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OSCILLATOR STRENGTHS FOR DIPOLE-ALLOWED FINE-STRUCTURE TRANSITIONS IN Fe XIII

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Oscillator strengths, line strengths, and transition probabilities for fine-structure levels in silicon-like iron, Fe XIII, are reported. The data obtained are for 1223 *LS* bound terms, 64,456 *LS* multiplets, and 307,863 fine-structure transitions. Calculations are carried out in *LS* coupling using the close coupling *R*-matrix approximation with a 14-term eigenfunction expansion. The fine-structure components are obtained through algebraic transformations. Present data considerably exceed the observed and the previously calculated data available, including those from the Opacity Project. Comparisons with previously measured and calculated values are made. © 1999 Academic Press

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INTRODUCTION

Iron is an important element as it exists in astrophysical spectra through all ionization stages. Fe XIII, a silicon-like ion, is abundant in many astronomical sources radiating primarily in the extreme ultraviolet. Complete analysis of astrophysical spectra requires a large number of transitions in the radiative–collisional models. Comparatively few studies have been carried out for this ion. The complexities involved are due to the electron–electron correlation effects and the relatively high ion charge, which result in closely spaced bands of energy levels. There are 36 measured bound levels, corresponding to 24 *LS* terms, below the ionization threshold [1]. Among the previous theoretical studies are multi-configuration Dirac–Fock calculations by Huang [2], Hartree–Fock calculations by Fawcett et al. [3], Hartree–Fock calculations including relativistic effects by Bromage et al. [4] and by Fawcett [5], and multi-configuration Thomas–Fermi calculations by Kastner et al. [6]. The lifetime of one single level, $3s3p^3\ {}^3S^o_1$, has been measured by Träbert et al. [7]. Previous works have been compiled in several National Institute of Standards and Technology (NIST) publications [8, 9, 10]. Under two international collaborations, the Opacity Project (OP) [11] and the Iron Project (IP) [12], efforts are being made to study the radiative and collisional processes of astrophysically abundant ions in detail. The first extensive calculations for Fe XIII were carried out by Butler et al. [13] under the OP [11] using a nine-term wave function expansion in the close coupling (CC) approximation using the *R*-matrix method. Their results have not yet been published, but the oscillator strengths (f-values) obtained in *LS* coupling are available through the OP database TOPbase [14].

For applications in astrophysical spectral analysis, and for comparison with laboratory plasma experiments, fine-structure data rather than *LS* multiplet data as obtained under the OP are needed. The aim of the present work is to provide a reasonably complete set of transition probabilities for fine-structure transitions through large scale *ab initio* calculations using the CC *R*-matrix method. Similar results for atomic transition probabilities have been obtained for other silicon-like ions, Si I, S III, Ar V, and Ca VII [15], and for iron ions, Fe II [16], Fe III [17], and Fe XXIV and Fe XXV [18]. A complementary set of data for the collision strengths for Fe XIII is being computed under the IP [12].

Theory and Computations

For a bound–bound transition from an initial state i to a final state j, the line strength, S, is defined (for example, in Ref. [11]) as

$$S = |\langle \Psi_j || \mathbf{D} || \Psi_i \rangle|^2, \qquad (1)$$

in atomic units (a.u.), where the dipole operator **D** is

$$\mathbf{D} = \sum_n \mathbf{r}_n, \qquad (2)$$

in the length form summed over the total number of electrons in the ion, and Ψ_i and Ψ_j are the initial and the final wave functions, respectively. The line strength S in atomic units is related to the oscillator strength f_{ij} (f-value) as

$$S = (3g_i/E_{ij})\, f_{ij}, \qquad (3)$$

where E_{ij} is the transition energy in rydberg and g_i is the statistical weight factor of the initial state, with $g_i = (2S_i + 1)(2L_i + 1)$ for an LS multiplet, and $(2J_i + 1)$ for a fine-structure transition. The transition probability, A_{ji} (Einstein A-coefficient), can be obtained from the oscillator strength as

$$A_{ji}(\text{a.u.}) = \frac{1}{2}\,\alpha^3\,\frac{g_i}{g_j}\,E_{ij}^2 f_{ij}, \quad A_{ji}(\text{s}^{-1}) = \frac{A_{ji}(\text{a.u.})}{\tau_0}, \quad (4)$$

where α is the fine-structure constant and $\tau_0 = 2.4191 \times 10^{-17}$ s is the atomic unit of time.

