A Complete set of radiative and Auger rates for K-vacancy states in Fe XXV–Fe XVIII

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ABSTRACT

A complete set of level energies, wavelengths, A-values, and total and partial Auger rates have been computed for transitions involving the K-vacancy states of the $n = 2$ complex of Fe XXV–Fe XVIII. Three different numerical packages, namely AUTOSTRUCTURE, the Breit–Pauli R-matrix suite (BPRM) and HFR, have been used for this purpose which allows reliable estimates of the physical effects involved and of the accuracy of the resulting data sets. It is found that the Breit interaction must be always taken into account as the contributions to small A-values and partial Auger rates do not decrease with electron occupancy. Semi-empirical adjustments can also lead to sizable differences in both the radiative and Auger decay data of strongly mixed levels. The accuracy of several experimental level energies and wavelengths are questioned, and significant discrepancies are found with previously computed decay rates that are attributed to numerical problems. The statistical accuracy of the present level energies and wavelengths is ranked at within 3 eV and 2 mÅ, respectively, whereas that for A-values and partial Auger rates greater than 10^{13} s^{-1} is estimated at better than 20%. The present data can be accessed online from TIPTOPbase.

Subject headings: atomic data — atomic processes — X-rays: general

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1. Introduction

We are currently involved in a project to calculate accurate atomic data for the astrophysical modeling of iron K lines. It has been motivated by the diagnostic potential of these lines in the X-ray spectra of high-energy environments (quasars, active galactic nuclei, galactic black-hole candidates, X-ray binaries) that are now focused by powerful satellite-borne telescopes (*Chandra*, *XMM-Newton*). In an earlier report on the decay properties of the K-vacancy states in Fe XXIV (**?**), to be referred hereafter as Paper I, a numerical approach was established that produced data sets of A-values and Auger rates firmly ranked with acceptable accuracy (10–15%). It relies on calculations with several state-of-the-art computational atomic physics codes and extensive comparisons with previous work. A formal treatment of the Breit interaction was essential to sort out the prominent magnetic properties Li-like Fe ion, thus leading to critical evaluations of the effectiveness of the different computational packages in the study of inner-shell processes and of the quality previously available data.

The method of Paper I is here extended to generate a complete set of energy levels, wavelengths, A-values, and Auger rates for all the K-vacancy states of the $n = 2$ complex in Fe XXV–Fe XVIII. In this respect, the compilation by **?** certifies the current incompleteness of the inner-shell level structures of Fe ions, which can be a major obstacle in line identification and spectral modeling in the above mentioned astrophysical endeavors. Although the precision of computed wavelengths does not match measurements in the $\lesssim 2$ Å spectral range by at least an order of magnitude as discussed in Paper I, an exhaustive and reasonably accurate (e.g. ~ 1 mÅ) inventory will certainly facilitate spectroscopic identifications, become an asset in the resolution of line blends, and encourage further structural refinement. Furthermore, a survey of the radiative and autoionization data for Fe ions with electron occupancy $N \leq 6$ computed by **?**, **??**, **?** and those listed in the data sets referred to as "Cornille" and "Safronova" in the compilation of **?** results in notable discrepancies that undermine confidence in spectral modeling. For ions with $N > 6$ there has hardly been any attention.

In the present work, A-values for the allowed and forbidden valence–valence transitions within the $n = 2$ complex have also been computed as the post-Auger radiative signature, rich in UV and optical emission lines, has been shown to have astrophysical potential (**?**). Details of the computational approach and of the approximations considered are given in Sections 2–3, as well as those of previously available data sets that are brought in for comparison purposes. Results, namely energy levels, wavelengths, A-values, and Auger rates, are discussed in Sections 4–6 closing with the summary and conclusions in Section 7.

2. Numerical methods

Contrary to most previous work on the K-vacancy states of the Fe isonuclear sequence, the present computational approach relies on widely available atomic physics codes, namely AUTOSTRUCTURE, HFR, and BPRM, rather than on in-house developments. These packages have been used during the past thirty years to study valence–electron processes and are now being successfully applied to the inner-shells as shown, for instance, in **?** and Paper I. They enable the inclusion of electron-correlation effects, relativistic corrections, and semi-empirical fine tuning. Radiative and collisional data are computed for N- or $(N+1)$-electron systems in the relativistic Breit–Pauli framework

$$H_{\rm bp} = H_{\rm nr} + H_{\rm 1b} + H_{\rm 2b} \tag{1}$$

where $H_{\rm nr}$ is the usual non-relativistic Hamiltonian. The one-body relativistic operators

$$H_{\rm 1b} = \sum_{n=1}^{N} f_n({\rm mass}) + f_n({\rm d}) + f_n({\rm so}) \tag{2}$$

comprise the spin–orbit interaction, $f_n({\rm so})$, and the non-fine structure mass-variation, $f_n({\rm mass})$, and one-body Darwin, $f_n({\rm d})$, corrections. The two-body corrections

$$H_{\rm 2b} = \sum_{n>m} g_{nm}({\rm so}) + g_{nm}({\rm ss}) + g_{nm}({\rm css}) + g_{nm}({\rm d}) + g_{nm}({\rm oo})\ , \tag{3}$$

usually referred to as the Breit interaction, include, on the one hand, the fine structure terms $g_{nm}({\rm so})$ (spin–other-orbit and mutual spin–orbit) and $g_{nm}({\rm ss})$ (spin–spin), and on the other, the non-fine structure terms: $g_{nm}({\rm css})$ (spin–spin contact), $g_{nm}({\rm d})$ (two-body Darwin), and $g_{nm}({\rm oo})$ (orbit–orbit).

2.1. AUTOSTRUCTURE

AUTOSTRUCTURE (**??**), based on the popular atomic structure code SUPERSTRUCTURE (**?**), computes relativistic fine structure level energies, A-values and Auger rates. Configuration-interaction (CI) wavefunctions are constructed from single-electron orbitals generated in a statistical Thomas–Fermi–Dirac potential (**?**). Continuum wavefunctions are obtained in a distorted-wave approximation. The Breit–Pauli implementation includes to order $\alpha^2 Z^4$ the one- and two-body operators (fine structure and non-fine structure) of Eqs. (**??**–**??**) where α is the fine structure constant and Z the atomic number. Fine tuning takes the form of term energy corrections (TEC) whereby an improved relativistic wavefuntion,

$\psi_i^{\rm r}$, is obtained in terms of the non-relativistic functions

$$\psi_i^{\rm r} = \psi_i^{\rm nr} + \sum_{j\neq i} \psi_j^{\rm nr} \times \frac{\langle \psi_j^{\rm nr} | H_{\rm 1b} + H_{\rm 2b} | \psi_i^{\rm nr} \rangle}{E_i^{\rm nr} - E_j^{\rm nr}} \ , \tag{4}$$

with the LS term energy differences $(E_i^{\rm nr} - E_j^{\rm nr})$ adjusted to fit the centers of gravity of the experimental multiplets. This procedure therefore relies on the availability of spectroscopic data.

2.2. HFR

In the HFR code by **?** an orbital basis is obtained for each electronic configuration by solving the Hartree–Fock equations for the spherically averaged atom. The equations to solve arise from the application of the variational principle to the configuration average energy and include relativistic corrections, namely the spin–orbit, mass–velocity and one-body Darwin terms. The Blume–Watson spin–orbit term contains the part of the Breit interaction that can be reduced to a one-body operator. The radial integrals can be adjusted to reproduce the experimental energy levels by least-squares fitting procedures. The eigenvalues and eigenstates thus obtained, *ab initio* or semi-empirically, are used to compute the wavelength and A-value for each possible transition. Autoionization rates are calculated in a perturbation theory scheme where the radial functions of the initial and final states are optimized separately, but CI is accounted for only in the autoionizing state.

2.3. BPRM

The BPRM method is based on the close-coupling approximation of **?** whereby the wavefunctions for states of an N-electron target and a colliding electron with total angular momentum and parity $J\pi$ are expanded in terms of the target eigenfunctions

$$\Psi^{J\pi} = \mathcal{A} \sum_i \chi_i \frac{F_i(r)}{r} + \sum_j c_j \Phi_j \ . \tag{5}$$

The functions χ_i are vector coupled products of the target eigenfunctions and the angular part of the incident-electron functions, $F_i(r)$ are the radial part of the latter, and $\mathcal{A}$ is an antisymmetrization operator. The functions Φ_j are bound-type functions of the total system constructed with target orbitals; they are introduced to compensate for orthogonality conditions imposed on the $F_i(r)$ and to improve short-range correlations. The Kohn variational principle gives rise to a set of coupled integro-differential equations that are solved by R-matrix techniques (**????**) within a box of radius, say, $r \leq a$. In the asymptotic region ($r > a$), resonance positions and widths are obtained from fits of the eigenphase sums with the STGQB module developed by **?** and **?**. Normalized partial widths are defined from projections onto the open channels. Breit–Pauli one-body relativistic corrections have been incorporated in the R-matrix suite by **?** and **?**, but the two-body terms (see Eq. **??**) have not as yet been implemented.

3. Approximations and external data sets

Following the scheme introduced in Paper I, we compute data in several approximations and compare with external data sets in an attempt to bring out the relevant physical effects and to establish the level of accuracy that can be claimed.

AST1: Data are computed with AUTOSTRUCTURE, the ionic models being represented with configurations only within the $n = 2$ complex and excludes the Breit interaction (i.e. the two-body terms in Eq. **??**). Following the findings in Paper I, Auger rates for the N-electron ion are computed with the orbital basis of the $(N-1)$-electron system.

AST2: The same as AST1 but includes the Breit interaction.

AST3: As AST2 but the ionic representations now include single and double excitations within the $n \leq 3$ complexes and level energies are fine-tuned with TEC with reference to the measured terms in the EXP1 data set (see below). In the case of unobserved levels, the TEC have been estimated from the reported set. This is our best approximation.

HFR2: A computation with HFR where the ion is represented with single and double excitations within the $n \leq 3$ complexes and the radial integrals are fitted to reproduce the EXP1 energies. In the case of unobserved levels, the theoretical values have not been adjusted. HFR2 is expected to give results comparable to AST3.

BPR1: A BPRM computation where ionic targets are modeled with configurations within the $n = 2$ complex. Since this code excludes the Breit interaction, this approximation is comparable to AST1.

EXP1: Contains the experimental level energies for Fe XXV–Fe XVIII listed in the critical compilation of **?**, except for the $1s2s^22p^4\ ^2L_j$ levels in Fe XX and the $1s2s^22p^6\ ^2S_{1/2}$ level in Fe XVIII where energies are derived from the laboratory wavelengths in the EXP2 data set. Present calculations suggest that the compiled energies for these levels, which have been obtained from flare spectra (**??**), are poor. In this respect, **?** has previously questioned the solar identifications of the F1 and F2 lines of the F-like Fe species.

EXP2: Includes 78 wavelengths reported for Fe XXV–Fe XVIII in the tokamak measurements by **?** and in experiments with an electron beam ion trap (**?**). In the case of duplicate measurements, we assume the most recent as the most accurate. The transition labeled O2 has been excluded due to a questionable assignment.

SAF: This external data set includes theoretical energy levels listed by **??** for Fe ions with electron occupancy $3 \leq N \leq 9$; wavelengths, A-values and total Auger rates for $3 \leq N \leq 6$ compiled in the "Safronova" data set by **?**; and partial Auger rates for $N = 5$ reported by **?**. They have been computed in a $1/Z$ perturbation expansion with the MZ code (**?**) which employs a hydrogenic orbital basis, includes electron correlation effects, and the Breit interaction and QED contributions are estimated in a hydrogenic approximation through screening constants.

COR: Corresponds to the "Cornille" data set compiled by **?** that tabulates wavelengths, A-values, and total Auger rates for ions with $3 \leq N \leq 6$ and the partial Auger rates for $N = 5$ reported by **?**. The data have been calculated with the program AUTOLSJ of **?**, an independent but similar implementation of AUTOSTRUCTURE.

MCDF: Wavelengths, A-values, and Auger (total and partial) rates computed in a multi-configuration Dirac–Fock method by **?**, **??**, and **?** for ions with $3 \leq N \leq 6$. The Breit interaction and QED corrections are taken into account in the energy calculations. CI is only assumed within the $n = 2$ complex.

Since most comparisons involve data sets of relative large volumes, we introduce simple statistical indicators. For two data sets, X and Y say, of energies or wavelengths, average energy and wavelength differences can be defined as

$$\overline{\Delta E}(Y,X) = \frac{1}{n}\sum_{i=1}^{n} E(Y_i) - E(X_i) \tag{6}$$

and

$$\overline{\Delta\lambda}(Y,X) = \frac{1}{n}\sum_{i=1}^{n} \lambda(Y_i) - \lambda(X_i) \tag{7}$$

while for rates, $A(X)$ and $A(Y)$, comparisons are more conveniently carried out in terms of an average ratio

$$\overline{R}(Y,X) = \frac{1}{n}\sum_{i=1}^{n} \frac{A(Y_i)}{A(X_i)} \ . \tag{8}$$

Levels are to be addressed with the notation (N, i), N being the electron occupancy of the ion and i the level index, and downward transitions $(k \to i)$ with (N, k, i) where in the case of an Auger process the lower ith level belongs to the $(N - 1)$-electron target ion.

4. Level energies and wavelengths

In the computation of the decay properties of K-vacancy states, it is essential to ensure adequate representations for both the upper resonances and the lower bound valence states, and therefore level energy comparisons must pay attention to both groups. In Table **??**, energies for the 217 fine structure levels that take part in the decay of the $n = 2$ K-vacancy states in Fe XXV–Fe XVIII are tabulated. Following conclusions in Paper I, they have been calculated in what we regard our best approximation: AST3. They are also compared with 131 spectroscopic values from EXP1 resulting in a mean energy difference of $\overline{\Delta E}(\mathrm{EXP1, AST3}) = -0.1 \pm 0.5$ eV. The larger discrepancies (less than 1.8 eV) arise in difficult spectral multiplets where level splittings are very sensitive to admixture, namely (5,20–23) and (6,22–24).

The AST3 level energies for species with electron occupancy of $3 \leq N \leq 9$ can also be compared with a complete HFR2 set and with 189 values in SAF (20 levels of Fe XXI and 1 level of Fe XX have not been quoted in SAF) resulting in mean energy differences of $\overline{\Delta E}(\mathrm{HFR2, AST3}) = 0.6 \pm 2.2$ eV and $\overline{\Delta E}(\mathrm{SAF, AST3}) = 0.00 \pm 3.0$ eV. The larger differences with HFR2 (up to 3.7 eV) are encountered in levels within the $1s2s^22p^3$ configuration of Fe XXI, i.e. (6,22–30). As previously mentioned, this is a particularly difficult spectral interval with strongly mixed components, questionable spectroscopic identifications, and sensitive fine structure splittings. Furthermore, levels belonging to configurations which have not been corrected in HFR2 due to the absence of reported measurements, mainly (6,31–50), (7,24–31), and (8,15–16), are systematically 5–7 eV higher than AST3. In the comparison with SAF, the (5,36), (5,39), and (5,42) levels have been excluded due to unusually gross discrepancies (up to 41 eV) which are probably due to misquoted data. Although the accuracy of the level energies in AST3 is strongly linked to that of EXP1 through the TEC, this strategy has been found to be reliable, and it has thus been possible to present a complete set of theoretical levels which can be confidently assigned a statistical accuracy of ±3 eV.

In Table **??** wavelengths for 937 transitions are listed. They include transitions arising from the K-vacancy resonances as well as those among the $n = 2$ valence levels. They have been determined from the experimental level energies when available otherwise from those in approximation AST3, and for convenience the data set will be referred hereafter with this label. A comparison with the 77 measured values in EXP2 results in a mean difference of $\overline{\Delta\lambda}(\mathrm{EXP2, AST3}) = 0.00 \pm 1.0$ mÅ where the experimental wavelengths $\lambda(7, 22, 1) = 1.90477$ Å (labeled N5), $\lambda(7, 20, 5) = 1.91359$ Å (N14), and $\lambda(7, 16, 3) = 1.91312$ Å (N15) are believed to be in error well outside the quoted experimental accuracy of a few tenths of a mÅ.

When wavelengths in AST3 are compared with other theoretical data sets, the outcome is also encouraging and suggests a statistical accuracy rating of ±2 mÅ. For instance, values in HFR2 for 888 transitions involving the K resonances in species with $3 \leq N \leq 9$ are somewhat longer since $\overline{\Delta\lambda}(\mathrm{HFR2}, \mathrm{AST3}) = -0.4 \pm 0.8$ mÅ, specially for transitions involving unadjusted levels, e.g. (7,24–31). COR, SAF, and MCDF respectively give values for 73, 101, and 502 transitions in ions with $4 \leq N \leq 6$. The following mean wavelength differences with AST3 are obtained: $\overline{\Delta\lambda}(\mathrm{COR}, \mathrm{AST3}) = -3.5 \pm 1.0$ mÅ, $\overline{\Delta\lambda}(\mathrm{SAF}, \mathrm{AST3}) = 0.2 \pm 1.2$ mÅ, and $\overline{\Delta\lambda}(\mathrm{MCDF}, \mathrm{AST3}) = 0.2 \pm 2.0$ mÅ. With reference to COR, the present findings are consistent with those in Paper I regarding their wavelengths being systematically shorter by ~ 3 mÅ. In MCDF discrepancies as large as 10 mÅ are found for the (5,k,8–9) and (6,44,i) transitions.

5. Radiative rates

Radiative rates, $A_{\mathrm{r}}(k,i)$, and total radiative widths, $A_{\mathrm{r}}(k) = \sum_i A_{\mathrm{r}}(k,i)$, computed with approximation AST3 are listed in Tables ??–??. In order to estimate their accuracy, we have considered several effects that have been found relevant in Paper I: CI, the Breit interaction, and fine tuning, and we are particularly interested in their variations along the isonuclear sequence. It is found by calculation that the contributions from configurations with orbitals with $n \geq 3$ are of little importance and can be practically neglected. The contributions of the Breit interaction are estimated by comparing the A-values computed with approximations AST1 and AST2 as shown in Fig. ?? for species with $3 \leq N \leq 8$. The general trend shows that differences become more conspicuous the weaker the transitions; while for transitions with $\log A_{\mathrm{r}}(k,i) > 14$ they are not larger than $\sim 10\%$, for those with $\log A_{\mathrm{r}}(k,i) < 13$ they can grow to several orders of magnitude. This trend is broken for 3 notorious transitions in the C-like system, namely (6,29,3–4) and (6,26,4), which belong to the strongly mixed spectral interval previously mentioned where the spin–spin coupling causes drastic changes. If they are excluded, the average ratios for transitions with $\log A_{\mathrm{r}}(k,i) > 13$ as listed in Table ?? for the AST1/AST2 data sets indicate that the effects of the Breit interaction are of the order of $\sim 15\%$ and do not decrease with N. Changes originating from fine tuning (TEC) (see $\overline{R}(\mathrm{AST2}, \mathrm{AST3})$ in Table ??) display a similar behaviour and are not greater than 17% if a few sensitive transitions are put aside, namely (4,20,4), (6,26,3–4), (6,28,2), and (6,29,4).

The key comparison is really between AST3 and HFR2 for several reasons; they are two completely independent numerical methods which have been used to generate complete sets of A-values; their fine tuning capabilities follow different approaches, AUTOSTRUCTURE employs TEC (see Section 2.1) whereas HFR relies on the treatment of radial integrals as fitting parameters; and their respective weaknesses have been well established in Paper I, the former by adopting an orthogonal orbital basis which limits accuracy in the simultaneous representation of K-vacancy and valence states and the latter by opting for a reduced implementation of the Breit interaction. It is shown in Fig. **??** and Table **??** that for $\log A_{\rm r}(k,i) > 13$ AST3 and HFR2 produce A-values in a 20% statistical accord, an acceptable level of accuracy mainly limited by the code shortcomings. This positive outcome establishes a milestone for evaluating previous work. A-values in COR and SAF agree with those in AST3 to within $\sim 20\%$ (see Fig. **??** and Table **??**) if a handful of transitions with discrepancies larger than a factor of 2 are excluded: (6,23,4), (6,26,4), and (6,29,4) in COR and those listed in Table **??** in SAF. On the other hand, it may be seen in Fig. **??** that the number of transitions in MCDF displaying large discrepancies with AST3 is noticeably larger, thus the statistical indicators in Table **??** have excluded the long list of questionable transitions given in Table **??**. Moreover, a contrasting and worrying aspect is that while the mean ratios $\overline{R}(\mathrm{MCDF},\mathrm{AST3})$ for $N \leq 5$ are within a comparable accuracy interval ($\sim$ 17%), that for the C-like ion indicates A-values that are on average 20% higher with a scatter of the order of 30%. This finding seems to point out at numerical problems in the MCDF radiative data for Fe XXI.

