+0	2.59+1	9.26-1	2.50+0	2.96+1	9.28-1	2.60+0	2.96+1	8.18-1	
2.70+0	3.70+1	9.07-1	2.80+0	4.15+1	9.08-1	2.90+0	4.54+1	8.90-1	
3.00+0	5.00+1	8.84-1	3.10+0	5.51+1	8.82-1	3.20+0	5.93+1	8.63-1	
3.30+0	6.46+1	8.58-1	3.40+0	6.86+1	8.35-1	3.50+0	7.71+1	8.63-1	
3.60+0	8.37+1	8.64-1	3.70+0	9.01+1	8.61-1	3.80+0	9.70+1	8.61-1	
3.90+0	1.05+2	8.69-1	4.00+0	1.12+2	8.66-1	4.10+0	1.11+2	8.03-1	
4.20+0	1.25+2	8.47-1	4.30+0	1.36+2	8.65-1	4.40+0	1.38+2	8.25-1	
8.00-1	5.39-1	1.11+0	1.00+0	1.28+0	1.08+0	1.20+0	2.42+0	1.01+0	133
1.40+0	4.20+0	9.86-1	1.60+0	7.06+0	1.02+0	1.80+0	1.03+1	9.77-1	
2.00+1	2.04+3	1.06+0	2.40+1	2.38+3	1.11+0	2.80+1	2.68+3	1.17+0	136
24	Chromium		Fluorescence yield = 0.275						
2.90+0	1.50+1	**4.04-1**	3.55+0	2.60+1	**3.78-1**	3.90+0	3.40+1	**3.77-1**	14
4.80+0	7.10+1	**4.48-1**	5.30+0	8.10+1	**3.99-1**				
5.00-1	5.30-2	1.25+0	6.00-1	1.25-1	1.29+0	7.00-1	2.38-1	1.25+0	67
8.00-1	4.25-1	1.28+0	9.00-1	6.61-1	1.22+0	1.00+0	1.03+0	1.25+0	
1.10+0	1.45+0	1.21+0	1.20+0	1.96+0	1.17+0	1.30+0	2.67+0	1.17+0	
1.40+0	3.51+0	1.17+0	1.50+0	4.24+0	1.09+0	1.60+0	5.24+0	1.07+0	
1.70+0	6.97+0	1.14+0	1.80+0	8.28+0	1.10+0	1.90+0	9.92+0	1.09+0	
2.00+0	1.15+1	1.06+0	2.10+0	1.35+1	1.05+0	2.20+0	1.58+1	1.05+0	
2.30+0	1.83+1	1.05+0	2.40+0	1.99+1	9.87-1				

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
9.00-1	1.10+0	2.04+0	1.10+0	2.09+0	1.74+0	1.30+0	4.15+0	1.83+0	80
1.50+0	5.75+0	1.48+0	1.70+0	9.93+0	1.62+0	1.90+0	1.40+1	1.54+0	
2.10+0	2.13+1	1.66+0	2.30+0	2.56+1	1.46+0	2.50+0	3.32+1	1.44+0	
2.70+0	4.70+1	1.59+0	2.90+0	5.40+1	1.45+0	3.10+0	7.46+1	1.63+0	
3.30+0	8.86+1	1.60+0	3.50+0	1.13+2	1.71+0	3.70+0	1.22+2	1.57+0	
3.90+0	1.56+2	1.73+0	4.10+0	1.91+2	1.84+0				
6.00+0	2.91+2	1.07+0	9.00+0	6.75+2	1.09+0	1.20+1	1.17+3	1.20+0	94
1.50+1	1.51+3	1.17+0	1.80+1	1.76+3	1.14+0				
8.00-1	4.02-1	1.21+0	1.00+0	9.17-1	1.12+0	1.20+0	1.80+0	1.07+0	133
1.40+0	3.06+0	1.02+0	1.60+0	4.90+0	9.98-1	1.80+0	6.96+0	9.28-1	
2.00+1	1.86+3	1.10+0	2.40+1	2.18+3	1.14+0	2.80+1	2.33+3	1.12+0	136
1.50+0	4.08+0	1.05+0	2.02+0	1.06+1	9.44-1	2.50+0	2.28+1	9.89-1	148
3.00+0	4.07+1	9.85-1	3.50+0	6.86+1	1.04+0				
25 Manganese			Fluorescence yield = 0.308						
1.00+0	8.14-1	1.41+0	1.10+0	1.02+0	1.21+0	1.30+0	1.66+0	1.03+0	78
1.50+0	2.50+0	9.07-1	1.70+0	3.54+0	8.11-1	1.90+0	6.27+0	9.63-1	
2.20+0	1.08+1	9.94-1	2.30+0	1.23+1	9.73-1	2.40+0	1.35+1	9.24-1	
2.50+0	1.61+1	9.62-1	2.60+0	1.59+1	8.33-1	2.70+0	1.98+1	9.17-1	
2.80+0	2.22+1	9.13-1	2.90+0	2.47+1	9.08-1	3.00+0	2.88+1	9.50-1	
3.10+0	3.01+1	8.96-1	3.20+0	3.19+1	8.59-1	3.30+0	3.53+1	8.65-1	
3.40+0	3.84+1	8.58-1	3.50+0	4.25+1	8.70-1	3.60+0	4.60+1	8.65-1	
3.70+0	4.94+1	8.56-1	3.80+0	5.43+1	8.70-1	3.90+0	5.57+1	8.27-1	
4.00+0	6.20+1	8.56-1	4.10+0	6.74+1	8.67-1	4.20+0	7.19+1	8.63-1	
4.30+0	7.76+1	8.72-1	4.40+0	8.36+1	8.81-1				
8.00-1	2.70-1	1.17+0	1.00+0	6.73-1	1.17+0	1.20+0	1.31+0	1.11+0	133
1.40+0	2.20+0	1.03+0	1.60+0	3.57+0	1.02+0	1.80+0	5.35+0	9.97-1	
26 Iron			Fluorescence yield = 0.34						
2.90+0	1.20+1	6.02-1	3.55+0	2.00+1	5.29-1	3.90+0	2.50+1	4.98-1	14
4.80+0	4.40+1	4.84-1	5.30+0	5.80+1	4.90-1				
3.00+1	2.55+3	1.47+0	4.00+1	2.59+3	1.32+0	5.00+1	2.66+3	1.30+0	24
6.00+1	2.75+3	1.33+0	7.00+1	2.77+3	1.35+0	8.00+1	2.58+3	1.29+0	
2.00+0	7.00+0	1.24+0	3.00+0	2.50+1	1.12+0	4.00+0	6.60+1	1.22+0	38
5.00+0	1.10+2	1.08+0	6.00+0	1.70+2	1.05+0	7.00+0	2.50+2	1.07+0	
8.00+0	3.40+2	1.08+0	9.00+0	4.20+2	1.05+0	1.00+1	5.20+2	1.07+0	
1.10+1	6.30+2	1.09+0	1.20+1	6.90+2	1.04+0				
2.00+1	1.30+3	1.02+0							42
3.00+1	2.18+3	1.26+0							49

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
1.00+0	4.14-1	1.02+0	1.50+0	1.76+0	8.93-1	2.00+0	4.86+0	8.64-1	54
2.50+0	1.02+1	8.37-1	3.00+0	1.94+1	8.71-1	3.50+0	3.03+1	8.37-1	
4.00+0	4.31+1	7.96-1	4.50+0	5.68+1	7.47-1	5.00+0	8.41+1	8.29-1	
1.00+0	4.53-1	1.12+0	2.20+0	7.48+0	9.51-1	2.30+0	8.66+0	9.44-1	78
2.40+0	9.86+0	9.29-1	2.50+0	1.10+1	9.03-1	2.60+0	1.17+1	8.41-1	
2.70+0	1.41+1	8.94-1	2.80+0	1.59+1	8.94-1	2.90+0	1.79+1	8.98-1	
3.00+0	1.93+1	8.67-1	3.10+0	2.15+1	8.69-1	3.20+0	2.34+1	8.56-1	
3.30+0	2.65+1	8.79-1	3.40+0	2.99+1	9.04-1	3.50+0	3.33+1	9.20-1	
3.60+0	3.59+1	9.10-1	3.70+0	3.89+1	9.07-1	3.80+0	4.14+1	8.91-1	
3.90+0	4.77+1	9.50-1	4.00+0	4.94+1	9.13-1	4.10+0	5.21+1	8.95-1	
4.20+0	5.66+1	9.07-1	4.30+0	6.00+1	8.98-1	4.40+0	6.12+1	8.58-1	
3.20+0	3.20+1	1.17+0	3.25+0	3.50+1	1.22+0	4.00+0	6.33+1	1.17+0	96
4.90+0	8.40+1	8.74-1							
1.00+1	4.56+2	9.36-1	1.20+1	6.59+2	9.89-1	1.40+1	8.74+2	1.04+0	105
1.60+1	1.05+3	1.05+0	1.80+1	1.34+3	1.17+0	2.00+1	1.35+3	1.06+0	
2.20+1	1.56+3	1.12+0	2.40+1	1.70+3	1.14+0	2.60+1	1.80+3	1.14+0	
2.80+1	1.85+3	1.11+0	3.00+1	1.85+3	1.07+0				
2.80-1	1.32-4	**1.78-1**	3.00-1	2.84-4	**2.47-1**	3.50-1	9.70-4	**3.35-1**	118
4.00-1	2.96-3	4.87-1	5.00-1	1.31-2	6.86-1	6.00-1	3.63-2	8.06-1	
7.00-1	7.96-2	8.83-1	8.00-1	1.49-1	9.28-1				
8.00-1	2.06-1	1.28+0	1.00+0	4.86-1	1.20+0	1.20+0	1.01+0	1.21+0	133
1.40+0	1.38+0	9.10-1	1.60+0	2.69+0	1.07+0	1.80+0	4.07+0	1.06+0	
4.50-1	1.40-2	1.24+0	5.00-1	2.50-2	1.31+0	5.50-1	4.03-2	1.34+0	153
6.00-1	6.07-2	1.35+0	6.50-1	8.70-2	1.34+0	7.00-1	1.20-1	1.33+0	
7.50-1	1.61-1	1.32+0	8.00-1	2.11-1	1.31+0	8.50-1	2.70-1	1.30+0	
9.00-1	3.40-1	1.29+0	1.00+0	5.17-1	1.27+0	1.10+0	7.48-1	1.26+0	
1.20+0	1.04+0	1.24+0	1.30+0	1.40+0	1.22+0	1.40+0	1.83+0	1.21+0	
1.50+0	2.34+0	1.19+0	1.60+0	2.93+0	1.17+0	1.80+0	4.38+0	1.14+0	
2.00+0	6.22+0	1.11+0	2.20+0	8.47+0	1.08+0	2.40+0	1.12+1	1.06+0	
2.60+0	1.43+1	1.03+0	2.80+0	1.80+1	1.01+0	3.00+0	2.22+1	9.97-1	
27 Cobalt			Fluorescence yield = 0.373						
2.00+0	6.50+0	1.58+0	2.50+0	1.30+1	1.45+0	3.00+0	2.30+1	1.40+0	38
3.50+0	3.80+1	1.41+0	4.00+0	5.70+1	1.40+0	4.50+0	7.60+1	1.32+0	
5.00+0	1.05+2	1.35+0	6.00+0	1.60+2	1.27+0	7.00+0	2.00+2	1.09+0	
8.00+0	2.70+2	1.08+0	9.00+0	3.60+2	1.12+0	1.00+1	4.60+2	1.17+0	
1.10+1	5.00+2	1.06+0	1.20+1	6.10+2	1.12+0				
2.00+1	1.10+3	1.00+0							42
1.00+0	3.99-1	1.38+0	1.10+0	6.19-1	1.46+0	1.30+0	9.75-1	1.19+0	78
1.50+0	1.47+0	1.04+0	1.70+0	2.12+0	9.35-1	1.90+0	3.39+0	9.95-1	
2.20+0	5.31+0	9.23-1	2.30+0	6.00+0	8.93-1	2.40+0	6.80+0	8.74-1	
2.50+0	7.83+0	8.74-1	2.60+0	9.69+0	9.47-1	2.70+0	9.86+0	8.49-1	
2.80+0	1.11+1	8.46-1	2.90+0	1.23+1	8.35-1	3.00+0	1.36+1	8.25-1	
3.10+0	1.48+1	8.07-1	3.20+0	1.62+1	7.98-1	3.30+0	1.79+1	7.98-1	
3.40+0	1.97+1	8.00-1	3.50+0	2.16+1	8.00-1	3.60+0	2.31+1	7.84-1	