In the present work, oscillator strengths in LS coupling are obtained in the CC R-matrix method similar to the OP work [11]. The fine-structure components of the transitions are obtained from LS multiplets through algebraic transformations. The transformations can be carried out via the line strength or directly from the oscillator strength [16]. The line strength, which is independent of the transition energy E_{ij}, is a better choice. As the observed transition energies are determined more accurately than the calculated ones, use of the former with the line strengths can provide more accurate f_{ij} and A_{ji}. Hence, in the present calculations, the fine-structure transition probabilities are obtained from S-values whenever observed energies are available and from f-values when calculated E_{ij} are used.

The fine-structure line strengths, S_{JJ}, are obtained as

$$S_{JJ} = C(J_i, J_j)S_{LS}/[(2S_i + 1)(2L_i + 1)(2L_j + 1)] \quad (5)$$

for the allowed transitions $(\Delta J = 0, \pm 1)$; S_i is the spin, which is the same as S_j. The values of the coefficients $C(J_i, J_j)$ can be found in Allen [19]. The S_{JJ} values satisfy the condition

$$S_{LS} = \sum_J S_{JJ}. \quad (6)$$

The fine-structure f-values, f_{JJ}, can be obtained directly from f_{LS} as [20]

$$f_{JJ}(n_jS_iL_jJ_j,\, n_iS_iL_iJ_i) = f_{LS}(n_jS_iL_j,\, n_iS_iL_i)(2J_j + 1) \times (2L_i + 1)W^2(L_jL_iJ_jJ_i;\, 1S_i), \quad (7)$$

where $W(L_jL_iJ_jJ_i;\, 1S_i)$ is a Racah coefficient. The above values also satisfy the sum rule

$$\sum_{J_iJ_j} (2J_i + 1)\, f_{JJ}(n_jS_iL_jJ_j,\, n_iS_iL_iJ_i) = (2S_i + 1)(2L_i + 1)\, f_{LS}(n_jS_iL_j,\, n_iS_iL_i). \quad (8)$$

The above form is used when one or both LS terms of the transition are unobserved or when not all the fine structure levels of an LS term are observed, and for transitions between high angular momentum states (transitions involving terms higher than $H \leftrightarrow I$ where Allen's coefficients are not available).

The lifetime, τ_j, of a state or level j can be obtained from the transition probabilities to the lower levels, that is, from the A-values, as

$$\tau_j = \frac{1}{A_j(\text{s}^{-1})}, \quad (9)$$

where A_j is the total radiative transition probability for the state or level j, that is,

$$A_j = \sum_i A_{ji}. \quad (10)$$

In the CC approximation the total wave function of the ion, $\Psi(E)$, is an expansion of core states, χ_i. The core is termed the "target" of N electrons. For any symmetry $SL\pi$,

$$\Psi(E) = \mathbf{A} \sum_i \chi_i\theta_i + \sum_j c_j\Phi_j, \quad (11)$$

where χ_i is a specific target state $S_iL_i\pi_i$; θ_i is the wave function of the $(N + 1)$th electron in a channel labeled $S_iL_i\pi_ik_i^2l_i(SL\pi)$ where k_i^2 is the electron energy, which for $k_i^2 < 0$ may represent a bound state of the electron–ion system; and $\mathbf{A}$ is the antisymmetrization operator. The Φ_j's are correlation functions of the $(N + 1)$th electron system that compensate for the orthogonality condition of the total wave function as well as account for short-range correlation effects, and the c_j's are the variational coefficients.