6. Auger decay data

Total Auger widths $A_{\rm a}(k) = \sum_i A_{\rm a}(k,i)$ computed in approximation AST3 for the K-vacancy levels of the $n = 2$ complex in Fe XXIV–Fe XVIII are presented in Table **??**. (The k index corresponds to the level of the N-electron parent ion while i belongs to the $(N-1)$-electron autoionized system.) It can be seen that while levels in ions with $N > 4$ have Auger widths of $\log A_{\rm a}(k) > 14$, with the sole exception of the sextet (5,19), levels in the Li- and Be-like systems have widths as low as 10^9 s^{-1} making them more susceptible to the approximation quality. This assertion is supported, for example, by the mean ratios $\overline{R}(\mathrm{BPR1},\mathrm{AST1})$ for $3 \leq N \leq 9$ given in Table **??** where the standard deviations of 14% and 11% in Fe XXIV and Fe XXIII, respectively, decrease to $\sim$ 5% in species with $N > 4$. It is also found that extra-complex CI and TEC have small effects on the total Auger rates.

An important finding realized in Paper I in connection with the Auger decay of the Li-like Fe species has been the conspicuous role of the Breit interaction; that is, the prominence of the spin–spin coupling not only between bound levels but also involving the final continuum states, a fact that was not always given adequate attention in most previous work. We are therefore concerned with its N behavior which can be discerned by comparing approximations AST1 and AST2 (see Table **??**). It is found that the Breit interaction on average diminishes Auger rates by as much as 10% for ions with low N but the differences are reduced to 4% for $N = 9$. The larger (30% to a factor of 2) occur in levels with small widths ($\log A_a(k) < 13$), namely the (3,5–7), (3,10), (3,13–14) quartet levels in Fe XXIV and the (4,14–16) and (4,28) quintet levels in Fe XXIII that autoionize via intersystem or magnetically coupled channels. By examining mean ratios for approximations HFR2 and AST3 in Table **??**, it can be inferred that discrepancies are mostly due to the treatment of the relativistic corrections in the HFR code as concluded in Paper I. The HFR package performs poorly with strong Breit coupling, as indicated by the poor agreement for ions with $N \leq 4$, but for the less ionized system the statistical agreement becomes acceptable at better than 10%.

The good statistical accord (better than 10%) obtained with our three numerical methods (AUTOSTRUCTURE, HFR, and BPRM) for the total Auger rates in ions with $N > 4$ depicted in Table **??** provides a second milestone for evaluating external data sets. A comparison of total Auger rates in COR, SAF, and MCDF with those in our best approximation (AST3) are shown in Fig. **??** and Table **??**. The discrepancies with COR, as discussed in Paper I, are well understood in terms of their neglect of the Breit interaction and thus decrease rapidly with N. In contrast, differences with SAF for $3 \leq N \leq 6$ are sustainedly higher by as much as 30% and increase with N, a trend difficult to explain. The situation with respect to MCDF is also curious as the statistical agreement with AST3 is good (better that 10%) for $N \leq 5$ but for the C-like species abruptly deteriorates.

Level-to-level (partial) Auger rates have also been calculated with approximation AST3 and are listed in Table **??**. We have found in the present project that the BPRM and HFR codes are not currently usable for the computation of partial Auger rates. In this respect, the STGQB module in the BPRM package lists asymptotic channel weights from which partial widths can be obtained. However, this procedures is deficient in the case of low-n resonances which display most of their wavefunctions in the R-matrix inner region, and thus the asymptotic weights are not really representative of channel strengths. We have found hardly any accord between the partial rates in BPR1 and AST1 in spite of the good accord of their total widths. In HFR, the only information available about the target states are the LS parent terms of the continuum states. Consequently, only partial Auger rates of autoionizing levels decaying to LS terms of the $(N-1)$-electron ion can be determined.

Excluding partial rates with $\log A_a(k,i) < 13$, the contribution of the Breit interaction is on average less than 20% but does not decrease with N. TEC cause the more sizable differences in Fe XXI (10%) and Fe XX (14%) with the exception of the transitions (6,29,i) and (7,18,7–8) where they reach a factor of 2. Partial Auger rates have only been previously reported by COR, SAF, and MCDF for the B- and C-like Fe species, and the comparison with AST3 shown in Fig. **??** only but asserts the findings previously discussed regarding the accuracy of their total Auger widths.

7. Summary and conclusions

We have successfully extended the multi-code approach of Paper I to generate for the first time a complete set of radiative and Auger decay data for all the $n = 2$ K-vacancy states in ionic members of the first row of the Fe isonuclear sequence, and to provide reliable rankings for their accuracy. The data set also includes radiative rates for both the allowed and forbidden transitions among the $n = 2$ valence levels that become the primary receptacles of the inner-shell decay process. Their multi-wavelength spectral signature might lead to interesting astrophysical diagnostics (**?**).

It has been found that the Breit interaction must be taken into account throughout in order to maintain accuracy, in particular for transitions with small rates and for those involving levels subject to sensitive relativistic couplings which in most cases are difficult to predict in advance. Due to the introduction of semi-empirical adjustments, the accuracy of the present level energies is directly linked to the selection in the critical compilation of **?**, but in spite of incompleteness and some questionable identifications, a reasonable degree of reliability has been attained. In this respect, it would have been resourceful to have had more reliable energy estimates of the tricky levels of the $1s2s^22p^3$ configuration in Fe XXI and of the questionable solar identifications of the $1s2s^22p^4\ ^2L_J$ and $1s2s^22p^6\ ^2S_{1/2}$ components in Fe XX and Fe XVIII, respectively. Transition data involving such levels should therefore be treated with caution, in spite of the attempt that was made to improve their energy positions with the laboratory wavelengths of **?** and **?**. By extensive comparisons with results from the several approximations considered, previous work, and experiment, the statistical accuracy of present level energy data set has been established at better than 3 eV. Similarly, our wavelengths and Auger-electron kinetic energies have been derived from the experimental levels when available, and we are confident that the statistical accuracy of the former is close to 2 mÅ.

With respect to the A-values and partial Auger rates, it has been found that very little can be asserted about transitions with values under 10^{13} s^{-1}. For the larger rates, the accuracy has been firmly ranked at within 20%. Relativistic effects are particularly conspicuous in Fe ions with $N \leq 4$, but become more manageable for the less ionized species. We are therefore puzzled with the large systematic discrepancies encountered in SAF and MCDF which affect even the large (greater than 10^{14} s^{-1}) total widths of the higher N systems. Such discrepancies can only be attributed to numerical problems. By contrast the data in COR are in general within the proposed bounds in spite of a suspected neglect of the spin–spin bound-free couplings in the Auger processes.

It has been found that the BPRM and the HFR suites are not usable at present in the calculation of partial Auger rates which are now in demand for the detailed modeling of ionization balances and post-Auger radiative emissions. In addition, their present shortcomings in the representation of the two-body operators of the Breit interaction reaffirm our early statements about AUTOSTRUCTURE being the platform of choice for inner-shell studies.

The data generated in the present work can be accessed online from TIPTOPbase[3]. We have also made fast progress in tackling the very interesting features of the decay pathways of members of the second row ($10 \leq N \leq 17$) which will be reported elsewhere. Complementary to the energy levels and to the radiative and Auger rates data, we are additionally computing photoionization and electron impact excitation cross sections which will soon place the modeling of Fe K spectra on a different footing.

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[3]http://heasarc.gsfc.nasa.gov/topbase/

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Fig. 1.— Comparison of A-values (s^{-1}) computed in approximations AST1 and AST2 for Fe ions with $3 \leq N \leq 8$. Differences are due to the contribution of the Breit interaction.

Fig. 2.— Comparison of A-values (s^{-1}) computed in approximations HFR2 and AST3 for Fe ions with $3 \leq N \leq 8$. An agreement of $\sim 20\%$ is found for transitions with $\log A_{\rm r}(k,i) > 13$.

Fig. 3.— Comparison of A-values (s^{-1}) computed in approximation AST3 for Fe ions with $4 \leq N \leq 6$ with those in the external data sets COR (circles), SAF (triangles), and MCFD (filled triangles).

Fig. 4.— Comparison of total Auger rates (s^{-1}) computed in approximations AST3 for Be- through C-like Fe ions with other data sets: COR (circles); SAF (triangles); and MCDF (filled triangles).

Fig. 5.— Comparison of partial Auger rates (s^{-1}) computed in approximations AST3 for B- and C-like Fe ions with other data sets: COR (circles); SAF (triangles); and MCDF (filled triangles).

Table 1. Energies and total radiative and Auger widths for levels within the $n = 2$ complex of N-electron Fe ions ($2 \le N \le 9$)

Ion	N	i	State	E(EXP1)[a] (keV)	E(AST3)[b] (keV)	$A_r(i)$ (s^{-1})	$A_a(i)$ (s^{-1})
Fe XXV	2	1	$1s^2\ ^1S_0$	0.00	0.00		
	2	2	$1s2s\ ^3S_1$	6.6366	6.6367	2.08+08	
	2	3	$1s2p\ ^3P^o_0$	6.6655	6.6656	3.74+08	
	2	4	$1s2p\ ^3P^o_1$	6.6676	6.6676	4.35+13	
	2	5	$1s2s\ ^1S_0$	6.6680	6.6684	4.11+09	
	2	6	$1s2p\ ^3P^o_2$	6.6823	6.6819	7.90+09	
	2	7	$1s2p\ ^1P^o_1$	6.7004	6.7005	4.61+14	
Fe XXIV	3	1	$1s^22s\ ^2S_{1/2}$	0.00	0.00		
	3	2	$1s^22p\ ^2P^o_{1/2}$	0.04860	0.04778	1.77+09	
	3	3	$1s^22p\ ^2P^o_{3/2}$	0.06457	0.06498	4.30+09	
	3	4	$1s2s^2\ ^2S_{1/2}$	6.6004	6.6003	1.88+13	1.43+14
	3	5	$1s(^2S)2s2p(^3P^o)\ ^4P^o_{1/2}$	6.6137	6.6131	4.97+12	1.33+10
	3	6	$1s(^2S)2s2p(^3P^o)\ ^4P^o_{3/2}$	6.6167	6.6169	1.55+13	3.91+11
	3	7	$1s(^2S)2s2p(^3P^o)\ ^4P^o_{5/2}$		6.6285	6.36+09	1.97+09
	3	8	$1s(^2S)2s2p(^3P^o)\ ^2P^o_{1/2}$	6.6535	6.6525	3.01+14	4.24+13
	3	9	$1s(^2S)2s2p(^3P^o)\ ^2P^o_{3/2}$	6.6619	6.6623	4.71+14	1.41+11
	3	10	$1s(^2S)2p^2(^3P)\ ^4P_{1/2}$	6.6710	6.6706	2.18+13	3.37+11
	3	11	$1s(^2S)2s2p(^1P^o)\ ^2P^o_{1/2}$	6.6764	6.6764	1.86+14	6.77+13
	3	12	$1s(^2S)2s2p(^1P^o)\ ^2P^o_{3/2}$	6.6792	6.6791	4.19+12	1.07+14
	3	13	$1s(^2S)2p^2(^3P)\ ^4P_{3/2}$	6.6793	6.6792	1.06+13	9.66+11
	3	14	$1s(^2S)2p^2(^3P)\ ^4P_{5/2}$	6.6850	6.6850	3.58+13	2.61+13
	3	15	$1s(^2S)2p^2(^1D)\ ^2D_{3/2}$	6.7027	6.7027	3.50+14	1.25+14
	3	16	$1s(^2S)2p^2(^3P)\ ^2P_{1/2}$	6.7046	6.7041	6.91+14	9.39+11
	3	17	$1s(^2S)2p^2(^1D)\ ^2D_{5/2}$	6.7090	6.7089	2.05+14	1.37+14
	3	18	$1s(^2S)2p^2(^3P)\ ^2P_{3/2}$	6.7224	6.7225	6.16+14	3.28+13
	3	19	$1s(^2S)2p^2(^1S)\ ^2S_{1/2}$	6.7415	6.7414	2.50+14	2.92+13
Fe XXIII	4	1	$1s^22s^2\ ^1S_0$	0.00	0.00		
	4	2	$1s^22s2p\ ^3P^o_0$	0.04317	0.04273		
	4	3	$1s^22s2p\ ^3P^o_1$	0.04701	0.04670	5.01+07	
	4	4	$1s^22s2p\ ^3P^o_2$	0.05849	0.05877	1.05+04	
	4	5	$1s^22s2p\ ^1P^o_1$	0.09329	0.09329	1.95+10	
	4	6	$1s^22p^2\ ^3P_0$	0.11854	0.11811	1.23+10	
	4	7	$1s^22p^2\ ^3P_1$	0.12736	0.12749	1.51+10	
	4	8	$1s^22p^2\ ^3P_2$	0.13287	0.13281	1.31+10	
	4	9	$1s^22p^2\ ^1D_2$	0.14930	0.14937	9.75+09	
	4	10	$1s^22p^2\ ^1S_0$	0.17638	0.17639	3.15+10	
	4	11	$1s2s^22p\ ^3P^o_0$		6.5938	8.04+12	1.83+14
	4	12	$1s2s^22p\ ^3P^o_1$	6.5958	6.5958	4.06+13	1.86+14
	4	13	$1s2s^22p\ ^3P^o_2$		6.6086	1.04+13	1.91+14
	4	14	$1s(^2S)2s2p^2(^4P)\ ^5P_1$		6.6148	1.17+13	2.22+12
	4	15	$1s(^2S)2s2p^2(^4P)\ ^5P_2$		6.6223	5.06+12	5.25+11
	4	16	$1s(^2S)2s2p^2(^4P)\ ^5P_3$	6.6287	6.6286	1.02+13	6.55+12
	4	17	$1s2s^22p\ ^1P^o_1$	6.6287	6.6287	4.53+14	1.28+14
	4	18	$1s(^2S)2s2p^2(^4P)\ ^3P_0$	6.6588	6.6588	6.01+14	7.13+13
	4	19	$1s(^2S)2s2p^2(^4P)\ ^3P_1$		6.6629	5.51+14	6.86+13
	4	20	$1s(^2S)2s2p^2(^2D)\ ^3D_2$	6.6643	6.6648	3.36+14	1.34+14
	4	21	$1s(^2S)2s2p^2(^2D)\ ^3D_3$	6.6686	6.6685	2.23+14	1.63+14
	4	22	$1s(^2S)2s2p^2(^2D)\ ^3D_1$	6.6703	6.6695	3.40+14	1.30+14

Table 1—Continued

Ion	N	i	State	E(EXP1)[a] (keV)	E(AST3)[b] (keV)	$A_{\rm r}(i)$ (s^{-1})	$A_{\rm a}(i)$ (s^{-1})
Fe XXIII	4	23	$1s(^2S)2s2p^2(^4P)\ ^3P_2$		6.6762	5.19+14	9.44+13
	4	24	$1s(^2S)2s2p^2(^2S)\ ^3S_1$	6.6858	6.6857	1.62+14	1.29+14
	4	25	$1s(^2S)2s2p^2(^2P)\ ^3P_0$		6.6883	1.30+14	1.38+14
	4	26	$1s(^2S)2s2p^2(^2D)\ ^1D_2$	6.6947	6.6947	2.62+14	2.28+14
	4	27	$1s(^2S)2s2p^2(^2P)\ ^3P_1$		6.7005	1.63+14	1.11+14
	4	28	$1s2p^3\ ^5S^o_2$		6.7016	1.18+13	5.95+12
	4	29	$1s(^2S)2s2p^2(^2P)\ ^3P_2$		6.7065	5.99+13	2.14+14
	4	30	$1s(^2S)2s2p^2(^2P)\ ^1P_1$	6.7177	6.7177	6.67+14	5.57+13
	4	31	$1s(^2S)2s2p^2(^2S)\ ^1S_0$	6.7264	6.7264	2.23+14	2.18+14
	4	32	$1s2p^3\ ^3D^o_1$		6.7330	3.08+14	1.92+14
	4	33	$1s2p^3\ ^3D^o_2$		6.7344	2.35+14	2.07+14
	4	34	$1s2p^3\ ^3D^o_3$		6.7363	2.32+14	2.28+14
	4	35	$1s2p^3\ ^3S^o_1$		6.7450	7.98+14	4.80+13
	4	36	$1s2p^3\ ^1D^o_2$		6.7535	5.20+14	1.97+14
	4	37	$1s2p^3\ ^3P^o_0$		6.7586	2.27+14	1.41+14
	4	38	$1s2p^3\ ^3P^o_1$		6.7605	3.20+14	1.37+14
	4	39	$1s2p^3\ ^3P^o_2$		6.7681	3.96+14	1.77+14
	4	40	$1s2p^3\ ^1P^o_1$		6.7834	6.83+14	1.31+14
Fe XXII	5	1	$1s^22s^22p\ ^2P^o_{1/2}$	0.00	0.00		
	5	2	$1s^22s^22p\ ^2P^o_{3/2}$	0.01466	0.01526	1.49+04	
	5	3	$1s^22s2p^2\ ^4P_{1/2}$	0.05016	0.05006	9.93+07	
	5	4	$1s^22s2p^2\ ^4P_{3/2}$	0.05706	0.05741	1.04+07	
	5	5	$1s^22s2p^2\ ^4P_{5/2}$	0.06364	0.06423	7.23+07	
	5	6	$1s^22s2p^2\ ^2D_{3/2}$	0.09129	0.09147	1.09+10	
	5	7	$1s^22s2p^2\ ^2D_{5/2}$	0.09413	0.09467	6.03+09	
	5	8	$1s^22s2p^2\ ^2P_{1/2}$	0.10584	0.10566	3.84+10	
	5	9	$1s^22s2p^2\ ^2S_{1/2}$	0.12130	0.12173	3.69+10	
	5	10	$1s^22s2p^2\ ^2P_{3/2}$	0.12303	0.12370	5.06+10	
	5	11	$1s^22p^3\ ^4S^o_{3/2}$	0.15569	0.15608	4.52+10	
	5	12	$1s^22p^3\ ^2D^o_{3/2}$	0.17310	0.17334	2.20+10	
	5	13	$1s^22p^3\ ^2D^o_{5/2}$	0.17687	0.17737	2.11+10	
	5	14	$1s^22p^3\ ^2P^o_{1/2}$	0.19461	0.19458	4.44+10	
	5	15	$1s^22p^3\ ^2P^o_{3/2}$	0.20181	0.20243	4.39+10	
	5	16	$1s2s^22p^2\ ^4P_{1/2}$		6.5540	3.15+13	2.38+14
	5	17	$1s2s^22p^2\ ^4P_{3/2}$		6.5626	1.33+13	2.32+14
	5	18	$1s2s^22p^2\ ^4P_{5/2}$		6.5682	3.01+13	2.50+14
	5	19	$1s(^2S)2s2p^3(^5S^o)\ ^6S^o_{5/2}$		6.5801	6.26+12	4.21+12
	5	20	$1s2s^22p^2\ ^2P_{1/2}$	6.5863	6.5846	6.30+14	1.58+14
	5	21	$1s2s^22p^2\ ^2D_{3/2}$	6.5865	6.5868	3.66+14	2.87+14
	5	22	$1s2s^22p^2\ ^2D_{5/2}$	6.5917	6.5922	2.04+14	3.41+14
	5	23	$1s2s^22p^2\ ^2P_{3/2}$	6.6012	6.6027	5.48+14	1.98+14
	5	24	$1s2s^22p^2\ ^2S_{1/2}$	6.6117	6.6121	2.76+14	2.82+14
	5	25	$1s(^2S)2s2p^3(^3D^o)\ ^4D^o_{3/2}$		6.6294	3.49+14	1.92+14
	5	26	$1s(^2S)2s2p^3(^3D^o)\ ^4D^o_{5/2}$		6.6305	2.26+14	2.20+14
	5	27	$1s(^2S)2s2p^3(^3D^o)\ ^4D^o_{1/2}$		6.6317	2.39+14	2.27+14
	5	28	$1s(^2S)2s2p^3(^3D^o)\ ^4D^o_{7/2}$		6.6328	2.24+14	2.35+14
	5	29	$1s(^2S)2s2p^3(^5S^o)\ ^4S^o_{3/2}$		6.6366	7.31+14	1.04+14
	5	30	$1s(^2S)2s2p^3(^3P^o)\ ^4P^o_{1/2}$		6.6501	2.30+14	1.78+14