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
3.70+0	2.52+1	7.86-1	3.80+0	2.72+1	7.81-1	3.90+0	2.95+1	7.83-1	
4.00+0	3.22+1	7.91-1	4.10+0	3.40+1	7.76-1	4.20+0	3.69+1	7.84-1	
4.30+0	3.92+1	7.77-1	4.40+0	4.35+1	8.07-1				
8.00-1	1.36-1	1.20+0	1.00+0	3.30-1	1.14+0	1.20+0	6.77-1	1.13+0	133
1.40+0	1.22+0	1.12+0	1.60+0	1.91+0	1.05+0	1.80+0	2.81+0	1.00+0	
1.50+0	1.15+0	8.10-1	2.02+0	3.26+0	7.67-1	2.50+0	6.72+0	7.50-1	148
3.00+0	1.23+1	7.46-1	3.20+0	1.55+1	7.63-1	3.50+0	1.98+1	7.33-1	
28	Nickel		Fluorescence yield = 0.406						
2.90+0	8.40+0	7.69-1	3.55+0	1.30+1	6.15-1	3.90+0	1.50+1	5.29-1	14
4.80+0	2.50+1	**4.75-1**	5.30+0	3.50+1	5.02-1				
3.00+1	1.71+3	1.25+0	4.00+1	1.85+3	1.15+0	5.00+1	2.05+3	1.19+0	24
6.00+1	2.30+3	1.29+0	7.00+1	2.34+3	1.30+0	8.00+1	2.33+3	1.31+0	
2.00+0	2.30+0	7.67-1	3.00+0	9.10+0	7.44-1	4.00+0	2.30+1	7.51-1	38
5.00+0	5.00+1	8.45-1	6.00+0	8.50+1	8.76-1	7.00+0	1.10+2	7.65-1	
8.00+0	1.70+2	8.62-1	9.00+0	2.00+2	7.82-1	1.00+1	2.60+2	8.17-1	
1.10+1	2.90+2	7.59-1	1.20+1	3.30+2	7.37-1				
1.50+0	6.60-1	6.41-1	2.00+0	1.40+0	**4.67-1**	2.50+0	3.70+0	5.61-1	43
3.00+0	7.40+0	6.05-1	3.50+0	1.10+1	5.45-1	4.00+0	1.80+1	5.88-1	
5.00+1	2.07+3	1.20+0	6.00+1	2.30+3	1.29+0	7.00+1	2.33+3	1.30+0	49
8.00+1	2.21+3	1.24+0	9.00+1	2.23+3	1.27+0	1.00+2	2.12+3	1.24+0	
1.00+0	2.07-1	1.01+0	2.20+0	3.95+0	9.36-1	2.30+0	4.52+0	9.16-1	78
2.40+0	4.97+0	8.67-1	2.50+0	5.80+0	8.79-1	2.60+0	6.66+0	8.82-1	
2.70+0	7.32+0	8.52-1	2.80+0	8.21+0	8.45-1	2.90+0	9.08+0	8.31-1	
3.00+0	1.02+1	8.34-1	3.10+0	1.10+1	8.07-1	3.20+0	1.20+1	7.93-1	
3.30+0	1.34+1	8.02-1	3.40+0	1.46+1	7.94-1	3.50+0	1.61+1	7.97-1	
3.60+0	1.76+1	7.97-1	3.70+0	1.92+1	7.98-1	3.80+0	2.09+1	7.99-1	
3.90+0	2.17+1	7.66-1	4.00+0	2.43+1	7.93-1	4.10+0	2.61+1	7.90-1	
4.20+0	2.81+1	7.91-1	4.30+0	2.97+1	7.79-1	4.40+0	3.24+1	7.94-1	
5.20+0	5.69+1	8.61-1	1.65+1	6.62+2	8.96-1	2.70+1	1.18+3	9.35-1	83
5.00+0	4.00+1	6.76-1							89
4.00+0	2.43+1	7.93-1	6.00+0	8.13+1	8.38-1	8.00+0	1.78+2	9.03-1	97
1.00+1	2.82+2	8.86-1	1.20+1	4.11+2	9.17-1	1.60+1	6.16+2	8.69-1	
2.00+1	8.77+2	9.32-1	2.40+1	1.08+3	9.48-1	2.80+1	1.25+3	9.62-1	
3.00+1	1.30+3	9.51-1							
1.10+1	4.61+2	1.21+0	1.60+1	7.32+2	1.03+0	2.10+1	1.06+3	1.07+0	109
2.70+1	1.32+3	1.05+0							
2.00-1	6.90-6	4.12-1	2.10-1	1.10-5	4.19-1	2.20-1	1.90-5	4.79-1	120
2.40-1	4.70-5	5.72-1	2.60-1	8.50-5	5.54-1	2.80-1	1.50-4	5.66-1	
3.00-1	2.50-4	5.83-1							

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
8.00-1	9.44-2	1.19+0	1.00+0	2.42-1	1.18+0	1.20+0	5.22-1	1.21+0	133
1.40+0	9.94-1	1.26+0	1.60+0	1.61+0	1.23+0	1.80+0	2.38+0	1.17+0	
29	Copper		Fluorescence yield = 0.44						
7.00-1	8.87-3	**2.87-1**	8.00-1	1.45-2	**2.56-1**	9.00-1	2.78-2	**2.93-1**	4
1.00+0	4.05-2	**2.73-1**							
2.90+0	3.60+0	**4.39-1**	3.55+0	6.40+0	**4.01-1**	3.90+0	8.70+0	**4.05-1**	14
4.80+0	1.70+1	**4.21-1**	5.30+0	2.70+1	5.03-1				
3.00+1	1.39+3	1.15+0	4.00+1	1.72+3	1.19+0	5.00+1	1.86+3	1.17+0	24
6.00+1	2.17+3	1.31+0	7.00+1	2.17+3	1.29+0	8.00+1	2.22+3	1.32+0	
2.00+0	2.30+0	1.04+0	3.00+0	8.60+0	9.37-1	4.00+0	2.30+1	9.89-1	38
5.00+0	4.30+1	9.46-1	6.00+0	7.60+1	1.00+0	7.00+0	1.10+2	9.72-1	
8.00+0	1.50+2	9.57-1	9.00+0	1.90+2	9.26-1	1.00+1	2.40+2	9.33-1	
1.10+1	3.00+2	9.62-1	1.20+1	3.40+2	9.26-1				
3.00+1	1.42+3	1.18+0	4.00+1	1.76+3	1.21+0	5.00+1	2.04+3	1.29+0	49
6.00+1	2.16+3	1.31+0	7.00+1	2.11+3	1.26+0	8.00+1	2.16+3	1.29+0	
9.00+1	2.12+3	1.28+0	1.00+2	2.06+3	1.26+0				
1.00+0	1.40-1	9.43-1	1.50+0	6.56-1	8.69-1	2.00+0	1.94+0	8.74-1	54
2.50+0	4.21+0	8.56-1	3.00+0	8.15+0	8.88-1	3.50+0	1.32+1	8.66-1	
4.00+0	1.94+1	8.34-1	4.50+0	2.77+1	8.31-1	5.00+0	3.68+1	8.09-1	
1.20+1	3.15+2	8.58-1	2.00+1	9.30+2	1.16+0				59
4.00+0	2.11+1	9.07-1							62
2.00+0	2.30+0	1.04+0							68
1.00+0	2.01-1	1.35+0	1.10+0	2.70-1	1.23+0	1.30+0	4.64-1	1.07+0	78
1.50+0	7.09-1	9.39-1	1.70+0	1.02+0	8.40-1	1.90+0	1.85+0	1.01+0	
2.10+0	2.81+0	1.06+0	2.20+0	3.02+0	9.65-1	2.30+0	3.38+0	9.21-1	
2.40+0	3.74+0	8.77-1	2.50+0	4.22+0	8.58-1	2.60+0	4.70+0	8.33-1	
2.70+0	5.45+0	8.49-1	2.80+0	6.12+0	8.42-1	2.90+0	6.84+0	8.35-1	
3.00+0	7.67+0	8.36-1	3.10+0	8.32+0	8.13-1	3.20+0	8.99+0	7.90-1	
3.30+0	9.80+0	7.79-1	3.40+0	1.08+1	7.79-1	3.50+0	1.21+1	7.94-1	
3.60+0	1.35+1	8.09-1	3.70+0	1.46+1	8.02-1	3.80+0	1.59+1	8.02-1	
3.90+0	1.67+1	7.77-1	4.00+0	1.85+1	7.95-1	4.10+0	1.97+1	7.85-1	
4.20+0	2.15+1	7.95-1	4.30+0	2.27+1	7.81-1	4.40+0	2.57+1	8.25-1	
9.00-1	1.60-1	1.69+0	1.00+0	1.60-1	1.08+0	1.20+0	5.10-1	1.62+0	80
1.40+0	9.17-1	1.59+0	1.60+0	1.48+0	1.53+0	1.80+0	2.36+0	1.57+0	
2.00+0	3.30+0	1.49+0	2.20+0	4.65+0	1.49+0	2.40+0	6.25+0	1.47+0	
2.60+0	8.68+0	1.54+0	2.80+0	1.11+1	1.53+0	3.00+0	1.37+1	1.49+0	
3.20+0	1.82+1	1.60+0	3.40+0	2.11+1	1.52+0	3.60+0	2.72+1	1.63+0	
3.80+0	3.22+1	1.62+0	4.00+0	3.69+1	1.59+0				
5.20+0	6.40+1	1.26+0	1.65+1	6.61+2	1.06+0	2.70+1	1.08+3	9.80-1	83