Table 1—Continued

Ion	N	i	State	E(EXP1)[a] (keV)	E(AST3)[b] (keV)	$A_{\rm r}(i)$ ($\rm s^{-1}$)	$A_{\rm a}(i)$ ($\rm s^{-1}$)
Fe XXII	5	31	$\rm 1s(^2S)2s2p^3(^3P^o)\ ^4P^o_{5/2}$		6.6508	2.61+14	1.88+14
	5	32	$\rm 1s(^2S)2s2p^3(^3P^o)\ ^4P^o_{3/2}$		6.6509	2.62+14	1.93+14
	5	33	$\rm 1s(^2S)2s2p^3(^3D^o)\ ^2D^o_{3/2}$		6.6660	5.36+14	3.48+14
	5	34	$\rm 1s(^2S)2s2p^3(^3D^o)\ ^2D^o_{5/2}$		6.6712	5.88+14	3.32+14
	5	35	$\rm 1s(^2S)2s2p^3(^3S^o)\ ^4S^o_{3/2}$		6.6749	1.30+14	2.29+14
	5	36	$\rm 1s(^2S)2s2p^3(^1D^o)\ ^2D^o_{3/2}$		6.6807	4.98+14	2.78+14
	5	37	$\rm 1s(^2S)2s2p^3(^3P^o)\ ^2P^o_{1/2}$		6.6825	6.76+14	2.35+14
	5	38	$\rm 1s(^2S)2s2p^3(^1D^o)\ ^2D^o_{5/2}$		6.6871	2.80+14	3.69+14
	5	39	$\rm 1s(^2S)2s2p^3(^3P^o)\ ^2P^o_{3/2}$		6.6949	4.69+14	2.81+14
	5	40	$\rm 1s(^2S)2s2p^3(^1P^o)\ ^2P^o_{1/2}$		6.6966	4.68+14	2.78+14
	5	41	$\rm 1s(^2S)2s2p^3(^1P^o)\ ^2P^o_{3/2}$		6.7069	2.26+14	3.55+14
	5	42	$\rm 1s(^2S)2s2p^3(^3S^o)\ ^2S^o_{1/2}$		6.7121	6.74+14	1.48+14
	5	43	$\rm 1s2p^4\ ^4P_{5/2}$		6.7227	2.31+14	2.56+14
	5	44	$\rm 1s2p^4\ ^4P_{3/2}$		6.7330	2.56+14	2.50+14
	5	45	$\rm 1s2p^4\ ^4P_{1/2}$		6.7363	2.36+14	2.49+14
	5	46	$\rm 1s2p^4\ ^2D_{3/2}$		6.7505	6.11+14	3.22+14
	5	47	$\rm 1s2p^4\ ^2D_{5/2}$		6.7546	4.34+14	3.86+14
	5	48	$\rm 1s2p^4\ ^2P_{3/2}$		6.7627	7.11+14	2.99+14
	5	49	$\rm 1s2p^4\ ^2P_{1/2}$		6.7634	8.43+14	2.51+14
	5	50	$\rm 1s2p^4\ ^2S_{1/2}$		6.7893	4.96+14	2.70+14
Fe XXI	6	1	$\rm 1s^22s^22p^2\ ^3P_0$	0.00	0.00		
	6	2	$\rm 1s^22s^22p^2\ ^3P_1$	0.00916	0.00968	6.54+03	
	6	3	$\rm 1s^22s^22p^2\ ^3P_2$	0.01455	0.01496	8.39+02	
	6	4	$\rm 1s^22s^22p^2\ ^1D_2$	0.03032	0.03073	3.19+04	
	6	5	$\rm 1s^22s^22p^2\ ^1S_0$	0.04612	0.04653	1.39+05	
	6	6	$\rm 1s^22s2p^3\ ^5S^o_2$	0.06037	0.06078	7.05+07	
	6	7	$\rm 1s^22s2p^3\ ^3D^o_1$	0.09630	0.09648	1.30+10	
	6	8	$\rm 1s^22s2p^3\ ^3D^o_2$	0.09638	0.09666	9.62+09	
	6	9	$\rm 1s^22s2p^3\ ^3D^o_3$	0.09963	0.10022	7.39+09	
	6	10	$\rm 1s^22s2p^3\ ^3P^o_0$	0.11361	0.11380	2.28+10	
	6	11	$\rm 1s^22s2p^3\ ^3P^o_1$	0.11468	0.11502	2.42+10	
	6	12	$\rm 1s^22s2p^3\ ^3P^o_2$	0.11685	0.11733	2.17+10	
	6	13	$\rm 1s^22s2p^3\ ^3S^o_1$	0.13585	0.13624	9.93+10	
	6	14	$\rm 1s^22s2p^3\ ^1D^o_2$	0.13976	0.14017	5.45+10	
	6	15	$\rm 1s^22s2p^3\ ^1P^o_1$	0.15636	0.15677	9.07+10	
	6	16	$\rm 1s^22p^4\ ^3P_2$	0.20412	0.20429	6.26+10	
	6	17	$\rm 1s^22p^4\ ^3P_0$	0.21520	0.21562	7.28+10	
	6	18	$\rm 1s^22p^4\ ^3P_1$	0.21579	0.21658	7.32+10	
	6	19	$\rm 1s^22p^4\ ^1D_2$	0.22529	0.22570	4.80+10	
	6	20	$\rm 1s^22p^4\ ^1S_0$	0.25394	0.25435	8.82+10	
	6	21	$\rm 1s2s^22p^3\ ^5S^o_2$		6.5182	1.48+13	2.85+14
	6	22	$\rm 1s2s^22p^3\ ^3D^o_1$	6.5436	6.5443	3.63+14	3.90+14
	6	23	$\rm 1s2s^22p^3\ ^3D^o_2$	6.5451	6.5467	2.30+14	4.34+14
	6	24	$\rm 1s2s^22p^3\ ^3D^o_3$	6.5517	6.5499	2.17+14	4.58+14
	6	25	$\rm 1s2s^22p^3\ ^3S^o_1$	6.5550	6.5550	6.88+14	2.57+14
	6	26	$\rm 1s2s^22p^3\ ^1D^o_2$	6.5621	6.5619	4.90+14	4.03+14
	6	27	$\rm 1s2s^22p^3\ ^3P^o_0$		6.5642	2.25+14	4.09+14
	6	28	$\rm 1s2s^22p^3\ ^3P^o_1$		6.5659	3.18+14	3.97+14

Table 1—Continued

Ion	N	i	State	E(EXP1)[a] (keV)	E(AST3)[b] (keV)	$A_{\rm r}(i)$ (s^{-1})	$A_{\rm a}(i)$ (s^{-1})
Fe XXI	6	29	$1s2s^22p^3\ ^3P^o_2$	6.5757	6.5741	3.69+14	4.14+14
	6	30	$1s2s^22p^3\ ^1P^o_1$	6.5841	6.5841	6.36+14	3.46+14
	6	31	$1s(^2S)2s2p^4(^4P)\ ^5P_3$		6.5877	2.20+14	2.67+14
	6	32	$1s(^2S)2s2p^4(^4P)\ ^5P_2$		6.5970	2.24+14	2.60+14
	6	33	$1s(^2S)2s2p^4(^4P)\ ^5P_1$		6.6009	2.24+14	2.63+14
	6	34	$1s(^2S)2s2p^4(^4P)\ ^3P_2$		6.6316	7.44+14	3.81+14
	6	35	$1s(^2S)2s2p^4(^2D)\ ^3D_1$		6.6349	5.95+14	3.76+14
	6	36	$1s(^2S)2s2p^4(^2D)\ ^3D_3$		6.6377	4.29+14	4.13+14
	6	37	$1s(^2S)2s2p^4(^2D)\ ^3D_2$		6.6394	4.90+14	4.34+14
	6	38	$1s(^2S)2s2p^4(^4P)\ ^3P_1$		6.6429	6.81+14	3.71+14
	6	39	$1s(^2S)2s2p^4(^4P)\ ^3P_0$		6.6437	8.35+14	3.78+14
	6	40	$1s(^2S)2s2p^4(^2S)\ ^3S_1$		6.6590	4.26+14	3.82+14
	6	41	$1s(^2S)2s2p^4(^2P)\ ^3P_2$		6.6605	3.78+14	4.93+14
	6	42	$1s(^2S)2s2p^4(^2P)\ ^3P_0$		6.6696	3.20+14	4.73+14
	6	43	$1s(^2S)2s2p^4(^2D)\ ^1D_2$		6.6696	3.53+14	6.14+14
	6	44	$1s(^2S)2s2p^4(^2P)\ ^3P_1$		6.6727	3.57+14	4.25+14
	6	45	$1s(^2S)2s2p^4(^2P)\ ^1P_1$		6.6868	7.88+14	3.19+14
	6	46	$1s(^2S)2s2p^4(^2S)\ ^1S_0$		6.6947	3.91+14	5.74+14
	6	47	$1s2p^5\ ^3P^o_2$		6.7355	4.26+14	4.70+14
	6	48	$1s2p^5\ ^3P^o_1$		6.7435	4.88+14	4.66+14
	6	49	$1s2p^5\ ^3P^o_0$		6.7524	4.28+14	4.58+14
	6	50	$1s2p^5\ ^1P^o_1$		6.7629	8.12+14	4.66+14
Fe XX	7	1	$1s^22s^22p^3\ ^4S^o_{3/2}$	0.00	0.00		
	7	2	$1s^22s^22p^3\ ^2D^o_{3/2}$	0.01719	0.01705	1.49+04	
	7	3	$1s^22s^22p^3\ ^2D^o_{5/2}$	0.02184	0.02194	1.87+03	
	7	4	$1s^22s^22p^3\ ^2P^o_{1/2}$	0.03227	0.03195	3.69+04	
	7	5	$1s^22s^22p^3\ ^2P^o_{3/2}$	0.04009	0.04026	8.30+04	
	7	6	$1s^22s2p^4\ ^4P_{5/2}$	0.09333	0.09317	1.34+10	
	7	7	$1s^22s2p^4\ ^4P_{3/2}$	0.10175	0.10190	1.79+10	
	7	8	$1s^22s2p^4\ ^4P_{1/2}$	0.10445	0.10464	2.02+10	
	7	9	$1s^22s2p^4\ ^2D_{3/2}$	0.12926	0.12913	4.50+10	
	7	10	$1s^22s2p^4\ ^2D_{5/2}$	0.13122	0.13132	3.64+10	
	7	11	$1s^22s2p^4\ ^2S_{1/2}$	0.14819	0.14819	8.28+10	
	7	12	$1s^22s2p^4\ ^2P_{3/2}$	0.15404	0.15386	1.33+11	
	7	13	$1s^22s2p^4\ ^2P_{1/2}$	0.16614	0.16653	1.24+11	
	7	14	$1s^22p^5\ ^2P^o_{3/2}$	0.24230	0.24213	9.96+10	
	7	15	$1s^22p^5\ ^2P^o_{1/2}$	0.25565	0.25602	1.09+11	
	7	16	$1s2s^22p^4\ ^4P_{5/2}$	6.4966	6.4964	2.19+14	5.35+14
	7	17	$1s2s^22p^4\ ^4P_{3/2}$	6.5060	6.5063	2.39+14	5.20+14
	7	18	$1s2s^22p^4\ ^4P_{1/2}$	6.5081	6.5082	2.36+14	5.31+14
	7	19	$1s2s^22p^4\ ^2D_{3/2}$	6.5237	6.5236	5.98+14	5.39+14
	7	20	$1s2s^22p^4\ ^2D_{5/2}$	6.5283	6.5283	4.10+14	6.28+14
	7	21	$1s2s^22p^4\ ^2P_{1/2}$	6.5335	6.5324	6.89+14	4.94+14
	7	22	$1s2s^22p^4\ ^2P_{3/2}$	6.5345	6.5353	6.48+14	5.22+14
	7	23	$1s2s^22p^4\ ^2S_{1/2}$	6.5497	6.5496	5.71+14	5.22+14
	7	24	$1s(^2S)2s2p^5(^3P^o)\ ^4P^o_{5/2}$		6.5899	4.19+14	4.94+14
	7	25	$1s(^2S)2s2p^5(^3P^o)\ ^4P^o_{3/2}$		6.5974	4.31+14	4.92+14
	7	26	$1s(^2S)2s2p^5(^3P^o)\ ^4P^o_{1/2}$		6.6039	4.28+14	4.85+14

Table 1—Continued

Ion	N	i	State	E(EXP1)[a] (keV)	E(AST3)[b] (keV)	$A_r(i)$ (s^{-1})	$A_a(i)$ (s^{-1})
Fe XX	7	27	$1s(^2S)2s2p^5(^3P^o)\ ^2P^o_{3/2}$		6.6268	7.45+14	7.04+14
	7	28	$1s(^2S)2s2p^5(^3P^o)\ ^2P^o_{1/2}$		6.6312	8.45+14	5.60+14
	7	29	$1s(^2S)2s2p^5(^1P^o)\ ^2P^o_{3/2}$		6.6463	5.20+14	6.23+14
	7	30	$1s(^2S)2s2p^5(^1P^o)\ ^2P^o_{1/2}$		6.6523	4.23+14	7.55+14
	7	31	$1s2p^6\ ^2S_{1/2}$		6.7403	6.24+14	6.59+14
Fe XIX	8	1	$1s^22s^22p^4\ ^3P_2$	0.00	0.00		
	8	2	$1s^22s^22p^4\ ^3P_0$	0.00933	0.00942	5.00−01	
	8	3	$1s^22s^22p^4\ ^3P_1$	0.01109	0.01151	1.45+04	
	8	4	$1s^22s^22p^4\ ^1D_2$	0.02094	0.02109	1.80+04	
	8	5	$1s^22s^22p^4\ ^1S_0$	0.04031	0.04047	1.43+05	
	8	6	$1s^22s2p5\ ^3P^o_2$	0.11442	0.11447	4.75+10	
	8	7	$1s^22s2p5\ ^3P^o_1$	0.12209	0.12231	5.66+10	
	8	8	$1s^22s2p5\ ^3P^o_0$	0.12771	0.12815	5.59+10	
	8	9	$1s^22s2p5\ ^1P^o_1$	0.15716	0.15731	1.63+11	
	8	10	$1s^22p^6\ ^1S_0$	0.26460	0.26476	1.55+11	
	8	11	$1s2s^22p^5\ ^3P^o_2$	6.4654	6.4654	4.03+14	7.45+14
	8	12	$1s2s^22p^5\ ^3P^o_1$		6.4730	4.61+14	7.32+14
	8	13	$1s2s^22p^5\ ^3P^o_0$		6.4815	4.04+14	7.25+14
	8	14	$1s2s^22p^5\ ^1P^o_1$		6.4914	7.61+14	6.99+14
	8	15	$1s2s2p^6\ ^3S_1$		6.5819	6.03+14	6.89+14
	8	16	$1s2s2p^6\ ^1S_0$		6.6083	6.12+14	1.04+15
Fe XVIII	9	1	$1s^22s^22p^5\ ^2P^o_{3/2}$	0.00	0.00		
	9	2	$1s^22s^22p^5\ ^2P^o_{1/2}$	0.01272	0.01301	1.94+04	
	9	3	$1s^22s2p^6\ ^2S_{1/2}$	0.13201	0.13210	1.06+11	
	9	4	$1s2s^22p^6\ ^2S_{1/2}$	6.4348	6.4348	5.83+14	9.20+14

[a]Experimental level energies from the EXP1 data set.

[b]Theoretical level energies from approximation AST3.

Note. — $a \pm b \equiv a \times 10^{\pm b}$

Table 2. Wavelengths and radiative rates for N-electron Fe ions

N	k	i	λ (Å)	$A_{\mathrm{r}}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\mathrm{r}}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\mathrm{r}}(k,i)$ (s^{-1})
2	2	1	1.8682	2.08+08	4	8	4	166.69	7.44+09	4	24	2	1.8665	5.27+12
2	3	2	428.23	3.74+08	4	8	5	313.19	3.74+08	4	24	3	1.8676	3.99+13
2	4	1	1.8595	4.35+13	4	9	3	121.20	4.74+08	4	24	4	1.8708	9.55+13
2	4	2	400.30	4.12+08	4	9	4	136.53	4.81+09	4	24	5	1.8807	2.18+13
2	5	1		4.11+09[a]	4	9	5	221.34	4.47+09	4	25	3	1.8669[b]	1.00+14
2	6	1	1.8554	6.48+09	4	10	3	95.834	1.72+08	4	25	5	1.8800[b]	2.97+13
2	6	2	271.12	1.42+09	4	10	5	149.21	3.14+10	4	26	3	1.8651	1.96+11
2	7	1	1.8504	4.61+14	4	11	7	1.9174[b]	8.04+12	4	26	4	1.8683	9.67+13
2	7	2	194.28	3.40+08	4	12	1	1.8797	3.13+13	4	26	5	1.8781	1.65+14
2	7	5	382.76	4.69+08	4	12	6	1.9141	3.69+12	4	27	2	1.8624[b]	2.73+11
3	2	1	255.11	1.77+09	4	12	7	1.9167	2.05+12	4	27	3	1.8635[b]	8.69+10
3	3	1	192.03	4.30+09	4	12	8	1.9184	3.51+12	4	27	4	1.8667[b]	1.51+14
3	3	2	776.55	2.08+04	4	12	9	1.9233	3.26+10	4	27	5	1.8765[b]	1.17+13
3	4	2	1.8924	9.27+12	4	12	10	1.9314	8.09+09	4	28	7	1.8859[b]	6.20+12
3	4	3	1.8970	9.52+12	4	13	7	1.9130[b]	3.25+12	4	28	8	1.8875[b]	5.35+12
3	5	1	1.8747	4.97+12	4	13	8	1.9146[b]	5.71+12	4	28	9	1.8922[b]	2.50+11
3	6	1	1.8738	1.55+13	4	13	9	1.9195[b]	1.40+12	4	29	3	1.8618[b]	8.07+11
3	7	1	1.8706[b]	6.16+09	4	14	2	1.8867[b]	3.77+12	4	29	4	1.8650[b]	5.99+12
3	7	3	1.8890[b]	1.94+08	4	14	3	1.8878[b]	7.64+12	4	29	5	1.8748[b]	5.31+13
3	8	1	1.8635	3.01+14	4	14	4	1.8911[b]	2.88+11	4	30	2	1.8576	1.02+12
3	9	1	1.8611	4.71+14	4	14	5	1.9012[b]	1.12+09	4	30	3	1.8586	8.31+09
3	10	2	1.8722	2.17+13	4	15	3	1.8856[b]	8.10+09	4	30	4	1.8618	1.71+12
3	10	3	1.8767	9.12+10	4	15	4	1.8889[b]	5.05+12	4	30	5	1.8716	6.64+14
3	11	1	1.8570	1.86+14	4	15	5	1.8990[b]	1.65+09	4	31	3	1.8562	4.31+10
3	12	1	1.8563	4.19+12	4	16	4	1.8871	1.02+13	4	31	5	1.8692	2.23+14
3	13	2	1.8699	4.51+10	4	17	1	1.8704	4.37+14	4	32	1	1.8414[b]	1.29+11
3	13	3	1.8744	1.06+13	4	17	6	1.9045	6.04+10	4	32	6	1.8745[b]	2.57+14
3	14	3	1.8728	3.58+13	4	17	7	1.9071	3.47+11	4	32	7	1.8770[b]	2.28+12
3	15	2	1.8633	3.14+14	4	17	8	1.9087	3.95+12	4	32	8	1.8785[b]	4.76+13
3	15	3	1.8678	3.64+13	4	17	9	1.9135	1.14+13	4	32	9	1.8832[b]	1.07+12
3	16	2	1.8628	5.31+14	4	17	10	1.9215	8.82+11	4	32	10	1.8910[b]	2.89+10
3	16	3	1.8672	1.60+14	4	18	3	1.8752	6.01+14	4	33	7	1.8766[b]	2.15+14
3	17	3	1.8660	2.05+14	4	18	5	1.8884	5.64+11	4	33	8	1.8781[b]	2.11+10
3	18	2	1.8578	9.69+12	4	19	2	1.8730[b]	3.80+14	4	33	9	1.8828[b]	2.01+13
3	18	3	1.8622	6.07+14	4	19	3	1.8741[b]	5.62+13	4	34	8	1.8776[b]	1.65+14
3	19	2	1.8525	1.03+13	4	19	4	1.8773[b]	1.14+14	4	34	9	1.8823[b]	6.69+13
3	19	3	1.8569	2.40+14	4	19	5	1.8873[b]	9.97+10	4	35	1	1.8382[b]	1.76+10
4	3	1	263.77	5.01+07	4	20	3	1.8736	3.14+14	4	35	6	1.8711[b]	4.99+13
4	4	1	211.96	7.71+00	4	20	4	1.8769	1.59+13	4	35	7	1.8736[b]	4.54+14
4	4	3	1079.3	1.05+04	4	20	5	1.8868	5.75+12	4	35	8	1.8751[b]	2.41+14
4	5	1	132.91	1.95+10	4	21	4	1.8757	2.23+14	4	35	9	1.8798[b]	5.27+13
4	6	3	173.32	1.22+10	4	22	2	1.8708	3.07+12	4	35	10	1.8875[b]	7.56+10
4	6	5	490.94	2.26+07	4	22	3	1.8719	2.61+14	4	36	7	1.8712[b]	5.71+11
4	7	2	147.27	6.52+09	4	22	4	1.8752	7.30+13	4	36	8	1.8727[b]	3.60+14
4	7	3	154.30	4.13+09	4	22	5	1.8851	3.23+12	4	36	9	1.8774[b]	1.60+14
4	7	4	180.04	4.42+09	4	23	3	1.8703[b]	3.47+13	4	37	7	1.8697[b]	2.27+14
4	7	5	363.91	8.10+06	4	23	4	1.8735[b]	4.70+14	4	38	1	1.8340[b]	3.42+10
4	8	3	144.39	5.31+09	4	23	5	1.8834[b]	1.49+13	4	38	6	1.8667[b]	2.77+12

Table 2—Continued

N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})
4	38	7	1.8692[b]	1.19+13	5	13	10	230.28	3.27+09[c]	5	21	13	1.9343	4.11+12
4	38	8	1.8708[b]	2.59+14	5	14	3	85.831	2.07+08[c]	5	21	14	1.9397	1.11+12
4	38	9	1.8754[b]	1.55+13	5	14	4	90.136	5.50+07[c]	5	21	15	1.9419	5.13+08
4	38	10	1.8831[b]	3.01+13	5	14	6	120.00	2.83+10[c]	5	22	2	1.8851	1.97+14
4	39	7	1.8670[b]	7.40+12	5	14	8	139.67	2.32+09[c]	5	22	11	1.9264	1.17+11
4	39	8	1.8686[b]	1.19+12	5	14	9	169.12	1.14+10[c]	5	22	12	1.9316	1.38+12
4	39	9	1.8732[b]	3.88+14	5	14	10	173.22	2.13+09[c]	5	22	13	1.9328	4.84+12
4	40	1	1.8278[b]	3.91+11	5	15	3	81.755	7.37+06[c]	5	22	15	1.9403	4.58+11
4	40	6	1.8603[b]	1.88+11	5	15	4	85.651	3.09+08[c]	5	23	1	1.8782	2.27+12
4	40	7	1.8627[b]	1.70+12	5	15	5	89.730	1.29+08[c]	5	23	2	1.8824	5.35+14
4	40	8	1.8643[b]	8.25+12	5	15	6	112.18	4.92+09[c]	5	23	11	1.9236	2.08+09
4	40	9	1.8689[b]	3.85+14	5	15	7	115.14	1.39+10[c]	5	23	12	1.9288	1.76+12
4	40	10	1.8766[b]	2.87+14	5	15	8	129.19	3.78+09[c]	5	23	13	1.9299	4.91+12
5	2	1	845.55	1.49+04[c]	5	15	9	154.00	1.73+09[c]	5	23	14	1.9353	8.90+09
5	3	1	247.19	8.50+07[c]	5	15	10	157.38	1.91+10[c]	5	23	15	1.9374	4.14+12
5	3	2	349.30	1.44+07[c]	5	16	1	1.8918[b]	2.97+13	5	24	1	1.8752	3.27+12
5	4	1	217.30	2.10+06[c]	5	16	2	1.8960[b]	9.20+11	5	24	2	1.8794	2.64+14
5	4	2	292.46	8.35+06[c]	5	16	11	1.9378[b]	3.17+12	5	24	11	1.9204	1.65+09
5	5	2	253.17	7.23+07[c]	5	16	12	1.9431[b]	2.30+10	5	24	12	1.9256	8.62+09
5	6	1	135.81	1.08+10[c]	5	16	14	1.9496[b]	1.16+10	5	24	14	1.9321	4.51+12
5	6	2	161.80	3.22+07[c]	5	16	15	1.9519[b]	4.93+09	5	24	15	1.9343	3.72+12
5	7	2	156.02	6.03+09[c]	5	17	1	1.8893[b]	1.25+11	5	25	3	1.8845[b]	2.89+14
5	8	1	117.14	3.84+10[c]	5	17	2	1.8935[b]	9.76+12	5	25	4	1.8865[b]	7.40+11
5	8	2	135.98	2.60+07[c]	5	17	11	1.9352[b]	3.20+12	5	25	5	1.8884[b]	5.35+13
5	9	1	102.21	2.58+09[c]	5	17	12	1.9404[b]	2.14+11	5	25	6	1.8964[b]	4.34+12
5	9	2	116.27	3.43+10[c]	5	17	13	1.9416[b]	4.51+10	5	25	7	1.8972[b]	7.40+11
5	10	1	100.77	6.27+09[c]	5	17	14	1.9470[b]	4.39+08	5	25	8	1.9006[b]	9.57+11
5	10	2	114.41	4.44+10[c]	5	17	15	1.9492[b]	2.44+09	5	25	9	1.9051[b]	3.85+10
5	11	3	117.49	1.02+10[c]	5	18	2	1.8919[b]	2.59+13	5	25	10	1.9056[b]	1.97+09
5	11	4	125.71	1.51+10[c]	5	18	11	1.9335[b]	3.84+12	5	26	4	1.8862[b]	2.16+14
5	11	5	134.69	1.96+10[c]	5	18	12	1.9387[b]	1.19+10	5	26	5	1.8880[b]	2.27+12
5	11	6	192.53	1.42+08[c]	5	18	13	1.9399[b]	3.55+11	5	26	6	1.8960[b]	9.39+10
5	11	7	201.41	1.34+07[c]	5	18	15	1.9475[b]	4.16+09	5	26	7	1.8969[b]	7.80+12
5	11	8	248.73	1.24+08[c]	5	19	4	1.9007[b]	2.96+12	5	26	10	1.9053[b]	3.78+11
5	11	9	360.56	1.21+07[c]	5	19	5	1.9026[b]	3.27+12	5	27	3	1.8838[b]	2.20+14
5	11	10	379.68	3.07+07[c]	5	19	6	1.9108[b]	2.58+09	5	27	4	1.8858[b]	8.52+12
5	12	3	100.85	4.57+07[c]	5	19	7	1.9116[b]	2.47+10	5	27	6	1.8957[b]	1.05+13
5	12	4	106.85	2.22+09[c]	5	19	10	1.9201[b]	1.65+08	5	27	8	1.8999[b]	3.49+11
5	12	5	113.27	2.25+08[c]	5	20	1	1.8825	5.00+14	5	27	9	1.9044[b]	3.42+10
5	12	6	151.56	7.49+09[c]	5	20	2	1.8867	1.19+14	5	27	10	1.9049[b]	6.84+10
5	12	7	157.01	4.88+09[c]	5	20	11	1.9280	3.54+11	5	28	5	1.8874[b]	2.10+14
5	12	8	184.35	6.31+09[c]	5	20	12	1.9333	9.90+12	5	28	7	1.8962[b]	1.33+13
5	12	9	239.37	7.93+08[c]	5	20	14	1.9398	7.09+11	5	29	3	1.8824[b]	4.58+13
5	12	10	247.65	5.18+07[c]	5	20	15	1.9420	1.06+11	5	29	4	1.8844[b]	4.18+14
5	13	4	103.48	3.84+07[c]	5	21	1	1.8824	2.98+14	5	29	5	1.8863[b]	2.61+14
5	13	5	109.49	1.89+09[c]	5	21	2	1.8866	6.07+13	5	29	6	1.8943[b]	2.55+12
5	13	6	144.87	3.36+09[c]	5	21	11	1.9280	2.01+11	5	29	7	1.8951[b]	3.50+12
5	13	7	149.84	1.26+10[c]	5	21	12	1.9332	2.05+12	5	29	8	1.8985[b]	7.45+11

Table 2—Continued

N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})
5	29	9	1.9030[b]	5.51+09	5	36	9	1.8902[b]	1.50+13	5	44	11	1.8850[b]	2.38+14
5	29	10	1.9035[b]	2.83+10	5	36	10	1.8907[b]	2.50+12	5	44	12	1.8900[b]	6.61+12
5	30	3	1.8786[b]	7.49+12	5	37	3	1.8694[b]	1.00+12	5	44	13	1.8911[b]	9.94+12
5	30	4	1.8806[b]	2.20+14	5	37	4	1.8713[b]	1.55+10	5	44	14	1.8963[b]	3.01+11
5	30	6	1.8904[b]	1.83+10	5	37	6	1.8811[b]	3.82+14	5	44	15	1.8984[b]	1.33+12
5	30	8	1.8946[b]	1.09+11	5	37	8	1.8852[b]	1.44+14	5	45	1	1.8405[b]	3.54+09
5	30	9	1.8991[b]	2.74+12	5	37	9	1.8897[b]	1.13+14	5	45	2	1.8446[b]	2.30+10
5	30	10	1.8996[b]	4.61+11	5	37	10	1.8902[b]	3.54+13	5	45	11	1.8841[b]	2.21+14
5	31	4	1.8803[b]	2.93+12	5	38	4	1.8701[b]	3.64+10	5	45	12	1.8891[b]	3.63+12
5	31	5	1.8822[b]	2.40+14	5	38	5	1.8719[b]	1.68+11	5	45	14	1.8953[b]	9.85+12
5	31	6	1.8901[b]	2.42+12	5	38	6	1.8798[b]	4.70+11	5	45	15	1.8974[b]	9.79+11
5	31	7	1.8910[b]	1.32+13	5	38	7	1.8806[b]	8.30+13	5	46	1	1.8367[b]	2.43+09
5	31	10	1.8993[b]	2.14+12	5	38	10	1.8889[b]	1.96+14	5	46	2	1.8407[b]	2.05+11
5	32	3	1.8784[b]	4.14+12	5	39	3	1.8659[b]	6.98+09	5	46	11	1.8801[b]	5.81+12
5	32	4	1.8803[b]	2.98+13	5	39	4	1.8678[b]	3.14+11	5	46	12	1.8850[b]	4.61+14
5	32	5	1.8822[b]	2.10+14	5	39	5	1.8697[b]	5.22+10	5	46	13	1.8861[b]	9.90+13
5	32	6	1.8902[b]	7.15+12	5	39	6	1.8775[b]	6.64+11	5	46	14	1.8912[b]	5.14+12
5	32	7	1.8910[b]	2.40+11	5	39	7	1.8783[b]	2.19+14	5	46	15	1.8933[b]	3.93+13
5	32	8	1.8944[b]	6.78+12	5	39	8	1.8817[b]	8.54+10	5	47	2	1.8396[b]	7.79+10
5	32	9	1.8988[b]	3.14+12	5	39	9	1.8861[b]	2.34+14	5	47	11	1.8789[b]	1.08+12
5	32	10	1.8994[b]	2.41+11	5	39	10	1.8866[b]	1.48+13	5	47	12	1.8838[b]	1.15+11
5	33	3	1.8741[b]	7.14+11	5	40	3	1.8654[b]	7.16+08	5	47	13	1.8849[b]	2.94+14
5	33	4	1.8760[b]	6.58+12	5	40	4	1.8674[b]	2.25+10	5	47	15	1.8921[b]	1.39+14
5	33	5	1.8779[b]	7.85+12	5	40	6	1.8770[b]	1.86+12	5	48	1	1.8334[b]	8.86+10
5	33	6	1.8858[b]	3.43+14	5	40	8	1.8812[b]	2.48+14	5	48	2	1.8374[b]	7.21+10
5	33	7	1.8866[b]	1.07+14	5	40	9	1.8856[b]	1.63+14	5	48	11	1.8766[b]	3.35+12
5	33	8	1.8900[b]	5.81+13	5	40	10	1.8861[b]	5.51+13	5	48	12	1.8815[b]	2.76+12
5	33	9	1.8944[b]	7.81+12	5	41	3	1.8625[b]	1.77+10	5	48	13	1.8826[b]	4.33+14
5	33	10	1.8949[b]	4.65+12	5	41	4	1.8645[b]	4.41+10	5	48	14	1.8877[b]	1.46+14
5	34	4	1.8746[b]	2.25+12	5	41	5	1.8663[b]	3.59+10	5	48	15	1.8898[b]	1.25+14
5	34	5	1.8764[b]	4.89+12	5	41	6	1.8741[b]	2.86+11	5	49	1	1.8332[b]	1.83+11
5	34	6	1.8843[b]	5.22+13	5	41	7	1.8749[b]	1.48+13	5	49	2	1.8372[b]	1.17+10
5	34	7	1.8851[b]	5.11+14	5	41	8	1.8783[b]	5.14+08	5	49	11	1.8764[b]	6.24+11
5	34	10	1.8934[b]	1.85+13	5	41	9	1.8827[b]	1.03+13	5	49	12	1.8813[b]	3.61+14
5	35	3	1.8716[b]	4.14+11	5	41	10	1.8832[b]	2.01+14	5	49	14	1.8875[b]	3.40+14
5	35	4	1.8735[b]	2.29+12	5	42	3	1.8611[b]	7.50+09	5	49	15	1.8896[b]	1.42+14
5	35	5	1.8754[b]	3.24+13	5	42	4	1.8630[b]	2.52+11	5	50	1	1.8262[b]	4.08+09
5	35	6	1.8832[b]	6.10+13	5	42	6	1.8727[b]	6.14+12	5	50	2	1.8301[b]	1.63+11
5	35	7	1.8841[b]	2.26+12	5	42	8	1.8768[b]	3.23+11	5	50	11	1.8690[b]	6.52+11
5	35	8	1.8874[b]	3.81+12	5	42	9	1.8812[b]	8.54+13	5	50	12	1.8740[b]	1.32+11
5	35	9	1.8919[b]	1.84+12	5	42	10	1.8817[b]	5.82+14	5	50	14	1.8801[b]	2.70+13
5	35	10	1.8924[b]	2.63+13	5	43	2	1.8483[b]	1.61+10	5	50	15	1.8821[b]	4.68+14
5	36	3	1.8699[b]	3.64+09	5	43	11	1.8880[b]	2.02+14	6	2	1	1354.1	6.54+03[d]
5	36	4	1.8719[b]	4.74+10	5	43	12	1.8930[b]	1.31+13	6	3	1	852.12	7.27−01[d]
5	36	5	1.8737[b]	6.59+10	5	43	13	1.8941[b]	1.66+13	6	3	2	2298.0	8.38+02[d]
5	36	6	1.8816[b]	2.15+14	5	43	15	1.9014[b]	7.55+10	6	4	1	408.90	1.28−01[d]
5	36	7	1.8824[b]	7.77+13	5	44	1	1.8415[b]	8.26+07	6	4	2	585.79	1.65+04[d]
5	36	8	1.8858[b]	1.88+14	5	44	2	1.8455[b]	4.17+10	6	4	3	786.12	1.54+04[d]

Table 2—Continued

N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})
6	5	2	335.43	1.39+05[d]	6	17	11	123.34	1.86+10	6	24	4	1.9012	5.27+13
6	5	3	392.73	6.36+01[d]	6	17	13	156.24	1.80+10	6	24	16	1.9533	2.24+12
6	5	4	784.81	1.47+01[d]	6	17	15	210.72	1.14+07	6	24	19	1.9598	1.71+11
6	6	2	242.07	3.67+07[e]	6	18	6	79.773	2.14+08	6	25	1	1.8914	1.74+13
6	6	3	270.57	3.23+07[e]	6	18	7	103.75	1.48+10	6	25	2	1.8941	4.17+14
6	6	4	412.56	1.45+06[e]	6	18	8	103.82	2.23+10	6	25	3	1.8956	2.08+14
6	7	1	128.75	1.19+10	6	18	10	121.33	4.92+09	6	25	4	1.9002	3.90+13
6	7	2	142.28	8.17+08	6	18	11	122.61	1.22+08	6	25	5	1.9048	4.58+10
6	7	3	151.67	8.19+07	6	18	12	125.30	1.64+10	6	25	16	1.9522	3.79+12
6	7	4	187.92	1.89+08	6	18	13	155.08	1.35+10	6	25	17	1.9556	1.35+10
6	7	5	247.09	4.14+07	6	18	14	163.06	3.88+08	6	25	18	1.9558	2.91+12
6	8	2	142.15	9.58+09	6	18	15	208.61	6.44+08	6	25	19	1.9588	1.32+11
6	8	3	151.52	2.43+06	6	19	6	75.179	4.61+07	6	25	20	1.9677	5.27+09
6	8	4	187.70	3.92+07	6	19	7	96.116	3.05+06	6	26	2	1.8920	5.07+12
6	9	3	145.73	6.43+09	6	19	8	96.176	7.96+08	6	26	3	1.8936	3.10+14
6	9	4	178.90	9.61+08	6	19	9	98.662	5.60+09	6	26	4	1.8982	1.70+14
6	10	2	118.70	2.28+10	6	19	11	112.09	1.21+09	6	26	16	1.9500	1.21+12
6	11	1	108.12	4.53+09	6	19	12	114.33	2.54+09	6	26	18	1.9536	8.85+11
6	11	2	117.50	1.65+10	6	19	13	138.61	4.77+06	6	26	19	1.9566	2.88+12
6	11	3	123.83	2.81+09	6	19	14	144.96	3.31+10	6	27	2	1.8914[b]	2.23+14
6	11	4	146.98	2.63+08	6	19	15	179.87	4.66+09	6	27	18	1.9530[b]	2.85+12
6	11	5	180.85	1.52+08	6	20	7	78.647	2.36+08	6	28	1	1.8883[b]	1.99+12
6	12	2	115.13	4.50+08	6	20	11	89.025	4.13+09	6	28	2	1.8910[b]	1.73+13
6	12	3	121.20	2.12+10	6	20	13	104.98	5.14+09	6	28	3	1.8925[b]	2.48+14
6	12	4	143.29	1.18+08	6	20	15	127.06	7.87+10	6	28	4	1.8971[b]	1.34+12
6	13	1	91.268	9.59+09	6	21	2	1.9048[b]	7.47+12	6	28	5	1.9017[b]	4.50+13
6	13	2	97.865	2.60+10	6	21	3	1.9064[b]	7.03+12	6	28	16	1.9489[b]	1.86+10
6	13	3	102.22	6.28+10	6	21	4	1.9110[b]	2.49+11	6	28	17	1.9523[b]	2.27+12
6	13	4	117.49	3.01+08	6	21	16	1.9636[b]	9.12+10	6	28	18	1.9525[b]	1.06+12
6	13	5	138.18	6.39+08	6	21	18	1.9673[b]	3.65+09	6	28	19	1.9554[b]	6.29+11
6	14	2	94.932	3.95+08	6	21	19	1.9702[b]	8.04+08	6	28	20	1.9643[b]	2.18+09
6	14	3	99.021	7.50+09	6	22	1	1.8947	2.72+14	6	29	2	1.8881	4.71+12
6	14	4	113.29	4.66+10	6	22	2	1.8974	4.05+12	6	29	3	1.8897	7.42+12
6	15	1	79.293	2.89+07	6	22	3	1.8990	7.98+13	6	29	4	1.8942	3.53+14
6	15	2	84.225	4.81+09	6	22	4	1.9036	3.63+12	6	29	16	1.9459	1.80+11
6	15	3	87.429	2.15+08	6	22	5	1.9082	2.52+10	6	29	18	1.9495	1.32+12
6	15	4	98.369	6.79+10	6	22	16	1.9557	2.31+12	6	29	19	1.9524	3.32+12
6	15	5	112.47	1.77+10	6	22	17	1.9592	8.20+11	6	30	1	1.8831	8.27+10
6	16	6	86.255	1.34+09	6	22	18	1.9594	1.34+11	6	30	2	1.8857	1.27+12
6	16	7	114.99	3.44+09	6	22	19	1.9623	1.62+10	6	30	3	1.8873	8.97+07
6	16	8	115.08	1.36+10	6	22	20	1.9712	7.29+09	6	30	4	1.8918	3.85+14
6	16	9	118.66	2.94+10	6	23	2	1.8970	2.00+14	6	30	5	1.8964	2.42+14
6	16	11	138.62	3.84+09	6	23	3	1.8985	4.26+12	6	30	16	1.9433	1.94+10
6	16	12	142.07	3.77+09	6	23	4	1.9031	2.42+13	6	30	17	1.9467	9.12+10
6	16	13	181.61	6.31+09	6	23	16	1.9553	1.90+12	6	30	18	1.9469	2.91+11
6	16	14	192.66	7.76+08	6	23	18	1.9589	4.61+11	6	30	19	1.9498	5.02+12
6	16	15	259.63	8.63+07	6	23	19	1.9618	8.59+09	6	30	20	1.9586	1.93+12
6	17	7	104.27	3.62+10	6	24	3	1.8966	1.62+14	6	31	6	1.8995[b]	2.10+14