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
6.00+0	7.42+1	9.79-1	9.00+0	1.92+2	9.36-1	1.20+1	3.67+2	1.00+0	94
1.50+1	5.55+2	1.03+0	1.80+1	7.22+2	1.03+0				
7.10-1	3.31-2	1.00+0	9.10-1	9.07-2	9.11-1	1.11+0	1.93-1	8.44-1	99
1.31+0	3.79-1	8.51-1	1.41+0	4.92-1	8.29-1	1.50+0	6.35-1	8.41-1	
1.71+0	1.05+0	8.45-1							
3.00-1	4.83-5	**1.84-1**	4.00-1	6.19-4	3.65-1	5.00-1	2.81-3	4.76-1	103
6.00-1	9.10-3	6.09-1	7.00-1	2.17-2	7.02-1	8.00-1	4.84-2	8.54-1	
1.00+1	2.36+2	9.18-1	1.20+1	3.65+2	9.94-1	1.40+1	4.90+2	1.02+0	105
1.60+1	6.36+2	1.07+0	1.80+1	8.14+2	1.16+0	2.00+1	8.37+2	1.04+0	
2.20+1	9.75+2	1.08+0	2.40+1	1.09+3	1.10+0	2.60+1	1.18+3	1.10+0	
2.80+1	1.34+3	1.17+0	3.00+1	1.42+3	1.18+0				
1.10+1	3.68+2	1.18+0	1.60+1	7.22+2	1.21+0	2.10+1	9.32+2	1.09+0	109
2.70+1	1.20+3	1.09+0							
3.50-1	2.54-4	3.41-1	4.00-1	7.52-4	4.43-1	4.50-1	1.84-3	5.52-1	118
5.00-1	3.69-3	6.25-1	6.00-1	1.12-2	7.50-1	7.00-1	2.62-2	8.47-1	
8.00-1	4.84-2	8.54-1							
3.20-1	1.58-4	3.83-1	3.60-1	5.83-4	6.54-1	4.00-1	1.12-3	6.60-1	126
4.80-1	3.92-3	8.26-1	5.60-1	9.99-3	9.43-1	6.40-1	2.07-2	1.01+0	
7.20-1	3.69-2	1.05+0	8.00-1	5.81-2	1.02+0	1.00+0	1.42-1	9.57-1	
1.20+0	2.73-1	8.70-1							
8.00-1	6.29-2	1.11+0	1.00+0	1.67-1	1.12+0	1.20+0	3.50-1	1.12+0	133
1.40+0	6.07-1	1.05+0	1.60+0	1.00+0	1.03+0	1.80+0	1.51+0	1.00+0	
8.00-1	7.96-2	1.40+0	9.00-1	1.26-1	1.33+0	1.00+0	2.16-1	1.45+0	134
1.10+0	3.14-1	1.42+0	1.20+0	4.49-1	1.43+0	1.30+0	6.34-1	1.47+0	
1.40+0	7.88-1	1.36+0	1.50+0	1.02+0	1.35+0	1.60+0	1.19+0	1.23+0	
1.70+0	1.42+0	1.17+0	1.80+0	1.70+0	1.13+0				
1.50+0	9.60-1	1.27+0	2.02+0	3.15+0	1.37+0	2.50+0	6.55+0	1.33+0	148
3.00+0	1.23+1	1.34+0	3.50+0	2.03+1	1.33+0				
7.00-1	3.24-2	1.05+0	8.00-1	6.59-2	1.16+0	9.00-1	1.01-1	1.06+0	160
1.00+0	1.72-1	1.16+0	1.20+0	3.64-1	1.16+0	1.40+0	6.59-1	1.14+0	
1.60+0	1.03+0	1.07+0	2.00+0	2.27+0	1.02+0	2.40+0	4.13+0	9.69-1	
30	Zinc		Fluorescence yield = 0.47						
1.16+0	2.17-1	1.09+0	1.36+0	4.03-1	1.07+0	1.55+0	6.60-1	1.05+0	67
1.76+0	1.03+0	1.01+0	1.96+0	1.54+0	1.01+0	2.16+0	2.12+0	9.75-1	
2.36+0	2.96+0	9.91-1	2.46+0	3.55+0	1.02+0				
1.00+0	1.04-1	9.72-1	2.20+0	2.11+0	9.07-1	2.30+0	2.38+0	8.73-1	78
2.40+0	2.68+0	8.45-1	2.50+0	3.05+0	8.32-1	2.60+0	3.39+0	8.06-1	
2.70+0	3.94+0	8.21-1	2.80+0	4.44+0	8.16-1	2.90+0	5.01+0	8.17-1	
3.00+0	5.58+0	8.11-1	3.10+0	6.24+0	8.12-1	3.20+0	6.42+0	7.51-1	
3.30+0	7.11+0	7.51-1	3.40+0	7.74+0	7.40-1	3.50+0	8.44+0	7.35-1	

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
3.60+0	9.42+0	7.48-1	3.70+0	1.04+1	7.55-1	3.80+0	1.13+1	7.54-1	
3.90+0	1.14+1	7.00-1	4.00+0	1.23+1	6.97-1	4.10+0	1.43+1	7.50-1	
4.20+0	1.54+1	7.49-1	4.30+0	1.65+1	7.46-1	4.40+0	1.81+1	7.63-1	
31	Gallium		Fluorescence yield = 0.507						
1.29+0	2.03-1	9.08-1	1.49+0	3.66-1	9.22-1	1.69+0	6.11-1	9.46-1	67
1.90+0	9.41-1	9.35-1	2.10+0	1.36+0	9.32-1	2.30+0	1.91+0	9.40-1	
2.41+0	2.21+0	9.20-1							
1.10+1	2.45+2	1.20+0	1.60+1	6.37+2	1.54+0	2.10+1	8.29+2	1.34+0	109
2.70+1	1.18+3	1.41+0							
32	Germanium		Fluorescence yield = 0.535						
1.00+0	6.76-2	1.21+0	1.10+0	9.08-2	1.08+0	1.30+0	1.61-1	9.57-1	78
1.50+0	2.62-1	8.77-1	1.70+0	3.89-1	8.00-1	1.90+0	6.30-1	8.47-1	
2.10+0	1.05+0	9.72-1	2.20+0	1.11+0	8.65-1	2.30+0	1.30+0	8.62-1	
2.40+0	1.48+0	8.41-1	2.50+0	1.66+0	8.14-1	2.60+0	1.83+0	7.81-1	
2.70+0	2.17+0	8.10-1	2.80+0	2.42+0	7.94-1	2.90+0	2.73+0	7.93-1	
3.00+0	2.96+0	7.65-1	3.10+0	3.28+0	7.56-1	3.20+0	3.68+0	7.62-1	
3.30+0	4.08+0	7.61-1	3.40+0	4.54+0	7.66-1	3.50+0	5.17+0	7.91-1	
3.60+0	5.56+0	7.75-1	3.70+0	5.91+0	7.53-1	3.80+0	6.49+0	7.57-1	
3.90+0	6.92+0	7.42-1	4.00+0	7.59+0	7.50-1	4.10+0	8.04+0	7.33-1	
4.20+0	8.72+0	7.36-1	4.30+0	9.17+0	7.18-1	4.40+0	1.00+1	7.28-1	
5.20+0	3.47+1	1.51+0	1.65+1	4.47+2	1.24+0	2.70+1	7.75+2	1.08+0	83
8.00-1	4.19-2	**2.05+0**	9.00-1	5.99-2	1.71+0	1.00+0	8.40-2	1.51+0	134
1.10+0	1.11-1	1.32+0	1.20+0	1.63-1	1.35+0	1.30+0	2.21-1	1.31+0	
1.40+0	2.88-1	1.27+0	1.50+0	3.65-1	1.22+0	1.60+0	4.36-1	1.13+0	
1.70+0	5.72-1	1.18+0	1.80+0	7.06-1	1.17+0				
8.00-1	2.49-2	1.22+0	1.00+0	6.87-2	1.23+0	1.20+0	1.50-1	1.24+0	160
1.40+0	2.76-1	1.22+0	1.60+0	4.53-1	1.18+0	2.00+0	1.03+0	1.14+0	
2.40+0	1.87+0	1.06+0							
33	Arsenic		Fluorescence yield = 0.562						
1.36+0	1.13-1	7.61-1	1.57+0	2.21-1	8.37-1	1.77+0	3.54-1	8.41-1	67
1.87+0	4.62-1	8.89-1	1.97+0	5.76-1	9.09-1	2.07+0	6.78-1	8.89-1	
2.17+0	8.66-1	9.53-1	2.37+0	1.19+0	9.46-1	2.47+0	1.40+0	9.59-1	
34	Selenium		Fluorescence yield = 0.589						
1.18+0	6.10-2	1.01+0	1.37+0	1.13-1	9.98-1	1.58+0	1.92-1	9.53-1	67
1.78+0	3.04-1	9.45-1	1.98+0	4.95-1	1.02+0				
1.00+0	3.03-2	1.03+0	1.10+0	4.82-2	1.08+0	1.30+0	7.36-2	8.08-1	78
1.50+0	1.21-1	7.40-1	1.70+0	1.86-1	6.92-1	1.90+0	2.95-1	7.14-1	
2.10+0	3.86-1	6.39-1	2.20+0	6.65-1	9.25-1	2.30+0	8.01-1	9.46-1	
2.40+0	8.87-1	8.95-1	2.50+0	9.43-1	8.20-1	2.60+0	1.12+0	8.45-1	
2.70+0	1.30+0	8.57-1	2.80+0	1.48+0	8.56-1	2.90+0	1.62+0	8.28-1	
3.00+0	1.76+0	7.98-1	3.10+0	1.89+0	7.64-1	3.20+0	2.11+0	7.64-1	