Table 2—Continued

N	k	i	λ (Å)	$A_r(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_r(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_r(k,i)$ (s^{-1})
6	31	8	1.9100[b]	3.52+12	6	37	9	1.8959[b]	2.21+14	6	43	14	1.8987[b]	1.81+14
6	31	9	1.9110[b]	6.08+12	6	37	11	1.9002[b]	1.65+14	6	43	15	1.9036[b]	1.24+14
6	31	12	1.9160[b]	2.82+11	6	37	12	1.9009[b]	3.86+13	6	44	6	1.8751[b]	8.50+09
6	31	14	1.9229[b]	8.13+08	6	37	13	1.9064[b]	6.99+12	6	44	7	1.8853[b]	2.78+11
6	32	6	1.8968[b]	2.17+14	6	37	14	1.9076[b]	3.13+12	6	44	8	1.8853[b]	1.09+12
6	32	7	1.9073[b]	6.23+11	6	37	15	1.9125[b]	1.71+12	6	44	10	1.8903[b]	7.20+11
6	32	8	1.9073[b]	1.76+12	6	38	6	1.8836[b]	3.37+11	6	44	11	1.8906[b]	1.80+11
6	32	9	1.9083[b]	1.27+12	6	38	7	1.8939[b]	1.79+12	6	44	12	1.8912[b]	9.76+13
6	32	11	1.9127[b]	4.14+11	6	38	8	1.8939[b]	2.98+14	6	44	13	1.8967[b]	2.12+14
6	32	12	1.9133[b]	2.31+12	6	38	10	1.8989[b]	2.01+14	6	44	14	1.8979[b]	4.41+13
6	32	13	1.9189[b]	2.92+11	6	38	11	1.8992[b]	2.59+13	6	44	15	1.9027[b]	9.36+11
6	32	14	1.9201[b]	3.07+10	6	38	12	1.8998[b]	1.32+14	6	45	6	1.8711[b]	1.12+07
6	32	15	1.9251[b]	1.53+10	6	38	13	1.9054[b]	1.10+13	6	45	7	1.8813[b]	2.02+10
6	33	6	1.8957[b]	2.18+14	6	38	14	1.9065[b]	9.32+12	6	45	8	1.8813[b]	1.56+12
6	33	7	1.9061[b]	1.88+11	6	38	15	1.9114[b]	7.63+11	6	45	10	1.8862[b]	4.27+11
6	33	8	1.9061[b]	3.21+11	6	39	7	1.8937[b]	2.38+14	6	45	11	1.8865[b]	4.28+11
6	33	10	1.9112[b]	1.60+12	6	39	11	1.8990[b]	5.52+14	6	45	12	1.8871[b]	3.91+11
6	33	11	1.9115[b]	3.32+12	6	39	13	1.9052[b]	4.36+13	6	45	13	1.8926[b]	8.00+12
6	33	12	1.9122[b]	6.97+11	6	39	15	1.9112[b]	1.58+12	6	45	14	1.8938[b]	4.92+14
6	33	13	1.9178[b]	3.09+11	6	40	6	1.8790[b]	2.85+11	6	45	15	1.8986[b]	2.86+14
6	33	14	1.9189[b]	9.44+09	6	40	7	1.8892[b]	6.49+11	6	46	7	1.8790[b]	2.82+11
6	33	15	1.9239[b]	1.46+10	6	40	8	1.8893[b]	7.89+12	6	46	11	1.8843[b]	3.20+11
6	34	6	1.8868[b]	3.43+12	6	40	10	1.8942[b]	1.28+13	6	46	13	1.8903[b]	2.73+11
6	34	7	1.8972[b]	4.23+13	6	40	11	1.8945[b]	9.71+13	6	46	15	1.8963[b]	3.90+14
6	34	8	1.8972[b]	4.10+14	6	40	12	1.8952[b]	2.81+14	6	47	2	1.8433[b]	1.60+10
6	34	9	1.8981[b]	2.18+14	6	40	13	1.9007[b]	7.75+12	6	47	3	1.8448[b]	4.52+10
6	34	11	1.9025[b]	2.28+12	6	40	14	1.9018[b]	1.32+12	6	47	4	1.8491[b]	2.81+10
6	34	12	1.9031[b]	6.37+13	6	40	15	1.9067[b]	1.77+13	6	47	16	1.8983[b]	2.86+14
6	34	13	1.9087[b]	3.08+12	6	41	6	1.8785[b]	1.47+10	6	47	18	1.9017[b]	1.06+14
6	34	14	1.9099[b]	1.99+12	6	41	7	1.8888[b]	3.67+11	6	47	19	1.9045[b]	3.40+13
6	34	15	1.9148[b]	2.19+11	6	41	8	1.8888[b]	1.30+12	6	48	1	1.8386[b]	2.31+10
6	35	6	1.8859[b]	3.02+11	6	41	9	1.8898[b]	7.59+13	6	48	2	1.8411[b]	1.19+10
6	35	7	1.8962[b]	5.03+14	6	41	11	1.8941[b]	8.09+12	6	48	3	1.8426[b]	8.39+09
6	35	8	1.8962[b]	3.36+12	6	41	12	1.8947[b]	4.18+11	6	48	4	1.8469[b]	6.31+10
6	35	10	1.9013[b]	1.38+12	6	41	13	1.9003[b]	1.60+14	6	48	5	1.8513[b]	1.73+10
6	35	11	1.9016[b]	1.85+13	6	41	14	1.9014[b]	1.32+14	6	48	16	1.8960[b]	2.25+14
6	35	12	1.9022[b]	6.09+13	6	41	15	1.9063[b]	6.30+11	6	48	17	1.8992[b]	1.43+14
6	35	13	1.9078[b]	6.61+12	6	42	7	1.8862[b]	3.30+12	6	48	18	1.8994[b]	9.21+13
6	35	14	1.9089[b]	1.11+12	6	42	11	1.8915[b]	8.47+13	6	48	19	1.9021[b]	2.83+13
6	35	15	1.9138[b]	1.00+10	6	42	13	1.8976[b]	2.07+14	6	48	20	1.9105[b]	3.51+08
6	36	6	1.8850[b]	1.70+11	6	42	15	1.9036[b]	2.53+13	6	49	2	1.8386[b]	5.84+10
6	36	8	1.8954[b]	9.80+11	6	43	6	1.8759[b]	1.14+10	6	49	18	1.8968[b]	4.28+14
6	36	9	1.8964[b]	2.84+14	6	43	7	1.8862[b]	3.74+11	6	50	1	1.8333[b]	1.59+09
6	36	12	1.9014[b]	1.33+14	6	43	8	1.8862[b]	5.07+11	6	50	2	1.8358[b]	2.12+09
6	36	14	1.9081[b]	1.09+13	6	43	9	1.8871[b]	1.29+12	6	50	3	1.8373[b]	3.59+10
6	37	6	1.8846[b]	1.12+12	6	43	11	1.8915[b]	1.95+12	6	50	4	1.8416[b]	7.42+10
6	37	7	1.8949[b]	1.73+10	6	43	12	1.8921[b]	2.01+13	6	50	5	1.8459[b]	1.22+11
6	37	8	1.8949[b]	5.19+13	6	43	13	1.8976[b]	2.40+13	6	50	16	1.8904[b]	1.25+13

Table 2—Continued

N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ (s^{-1})
6	50	17	1.8936[b]	1.63+10	7	13	5	98.357	9.12+10	7	21	5	1.9094	5.13+13
6	50	18	1.8938[b]	1.47+13	7	14	6	83.224	2.77+09	7	21	14	1.9708	3.56+12
6	50	19	1.8965[b]	6.38+14	7	14	7	88.208	1.50+09	7	21	15	1.9749	7.65+11
6	50	20	1.9049[b]	1.47+14	7	14	8	89.942	4.63+08	7	22	1	1.8974	3.33+12
7	2	1	721.40	1.49+04[f]	7	14	9	109.68	1.59+10	7	22	2	1.9024	2.96+12
7	3	1	567.76	1.44+03[f]	7	14	10	111.61	4.04+10	7	22	3	1.9037	3.92+14
7	3	2	2665.2	4.24+02[f]	7	14	11	131.74	8.55+09	7	22	4	1.9068	1.35+14
7	4	1	384.22	3.16+04[f]	7	14	12	140.47	2.85+10	7	22	5	1.9091	1.12+14
7	4	2	822.03	5.27+03[f]	7	14	13	162.79	1.52+09	7	22	14	1.9704	1.47+12
7	4	3	1188.5	7.29−01[f]	7	15	7	80.557	2.63+08	7	22	15	1.9746	2.08+12
7	5	1	309.27	2.42+04[f]	7	15	8	82.000	8.37+08	7	23	1	1.8930	1.47+11
7	5	2	541.36	4.53+04[f]	7	15	9	98.095	4.30+10	7	23	2	1.8980	8.78+12
7	5	3	679.30	1.19+04[f]	7	15	11	115.38	2.45+09	7	23	4	1.9023	7.78+10
7	5	4	1585.5	1.61+03[f]	7	15	12	122.02	3.35+10	7	23	5	1.9046	5.58+14
7	6	1	132.85	1.26+10	7	15	13	138.51	2.95+10	7	23	14	1.9657	6.01+10
7	6	2	162.84	5.42+08	7	16	1	1.9085	1.89+14	7	23	15	1.9699	3.94+12
7	6	3	173.43	2.46+08	7	16	2	1.9135	1.52+13	7	24	6	1.9085[b]	2.85+14
7	6	5	232.89	2.33+07	7	16	3	1.9149	1.44+13	7	24	7	1.9110[b]	1.23+14
7	7	1	121.86	1.76+10	7	16	5	1.9203	3.35+11	7	24	9	1.9191[b]	2.00+12
7	7	2	146.63	7.10+07	7	16	14	1.9824	5.33+10	7	24	10	1.9197[b]	8.70+12
7	7	3	155.16	5.11+07	7	17	1	1.9057	2.23+14	7	24	12	1.9265[b]	3.61+11
7	7	4	178.46	3.33+06	7	17	2	1.9107	2.67+12	7	25	6	1.9063[b]	1.97+14
7	7	5	201.09	1.60+08	7	17	3	1.9121	9.14+12	7	25	7	1.9087[b]	5.22+13
7	8	1	118.70	1.97+10	7	17	4	1.9152	1.78+11	7	25	8	1.9095[b]	1.72+14
7	8	2	142.07	2.74+08	7	17	5	1.9175	3.80+12	7	25	9	1.9169[b]	4.09+12
7	8	4	171.76	2.22+08	7	17	14	1.9794	1.64+11	7	25	10	1.9174[b]	3.03+12
7	8	5	192.63	8.61+06	7	17	15	1.9836	2.79+09	7	25	11	1.9225[b]	1.20+12
7	9	1	95.917	1.46+09	7	18	1	1.9051	2.12+14	7	25	12	1.9242[b]	8.86+11
7	9	2	110.63	4.02+10	7	18	2	1.9101	1.01+12	7	25	13	1.9278[b]	4.04+10
7	9	3	115.41	3.99+07	7	18	4	1.9146	1.97+13	7	26	7	1.9068[b]	3.53+14
7	9	4	127.83	2.80+09	7	18	5	1.9169	2.57+12	7	26	8	1.9076[b]	7.09+13
7	9	5	139.04	5.14+08	7	18	14	1.9788	1.75+11	7	26	9	1.9149[b]	2.08+12
7	10	1	94.486	2.07+07	7	18	15	1.9830	4.63+10	7	26	11	1.9205[b]	8.78+10
7	10	2	108.73	8.76+06	7	19	1	1.9005	1.04+13	7	26	12	1.9223[b]	1.46+12
7	10	3	113.35	3.07+10	7	19	2	1.9055	4.50+14	7	26	13	1.9259[b]	1.02+12
7	10	5	136.05	5.67+09	7	19	3	1.9069	1.15+14	7	27	6	1.8977[b]	4.93+12
7	11	1	83.664	1.60+09	7	19	4	1.9100	2.70+12	7	27	7	1.9002[b]	5.83+12
7	11	2	94.640	4.30+10	7	19	5	1.9123	1.79+13	7	27	8	1.9009[b]	6.24+11
7	11	4	106.95	3.58+10	7	19	14	1.9738	2.97+12	7	27	9	1.9082[b]	8.19+13
7	11	5	114.69	2.50+09	7	19	15	1.9780	4.16+10	7	27	10	1.9088[b]	4.76+14
7	12	1	80.487	3.92+09	7	20	1	1.8992	2.65+11	7	27	11	1.9138[b]	1.21+14
7	12	2	90.595	1.42+10	7	20	2	1.9042	1.53+12	7	27	12	1.9155[b]	5.32+13
7	12	3	93.782	9.68+10	7	20	3	1.9056	2.81+14	7	27	13	1.9191[b]	2.19+12
7	12	4	101.82	8.57+09	7	20	5	1.9109	1.26+14	7	28	7	1.8989[b]	9.92+10
7	12	5	108.80	9.42+09	7	20	14	1.9724	1.83+12	7	28	8	1.8997[b]	2.27+12
7	13	1	74.625	1.10+08	7	21	1	1.8977	2.11+10	7	28	9	1.9069[b]	6.66+14
7	13	2	83.235	2.86+10	7	21	2	1.9027	3.02+14	7	28	11	1.9125[b]	9.82+13
7	13	4	92.612	3.86+09	7	21	4	1.9071	3.31+14	7	28	12	1.9142[b]	4.06+13

Table 2—Continued

N	k	i	λ (Å)	$A_{\rm r}(k,i)$ ($\rm s^{-1}$)	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ ($\rm s^{-1}$)	N	k	i	λ (Å)	$A_{\rm r}(k,i)$ ($\rm s^{-1}$)
7	28	13	1.9178[b]	3.80+13	8	4	2	1068.4	7.07−02[d]	8	12	2	1.9182[b]	1.33+14
7	29	6	1.8920[b]	1.16+11	8	4	3	1259.3	6.69+02[d]	8	12	3	1.9187[b]	8.68+13
7	29	7	1.8945[b]	6.22+09	8	5	1	307.56	9.71+00[d]	8	12	4	1.9216[b]	3.05+13
7	29	8	1.8953[b]	1.13+11	8	5	3	424.27	1.43+05[d]	8	12	5	1.9274[b]	9.41+11
7	29	9	1.9025[b]	9.72+09	8	5	4	639.84	4.90+01[d]	8	12	10	1.9971[b]	3.00+11
7	29	10	1.9030[b]	1.50+14	8	6	1	108.36	3.59+10	8	13	3	1.9162[b]	4.04+14
7	29	11	1.9080[b]	2.25+12	8	6	3	119.98	9.65+09	8	14	1	1.9100[b]	8.80+12
7	29	12	1.9097[b]	2.82+14	8	6	4	132.62	2.00+09	8	14	2	1.9128[b]	7.55+11
7	29	13	1.9133[b]	8.54+13	8	7	1	101.55	2.93+10	8	14	3	1.9133[b]	1.40+13
7	30	7	1.8927[b]	1.37+10	8	7	2	109.95	1.50+10	8	14	4	1.9162[b]	6.05+14
7	30	8	1.8935[b]	3.43+11	8	7	3	111.69	1.16+10	8	14	5	1.9219[b]	1.31+14
7	30	9	1.9007[b]	9.96+12	8	7	4	122.57	1.71+07	8	14	10	1.9912[b]	2.53+12
7	30	11	1.9063[b]	7.32+13	8	7	5	151.61	6.14+08	8	15	6	1.9171[b]	3.35+14
7	30	12	1.9080[b]	1.32+14	8	8	3	106.32	5.59+10	8	15	7	1.9193[b]	1.94+14
7	30	13	1.9115[b]	2.08+14	8	9	1	78.889	1.11+10	8	15	8	1.9210[b]	6.69+13
7	31	1	1.8395[b]	9.15+09	8	9	2	83.868	1.17+09	8	15	9	1.9298[b]	6.47+12
7	31	2	1.8442[b]	1.79+10	8	9	3	84.878	8.62+08	8	16	7	1.9115[b]	1.98+13
7	31	4	1.8483[b]	5.43+10	8	9	4	91.013	1.40+11	8	16	9	1.9219[b]	5.92+14
7	31	5	1.8505[b]	1.05+11	8	9	5	106.11	1.01+10	9	2	1	974.86	1.94+04[g]
7	31	14	1.9081[b]	4.17+14	8	10	7	86.999	1.05+10	9	3	1	93.923	7.73+10[g]
7	31	15	1.9120[b]	2.08+14	8	10	9	115.40	1.45+11	9	3	2	103.94	2.85+10[g]
8	2	1	1328.9	5.00−01[d]	8	11	1	1.9176	2.73+14	9	4	1	1.9268	3.89+14
8	3	1	1118.1	1.45+04[d]	8	11	3	1.9209	1.01+14	9	4	2	1.9306	1.94+14
8	3	2	7044.8	4.15+01[d]	8	11	4	1.9239	2.92+13					
8	4	1	592.23	1.74+04[d]	8	12	1	1.9154[b]	2.09+14					

[a]Two-photon transition rate from **?**

[b]Theoretical wavelength

[c]Transition rate from **?**

[d]Transition rate from **?**

[e]Transition rate from **?**

[f]Transition rate from **?**

[g]Transition rate from C. Mendoza & C.J. Zeippen, private communication

Note. — $a \pm b \equiv a \times 10^{\pm b}$

Table 3. Comparison of data sets of radiative rates for Fe XXIV–Fe XVIII

Data sets[a]	Fe XXIV	Fe XXIII	Fe XXII	Fe XXI	Fe XX	Fe XIX	Fe XVIII
$\overline{R}$(AST1, AST2)	0.95 ± 0.09	0.98 ± 0.15	1.01 ± 0.15	1.00 ± 0.12[b]	1.00 ± 0.12	1.04 ± 0.08	1.00
$\overline{R}$(AST2, AST3)	1.01 ± 0.08	1.00 ± 0.17[c]	1.00 ± 0.07	0.99 ± 0.11[d]	1.00 ± 0.08	1.00 ± 0.02	1.00
$\overline{R}$(HFR2, AST3)	0.96 ± 0.13	1.00 ± 0.20	1.00 ± 0.15	1.00 ± 0.16	1.01 ± 0.14	1.09 ± 0.05	1.05
$\overline{R}$(COR, AST3)	1.02 ± 0.05	1.01 ± 0.17	0.95 ± 0.16	0.95 ± 0.23[e]			
$\overline{R}$(SAF, AST3)	0.97 ± 0.06	1.00 ± 0.23[f]	0.96 ± 0.16[g]	1.00 ± 0.18[h]			
$\overline{R}$(MCDF, AST3)	0.95 ± 0.05	1.03 ± 0.17[i]	0.96 ± 0.14[j]	1.18 ± 0.28[k]			

[a]Comparison includes only transitions with $\log A_{\rm r} > 13$

[b]Excludes transitions (6,29,3–4) and (6,26,4)

[c]Excludes transition (4,20,4)

[d]Excludes transitions (6,26,3–4), (6,28,2), and (6,29,4)

[e]Excludes transitions (6,23,4), (6,26,4), and (6,29,4)

[f]Excludes transitions (4,24–25,3), (4,20,4), and (4,24,4) listed in Table **??**

[g]Excludes transitions (5,43,13), (5,46,15), and (5,49,15) listed in Table **??**

[h]Excludes transitions (6,26,3–4) and (6,29,4) listed in Table **??**

[i]Excludes transitions (4,20,4) and (4,38,9) listed in Table **??**

[j]Excludes transitions (5,k,i) in listed Table **??**

[k]Excludes transitions (6,k,i) in listed Table **??**

Table 4. Radiative rates (s^{-1}) in SAF that show large discrepancies with AST3

N	k	i	SAF	AST3	HFR2	COR	MCDF
4	20	4	8.17+12	1.59+13	1.98+13	2.61+13	2.84+13
4	24	3	8.85+13	3.99+13	3.11+13	4.23+13	3.44+13
4	24	4	3.67+13	9.55+13	8.37+13	7.95+13	1.04+14
4	25	3	2.13+14	1.00+14	1.00+14		8.27+13
5	43	13	2.40+12	1.66+13	1.82+13		1.67+13
5	46	15	1.40+14	3.93+13	3.08+13		4.19+13
5	49	15	2.67+13	1.42+14	1.32+14		1.31+14
6	26	3	4.70+12	3.10+14	3.13+14		6.26+12
6	26	4	4.86+14	1.70+14	1.05+14	4.85+14	6.05+14
6	29	4	6.89+13	3.53+14	4.63+14	5.82+13	6.58+13

Note. — $a \pm b \equiv a \times 10^{\pm b}$

Table 5. Radiative rates (s^{-1}) in MCDF that show large discrepancies with AST3

N	k	i	MCDF	AST3	HFR2	COR	SAF
4	20	4	2.84+13	1.59+13	1.98+13	2.61+13	8.17+12
4	38	9	7.14+12	1.55+13	1.30+13		
5	33	8	7.87+12	5.81+13	6.36+13		
5	36	6	3.75+11	2.15+14	2.37+14		
5	36	7	1.99+14	7.77+13	6.25+13		
5	36	9	1.19+11	1.50+13	9.05+12		
5	39	7	8.96+13	2.19+14	2.39+14		
5	39	10	5.26+11	1.48+13	1.62+13		
5	41	7	8.18+12	1.48+13	1.65+13		
5	41	9	1.23+10	1.03+13	1.09+13		
5	42	9	1.84+09	8.54+13	1.02+14		
6	26	3	6.26+12	3.10+14	3.13+14		4.70+12
6	26	4	6.05+14	1.70+14	1.05+14	4.85+14	4.86+14
6	28	2	8.18+10	1.73+13	7.25+12		
6	29	4	6.58+13	3.53+14	4.63+14	5.82+13	6.89+13
6	34	7	5.63+12	4.23+13	4.31+13		
6	34	8	2.79+10	4.10+14	4.45+14		
6	34	9	4.94+14	2.18+14	1.82+14		
6	37	8	5.77+14	5.19+13	3.11+13		
6	37	9	1.03+14	2.21+14	2.66+14		
6	37	11	1.13+13	1.65+14	1.74+14		
6	38	11	6.58+13	2.59+13	3.69+13		
6	38	13	4.24+12	1.10+13	1.06+13		
6	40	10	2.21+12	1.28+13	9.07+12		
6	42	11	3.72+13	8.47+13	9.11+13		
6	43	13	7.83+12	2.40+13	2.31+13		
6	44	12	1.50+12	9.76+13	1.07+14		
6	44	13	3.91+12	2.12+14	2.17+14		
6	44	14	5.84+14	4.41+13	4.86+13		
6	45	14	8.58+13	4.92+14	5.09+14		
6	45	15	2.00+12	2.86+14	2.96+14		

Note. — $a \pm b \equiv a \times 10^{\pm b}$

Table 6. Comparison of data sets of Auger rates for Fe XXIV–Fe XVIII

Data sets[a]	Fe XXIV	Fe XXIII	Fe XXII	Fe XXI	Fe XX	Fe XIX	Fe XVIII
$\overline{R}$(AST1, AST2)	1.10 ± 0.24	1.11±0.29	1.05±0.09	1.04±0.03	1.04±0.02	1.04±0.02	1.04
$\overline{R}$(BPR1, AST1)	0.99 ± 0.14	0.98±0.11	0.98±0.04	1.00±0.02	1.01±0.02	1.03±0.01	1.06
$\overline{R}$(HFR2, AST3)	2.10 ± 2.33	1.06±0.25	1.00±0.08	1.00±0.03	1.01±0.02	1.03±0.02	1.03
$\overline{R}$(COR, AST3)	1.06 ± 0.20	1.04±0.27	0.99±0.10	0.95±0.06			
$\overline{R}$(SAF, AST3)	1.08 ± 0.15	1.16±0.23	1.21±0.27	1.28±0.04			
$\overline{R}$(MCDF, AST3)	0.96 ± 0.33	1.02±0.08	1.04±0.04	1.20±0.19			

[a]Comparison includes only transitions with $\log A_{\rm a} > 13$

Table 7. Transition energies and partial Auger rates for N-electron Fe ions

N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{a}(k,i)$ (s^{-1})	N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{a}(k,i)$ (s^{-1})	N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{a}(k,i)$ (s^{-1})
3	4	1	4.555	1.43+14	4	21	3	4.654	1.62+13	4	37	3	4.744	1.15+14
3	5	1	4.568	1.33+10	4	22	1	4.720	1.04+14	4	38	1	4.810	1.71+12
3	6	1	4.571	3.91+11	4	22	2	4.671	2.07+13	4	38	2	4.761	1.96+13
3	7	1	4.583	1.97+09	4	22	3	4.655	5.20+12	4	38	3	4.745	1.16+14
3	8	1	4.608	4.24+13	4	23	1	4.726	4.00+13	4	39	1	4.818	1.28+12
3	9	1	4.616	1.41+11	4	23	2	4.677	3.37+13	4	39	2	4.769	4.20+12
3	10	1	4.625	3.37+11	4	23	3	4.661	2.06+13	4	39	3	4.753	1.72+14
3	11	1	4.631	6.77+13	4	24	1	4.735	3.28+13	4	40	1	4.833	4.72+10
3	12	1	4.634	1.07+14	4	24	2	4.687	7.36+13	4	40	2	4.784	2.02+13
3	13	1	4.634	9.66+11	4	24	3	4.671	2.25+13	4	40	3	4.768	1.10+14
3	14	1	4.639	2.61+13	4	25	1	4.738	4.30+12	5	16	1	4.755	7.97+12
3	15	1	4.657	1.25+14	4	25	2	4.689	1.20+14	5	16	2	4.712	1.91+13
3	16	1	4.659	9.39+11	4	25	3	4.673	1.33+13	5	16	3	4.708	1.03+14
3	17	1	4.663	1.37+14	4	26	1	4.744	9.62+13	5	16	4	4.697	7.51+12
3	18	1	4.677	3.28+13	4	26	2	4.696	5.35+13	5	16	5	4.662	2.31+11
3	19	1	4.696	2.92+13	4	26	3	4.680	7.80+13	5	16	6	4.637	7.88+13
4	11	1	4.643	6.35+13	4	27	1	4.750	2.90+13	5	16	7	4.628	1.78+13
4	11	2	4.595	1.15+14	4	27	2	4.701	2.33+13	5	16	8	4.623	3.39+12
4	11	3	4.579	4.17+12	4	27	3	4.685	5.89+13	5	16	9	4.606	1.27+11
4	12	1	4.645	6.63+13	4	28	1	4.751	3.02+11	5	16	10	4.579	1.57+10
4	12	2	4.597	1.02+14	4	28	2	4.703	4.47+12	5	17	1	4.764	2.32+11
4	12	3	4.581	1.75+13	4	28	3	4.687	1.18+12	5	17	2	4.721	3.83+13
4	13	1	4.658	6.79+13	4	29	1	4.756	4.43+13	5	17	3	4.717	3.35+13
4	13	2	4.610	3.42+12	4	29	2	4.707	4.46+11	5	17	4	4.706	5.77+13
4	13	3	4.594	1.20+14	4	29	3	4.691	1.69+14	5	17	5	4.671	5.97+08
4	14	1	4.664	2.09+12	4	30	1	4.767	2.74+12	5	17	6	4.646	7.39+10
4	14	2	4.616	6.82+10	4	30	2	4.719	6.78+12	5	17	7	4.637	9.06+13
4	14	3	4.600	5.27+10	4	30	3	4.703	4.62+13	5	17	8	4.631	9.83+12
4	15	1	4.672	4.41+11	4	31	1	4.776	6.22+13	5	17	9	4.615	1.69+12
4	15	2	4.623	4.57+10	4	31	2	4.727	1.13+13	5	17	10	4.588	2.55+08
4	15	3	4.607	3.81+10	4	31	3	4.711	1.45+14	5	18	1	4.770	1.56+13
4	16	1	4.678	6.14+12	4	32	1	4.783	3.40+11	5	18	2	4.727	6.85+08
4	16	2	4.630	9.48+08	4	32	2	4.734	1.49+14	5	18	3	4.723	4.38+13
4	16	3	4.614	4.14+11	4	32	3	4.718	4.27+13	5	18	4	4.711	8.37+13
4	17	1	4.678	3.33+12	4	33	1	4.784	4.82+11	5	18	5	4.676	3.17+12
4	17	2	4.630	1.69+13	4	33	2	4.735	1.40+14	5	18	6	4.651	1.20+12
4	17	3	4.614	1.08+14	4	33	3	4.719	6.67+13	5	18	7	4.642	1.69+12
4	18	1	4.708	3.29+12	4	34	1	4.786	4.82+05	5	18	8	4.637	9.57+13
4	18	2	4.660	6.38+13	4	34	2	4.737	5.24+13	5	18	9	4.620	5.40+12
4	18	3	4.644	4.18+12	4	34	3	4.721	1.75+14	5	18	10	4.593	1.16+11
4	19	1	4.712	4.47+13	4	35	1	4.795	1.23+11	5	19	1	4.782	2.54+06
4	19	2	4.664	4.51+12	4	35	2	4.746	5.12+12	5	19	2	4.738	9.70+11
4	19	3	4.648	1.95+13	4	35	3	4.730	4.28+13	5	19	3	4.735	1.48+12
4	20	1	4.714	1.20+14	4	36	1	4.803	6.15+11	5	19	4	4.723	1.61+12
4	20	2	4.665	5.41+12	4	36	2	4.754	6.71+13	5	19	5	4.688	1.12+09
4	20	3	4.649	8.50+12	4	36	3	4.738	1.29+14	5	19	6	4.663	5.98+08
4	21	1	4.718	1.47+14	4	37	1	4.808	1.83+12	5	19	7	4.654	7.34+10
4	21	2	4.670	1.52+09	4	37	2	4.759	2.38+13	5	19	8	4.649	6.19+10

Table 7—Continued

N	k^a	i^b	ΔE^c (keV)	$A_a(k,i)$ (s^{-1})	N	k^a	i^b	ΔE^c (keV)	$A_a(k,i)$ (s^{-1})	N	k^a	i^b	ΔE^c (keV)	$A_a(k,i)$ (s^{-1})
5	19	9	4.632	9.56+09	5	24	7	4.686	1.88+12	5	29	5	4.745	1.95+11
5	19	10	4.605	2.12+06	5	24	8	4.680	2.41+12	5	29	6	4.720	1.28+13
5	20	1	4.788	7.24+12	5	24	9	4.664	1.01+13	5	29	7	4.711	6.59+12
5	20	2	4.745	1.65+12	5	24	10	4.637	9.25+13	5	29	8	4.705	2.66+13
5	20	3	4.741	1.63+11	5	25	1	4.831	1.49+10	5	29	9	4.689	4.01+12
5	20	4	4.729	9.47+12	5	25	2	4.788	3.80+13	5	29	10	4.662	9.23+09
5	20	5	4.695	3.54+13	5	25	3	4.784	1.14+14	5	30	1	4.852	4.70+09
5	20	6	4.669	1.71+13	5	25	4	4.772	2.11+13	5	30	2	4.808	2.85+13
5	20	7	4.661	8.19+13	5	25	5	4.738	1.27+12	5	30	3	4.805	1.15+13
5	20	8	4.655	2.39+12	5	25	6	4.712	4.34+12	5	30	4	4.793	1.22+14
5	20	9	4.639	9.68+11	5	25	7	4.704	9.45+12	5	30	5	4.758	1.49+11
5	20	10	4.611	2.10+12	5	25	8	4.698	2.61+12	5	30	6	4.733	1.74+11
5	21	1	4.788	1.02+14	5	25	9	4.682	6.77+11	5	30	7	4.724	1.46+13
5	21	2	4.745	3.29+12	5	25	10	4.655	6.78+10	5	30	8	4.719	1.12+12
5	21	3	4.741	5.82+12	5	26	1	4.832	7.17+06	5	30	9	4.702	3.85+11
5	21	4	4.730	6.37+12	5	26	2	4.789	8.41+13	5	30	10	4.675	4.43+10
5	21	5	4.695	6.35+13	5	26	3	4.785	5.30+13	5	31	1	4.852	2.50+07
5	21	6	4.670	1.00+12	5	26	4	4.774	6.72+13	5	31	2	4.809	2.60+12
5	21	7	4.661	5.05+12	5	26	5	4.739	1.61+11	5	31	3	4.805	3.73+13
5	21	8	4.655	7.64+13	5	26	6	4.713	8.00+08	5	31	4	4.794	1.27+14
5	21	9	4.639	2.29+13	5	26	7	4.705	1.49+13	5	31	5	4.759	5.23+12
5	21	10	4.612	1.43+12	5	26	8	4.699	1.06+12	5	31	6	4.734	1.16+08
5	22	1	4.793	1.27+14	5	26	9	4.683	7.77+10	5	31	7	4.725	6.27+11
5	22	2	4.750	6.86+08	5	26	10	4.656	2.93+07	5	31	8	4.719	1.33+13
5	22	3	4.746	1.68+12	5	27	1	4.833	4.48+10	5	31	9	4.703	2.19+12
5	22	4	4.735	3.94+13	5	27	2	4.790	6.19+11	5	31	10	4.676	5.20+08
5	22	5	4.700	6.43+13	5	27	3	4.786	1.82+14	5	32	1	4.852	5.27+10
5	22	6	4.675	5.75+10	5	27	4	4.775	2.57+13	5	32	2	4.809	3.63+12
5	22	7	4.666	4.05+11	5	27	5	4.740	1.92+12	5	32	3	4.805	3.69+13
5	22	8	4.660	6.71+12	5	27	6	4.715	1.23+13	5	32	4	4.794	1.11+14
5	22	9	4.644	9.97+13	5	27	7	4.706	4.27+12	5	32	5	4.759	1.44+12
5	22	10	4.617	2.21+12	5	27	8	4.700	1.13+11	5	32	6	4.734	1.29+13
5	23	1	4.803	3.64+13	5	27	9	4.684	2.25+10	5	32	7	4.725	2.44+13
5	23	2	4.760	1.48+12	5	27	10	4.657	1.24+11	5	32	8	4.720	1.18+12
5	23	3	4.756	4.98+12	5	28	1	4.834	1.20+04	5	32	9	4.703	7.40+11
5	23	4	4.744	2.31+12	5	28	2	4.791	8.08+00	5	32	10	4.676	2.18+10
5	23	5	4.709	4.42+13	5	28	3	4.787	7.26+13	5	33	1	4.868	3.92+11
5	23	6	4.684	1.64+11	5	28	4	4.776	1.45+14	5	33	2	4.824	4.30+13
5	23	7	4.675	6.32+12	5	28	5	4.741	1.68+12	5	33	3	4.821	9.25+13
5	23	8	4.670	2.00+13	5	28	6	4.716	2.15+08	5	33	4	4.809	5.57+13
5	23	9	4.653	8.18+13	5	28	7	4.707	6.29+08	5	33	5	4.774	4.19+12
5	23	10	4.626	7.77+11	5	28	8	4.701	1.22+13	5	33	6	4.749	3.93+13
5	24	1	4.813	8.31+13	5	28	9	4.685	3.61+12	5	33	7	4.740	6.55+13
5	24	2	4.770	1.64+12	5	28	10	4.658	1.31+07	5	33	8	4.735	1.88+13
5	24	3	4.766	5.99+12	5	29	1	4.838	5.69+10	5	33	9	4.718	2.76+13
5	24	4	4.755	1.34+13	5	29	2	4.795	2.28+12	5	33	10	4.691	9.76+11
5	24	5	4.720	7.00+13	5	29	3	4.791	2.00+13	5	34	1	4.873	8.07+06
5	24	6	4.695	1.30+12	5	29	4	4.780	3.10+13	5	34	2	4.830	8.61+12

Table 7—Continued

N	k[a]	i[b]	ΔE[c] (keV)	$A_{\rm a}(k,i)$ (s^{-1})	N	k[a]	i[b]	ΔE[c] (keV)	$A_{\rm a}(k,i)$ (s^{-1})	N	k[a]	i[b]	ΔE[c] (keV)	$A_{\rm a}(k,i)$ (s^{-1})
5	34	3	4.826	4.60+13	5	39	1	4.896	1.11+10	5	43	9	4.775	6.68+12
5	34	4	4.814	1.55+14	5	39	2	4.853	1.32+12	5	43	10	4.748	2.12+09
5	34	5	4.779	4.11+12	5	39	3	4.849	5.63+12	5	44	1	4.935	2.65+08
5	34	6	4.754	3.81+08	5	39	4	4.838	5.20+13	5	44	2	4.891	2.88+11
5	34	7	4.745	1.19+13	5	39	5	4.803	1.19+14	5	44	3	4.888	4.80+11
5	34	8	4.740	7.71+13	5	39	6	4.778	6.95+11	5	44	4	4.876	6.88+11
5	34	9	4.723	2.97+13	5	39	7	4.769	8.78+12	5	44	5	4.841	1.93+11
5	34	10	4.696	1.73+08	5	39	8	4.764	8.89+11	5	44	6	4.816	1.51+13
5	35	1	4.876	2.06+11	5	39	9	4.747	9.30+13	5	44	7	4.807	7.74+13
5	35	2	4.833	9.51+11	5	39	10	4.720	4.93+09	5	44	8	4.802	1.24+14
5	35	3	4.829	8.15+12	5	40	1	4.898	1.48+12	5	44	9	4.785	3.15+13
5	35	4	4.818	1.27+13	5	40	2	4.855	1.88+12	5	44	10	4.758	3.13+11
5	35	5	4.783	1.95+13	5	40	3	4.851	1.23+13	5	45	1	4.938	2.68+10
5	35	6	4.758	1.36+13	5	40	4	4.840	1.33+13	5	45	2	4.895	2.95+11
5	35	7	4.749	7.59+13	5	40	5	4.805	8.52+13	5	45	3	4.891	1.20+12
5	35	8	4.744	8.69+13	5	40	6	4.780	7.65+10	5	45	4	4.879	2.61+10
5	35	9	4.727	1.04+13	5	40	7	4.771	1.21+13	5	45	5	4.845	1.94+11
5	35	10	4.700	1.04+12	5	40	8	4.765	9.55+13	5	45	6	4.819	1.05+13
5	36	1	4.882	2.72+10	5	40	9	4.749	6.71+12	5	45	7	4.810	2.21+13
5	36	2	4.839	2.73+12	5	40	10	4.722	4.90+13	5	45	8	4.805	1.89+14
5	36	3	4.835	2.97+13	5	41	1	4.908	1.77+12	5	45	9	4.789	2.52+13
5	36	4	4.824	4.44+13	5	41	2	4.865	4.45+10	5	45	10	4.761	9.42+11
5	36	5	4.789	1.01+14	5	41	3	4.861	1.65+12	5	46	1	4.952	1.75+09
5	36	6	4.764	1.17+12	5	41	4	4.850	2.72+13	5	46	2	4.909	1.92+11
5	36	7	4.755	1.28+13	5	41	5	4.815	1.27+14	5	46	3	4.905	3.76+10
5	36	8	4.749	6.02+13	5	41	6	4.790	2.16+10	5	46	4	4.893	4.27+10
5	36	9	4.733	2.49+13	5	41	7	4.781	1.64+12	5	46	5	4.859	8.21+11
5	36	10	4.706	5.89+11	5	41	8	4.776	1.15+13	5	46	6	4.833	1.65+13
5	37	1	4.884	7.35+10	5	41	9	4.759	1.29+14	5	46	7	4.825	4.16+13
5	37	2	4.841	1.18+13	5	41	10	4.732	5.42+13	5	46	8	4.819	1.46+14
5	37	3	4.837	2.69+13	5	42	1	4.914	5.76+11	5	46	9	4.803	1.01+14
5	37	4	4.826	9.66+13	5	42	2	4.870	1.20+08	5	46	10	4.776	1.53+13
5	37	5	4.791	1.08+13	5	42	3	4.867	2.92+11	5	47	1	4.956	6.08+09
5	37	6	4.765	1.41+13	5	42	4	4.855	1.97+12	5	47	2	4.913	2.86+07
5	37	7	4.757	5.16+13	5	42	5	4.820	6.38+13	5	47	3	4.909	2.33+11
5	37	8	4.751	1.10+13	5	42	6	4.795	3.07+12	5	47	4	4.898	2.66+11
5	37	9	4.735	1.59+11	5	42	7	4.786	1.54+13	5	47	5	4.863	8.16+11
5	37	10	4.708	1.22+13	5	42	8	4.781	6.99+11	5	47	6	4.838	7.89+10
5	38	1	4.889	1.03+06	5	42	9	4.764	3.86+13	5	47	7	4.829	6.38+12
5	38	2	4.845	1.73+12	5	42	10	4.737	2.34+13	5	47	8	4.823	6.17+13
5	38	3	4.842	2.81+12	5	43	1	4.924	7.22+08	5	47	9	4.807	2.67+14
5	38	4	4.830	4.38+12	5	43	2	4.881	6.25+06	5	47	10	4.780	4.90+13
5	38	5	4.795	2.07+14	5	43	3	4.877	3.30+11	5	48	1	4.964	5.18+09
5	38	6	4.770	9.17+07	5	43	4	4.866	1.66+12	5	48	2	4.921	7.40+09
5	38	7	4.761	5.33+12	5	43	5	4.831	2.40+11	5	48	3	4.917	5.69+10
5	38	8	4.756	5.43+13	5	43	6	4.806	4.89+13	5	48	4	4.906	1.08+11
5	38	9	4.739	9.39+13	5	43	7	4.797	1.01+14	5	48	5	4.871	5.36+11
5	38	10	4.712	6.70+07	5	43	8	4.791	9.70+13	5	48	6	4.846	1.09+13