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
3.30+0	2.62+0	8.53-1	3.40+0	3.15+0	9.26-1	3.50+0	2.84+0	7.56-1	
3.60+0	3.41+0	8.25-1	3.70+0	3.56+0	7.86-1	3.80+0	3.87+0	7.81-1	
3.90+0	4.26+0	7.88-1	4.00+0	4.92+0	8.37-1	4.10+0	5.08+0	7.97-1	
4.20+0	5.90+0	8.56-1	4.30+0	5.76+0	7.74-1	4.40+0	5.81+0	7.24-1	
1.00+1	8.94+1	1.07+0	1.20+1	1.25+2	9.78-1	1.40+1	1.79+2	1.01+0	105
1.60+1	2.44+2	1.06+0	1.80+1	3.22+2	1.13+0	2.00+1	3.70+2	1.09+0	
2.20+1	4.41+2	1.12+0	2.40+1	5.09+2	1.14+0	2.60+1	5.78+2	1.16+0	
2.80+1	6.20+2	1.14+0	3.00+1	6.79+2	1.15+0				
1.50+0	1.32-1	8.07-1	2.02+0	3.94-1	7.55-1	2.50+0	8.25-1	7.17-1	148
3.00+0	1.56+0	7.08-1	3.20+0	1.99+0	7.20-1	3.50+0	2.67+0	7.10-1	
3.60+0	2.85+0	6.90-1	3.70+0	3.04+0	6.71-1				
35	Bromine		Fluorescence yield = 0.615						
1.10+1	9.68+1	1.15+0	1.60+1	2.42+2	1.28+0	2.10+1	3.76+2	1.22+0	109
2.70+1	4.99+2	1.12+0							
37	Rubidium		Fluorescence yield = 0.667						
1.17+0	2.00-2	8.35-1	1.37+0	3.80-2	8.01-1				67
1.00+0	2.00-2	1.71+0	1.20+0	3.80-2	1.42+0	1.40+0	5.50-2	1.06+0	72
1.60+0	7.30-2	8.07-1	1.80+0	1.10-1	7.58-1	2.00+0	1.90-1	8.67-1	
2.10+0	2.20-1	8.32-1	2.20+0	2.50-1	7.92-1	2.40+0	3.80-1	8.67-1	
3.00+0	9.20-1	9.28-1	4.00+0	2.80+0	1.04+0	5.00+0	6.00+0	1.06+0	
6.00+0	1.20+1	1.20+0	7.00+0	1.70+1	1.07+0	8.00+0	2.30+1	9.81-1	
9.00+0	3.20+1	9.85-1	1.00+1	4.40+1	1.02+0	1.10+1	5.50+1	1.01+0	
1.20+1	7.00+1	1.03+0							
1.50+0	5.49-2	7.91-1	2.02+0	1.85-1	8.12-1	2.50+0	4.10-1	8.03-1	148
3.00+0	8.20-1	8.27-1	3.50+0	1.48+0	8.67-1				
39	Yttrium		Fluorescence yield = 0.71						
1.00+0	4.30-3	6.67-1	1.50+0	3.18-2	7.98-1	2.00+0	1.13-1	8.79-1	54
2.50+0	2.78-1	9.20-1	3.00+0	5.68-1	9.60-1	3.50+0	1.00+0	9.74-1	
3.75+0	1.40+0	1.07+0	4.00+0	1.71+0	1.05+0	4.25+0	2.46+0	1.23+0	
4.50+0	2.56+0	1.05+0							
1.20+1	3.60+1	8.15-1	2.00+1	1.09+2	7.92-1				59
3.00+0	7.80-1	1.32+0	4.00+0	2.10+0	1.29+0	5.00+0	4.20+0	1.22+0	95
6.00+0	7.10+0	1.15+0	8.00+0	1.60+1	1.08+0	1.00+1	3.10+1	1.12+0	
1.20+1	5.30+1	1.20+0							
1.00+1	2.63+1	9.53-1	1.20+1	4.58+1	1.04+0	1.40+1	6.40+1	9.97-1	105
1.60+1	9.24+1	1.06+0	1.80+1	1.21+2	1.08+0	2.00+1	1.49+2	1.08+0	
2.20+1	1.92+2	1.17+0	2.40+1	2.28+2	1.19+0	2.60+1	2.60+2	1.19+0	
2.80+1	2.77+2	1.13+0	3.00+1	3.06+2	1.12+0				

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
40 Zirconium			Fluorescence yield = 0.73						
3.00+1	2.27+2	9.78-1	4.00+1	3.24+2	9.47-1	5.00+1	4.23+2	9.77-1	24
6.00+1	5.51+2	1.09+0	7.00+1	5.99+2	1.07+0	8.00+1	6.42+2	1.06+0	
2.00+1	1.20+2	1.05+0							42
1.50+0	2.20-2	7.22-1	2.02+0	8.20-2	7.94-1	2.50+0	1.90-1	8.09-1	148
3.00+0	3.67-1	7.95-1	3.50+0	6.40-1	7.97-1				
41 Niobium			Fluorescence yield = 0.74						
3.00+1	1.70+2	8.61-1	4.00+1	2.37+2	8.02-1	5.00+1	3.23+2	8.52-1	24
6.00+1	3.96+2	8.87-1	7.00+1	4.75+2	9.50-1	8.00+1	5.20+2	9.61-1	
1.02+0	5.40-3	**1.36+0**	1.23+0	1.10-2	1.14+0	1.44+0	2.30-2	1.17+0	87
1.66+0	4.30-2	1.20+0	1.87+0	8.50-2	1.45+0	2.08+0	1.00-1	1.11+0	
2.29+0	1.40-1	1.07+0	2.49+0	2.00-1	1.11+0	2.70+0	2.80-1	1.15+0	
6.40-1	1.40-4	4.92-1	8.00-1	1.14-3	1.04+0	9.60-1	2.97-3	1.02+0	126
1.12+0	7.37-3	1.18+0	1.28+0	1.44-2	1.24+0	1.44+0	2.57-2	1.31+0	
1.60+0	4.04-2	1.31+0	1.80+0	7.02-2	1.40+0				
2.02+0	6.20-2	7.75-1	2.50+0	1.46-1	7.98-1	3.00+0	3.00-1	8.31-1	148
3.50+0	5.03-1	7.99-1							
42 Molybdenum			Fluorescence yield = 0.765						
2.90+0	8.20-1	**3.27+0**	5.30+0	2.10+0	1.01+0				14
2.90+0	7.90-1	**3.15+0**	3.55+0	1.20+0	**2.29+0**	3.90+0	1.40+0	1.92+0	15
4.45+0	1.60+0	1.39+0	4.80+0	1.80+0	1.21+0	5.30+0	2.00+0	9.65-1	
1.50+0	1.10-2	6.09-1	2.00+0	3.40-2	5.66-1	2.50+0	6.90-2	**4.80-1**	43
3.00+0	1.40-1	**4.92-1**	3.50+0	2.60-1	5.23-1	4.00+0	3.70-1	**4.64-1**	
1.00+0	2.00-3	7.41-1	1.50+0	1.83-2	1.01+0	2.00+0	5.81-2	9.68-1	54
2.50+0	1.43-1	9.95-1	3.00+0	2.93-1	1.03+0	3.75+0	6.40-1	1.01+0	
4.00+0	8.86-1	1.11+0	4.50+0	1.38+0	1.15+0				
1.02+0	3.30-3	1.11+0	1.23+0	8.00-3	1.08+0	1.44+0	1.70-2	1.13+0	87
1.66+0	3.10-2	1.11+0	1.87+0	4.90-2	1.07+0	2.08+0	7.80-2	1.11+0	
2.29+0	1.10-1	1.07+0	2.49+0	1.60-1	1.13+0				
3.00+0	3.30-1	1.16+0	4.00+0	9.20-1	1.15+0	5.00+0	1.80+0	1.05+0	95
6.00+0	3.40+0	1.10+0	8.00+0	7.60+0	1.00+0	1.00+1	1.50+1	1.04+0	
1.20+1	2.30+1	9.66-1							
1.00+0	2.56-3	9.49-1	1.10+0	3.52-3	8.09-1	1.20+0	5.71-3	8.63-1	134
1.30+0	9.18-3	9.63-1	1.40+0	1.19-2	8.93-1	1.50+0	1.61-2	8.91-1	
1.60+0	2.67-2	1.12+0	1.70+0	3.46-2	1.12+0	1.80+0	3.85-2	9.85-1	
2.02+0	4.90-2	7.84-1	2.50+0	1.13-1	7.86-1	3.00+0	2.32-1	8.16-1	148
3.50+0	4.00-1	8.04-1	3.80+0	5.50-1	8.26-1				

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
45	Rhodium		Fluorescence yield = 0.808						
5.20+1	2.10+2	9.01-1							8
3.00+1	9.48+1	9.09-1	4.00+1	1.47+2	8.86-1	5.00+1	2.02+2	9.08-1	24
6.00+1	2.69+2	9.91-1	7.00+1	3.29+2	1.05+0	8.00+1	3.78+2	1.09+0	
1.02+0	1.20-3	9.30-1	1.23+0	3.30-3	9.80-1	1.44+0	6.60-3	9.36-1	87
1.66+0	1.30-2	9.78-1	1.87+0	2.20-2	9.97-1	2.08+0	3.70-2	1.08+0	
2.29+0	4.50-2	8.93-1	2.49+0	7.40-2	1.06+0	2.70+0	9.90-2	1.04+0	
46	Palladium		Fluorescence yield = 0.82						
3.00+1	6.26+1	7.03-1	4.00+1	1.02+2	7.13-1	5.00+1	1.53+2	7.87-1	24
6.00+1	2.03+2	8.47-1	7.00+1	2.56+2	9.21-1	8.00+1	2.89+2	9.31-1	
1.50+0	3.98-3	5.98-1	2.02+0	1.99-2	8.25-1	2.50+0	4.99-2	8.79-1	148
3.00+0	1.04-1	9.13-1	3.20+0	1.35-1	9.33-1	3.50+0	1.91-1	9.50-1	
3.60+0	2.11-1	9.47-1							
47	Silver		Fluorescence yield = 0.831						
2.70+1	5.60+1	9.05-1	3.40+1	8.40+1	8.87-1	3.90+1	1.01+2	8.49-1	8
4.40+1	1.11+2	7.78-1	5.20+1	1.35+2	7.57-1				
3.00+1	6.52+1	8.60-1	4.00+1	1.02+2	8.25-1	5.00+1	1.41+2	8.30-1	24
6.00+1	2.16+2	1.02+0	7.00+1	2.50+2	1.01+0	8.00+1	2.96+2	1.07+0	
3.00+0	1.00-1	1.09+0	4.00+0	3.10-1	1.18+0	5.00+0	7.70-1	1.35+0	38
6.00+0	1.30+0	1.23+0	7.00+0	2.20+0	1.27+0	8.00+0	3.30+0	1.25+0	
9.00+0	4.60+0	1.21+0	1.00+1	6.30+0	1.21+0	1.10+1	7.80+0	1.14+0	
1.20+1	9.90+0	1.13+0							
1.50+0	2.01-3	**3.84-1**	2.00+0	9.17-3	4.98-1	2.50+0	2.82-2	6.20-1	54
3.00+0	6.46-2	7.06-1	3.50+0	1.20-1	7.41-1	4.00+0	1.66-1	6.33-1	
4.50+0	2.54-1	6.40-1	5.00+0	4.03-1	7.06-1				
5.20+0	9.10-1	1.39+0	1.65+1	2.14+1	1.05+0	2.70+1	5.11+1	8.26-1	83
8.00-1	2.10-4	**1.22+0**	1.00+0	5.40-4	8.08-1	1.20+0	1.50-3	8.42-1	87
1.40+0	3.60-3	9.45-1	1.60+0	6.30-3	8.98-1	1.80+0	1.20-2	1.02+0	
2.00+0	2.00-2	1.09+0	2.20+0	2.60-2	9.53-1	2.40+0	4.30-2	1.11+0	
3.00+0	1.00-1	1.09+0	4.00+0	2.70-1	1.03+0	5.00+0	5.90-1	1.03+0	95
6.00+0	1.10+0	1.04+0	8.00+0	2.60+0	9.82-1	1.00+1	5.10+0	9.80-1	
1.20+1	8.30+0	9.45-1							
1.11+0	6.13-4	5.17-1	1.31+0	1.55-3	5.61-1	1.41+0	2.21-3	5.61-1	99
1.50+0	3.14-3	6.00-1	1.71+0	6.25-3	6.63-1				
1.10+1	7.72+0	1.13+0	1.60+1	1.89+1	9.99-1	2.10+1	3.46+1	9.54-1	109
2.70+1	5.97+1	9.65-1							

TABLE 5. K-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\text{Exper}}/\sigma^{\text{ECPSSR}}$	Ref.
6.00-1	4.56-6	**2.21-1**	8.00-1	1.10-4	6.39-1	1.00+0	5.10-4	7.63-1	126
1.20+0	1.55-3	8.70-1	1.40+0	3.68-3	9.66-1	1.60+0	6.73-3	9.59-1	
1.80+0	1.27-2	1.08+0	2.00+0	2.00-2	1.09+0	2.20+0	3.14-2	1.15+0	
2.40+0	4.63-2	1.20+0							
1.20+0	6.64-4	3.73-1	1.30+0	1.43-3	5.37-1	1.40+0	2.28-3	5.99-1	134
1.50+0	2.97-3	5.68-1	1.60+0	4.16-3	5.93-1	1.70+0	5.04-3	5.49-1	
1.80+0	6.50-3	5.51-1							
1.50+0	2.69-3	5.14-1	2.02+0	1.89-2	9.84-1	2.50+0	3.89-2	8.56-1	148
3.00+0	8.18-2	8.94-1	3.20+0	1.13-1	9.70-1	3.50+0	1.43-1	8.83-1	
3.60+0	1.65-1	9.20-1	3.70+0	1.86-1	9.39-1				
48	Cadmium		Fluorescence yield = 0.843						
1.30+0	6.22-4	**2.99-1**	1.40+0	1.26-3	4.20-1	1.42+0	1.26-3	3.93-1	111
1.44+0	1.37-3	3.99-1	1.45+0	1.53-3	4.31-1	1.46+0	1.66-3	4.53-1	
1.48+0	1.69-3	4.33-1	1.50+0	1.68-3	4.04-1	1.53+0	1.96-3	**4.32-1**	
1.55+0	2.12-3	**4.40-1**	1.60+0	2.90-3	5.21-1	1.70+0	4.09-3	5.59-1	
1.80+0	4.98-3	5.30-1	1.90+0	6.75-3	5.68-1	2.00+0	9.40-3	6.37-1	
2.10+0	1.20-2	6.63-1	2.20+0	1.38-2	6.30-1	2.30+0	1.59-2	6.06-1	
2.40+0	1.98-2	6.36-1	2.60+0	2.74-2	6.41-1	2.80+0	3.69-2	6.49-1	
2.40+0	2.45-2	7.87-1	2.60+0	3.32-2	7.77-1	2.80+0	3.70-2	6.50-1	138
49	Indium		Fluorescence yield = 0.853						
1.20+1	5.40+0	9.00-1	2.00+1	2.02+1	8.84-1				59
6.00+0	5.10-1	7.27-1	9.00+0	1.86+0	7.25-1	1.20+1	4.20+0	7.00-1	94
1.50+1	8.97+0	8.09-1	1.80+1	1.26+1	7.10-1				
50	Tin		Fluorescence yield = 0.862						
5.20+1	8.90+1	7.44-1							8
3.00+1	3.89+1	8.23-1	4.00+1	6.63+1	8.30-1	5.00+1	9.65+1	8.52-1	24
6.00+1	1.33+2	9.22-1	7.00+1	1.72+2	9.99-1	8.00+1	1.93+2	9.81-1	
2.00+1	2.00+1	1.04+0							42
3.00+1	4.08+1	8.63-1	4.00+1	7.05+1	8.83-1	5.00+1	1.05+2	9.27-1	49
6.00+1	1.32+2	9.15-1	7.00+1	1.70+2	9.88-1	8.00+1	1.89+2	9.61-1	
9.00+1	2.02+2	9.27-1	1.00+2	2.19+2	9.29-1				
1.50+0	5.21-4	**1.99-1**	2.00+0	3.41-3	**3.57-1**	2.50+0	9.88-3	**4.12-1**	54
3.00+0	2.50-2	**5.12-1**	3.50+0	4.97-2	5.71-1	4.00+0	7.15-2	**5.06-1**	
4.50+0	1.12-1	5.21-1	5.00+0	1.62-1	5.22-1				
5.20+0	3.70-1	1.04+0	1.65+1	1.51+1	1.27+0	2.70+1	3.81+1	1.00+0	83
1.00+0	1.70-4	5.71-1	1.20+0	5.30-4	6.30-1	1.40+0	1.50-3	8.04-1	87
1.60+0	2.80-3	7.89-1	1.80+0	4.60-3	7.63-1	2.00+0	8.50-3	8.90-1	
2.20+0	1.30-2	9.13-1	2.40+0	1.90-2	9.34-1				

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
3.00+0	4.80-2	9.83-1	4.00+0	1.50-1	1.06+0	5.00+0	3.20-1	1.03+0	95
6.00+0	5.80-1	1.01+0	8.00+0	1.50+0	1.03+0	1.00+1	2.80+0	9.62-1	
1.20+1	4.60+0	9.25-1							
1.40+0	1.11-4	**5.95-2**	1.50+0	3.81-4	**1.46-1**	1.58+0	6.94-4	**2.07-1**	111
1.60+0	8.84-4	**2.49-1**	1.62+0	9.36-4	**2.50-1**	1.64+0	9.97-4	**2.52-1**	
1.68+0	1.37-3	**3.10-1**	1.70+0	1.39-3	**2.98-1**	1.80+0	1.92-3	**3.19-1**	
1.90+0	3.05-3	**3.99-1**	2.00+0	3.41-3	**3.57-1**	2.10+0	4.52-3	**3.85-1**	
2.20+0	5.30-3	**3.72-1**	2.30+0	6.56-3	**3.83-1**	2.40+0	7.59-3	**3.73-1**	
2.60+0	1.16-2	**4.14-1**	2.80+0	1.50-2	**4.01-1**				
9.00+0	2.68+0	1.27+0	1.55+1	1.16+1	1.15+0	1.65+1	1.37+1	1.15+0	128
1.75+1	1.59+1	1.15+0	1.80+1	1.72+1	1.16+0	1.85+1	1.80+1	1.13+0	
1.90+1	1.98+1	1.16+0	1.95+1	2.09+1	1.16+0	2.05+1	2.45+1	1.20+0	
2.15+1	2.65+1	1.16+0	2.25+1	2.90+1	1.14+0	9.00+1	2.35+2	1.08+0	
1.00+2	2.57+2	1.09+0	1.10+2	2.69+2	1.07+0	1.20+2	2.62+2	9.93-1	
1.30+2	3.01+2	1.10+0	1.40+2	3.04+2	1.07+0	1.55+2	3.08+2	1.05+0	
2.40+0	1.11-2	5.45-1	2.60+0	1.59-2	5.68-1	2.80+0	2.16-2	5.77-1	138
2.50+0	1.90-2	7.93-1	3.00+0	3.90-2	7.99-1	3.50+0	7.20-2	8.27-1	148
51	Antimony		Fluorescence yield = 0.87						
1.20+0	4.70-4	7.15-1	1.40+0	1.30-3	8.79-1	1.60+0	2.50-3	8.80-1	87
1.80+0	4.60-3	9.48-1	2.00+0	7.30-3	9.46-1	2.20+0	1.20-2	1.04+0	
2.40+0	1.70-2	1.03+0							
8.00-1	2.03-5	4.01-1	1.00+0	1.38-4	6.07-1	1.20+0	4.46-4	6.78-1	126
1.40+0	1.18-3	7.98-1	1.60+0	2.50-3	8.80-1	1.80+0	4.85-3	1.00+0	
2.00+0	7.59-3	9.84-1	2.20+0	1.17-2	1.01+0	2.40+0	1.70-2	1.03+0	
52	Tellurium		Fluorescence yield = 0.877						
3.00+1	3.00+1	8.70-1	4.00+1	5.43+1	9.04-1	5.00+1	7.90+1	9.16-1	49
6.00+1	1.02+2	9.14-1	7.00+1	1.40+2	1.04+0	8.00+1	1.56+2	1.00+0	
2.20+0	7.97-3	8.47-1	2.40+0	1.02-2	7.55-1	2.60+0	1.45-2	7.77-1	138
2.80+0	1.71-2	6.83-1							
53	Iodine		Fluorescence yield = 0.884						
1.00+0	6.60-5	4.95-1	1.20+0	2.50-4	6.18-1	1.40+0	8.10-4	8.64-1	87
1.60+0	1.70-3	9.27-1	1.80+0	2.60-3	8.18-1	2.00+0	4.30-3	8.44-1	
2.20+0	6.50-3	8.45-1	2.40+0	1.00-2	9.04-1				
2.40+0	1.11-2	1.00+0	2.60+0	1.48-2	9.65-1				138
55	Cesium		Fluorescence yield = 0.897						
1.10+1	8.60-1	5.50-1	1.60+1	3.03+0	6.58-1	2.10+1	7.84+0	8.32-1	109
2.70+1	1.21+1	7.02-1							