Table 7—Continued

N	k[a]	i[b]	ΔE[c] (keV)	$A_a(k,i)$ (s^{-1})	N	k[a]	i[b]	ΔE[c] (keV)	$A_a(k,i)$ (s^{-1})	N	k[a]	i[b]	ΔE[c] (keV)	$A_a(k,i)$ (s^{-1})
5	48	7	4.837	5.43+13	6	22	10	4.734	3.96+12	6	25	13	4.691	1.54+11
5	48	8	4.831	2.16+13	6	22	11	4.701	3.51+13	6	25	14	4.673	1.07+12
5	48	9	4.815	1.78+14	6	22	12	4.683	4.87+13	6	25	15	4.666	3.66+12
5	48	10	4.788	3.38+13	6	22	13	4.680	1.26+12	6	26	1	4.875	4.93+13
5	49	1	4.965	3.13+10	6	22	14	4.662	3.04+12	6	26	2	4.860	1.37+14
5	49	2	4.922	4.63+08	6	22	15	4.655	6.95+11	6	26	3	4.825	9.05+09
5	49	3	4.918	3.69+10	6	23	1	4.858	1.36+14	6	26	4	4.818	2.98+11
5	49	4	4.906	2.63+11	6	23	2	4.843	5.02+13	6	26	5	4.811	4.09+12
5	49	5	4.872	8.29+11	6	23	3	4.808	2.75+12	6	26	6	4.784	2.11+13
5	49	6	4.846	5.00+12	6	23	4	4.801	2.60+13	6	26	7	4.781	1.63+13
5	49	7	4.838	4.02+13	6	23	5	4.794	1.88+12	6	26	8	4.769	2.00+13
5	49	8	4.832	1.60+14	6	23	6	4.767	2.36+13	6	26	9	4.754	1.94+11
5	49	9	4.816	3.98+13	6	23	7	4.764	5.39+13	6	26	10	4.752	6.19+13
5	49	10	4.789	4.25+12	6	23	8	4.752	4.33+13	6	26	11	4.719	5.63+11
5	50	1	4.991	1.49+11	6	23	9	4.737	3.39+12	6	26	12	4.702	8.01+12
5	50	2	4.948	8.62+10	6	23	10	4.735	2.36+12	6	26	13	4.698	6.78+13
5	50	3	4.944	2.26+11	6	23	11	4.702	5.12+11	6	26	14	4.680	6.66+11
5	50	4	4.932	4.51+11	6	23	12	4.685	7.30+13	6	26	15	4.673	1.52+13
5	50	5	4.898	3.02+12	6	23	13	4.681	1.25+13	6	27	1	4.877	5.80+13
5	50	6	4.872	7.69+10	6	23	14	4.663	1.49+12	6	27	2	4.862	1.08+14
5	50	7	4.863	2.37+12	6	23	15	4.656	2.37+12	6	27	3	4.827	7.55+11
5	50	8	4.858	7.18+12	6	24	1	4.865	4.69+13	6	27	4	4.820	1.83+13
5	50	9	4.842	2.14+14	6	24	2	4.850	1.56+14	6	27	5	4.813	6.46+08
5	50	10	4.814	4.24+13	6	24	3	4.815	6.50+07	6	27	6	4.786	5.86+13
6	21	1	4.831	6.76+12	6	24	4	4.808	2.62+12	6	27	7	4.783	4.05+07
6	21	2	4.816	5.38+12	6	24	5	4.801	2.96+13	6	27	8	4.771	8.03+10
6	21	3	4.781	3.77+13	6	24	6	4.773	1.72+13	6	27	9	4.756	6.73+13
6	21	4	4.774	6.19+13	6	24	7	4.771	8.25+13	6	27	10	4.754	6.00+12
6	21	5	4.767	8.67+13	6	24	8	4.759	4.40+08	6	27	11	4.721	2.37+11
6	21	6	4.740	3.68+11	6	24	9	4.743	2.83+08	6	27	12	4.704	3.90+12
6	21	7	4.737	2.09+11	6	24	10	4.742	3.14+13	6	27	13	4.700	3.20+12
6	21	8	4.725	7.71+11	6	24	11	4.709	5.13+11	6	27	14	4.683	8.32+13
6	21	9	4.710	9.96+09	6	24	12	4.692	6.30+11	6	27	15	4.675	6.32+11
6	21	10	4.708	2.38+11	6	24	13	4.688	8.62+13	6	28	1	4.879	4.98+13
6	21	11	4.675	8.40+13	6	24	14	4.670	9.40+11	6	28	2	4.864	1.11+14
6	21	12	4.658	5.98+11	6	24	15	4.663	3.11+12	6	28	3	4.829	4.39+12
6	21	13	4.654	2.93+11	6	25	1	4.868	1.71+13	6	28	4	4.822	6.46+12
6	21	14	4.637	1.89+10	6	25	2	4.853	5.10+13	6	28	5	4.815	5.10+12
6	21	15	4.629	1.62+10	6	25	3	4.818	5.71+12	6	28	6	4.787	4.00+13
6	22	1	4.857	1.31+14	6	25	4	4.811	1.77+12	6	28	7	4.785	5.73+12
6	22	2	4.842	3.24+13	6	25	5	4.804	8.79+12	6	28	8	4.773	8.32+12
6	22	3	4.806	9.04+12	6	25	6	4.777	2.49+13	6	28	9	4.757	7.12+13
6	22	4	4.800	2.60+12	6	25	7	4.774	2.98+12	6	28	10	4.756	3.50+12
6	22	5	4.793	7.08+12	6	25	8	4.762	1.31+13	6	28	11	4.723	4.07+12
6	22	6	4.765	5.99+13	6	25	9	4.747	5.17+12	6	28	12	4.706	3.90+12
6	22	7	4.762	9.24+12	6	25	10	4.745	3.67+13	6	28	13	4.702	2.81+12
6	22	8	4.751	3.95+13	6	25	11	4.712	4.75+13	6	28	14	4.684	7.18+13
6	22	9	4.735	6.59+12	6	25	12	4.695	3.71+13	6	28	15	4.677	9.26+12

Table 7—Continued

N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{a}(k,i)$ (s^{-1})	N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{a}(k,i)$ (s^{-1})	N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{a}(k,i)$ (s^{-1})
6	29	1	4.889	4.80+12	6	32	4	4.853	8.98+13	6	35	7	4.854	4.02+13
6	29	2	4.874	1.81+14	6	32	5	4.846	1.29+14	6	35	8	4.842	2.56+13
6	29	3	4.839	2.16+10	6	32	6	4.819	4.07+12	6	35	9	4.826	5.24+12
6	29	4	4.832	6.05+11	6	32	7	4.816	3.30+12	6	35	10	4.825	5.46+12
6	29	5	4.825	8.61+12	6	32	8	4.804	1.56+11	6	35	11	4.792	2.39+13
6	29	6	4.797	4.27+12	6	32	9	4.789	1.05+11	6	35	12	4.775	7.87+12
6	29	7	4.795	2.55+13	6	32	10	4.787	4.45+11	6	35	13	4.771	1.81+12
6	29	8	4.783	4.02+11	6	32	11	4.754	1.45+13	6	35	14	4.753	3.62+12
6	29	9	4.767	2.98+13	6	32	12	4.737	2.70+11	6	35	15	4.746	3.53+12
6	29	10	4.766	6.43+13	6	32	13	4.733	1.16+11	6	36	1	4.951	2.70+07
6	29	11	4.733	1.69+11	6	32	14	4.715	1.32+10	6	36	2	4.936	1.64+11
6	29	12	4.716	7.14+12	6	32	15	4.708	1.83+11	6	36	3	4.900	1.64+10
6	29	13	4.712	1.30+13	6	33	1	4.914	2.67+09	6	36	4	4.894	8.41+11
6	29	14	4.694	1.27+12	6	33	2	4.899	2.43+10	6	36	5	4.887	1.00+13
6	29	15	4.687	7.24+13	6	33	3	4.864	1.95+13	6	36	6	4.859	6.11+13
6	30	1	4.897	1.73+13	6	33	4	4.857	3.48+13	6	36	7	4.856	2.61+14
6	30	2	4.882	1.34+14	6	33	5	4.850	1.87+14	6	36	8	4.845	1.95+13
6	30	3	4.847	2.26+11	6	33	6	4.822	2.95+12	6	36	9	4.829	2.69+13
6	30	4	4.840	1.98+12	6	33	7	4.820	1.53+12	6	36	10	4.828	2.96+12
6	30	5	4.833	2.13+11	6	33	8	4.808	1.08+11	6	36	11	4.795	3.38+09
6	30	6	4.806	1.70+12	6	33	9	4.792	8.03+11	6	36	12	4.778	2.37+10
6	30	7	4.803	5.43+09	6	33	10	4.791	1.33+11	6	36	13	4.774	2.14+13
6	30	8	4.791	7.04+12	6	33	11	4.758	1.57+13	6	36	14	4.756	7.42+08
6	30	9	4.776	3.89+11	6	33	12	4.741	3.65+11	6	36	15	4.749	8.41+12
6	30	10	4.774	8.80+13	6	33	13	4.737	1.66+08	6	37	1	4.952	3.23+10
6	30	11	4.741	1.43+12	6	33	14	4.719	1.28+11	6	37	2	4.938	4.88+11
6	30	12	4.724	2.26+12	6	33	15	4.712	1.07+11	6	37	3	4.902	1.53+13
6	30	13	4.720	5.36+12	6	34	1	4.945	4.29+10	6	37	4	4.895	1.86+13
6	30	14	4.702	1.02+13	6	34	2	4.930	2.03+11	6	37	5	4.889	2.06+13
6	30	15	4.695	7.52+13	6	34	3	4.894	4.17+13	6	37	6	4.861	1.36+14
6	31	1	4.901	2.15+06	6	34	4	4.887	7.50+13	6	37	7	4.858	1.07+14
6	31	2	4.886	1.64+10	6	34	5	4.881	7.88+13	6	37	8	4.846	2.44+13
6	31	3	4.850	6.90+13	6	34	6	4.853	2.75+13	6	37	9	4.831	1.44+13
6	31	4	4.844	9.59+13	6	34	7	4.850	5.38+13	6	37	10	4.829	3.61+12
6	31	5	4.837	8.35+13	6	34	8	4.839	6.36+12	6	37	11	4.797	3.45+13
6	31	6	4.809	2.39+11	6	34	9	4.823	2.54+12	6	37	12	4.779	4.58+13
6	31	7	4.807	3.13+12	6	34	10	4.821	6.47+11	6	37	13	4.775	9.10+12
6	31	8	4.795	4.91+11	6	34	11	4.789	5.81+13	6	37	14	4.758	1.28+12
6	31	9	4.779	9.52+09	6	34	12	4.771	3.80+12	6	37	15	4.750	2.77+12
6	31	10	4.778	9.80+10	6	34	13	4.768	2.73+13	6	38	1	4.956	2.66+10
6	31	11	4.745	1.42+13	6	34	14	4.750	2.58+12	6	38	2	4.941	2.36+11
6	31	12	4.728	6.75+11	6	34	15	4.743	2.60+12	6	38	3	4.906	5.29+12
6	31	13	4.724	1.55+11	6	35	1	4.948	6.87+10	6	38	4	4.899	5.46+13
6	31	14	4.706	1.13+08	6	35	2	4.933	1.22+11	6	38	5	4.892	6.66+13
6	31	15	4.699	6.73+10	6	35	3	4.898	7.55+12	6	38	6	4.865	6.45+13
6	32	1	4.910	2.54+08	6	35	4	4.891	1.43+13	6	38	7	4.862	7.29+13
6	32	2	4.895	1.96+10	6	35	5	4.884	6.86+13	6	38	8	4.850	8.52+12
6	32	3	4.860	1.86+13	6	35	6	4.856	1.68+14	6	38	9	4.835	1.58+13

Table 7—Continued

N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{\mathrm{a}}(k,i)$ (s^{-1})	N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{\mathrm{a}}(k,i)$ (s^{-1})	N	k^{a}	i^{b}	ΔE^{c} (keV)	$A_{\mathrm{a}}(k,i)$ (s^{-1})
6	38	10	4.833	4.33+12	6	41	13	4.797	8.41+13	6	45	1	5.000	1.71+11
6	38	11	4.800	3.07+13	6	41	14	4.779	2.04+10	6	45	2	4.985	3.92+11
6	38	12	4.783	3.10+13	6	41	15	4.772	2.40+13	6	45	3	4.950	4.19+10
6	38	13	4.779	9.01+11	6	42	1	4.982	1.96+12	6	45	4	4.943	3.11+11
6	38	14	4.761	1.49+12	6	42	2	4.968	1.89+11	6	45	5	4.936	5.56+11
6	38	15	4.754	1.44+13	6	42	3	4.932	1.23+12	6	45	6	4.908	9.00+11
6	39	1	4.957	4.79+11	6	42	4	4.925	7.10+10	6	45	7	4.906	8.61+12
6	39	2	4.942	1.24+11	6	42	5	4.919	1.75+12	6	45	8	4.894	1.61+13
6	39	3	4.906	2.13+13	6	42	6	4.891	4.13+13	6	45	9	4.878	3.24+13
6	39	4	4.900	1.82+13	6	42	7	4.888	3.18+13	6	45	10	4.877	1.91+14
6	39	5	4.893	1.97+14	6	42	8	4.877	3.18+13	6	45	11	4.844	2.00+12
6	39	6	4.865	4.92+12	6	42	9	4.861	4.81+11	6	45	12	4.827	1.53+13
6	39	7	4.862	2.22+11	6	42	10	4.859	1.50+14	6	45	13	4.823	8.00+12
6	39	8	4.851	4.29+10	6	42	11	4.827	2.37+13	6	45	14	4.805	8.67+12
6	39	9	4.835	2.68+12	6	42	12	4.809	7.05+13	6	45	15	4.798	3.42+13
6	39	10	4.834	5.69+12	6	42	13	4.806	5.78+09	6	46	1	5.008	3.42+11
6	39	11	4.801	8.43+13	6	42	14	4.788	1.13+14	6	46	2	4.993	3.72+12
6	39	12	4.784	5.00+12	6	42	15	4.781	5.44+12	6	46	3	4.957	8.76+09
6	39	13	4.780	6.58+09	6	43	1	4.983	6.47+11	6	46	4	4.951	2.69+11
6	39	14	4.762	3.21+13	6	43	2	4.968	6.78+11	6	46	5	4.944	2.60+12
6	39	15	4.755	5.58+12	6	43	3	4.932	4.67+11	6	46	6	4.916	3.03+13
6	40	1	4.972	6.29+11	6	43	4	4.925	3.49+12	6	46	7	4.914	1.28+14
6	40	2	4.957	1.50+11	6	43	5	4.919	4.28+12	6	46	8	4.902	1.19+13
6	40	3	4.922	8.62+11	6	43	6	4.891	6.38+13	6	46	9	4.886	5.40+13
6	40	4	4.915	8.42+12	6	43	7	4.888	1.28+14	6	46	10	4.885	6.20+13
6	40	5	4.908	1.31+13	6	43	8	4.877	1.30+13	6	46	11	4.852	6.77+11
6	40	6	4.881	7.18+13	6	43	9	4.861	5.76+13	6	46	12	4.835	1.59+11
6	40	7	4.878	1.19+14	6	43	10	4.859	6.44+13	6	46	13	4.831	3.65+08
6	40	8	4.866	3.82+13	6	43	11	4.827	7.50+12	6	46	14	4.813	2.05+13
6	40	9	4.851	2.39+13	6	43	12	4.809	1.32+13	6	46	15	4.806	2.60+14
6	40	10	4.849	1.21+13	6	43	13	4.806	1.53+14	6	47	1	5.048	3.03+08
6	40	11	4.816	1.10+13	6	43	14	4.788	3.82+13	6	47	2	5.034	5.90+10
6	40	12	4.799	3.88+13	6	43	15	4.781	6.60+13	6	47	3	4.998	8.16+10
6	40	13	4.795	4.95+12	6	44	1	4.986	2.95+11	6	47	4	4.991	1.38+11
6	40	14	4.777	3.36+13	6	44	2	4.971	8.48+11	6	47	5	4.985	2.55+11
6	40	15	4.770	5.32+12	6	44	3	4.935	1.28+11	6	47	6	4.957	4.44+10
6	41	1	4.973	2.10+09	6	44	4	4.929	1.37+12	6	47	7	4.954	1.04+12
6	41	2	4.959	1.38+12	6	44	5	4.922	4.57+12	6	47	8	4.943	6.83+11
6	41	3	4.923	4.64+11	6	44	6	4.894	3.09+12	6	47	9	4.927	2.78+11
6	41	4	4.916	5.41+11	6	44	7	4.891	1.42+13	6	47	10	4.925	1.02+12
6	41	5	4.910	3.22+12	6	44	8	4.880	3.30+13	6	47	11	4.893	1.49+13
6	41	6	4.882	3.64+13	6	44	9	4.864	4.98+13	6	47	12	4.875	1.43+14
6	41	7	4.879	9.14+13	6	44	10	4.863	1.42+14	6	47	13	4.871	2.25+14
6	41	8	4.868	6.14+13	6	44	11	4.830	6.43+12	6	47	14	4.854	5.47+13
6	41	9	4.852	3.09+13	6	44	12	4.813	3.93+13	6	47	15	4.847	2.79+13
6	41	10	4.850	6.97+13	6	44	13	4.809	5.43+13	6	48	1	5.056	1.15+10
6	41	11	4.818	1.97+13	6	44	14	4.791	1.72+13	6	48	2	5.042	4.35+10
6	41	12	4.800	6.94+13	6	44	15	4.784	5.83+13	6	48	3	5.006	7.48+10