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
56	Barium		Fluorescence yield = 0.902						
1.40+0	2.50-4	5.19-1	1.60+0	5.00-4	5.14-1	1.80+0	1.00-3	5.76-1	87
2.00+0	1.80-3	6.40-1	2.20+0	3.00-3	6.99-1	2.40+0	4.90-3	7.86-1	
2.40+0	4.23-3	6.79-1	2.60+0	5.71-3	6.57-1				138
58	Cerium		Fluorescence yield = 0.912						
5.20+1	5.00+1	1.20+0							8
1.40+0	1.10-4	3.52-1	1.60+0	3.10-4	4.79-1	1.80+0	5.90-4	5.02-1	87
2.00+0	1.20-3	6.22-1	2.20+0	2.00-3	6.74-1	2.40+0	3.00-3	6.92-1	
59	Praseodymium		Fluorescence yield = 0.917						
3.00+0	5.60-3	6.12-1	4.00+0	2.10-2	7.65-1	5.00+0	4.80-2	7.87-1	95
6.00+0	9.20-2	8.05-1	8.00+0	2.30-1	7.77-1	1.00+1	4.90-1	8.18-1	
1.20+1	8.10-1	7.76-1							
60	Neodymium		Fluorescence yield = 0.921						
2.00+1	2.60+0	6.84-1							42
3.00+1	6.50+0	6.24-1	4.00+1	1.58+1	8.09-1	5.00+1	2.89+1	9.61-1	49
6.00+1	3.37+1	8.23-1	7.00+1	5.01+1	9.65-1	8.00+1	6.61+1	1.06+0	
1.20+1	8.00-1	8.97-1	2.00+1	3.40+0	8.95-1				59
62	Samarium		Fluorescence yield = 0.929						
2.00+0	4.40-4	4.65-1	2.50+0	1.30-3	4.96-1	3.00+0	2.10-3	**3.73-1**	43
3.50+0	3.60-3	**3.48-1**	4.00+0	5.30-3	**3.10-1**				
3.00+0	4.30-3	7.64-1	4.00+0	1.50-2	8.77-1	5.00+0	3.40-2	8.90-1	95
6.00+0	6.40-2	8.93-1	8.00+0	1.60-1	8.63-1	1.00+1	3.20-1	8.51-1	
1.20+1	5.10-1	7.77-1							
64	Gadolinium		Fluorescence yield = 0.935						
3.00+1	4.80+0	8.03-1	4.00+1	8.80+0	7.66-1	5.00+1	1.76+1	9.70-1	49
6.00+1	2.72+1	1.07+0	7.00+1	3.28+1	1.00+0	8.00+1	3.98+1	9.95-1	
1.20+0	1.30-5	4.23-1	1.40+0	4.40-5	4.94-1	1.60+0	1.00-4	4.96-1	87
1.80+0	1.90-4	4.88-1	2.00+0	3.10-4	4.62-1	2.20+0	4.70-4	**4.43-1**	
1.33+1	7.47-1	1.12+0	1.52+1	1.12+0	1.14+0	1.83+1	1.83+0	1.10+0	140
2.03+1	2.41+0	1.09+0	2.50+1	4.55+0	1.20+0				
3.49+0	6.54-3	8.66-1	4.54+0	2.02-2	1.00+0	5.40+0	4.93-2	1.33+0	141
6.50+0	7.35-2	1.05+0	8.00+0	1.48-1	1.07+0	9.54+0	2.65-1	1.10+0	
1.10+1	3.81-1	1.01+0	1.30+1	6.68-1	1.07+0	1.51+1	1.01+0	1.06+0	

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	E_1 (MeV)	$\sigma^{\rm Exper}$ (barn)	$\sigma^{\rm Exper}/\sigma^{\rm ECPSSR}$	Ref.
67	Holmium		Fluorescence yield = 0.944						
4.00+1	8.58+0	1.10+0	5.00+1	1.55+1	1.24+0	6.00+1	1.77+1	9.95-1	90
8.00+1	2.94+1	1.02+0	1.10+2	4.25+1	9.53-1				
3.00+0	1.80-3	6.75-1	4.00+0	8.60-3	1.04+0	5.00+0	2.00-2	1.07+0	95
6.00+0	3.50-2	9.97-1	8.00+0	7.70-2	8.48-1	1.00+1	1.70-1	9.25-1	
1.20+1	2.70-1	8.41-1							
9.00+0	1.71-1	1.29+0	1.55+1	8.02-1	1.18+0	1.65+1	9.52-1	1.17+0	128
1.75+1	1.15+0	1.19+0	1.85+1	1.30+0	1.15+0	1.95+1	1.53+0	1.17+0	
2.05+1	1.79+0	1.20+0	2.15+1	1.98+0	1.16+0	2.25+1	2.24+0	1.17+0	
69	Thulium		Fluorescence yield = 0.949						
3.00+1	1.90+0	6.14-1	4.00+1	4.20+0	6.89-1	5.00+1	7.50+0	7.60-1	49
6.00+1	1.18+1	8.35-1	7.00+1	1.72+1	9.22-1	8.00+1	2.00+1	8.62-1	
1.20+1	3.00-1	1.22+0	2.00+1	1.09+0	1.02+0				59
4.00+1	6.18+0	1.01+0	5.00+1	9.94+0	1.01+0	6.00+1	1.43+1	1.01+0	90
8.00+1	2.33+1	1.00+0	1.10+2	3.53+1	9.65-1				
9.00+0	1.31-1	1.29+0	1.55+1	5.83-1	1.12+0	1.65+1	6.89-1	1.10+0	128
1.75+1	7.75-1	1.05+0	1.85+1	9.41-1	1.09+0	1.95+1	1.12+0	1.12+0	
2.05+1	1.29+0	1.12+0	2.15+1	1.54+0	1.18+0	2.25+1	1.68+0	1.14+0	
71	Lutetium		Fluorescence yield = 0.953						
4.00+1	5.04+0	1.05+0	5.00+1	8.71+0	1.12+0	6.00+1	1.24+1	1.10+0	90
8.00+1	2.00+1	1.06+0	1.10+2	3.17+1	1.05+0				
72	Hafnium		Fluorescence yield = 0.955						
3.00+0	1.10-3	8.20-1	4.00+0	4.30-3	9.90-1	5.00+0	1.00-2	1.01+0	95
6.00+0	1.90-2	1.02+0	8.00+0	4.70-2	9.80-1	1.00+1	9.50-2	9.84-1	
1.20+1	1.60-1	9.52-1							
73	Tantalum		Fluorescence yield = 0.957						
5.20+1	5.60+0	8.34-1							8
3.00+1	1.60+0	8.49-1	4.00+1	3.00+0	7.94-1	5.00+1	5.60+0	9.04-1	49
6.00+1	8.50+0	9.45-1	7.00+1	1.38+1	1.15+0	8.00+1	1.40+1	9.19-1	
4.00+1	3.87+0	1.02+0	6.00+1	8.76+0	9.74-1	8.00+1	1.51+1	9.92-1	90
1.10+2	2.45+1	9.90-1							
3.00+0	6.70-4	5.70-1	4.00+0	3.30-3	8.59-1	5.00+0	8.50-3	9.68-1	95
6.00+0	1.60-2	9.67-1	8.00+0	4.00-2	9.39-1	1.00+1	8.20-2	9.58-1	
1.20+1	1.40-1	9.40-1							

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{\mathrm{Exper}}/\sigma^{\mathrm{ECPSSR}}$	Ref.
74	Tungsten		Fluorescence yield = 0.958						
5.20+1	5.40+0	9.00-1							8
4.00+1	3.82+0	1.14+0	5.00+1	7.42+0	1.34+0	6.00+1	9.10+0	1.13+0	90
8.00+1	1.49+1	1.09+0	1.10+2	2.51+1	1.12+0				
3.49+0	1.38-3	6.99-1	4.54+0	4.11-3	7.48-1	5.40+0	9.00-3	8.79-1	141
6.50+0	2.01-2	1.04+0	8.00+0	4.02-2	1.06+0	9.54+0	7.13-2	1.08+0	
1.10+1	1.13-1	1.11+0	1.30+1	1.82-1	1.08+0				
2.20+0	9.15-5	4.08-1	2.40+0	1.61-4	4.52-1	2.60+0	2.54-4	4.80-1	147
2.88+0	4.25-4	4.95-1	3.20+0	6.80-4	4.96-1	3.40+0	8.78-4	4.96-1	
3.60+0	1.07-3	4.77-1	3.80+0	1.36-3	4.88-1	4.00+0	1.67-3	4.90-1	
75	Rhenium		Fluorescence yield = 0.959						
4.00+0	3.00-3	9.92-1	5.00+0	7.10-3	1.02+0	6.00+0	1.30-2	9.90-1	95
8.00+0	3.40-2	1.01+0	1.00+1	6.50-2	9.59-1	1.20+1	1.05-1	8.93-1	
78	Platinum		Fluorescence yield = 0.963						
5.20+1	3.10+0	8.06-1							8
4.00+1	1.97+0	9.25-1	6.00+1	5.45+0	1.05+0	8.00+1	9.24+0	1.02+0	90
1.10+2	1.55+1	1.01+0							
3.00+0	2.60-4	4.19-1	4.00+0	1.40-3	6.53-1	5.00+0	3.90-3	7.80-1	95
6.00+0	8.70-3	9.18-1	8.00+0	2.50-2	1.03+0	1.00+1	4.70-2	9.66-1	
1.20+1	8.20-2	9.75-1							
79	Gold		Fluorescence yield = 0.964						
5.20+1	2.80+0	8.11-1							8
5.00+1	3.10+0	9.77-1	6.00+1	5.30+0	1.13+0	7.00+1	7.60+0	1.19+0	49
8.00+1	9.80+0	1.19+0							
4.00+1	2.04+0	1.07+0	5.00+1	3.58+0	1.13+0	6.00+1	5.24+0	1.12+0	90
8.00+1	8.50+0	1.03+0	1.10+2	1.44+1	1.03+0				
4.00+0	1.30-3	6.78-1	5.00+0	3.50-3	7.79-1	6.00+0	7.30-3	8.56-1	95
8.00+0	1.90-2	8.67-1	1.00+1	4.10-2	9.37-1	1.20+1	6.70-2	8.87-1	
9.00+0	3.73-2	1.18+0	1.65+1	2.35-1	1.24+0	1.75+1	2.70-1	1.21+0	128
1.80+1	2.92-1	1.21+0	1.85+1	2.93-1	1.13+0	1.95+1	3.74-1	1.24+0	
2.05+1	4.04-1	1.17+0	2.15+1	5.09-1	1.30+0	2.25+1	5.40-1	1.22+0	
9.00+1	1.05+1	1.04+0	1.00+2	1.19+1	9.87-1	1.10+2	1.33+1	9.54-1	
1.20+2	1.40+1	8.80-1	1.30+2	1.83+1	1.03+0	1.40+2	1.93+1	9.85-1	
1.55+2	2.06+1	9.29-1							
2.60+0	7.11-5	**2.66-1**	2.84+0	1.29-4	3.08-1	3.04+0	1.96-4	3.36-1	147
3.29+0	3.08-4	3.67-1	3.60+0	5.62-4	4.53-1	3.80+0	7.63-4	4.90-1	
4.00+0	1.10-3	5.74-1							

TABLE 5. *K*-shell x-ray production by helium-4 in target elements from beryllium to uranium[a,b]—Continued

E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	E_1 (MeV)	σ^{Exper} (barn)	$\sigma^{Exper}/\sigma^{ECPSSR}$	Ref.
82 Lead			Fluorescence yield = 0.967						
5.20+1	1.90+0	7.52-1							8
1.20+1	5.70-2	1.03+0	2.00+1	2.25-1	9.59-1				59
4.00+1	1.42+0	1.03+0	6.00+1	3.26+0	9.49-1	8.00+1	5.47+0	8.98-1	90
1.10+2	9.68+0	9.16-1							
4.00+0	8.80-4	6.37-1	5.00+0	2.30-3	6.97-1	6.00+0	4.80-3	7.61-1	95
8.00+0	1.40-2	8.63-1	1.00+1	3.00-2	9.28-1	1.20+1	5.00-2	9.00-1	
9.00+0	2.50-2	1.06+0	1.75+1	1.87-1	1.15+0	1.85+1	2.06-1	1.09+0	128
1.95+1	2.44-1	1.11+0	2.05+1	2.88-1	1.15+0	2.15+1	3.16-1	1.11+0	
2.25+1	3.49-1	1.08+0	5.00+1	2.36+0	1.02+0	6.00+1	3.26+0	9.49-1	
7.00+1	4.56+0	9.69-1	8.00+1	5.91+0	9.70-1	9.00+1	7.24+0	9.59-1	
1.00+2	9.78+0	1.08+0	1.10+2	1.11+1	1.05+0	1.20+2	1.19+1	9.88-1	
1.30+2	1.46+1	1.07+0	1.40+2	1.60+1	1.07+0	1.55+2	1.88+1	1.09+0	
83 Bismuth			Fluorescence yield = 0.968						
4.00+1	1.32+0	1.06+0	6.00+1	3.04+0	9.80-1	8.00+1	4.87+0	8.81-1	90
1.10+2	8.73+0	9.05-1							
4.00+0	7.60-4	6.12-1	5.00+0	2.10-3	7.04-1	6.00+0	4.60-3	8.03-1	95
8.00+0	1.40-2	9.49-1	1.00+1	2.80-2	9.54-1	1.20+1	4.70-2	9.33-1	
1.75+1	1.30-1	8.84-1	1.85+1	1.74-1	1.02+0	1.95+1	2.59-1	1.31+0	128
2.05+1	2.95-1	1.30+0	2.15+1	2.97-1	1.15+0	2.25+1	3.21-1	1.10+0	
90 Thorium			Fluorescence yield = 0.971						
4.00+0	3.20-4	5.39-1	5.00+0	8.90-4	5.85-1	6.00+0	2.10-3	6.97-1	95
8.00+0	6.70-3	8.47-1	1.00+1	1.60-2	1.02+0	1.20+1	2.50-2	9.32-1	
2.60+0	3.00-5	5.29-1							124
4.45+0	4.85-4	5.12-1	5.45+0	1.46-3	6.89-1	6.19+0	2.29-3	6.81-1	141
6.32+0	2.97-3	8.21-1	7.49+0	5.47-3	8.53-1	7.81+0	6.04-3	8.24-1	
8.69+0	1.08-2	1.05+0	9.15+0	1.12-2	9.31-1	9.78+0	1.82-2	1.24+0	
1.16+1	2.94-2	1.21+0	1.17+1	3.06-2	1.22+0	1.21+1	3.02-2	1.09+0	
1.37+1	4.51-2	1.16+0	1.54+1	5.92-2	1.11+0				
92 Uranium			Fluorescence yield = 0.972						
4.00+0	2.20-4	4.58-1	5.00+0	6.90-4	5.46-1	6.00+0	1.80-3	7.11-1	95
8.00+0	6.00-3	8.93-1	1.00+1	1.20-2	8.97-1	1.20+1	2.20-2	9.66-1	

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[a] Cross sections and their ratios are printed in a compressed power of 10 notation, e.g. 9.66-1 means $9.66*10^{-1}$.

[b] The ratios shown in **bold** print differ by more than a factor of 2 from the averaged ratios and were -- as described in the text -- rejected. This rejection criterion was applied only to the Z2 > 9 data.

Table 6. Number of K-shell x-ray production cross sections compiled for each target element (identified in columns by Z2) with source references of Sec. 6.2 (listed in the first column), and tabulated separately for four projectiles: protons, deuterons, helium-3, and helium-4 ions.

Z1 = 1 A1 = 1 Protons

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Ref.	Z2 --> 4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
5																			10	
7																			5	
9									7	8										
10			1							1									1	
11			25						21	22										
12									4	8										
13										11										
16			7																	
17										13										
18					17															
20																	15		15	
22										13										
23			7																	
25										4									5	
26			15																	
29					1															
33					13															
34					12															
35	16																			
36																			3	3
37			7																	
38																			9	
40															7					
44																			8	
45										51										
46			13	13			7								8					
47																			3	1
48															8					
50			18																	
51			11		11					11										
55																			9	
57																			9	
58							1													
64																		16		
65															1					
66													4					4		
69																			20	20
70			11																	
71	8																			
72																			9	
73																			13	12
74															1					
75										9	9									
76														1		1				1
77																			21	
79																			6	
81			19																	
82			13	8			14								12					

Table 6. Number of K-shell x-ray production cross sections compiled for each target element (identified in columns by Z2) with source references of Sec. 6.2 (listed in the first column), and tabulated separately for four projectiles: protons, deuterons, helium-3, and helium-4 ions.

Continued. Protons

Ref. Z2 -->	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
84																			3	
85			9																	
86																				14
88										1										
92	7																			
94									1	1	1		1	1		1	5		1	
97										6										
98																	31	31	31	31
101								8	8	16	6								7	
105																			10	
106																	13	13	13	13
108																			10	
110						3				5										
112																			9	
113																			11	8
116						15														
117										17										
118																			11	
119	12																			
121																		8		
122												7	7	7		7				
123												11	11	11		12	12			
132																			14	
137																		14	14	7
148																			5	
149										3									1	
156												11	11	11		11	11			
157			8																	

Ref.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
1																			1				
2			2																				
3						9													8				
4						7																	
5					11																		
6			20			22													15				
7			1			5											5		1				
9						5																	
10			1			1																	
20					8																		
21						14																	
27			10			10	10																
30			1			1											1		1			1	
36	3	3	3	3	3	2																	
38			10	11					11														
39						2					2												
40													7										
44																		9					
47			3		3	3			3					3			3						
48													8										
52		13	15		15	15	15									15			15				

Table 6. Number of K-shell x-ray production cross sections compiled for each target element (identified in columns by Z2) with source references of Sec. 6.2 (listed in the first column), and tabulated separately for four projectiles: protons, deuterons, helium-3, and helium-4 ions. Continued.

Protons

Ref.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
53			16	16		16	16	16	16	16													
55			10	10	11	9																	
56							18																
57		9	9		14	9	8																
59						2										2							
61											9	8		9	8	8			9				8
64						16																	
65													1										
66			4			4																	
68													7										
69	18	20	20	19	17	19																	
72														5									
73	12		12	6	10		6																
74						1																	
76	1		1		1	1																	
77					21	13													13				
79	6		6																				
80	25					32																	
84			3	2	3																		
86			9				12	11								11							
87																		9				9	
89					1																		
94	5	1	1	1	1	5			1		1				1			1					
95																7			7				
97					6																		
98	31	31	31																				
99						15																	
103						8																	
104						3								3									
105			10			10					10					10							
106	13	13	11																				
108			9		8		6																
111														6	12		11						
112						9																	
113		8	8		11	11					10						2						
114	1				1	1	1				1						1						
115				22	22	22	22		21		22												
117						23																	
118			11			11											9						
120					21																		6
121			9																				
122					7	7		7															
125	1					1	1				1						1		1		1		
126						8												8					
130						6																	
132	14			15	15	15	15																
135						23			21										20				
137	11			10	7	11	11																
143						6						6											
144																			23				23
148														5			5	5	4				7

Table 6. Number of K-shell x-ray production cross sections compiled for each target element (identified in columns by Z2) with source references of Sec. 6.2 (listed in the first column), and tabulated separately for four projectiles: protons, deuterons, helium-3, and helium-4 ions. Continued.