Table 7—Continued

N	k[a]	i[b]	ΔE[c] (keV)	$A_{\rm a}(k,i)$ ($\rm s^{-1}$)	N	k[a]	i[b]	ΔE[c] (keV)	$A_{\rm a}(k,i)$ ($\rm s^{-1}$)	N	k[a]	i[b]	ΔE[c] (keV)	$A_{\rm a}(k,i)$ ($\rm s^{-1}$)
6	48	4	4.999	5.66+10	7	16	7	4.826	8.09+12	7	18	15	4.778	8.99+11
6	48	5	4.993	1.56+11	7	16	8	4.826	4.84+13	7	18	16	4.730	2.45+12
6	48	6	4.965	6.86+11	7	16	9	4.823	7.64+13	7	18	17	4.719	5.35+13
6	48	7	4.962	1.75+11	7	16	10	4.809	2.54+07	7	18	18	4.718	1.96+13
6	48	8	4.951	4.52+11	7	16	11	4.808	1.37+13	7	18	19	4.709	3.02+11
6	48	9	4.935	5.41+11	7	16	12	4.806	1.78+13	7	18	20	4.680	8.65+10
6	48	10	4.933	9.41+11	7	16	13	4.787	2.07+13	7	19	1	4.950	1.79+13
6	48	11	4.901	8.91+12	7	16	14	4.783	1.74+11	7	19	2	4.941	4.68+13
6	48	12	4.883	1.20+14	7	16	15	4.766	9.28+11	7	19	3	4.935	1.30+14
6	48	13	4.880	1.99+14	7	16	16	4.718	7.21+13	7	19	4	4.919	9.87+13
6	48	14	4.862	4.60+13	7	16	17	4.707	4.45+11	7	19	5	4.904	9.12+12
6	48	15	4.855	8.92+13	7	16	18	4.707	8.81+11	7	19	6	4.889	1.65+12
6	49	1	5.065	4.02+10	7	16	19	4.697	1.17+12	7	19	7	4.853	3.24+12
6	49	2	5.051	1.18+09	7	16	20	4.669	5.01+08	7	19	8	4.853	1.30+13
6	49	3	5.015	1.03+10	7	17	1	4.932	1.36+13	7	19	9	4.850	1.56+12
6	49	4	5.008	2.88+11	7	17	2	4.923	8.01+13	7	19	10	4.836	7.15+12
6	49	5	5.002	8.11+05	7	17	3	4.918	1.17+14	7	19	11	4.835	6.92+12
6	49	6	4.974	1.08+12	7	17	4	4.902	2.89+13	7	19	12	4.833	9.48+12
6	49	7	4.971	6.17+08	7	17	5	4.886	3.42+10	7	19	13	4.814	5.24+13
6	49	8	4.960	7.98+07	7	17	6	4.872	1.26+13	7	19	14	4.810	6.01+13
6	49	9	4.944	1.24+12	7	17	7	4.836	2.83+13	7	19	15	4.793	3.32+12
6	49	10	4.942	1.21+11	7	17	8	4.836	3.53+13	7	19	16	4.746	3.60+13
6	49	11	4.910	5.30+11	7	17	9	4.832	1.78+13	7	19	17	4.735	3.73+11
6	49	12	4.892	7.40+13	7	17	10	4.818	1.24+13	7	19	18	4.734	2.12+13
6	49	13	4.888	1.38+14	7	17	11	4.817	7.22+12	7	19	19	4.724	1.93+13
6	49	14	4.871	2.55+13	7	17	12	4.815	5.54+13	7	19	20	4.696	4.08+11
6	49	15	4.864	2.17+14	7	17	13	4.796	3.13+13	7	20	1	4.954	4.09+11
6	50	1	5.076	3.10+10	7	17	14	4.792	1.37+12	7	20	2	4.945	5.29+12
6	50	2	5.061	1.94+10	7	17	15	4.776	3.21+12	7	20	3	4.940	5.51+13
6	50	3	5.026	2.12+10	7	17	16	4.728	2.78+13	7	20	4	4.924	2.60+14
6	50	4	5.019	9.26+09	7	17	17	4.717	1.60+11	7	20	5	4.908	4.11+13
6	50	5	5.012	2.87+10	7	17	18	4.716	4.72+13	7	20	6	4.894	2.60+11
6	50	6	4.984	2.14+11	7	17	19	4.707	3.26+11	7	20	7	4.858	6.92+11
6	50	7	4.982	1.01+10	7	17	20	4.678	1.06+10	7	20	8	4.858	2.90+12
6	50	8	4.970	2.21+11	7	18	1	4.934	2.43+13	7	20	9	4.855	3.16+13
6	50	9	4.954	6.69+11	7	18	2	4.925	2.16+13	7	20	10	4.841	3.69+08
6	50	10	4.953	9.01+11	7	18	3	4.920	1.86+14	7	20	11	4.840	8.65+12
6	50	11	4.920	5.88+12	7	18	4	4.904	1.11+13	7	20	12	4.837	1.67+13
6	50	12	4.903	9.20+13	7	18	5	4.888	5.67+12	7	20	13	4.818	2.84+12
6	50	13	4.899	1.61+14	7	18	6	4.874	1.37+13	7	20	14	4.815	9.62+13
6	50	14	4.881	3.79+13	7	18	7	4.838	2.96+13	7	20	15	4.798	2.74+13
6	50	15	4.874	1.67+14	7	18	8	4.838	2.95+13	7	20	16	4.750	1.57+12
7	16	1	4.923	4.39+13	7	18	9	4.834	2.36+09	7	20	17	4.739	1.61+11
7	16	2	4.913	9.24+13	7	18	10	4.820	1.28+13	7	20	18	4.739	4.99+10
7	16	3	4.908	9.75+13	7	18	11	4.819	5.94+13	7	20	19	4.729	7.57+13
7	16	4	4.892	1.40+13	7	18	12	4.817	1.01+13	7	20	20	4.700	1.44+12
7	16	5	4.876	3.10+11	7	18	13	4.798	5.01+13	7	21	1	4.960	9.20+12
7	16	6	4.862	2.57+13	7	18	14	4.794	4.16+11	7	21	2	4.950	4.29+13

Table 7—Continued

N	$k^{\rm a}$	$i^{\rm b}$	$\Delta E^{\rm c}$ (keV)	$A_{\rm a}(k,i)$ ($\rm s^{-1}$)	N	$k^{\rm a}$	$i^{\rm b}$	$\Delta E^{\rm c}$ (keV)	$A_{\rm a}(k,i)$ ($\rm s^{-1}$)	N	$k^{\rm a}$	$i^{\rm b}$	$\Delta E^{\rm c}$ (keV)	$A_{\rm a}(k,i)$ ($\rm s^{-1}$)
7	21	3	4.945	1.27+14	7	23	11	4.861	7.50+12	7	25	19	4.798	9.61+11
7	21	4	4.929	6.03+13	7	23	12	4.859	7.21+12	7	25	20	4.769	2.89+11
7	21	5	4.913	2.73+13	7	23	13	4.840	1.07+13	7	26	1	5.030	3.41+10
7	21	6	4.899	1.62+10	7	23	14	4.836	1.33+13	7	26	2	5.021	1.64+11
7	21	7	4.863	1.09+12	7	23	15	4.819	1.14+14	7	26	3	5.015	3.95+10
7	21	8	4.863	2.33+09	7	23	16	4.772	2.46+11	7	26	4	5.000	4.32+10
7	21	9	4.860	3.05+09	7	23	17	4.761	5.49+12	7	26	5	4.984	3.13+09
7	21	10	4.846	1.00+11	7	23	18	4.760	9.51+12	7	26	6	4.970	1.18+12
7	21	11	4.845	1.03+13	7	23	19	4.750	6.39+12	7	26	7	4.934	3.27+13
7	21	12	4.843	3.25+13	7	23	20	4.722	5.92+13	7	26	8	4.933	8.46+13
7	21	13	4.824	5.00+13	7	24	1	5.016	8.09+06	7	26	9	4.930	6.39+13
7	21	14	4.820	4.41+12	7	24	2	5.007	5.87+10	7	26	10	4.916	2.13+13
7	21	15	4.803	5.07+13	7	24	3	5.001	1.55+11	7	26	11	4.915	4.65+13
7	21	16	4.755	1.93+12	7	24	4	4.986	9.00+10	7	26	12	4.913	1.96+14
7	21	17	4.744	1.46+13	7	24	5	4.970	8.25+06	7	26	13	4.894	7.62+11
7	21	18	4.744	4.64+13	7	24	6	4.955	3.83+12	7	26	14	4.890	8.16+12
7	21	19	4.734	2.06+12	7	24	7	4.920	5.42+13	7	26	15	4.874	9.85+11
7	21	20	4.706	1.31+13	7	24	8	4.919	1.57+14	7	26	16	4.826	7.02+12
7	22	1	4.961	7.00+12	7	24	9	4.916	1.75+14	7	26	17	4.815	3.42+12
7	22	2	4.951	4.62+13	7	24	10	4.902	2.12+13	7	26	18	4.814	1.80+13
7	22	3	4.946	3.14+13	7	24	11	4.901	1.84+13	7	26	19	4.805	7.89+10
7	22	4	4.930	1.74+14	7	24	12	4.899	2.82+13	7	26	20	4.776	4.69+10
7	22	5	4.914	3.29+13	7	24	13	4.880	2.88+12	7	27	1	5.053	1.57+11
7	22	6	4.900	3.31+11	7	24	14	4.876	3.93+12	7	27	2	5.044	3.65+11
7	22	7	4.864	8.96+12	7	24	15	4.859	5.40+10	7	27	3	5.038	7.53+11
7	22	8	4.864	7.34+12	7	24	16	4.812	2.01+13	7	27	4	5.022	7.89+11
7	22	9	4.861	2.56+11	7	24	17	4.801	3.57+08	7	27	5	5.007	1.33+11
7	22	10	4.847	6.67+11	7	24	18	4.800	6.48+12	7	27	6	4.992	4.05+12
7	22	11	4.846	1.93+11	7	24	19	4.791	1.51+12	7	27	7	4.956	5.72+13
7	22	12	4.844	3.58+12	7	24	20	4.762	1.40+08	7	27	8	4.956	1.12+14
7	22	13	4.825	2.88+13	7	25	1	5.023	6.32+10	7	27	9	4.953	1.72+14
7	22	14	4.821	5.76+13	7	25	2	5.014	6.39+10	7	27	10	4.939	1.55+13
7	22	15	4.804	4.38+13	7	25	3	5.009	1.07+11	7	27	11	4.938	4.34+13
7	22	16	4.756	1.31+13	7	25	4	4.993	7.03+10	7	27	12	4.936	4.78+13
7	22	17	4.745	8.45+06	7	25	5	4.977	1.11+09	7	27	13	4.917	3.34+12
7	22	18	4.745	7.06+12	7	25	6	4.963	1.99+12	7	27	14	4.913	5.07+12
7	22	19	4.735	5.75+13	7	25	7	4.927	8.44+13	7	27	15	4.896	1.46+12
7	22	20	4.707	1.04+12	7	25	8	4.927	3.71+13	7	27	16	4.849	1.31+14
7	23	1	4.976	2.15+11	7	25	9	4.924	1.52+14	7	27	17	4.838	1.78+13
7	23	2	4.967	9.68+12	7	25	10	4.910	6.21+12	7	27	18	4.837	4.99+13
7	23	3	4.961	2.06+13	7	25	11	4.909	8.84+13	7	27	19	4.827	3.88+13
7	23	4	4.945	1.86+14	7	25	12	4.907	8.78+13	7	27	20	4.799	1.66+12
7	23	5	4.930	6.61+13	7	25	13	4.888	1.80+12	7	28	1	5.057	1.29+11
7	23	6	4.915	2.49+11	7	25	14	4.884	1.22+12	7	28	2	5.048	3.99+11
7	23	7	4.879	2.71+12	7	25	15	4.867	1.63+12	7	28	3	5.043	1.45+11
7	23	8	4.879	5.20+11	7	25	16	4.819	1.46+13	7	28	4	5.027	9.19+10
7	23	9	4.876	1.58+09	7	25	17	4.808	6.44+12	7	28	5	5.011	1.18+10
7	23	10	4.862	2.64+12	7	25	18	4.808	7.09+12	7	28	6	4.997	2.15+12

Table 7—Continued

N	$k^{\rm a}$	$i^{\rm b}$	$\Delta E^{\rm c}$ (keV)	$A_{\rm a}(k,i)$ (s^{-1})	N	$k^{\rm a}$	$i^{\rm b}$	$\Delta E^{\rm c}$ (keV)	$A_{\rm a}(k,i)$ (s^{-1})	N	$k^{\rm a}$	$i^{\rm b}$	$\Delta E^{\rm c}$ (keV)	$A_{\rm a}(k,i)$ (s^{-1})
7	28	7	4.961	4.37+13	7	30	15	4.922	1.04+14	8	12	8	4.909	1.13+13
7	28	8	4.961	4.73+13	7	30	16	4.874	1.95+12	8	12	9	4.884	5.27+13
7	28	9	4.958	5.77+13	7	30	17	4.863	9.02+12	8	12	10	4.882	2.79+13
7	28	10	4.944	1.43+13	7	30	18	4.862	5.52+13	8	12	11	4.865	2.16+13
7	28	11	4.942	4.73+13	7	30	19	4.853	1.76+14	8	12	12	4.859	6.88+13
7	28	12	4.940	1.74+14	7	30	20	4.824	5.17+13	8	12	13	4.847	1.88+13
7	28	13	4.921	5.43+12	7	31	1	5.166	6.81+09	8	12	14	4.771	4.63+13
7	28	14	4.917	5.29+13	7	31	2	5.157	4.52+07	8	12	15	4.758	1.94+13
7	28	15	4.901	1.69+13	7	31	3	5.152	1.95+08	8	13	1	5.022	9.70+11
7	28	16	4.853	2.13+13	7	31	4	5.136	2.62+08	8	13	2	5.005	4.45+13
7	28	17	4.842	1.65+13	7	31	5	5.120	1.05+11	8	13	3	5.000	1.28+14
7	28	18	4.841	5.17+13	7	31	6	5.106	9.67+09	8	13	4	4.990	4.81+13
7	28	19	4.832	3.27+12	7	31	7	5.070	5.92+10	8	13	5	4.982	2.14+14
7	28	20	4.803	4.45+12	7	31	8	5.070	1.14+11	8	13	6	4.929	7.35+08
7	29	1	5.072	8.82+10	7	31	9	5.067	5.50+06	8	13	7	4.920	2.17+13
7	29	2	5.063	5.06+10	7	31	10	5.053	1.50+11	8	13	8	4.917	1.78+12
7	29	3	5.058	2.32+11	7	31	11	5.052	3.00+11	8	13	9	4.893	8.02+13
7	29	4	5.042	9.09+11	7	31	12	5.049	4.01+11	8	13	10	4.891	1.73+08
7	29	5	5.026	6.30+11	7	31	13	5.030	5.18+11	8	13	11	4.874	4.32+11
7	29	6	5.012	3.57+10	7	31	14	5.027	5.07+10	8	13	12	4.868	4.97+13
7	29	7	4.976	1.07+12	7	31	15	5.010	2.99+12	8	13	13	4.856	6.90+13
7	29	8	4.976	2.61+12	7	31	16	4.962	6.47+13	8	13	14	4.780	1.94+12
7	29	9	4.973	1.95+12	7	31	17	4.951	5.54+12	8	13	15	4.766	6.46+13
7	29	10	4.959	2.60+10	7	31	18	4.950	2.67+11	8	14	1	5.032	7.16+12
7	29	11	4.958	1.28+12	7	31	19	4.941	5.52+14	8	14	2	5.015	7.23+13
7	29	12	4.955	1.41+13	7	31	20	4.912	3.18+13	8	14	3	5.010	1.46+14
7	29	13	4.936	2.49+13	8	11	1	5.006	1.84+13	8	14	4	4.999	4.90+13
7	29	14	4.933	2.99+14	8	11	2	4.989	1.36+14	8	14	5	4.992	1.73+14
7	29	15	4.916	1.19+14	8	11	3	4.984	2.09+14	8	14	6	4.938	1.26+12
7	29	16	4.868	3.17+13	8	11	4	4.974	4.85+13	8	14	7	4.930	5.32+11
7	29	17	4.857	6.42+12	8	11	5	4.966	3.76+13	8	14	8	4.927	2.41+12
7	29	18	4.856	7.75+12	8	11	6	4.913	3.09+13	8	14	9	4.903	2.37+12
7	29	19	4.847	9.49+13	8	11	7	4.904	1.32+13	8	14	10	4.901	4.62+12
7	29	20	4.818	1.56+13	8	11	8	4.901	5.19+12	8	14	11	4.884	8.43+12
7	30	1	5.078	2.09+10	8	11	9	4.877	2.63+13	8	14	12	4.878	9.35+13
7	30	2	5.069	3.79+11	8	11	10	4.875	7.91+13	8	14	13	4.866	7.14+13
7	30	3	5.064	8.34+11	8	11	11	4.858	2.70+13	8	14	14	4.789	2.08+13
7	30	4	5.048	5.04+11	8	11	12	4.852	4.78+13	8	14	15	4.776	4.64+13
7	30	5	5.032	1.06+12	8	11	13	4.840	1.13+12	8	15	1	5.122	3.76+10
7	30	6	5.018	3.05+11	8	11	14	4.764	6.45+13	8	15	2	5.105	7.79+10
7	30	7	4.982	7.98+12	8	11	15	4.750	7.73+11	8	15	3	5.100	7.84+05
7	30	8	4.982	9.94+12	8	12	1	5.013	1.15+13	8	15	4	5.090	1.76+11
7	30	9	4.979	3.12+13	8	12	2	4.996	1.08+14	8	15	5	5.082	3.80+11
7	30	10	4.965	2.23+12	8	12	3	4.992	1.82+14	8	15	6	5.029	9.66+12
7	30	11	4.964	1.93+13	8	12	4	4.981	5.04+13	8	15	7	5.021	2.76+12
7	30	12	4.961	1.51+13	8	12	5	4.973	9.37+13	8	15	8	5.018	2.66+12
7	30	13	4.942	1.88+13	8	12	6	4.920	5.11+12	8	15	9	4.993	2.25+14
7	30	14	4.939	2.50+14	8	12	7	4.912	1.50+13	8	15	10	4.991	3.45+14

Table 7—Continued

N	k^a	i^b	ΔE^c (keV)	$A_a(k,i)$ (s^{-1})	N	k^a	i^b	ΔE^c (keV)	$A_a(k,i)$ (s^{-1})	N	k^a	i^b	ΔE^c (keV)	$A_a(k,i)$ (s^{-1})
8	15	11	4.974	3.82+13	8	16	6	5.055	1.25+13	9	4	1	5.077	5.26+13
8	15	12	4.968	1.22+13	8	16	7	5.047	3.64+12	9	4	2	5.068	1.25+13
8	15	13	4.956	1.23+13	8	16	8	5.044	2.68+12	9	4	3	5.066	2.37+11
8	15	14	4.880	2.86+13	8	16	9	5.019	2.13+14	9	4	4	5.056	5.02+14
8	15	15	4.867	1.17+13	8	16	10	5.018	3.47+14	9	4	5	5.037	5.35+13
8	16	1	5.149	2.57+11	8	16	11	5.001	3.88+13	9	4	6	4.963	3.08+13
8	16	2	5.132	5.42+11	8	16	12	4.995	1.77+13	9	4	7	4.955	2.85+13
8	16	3	5.127	9.06+06	8	16	13	4.983	1.25+13	9	4	8	4.949	9.76+12
8	16	4	5.116	1.68+12	8	16	14	4.906	2.50+14	9	4	9	4.920	1.75+14
8	16	5	5.109	2.72+12	8	16	15	4.893	1.40+14	9	4	10	4.812	5.60+13

[a] kth level of the N-electron system.

[b] ith level of the $(N-1)$-electron system.

[c] $\Delta E = E(k) - I_p^N - E(i)$ where energies are taken from Table ??, experimental values used when available. Ionization potentials, I_p^N, of the N-electron systems are taken from ?.

Note. — $a \pm b \equiv a \times 10^{\pm b}$