Protons

Ref.	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**
149						2																	
151					5	5																	
152	21		21	11			21																

Ref.	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**
1	6																						
4	5																						
5	14																						
6	13			12																			
30	1			1						1						1			1				
32	27																						
38	9																						
39	2																						
47	3			3	3																		
48								2															
52	15	15																					
55	11																						
59			2											2									2
60				8																			
63	8	8		8	8	8				6	7												
64				11																			
77	21																						
80			17																				
86		11	11	12																			
87	11		10				10		9			10	10	10			9	9					
91																					20		
94	1	1	5	1			5																
95	7			7									7			6					6		
99	14																						
100	10																	9					
103	5																						
104	3																3						
107																		1					
111		18	16	14																			
113	12																						
118	8																						
120	7																						
121	10																						
125	1	1		1		1				1		1			1						1		1
126	8				8																		
127							18																
129			9		8							6											
130	5																						
135	19			17																			
138						8																	
139																		9					
143							6		6	6	5												
144				25						26		27		24		25							
145																					15		
148	7				4																		
151	5																						

Table 6. Number of K-shell x-ray production cross sections compiled for each target element (identified in columns by Z2) with source references of Sec. 6.2 (listed in the first column), and tabulated separately for four projectiles: protons, deuterons, helium-3, and helium-4 ions. Continued.

Protons

Ref.	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69
154														9		10							9
155														6		7			15				14
159														8		9			9		15		

Ref.	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
1				6						1			4										
2																							2
5				11									20										12
6				3																			
30				1					1	1			1										1
41										12													
59													2										
91										22													15
93										16													
95			6	6		6			6	6			6	6									4
100	10			9						9			10								9		
104										3													
107					1																5		1
113													12										
124																					12		
125				1					1	1			1	1									
139					15																		
142					16					13													10
145										6													
158				15																			
159				14																			

Z1 = 1 A1 = 2 Deuterons

Ref. Z2 -->	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
25										4									5	
31																			3	
45										19										
97										12										
102								3		10	2									
119	7																			
121																		8		
122												13	13	13		13				
131																			4	4
133																	6	6	6	6
153																			24	

Ref.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
4						5																	
97					12																		
111														10	11		10						
120					14																		
121			9																				
122					13	13		13															
126						10												8					

Table 6. Number of K-shell x-ray production cross sections compiled for each target element (identified in columns by Z2) with source references of Sec. 6.2 (listed in the first column), and tabulated separately for four projectiles: protons, deuterons, helium-3, and helium-4 ions. Continued.

Deuterons

Ref.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
131				4		4			4														
133	6	6	6	6	6	6																	
153			23																				

Ref.	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69
111		10		8																			
121	9																						
126	9				9																		
129			8		7							5											
150																		11					

Ref.	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
147					15					14													
158				11																			

Z1 = 2 A1 = 3 Helium-3

* * *

Ref. Z2 -->	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
12										5										
17										12										
28										6										
45										30										
75										7	7									
160																			19	
161										10		10			10				14	

Ref.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
160	18			9		19			9								9						
161	14			14	14				14		13							8					11

Ref.	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69
160	8																						

Z1 = 2 A1 = 4 Helium-4

* * *

Ref. Z2 -->	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
12									4	5										
14																			4	
15										6	6									
16			5																	
17										8										
19									8	9										
22										8										
23			16																	
26			16																	
28										5										
31														4					4	
38																	12		12	

Table 6. Number of K-shell x-ray production cross sections compiled for each target element (identified in columns by Z2) with source references of Sec. 6.2 (listed in the first column), and tabulated separately for four projectiles: protons, deuterons, helium-3, and helium-4 ions. Continued.

Helium-4

Ref. Z2 -->	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
42																			1	
45										37										
46			2	3			3													
54										9										10
67																			20	20
71	7																			
72																			21	
78																			30	24
82			13	15			9								5					
92	9																			
94																	5			
96										5									5	
97										10										
105																			11	
109													4	4		4				
110						3				2										
116						9														
118																			10	
119	6																			
123														11			11			
133																	6	6	6	6
136																	3	3	3	3
146																			4	
148																			5	
153																			24	
160																			9	

Ref.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
4						4																	
8																						1	
14	5		5		5	5													2				
15																			6				
24			6		6	6											6	6				6	6
38			11	14	11	11																	
42			1	1													1						
43					6														6				
49			1		6	8																	
54			9			9										10			8				
59						2										2							
62						1																	
67	20						8	7		9	5			2									
68						1																	
72														19									
78		29	24	29	24	30	24		30		30												
80	17					17																	
83					3	3			3														
87																		9	8			9	
89					1																		
94	5					5																	
95																7			7				
96			4																				

Table 6. Number of K-shell x-ray production cross sections compiled for each target element (identified in columns by Z2) with source references of Sec. 6.2 (listed in the first column), and tabulated separately for four projectiles: protons, deuterons, helium-3, and helium-4 ions. Continued.

Helium-4

Ref.	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
97					10																		
99						7																	
103						6																	
105			11			11					11					11							
109					4	4		4				4											
118			8			7																	
120					7																		
126						10												8					
133	6	6	6	6	6	6																	
134						11			11										9				
136	3																						
148	5			6		5					8			5			5	4	5				7
153			24																				
160						9			7														

Ref.	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69
8	5			1								1											
24	6			6																			
38	10																						
42				1										1									
43																5							
49				8		6								6				6					6
54	8			8																			
59			2											2									2
83	3			3																			
87	9			8	7		8			6		6						6					
90																					5		5
94			5																				
95	7			7									7			7					7		
99	5																						
109	4								4														
111		21		17																			
126	10				9																		
128				18																	9		9
134	7																						
138		3		3		4	2			2													
140																		5					
141																		9					
148	8			3																			

Ref.	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
8				1	1				1	1			1										
49				6						4													
59													2										
90		5		4	5				4	5			4	4									
95			7	7		6			7	6			6	6							6		6
124																					1		
128										16			18	6									
141					8																14		
147					9					7													

Table 7. Contribution (in percentage) of electron capture to ionization according to the ECPSSR theory (Refs. 15 and 16). Collision systems are specified by the target's atomic number Z2 plus projectile's energies per mass and atomic number Z1. Stars appear when the contribution of electron capture to ionization is less than 0.5 %; the numbers in bold print pertain to the systems for which data exist as compiled in Tables 2-5.

Z2	Energy/Mass (in MeV/u) of Hydrogen Ions (Z1 = 1)											
	0.01	0.02	0.04	0.08	0.10	0.20	0.40	0.80	1.00	2.00	4.00	8.00
4	**25**	**26**	**27**	**26**	**25**	**16**	**7**	**1**	**1**	*	*	*
5	10	12	13	15	15	13	8	3	2	*	*	*
6	**5**	**6**	**7**	**8**	**8**	**9**	**7**	**3**	**2**	*	*	*
7	3	**3**	**4**	**4**	**5**	**6**	**5**	**3**	2	1	*	*
8	2	**2**	**2**	**3**	**3**	4	4	3	2	1	*	*
9	2	1	1	2	2	**2**	**3**	**2**	**2**	**1**	*	*
10	1	1	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**1**	*	*
11	1	**1**	**1**	**1**	1	1	1	1	1	1	*	*
12	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	*	*
13	**1**	*	*	*	*	*	**1**	**1**	**1**	**1**	*	*
14	1	*	*	*	*	*	*	**1**	**1**	**1**	*	*
15	1	*	*	*	*	*	*	*	**1**	**1**	*	*

Z2	Energy/Mass (in MeV/u) of Helium Ions (Z1 = 2)											
	0.01	0.02	0.04	0.08	0.10	0.20	0.40	0.80	1.00	2.00	4.00	8.00
4	**99**	**97**	**89**	**74**	**68**	**48**	**25**	**7**	5	*	*	*
5	78	80	73	64	61	50	32	13	8	1	*	*
6	**45**	**49**	**50**	**47**	**46**	**42**	**32**	**17**	12	2	*	*
7	26	**28**	**30**	**31**	**31**	**32**	**28**	**18**	14	4	1	*
8	17	17	19	20	21	23	22	16	14	5	1	*
9	11	11	12	13	**14**	**16**	**17**	**15**	13	6	1	*
10	8	**7**	**8**	**9**	**9**	**11**	**13**	12	11	6	2	*
11	6	5	6	6	7	8	9	10	9	6	2	*
12	5	**4**	**4**	**4**	**5**	**5**	**7**	**8**	**8**	**6**	2	*
13	**4**	**3**	**3**	**3**	**3**	**4**	**5**	**6**	**6**	**5**	**2**	**1**
14	4	3	2	2	3	3	**4**	**5**	**5**	**4**	2	1
15	3	2	2	2	2	2	3	4	4	4	2	1
16	3	2	2	2	2	2	2	3	3	3	2	1
17	3	2	1	1	1	**1**	**2**	**2**	**2**	**3**	**2**	**1**
18	3	1	**1**	**1**	**1**	**1**	**1**	2	2	2	2	1
19	3	1	1	1	1	1	1	1	1	2	2	1
20	4	1	1	1	1	**1**	**1**	**1**	**1**	**2**	**2**	**1**
21	5	1	1	1	1	1	1	1	1	1	**1**	**1**
22	6	1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
23	9	1	1	*	*	*	*	**1**	**1**	**1**	**1**	**1**
24	14	1	1	*	*	*	*	**1**	**1**	**1**	**1**	**1**
25	23	1	1	*	*	*	*	*	*	**1**	1	1
26	40	1	*	*	*	*	*	*	*	**1**	**1**	**1**
27	64	2	*	*	*	*	*	*	*	*	**1**	**1**
28	86	2	*	*	*	*	*	*	*	*	**1**	**1**
29	96	3	*	*	*	*	*	*	*	*	**1**	*
30	99	4	*	*	*	*	*	*	*	*	*	*

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6.1 Text references

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6.3. Author index for the data base references in Section 6.2

6.3. Author index for the data base references in Sec. 6.2 -- Continued

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