The present wave function expansion of Fe XIII is a 14-term expansion consisting of the 14 lowest terms of the core Fe XIV. The terms and the energies are given in Table A. The term energies and the orbital wave functions of the core or the target ion are obtained from atomic structure calculations using the program SUPERSTRUCTURE [21]. However, the calculated energies of observed terms have been replaced by the measured values listed in the NIST compilation [1] where available. Not all the terms in Table A have been observed; the unobserved term energies are marked by asterisks. The sets of spectroscopic and correlation configurations, and the values of the scaling parameter λ for each orbital in the Thomas–Fermi–Dirac potential used in the atomic structure calculations are given in the note to Table A. The second sum in the wave function expansion, Eq. (11), includes all possible $(N + 1)$-electron configurations of Fe XIII up to $3p^4$, $3d^2$, $4s$, and $4p$.

TABLE A
Fe XIV States and Excitation Energies Used in the Wave Function Expansion of Fe XIII

	Configuration	$SL\pi$	E(Ry)		Configuration	$SL\pi$	E(Ry)
1	$3s^23p$	$^2P^o$	0.0	8	$3p^3$	$^4S^o$	5.34121
2	$3s3p^2$	$^4P^e$	2.12457	9	$3p^3$	$^2P^o$	5.58566*
3	$3s3p^2$	$^2D^e$	2.73911	10	$3s3p3d$	$^4F^o$	5.63024*
4	$3s3p^2$	$^2S^e$	3.32333	11	$3s3p3d$	$^4P^o$	6.07468*
5	$3s3p^2$	$^2P^e$	3.58899	12	$3s3p3d$	$^4D^o$	6.11603
6	$3s^23d$	$^2D^e$	4.32324	13	$3s3p3d$	$^2D^o$	6.35966*
7	$3p^3$	$^2D^o$	4.91648*	14	$3s3p3d$	$^2F^o$	6.67736*

Note. The energies marked with an asterisk are calculated energies, given here for unobserved terms. Following are the sets of spectroscopic and correlation configurations, and the scaling parameters, λ, for each orbital in the Thomas–Fermi–Dirac potential used in the atomic structure calculations.

Spectroscopic configurations: $3s^23p$, $3s3p^2$, $3p^3$, $3s^23d$, $3s3p3d$, $3p^23d$.

Correlation configurations: $3s^24s$, $3s^24p$, $3s3p4s$, $3s3p4p$, $3s3d4s$, $3s3d4p$, $3p^24s$, $3p^24p$, $3p^24p$, $3p3d4s$, $3p3d4p$.

λ (Scaling parameters): 1.1(1s), 1.08576(2s), 1.03329(2p), 0.947(3s), 0.90957(3p), 1.00689(3d), 4.85982(4s), 2.19876(4p).

The computations of the oscillator strengths for bound–bound transitions are carried out using the R-matrix package of codes developed for the OP [22] and extended for the IP [12]. Computations include all $SL\pi$ of Fe XIII formed from the target states in combination with the outer electron with $l \leq 9$. The fine-structure components of the f-values are obtained using the code JJTOLS [16]. Due to the large volume, computations and processing of data are carried out separately for each spin symmetry $(2S + 1) = 5, 3,$ and 1.

All bound states of the Hamiltonian matrix are scanned for up to $n = 10$ and $l = 9$ with an effective quantum number mesh $\Delta\nu = 0.01$. Identification of the large number of LS bound states obtained has been a major task for this ion. A term is designated as a possible combination of the configuration of the core and the outer electron, corresponding to an appropriate value of ν for the outer electron quantum numbers n, l and a larger channel percentage contribution. One way to identify the states is to sort out the series of ν for the terms of same configuration but with increasing n of the valence electron. However, small differences in ν for various terms of the same symmetry have caused difficulties in assignments of proper configurations. The quantum defects for these states are almost the same. Hence, some uncertainties may have been introduced in the identification of some of the states; that is, the exact identification could also be the immediate upper or lower term for such cases. Almost all the bound terms of Fe XIII are formed from the 14 Fe XIV target states included in combination with the outer electron quantum numbers. However, some additional bound states are found to have formed from the bound channel configurations included (second sum of Eq. (11)) in the calculations. These terms are assigned with possible configurations with core of the forms $3s3d^2$, $3p3d^2$, and $3d^24s$.

Results and Discussion

The 14 CC R-matrix calculations have resulted in a total of 1223 bound LS terms of Fe XIII lying below the first ionization threshold. Of these, 24 states have been observed [1] and identified. The calculated term energies are compared with the observed ones in Table B. The earlier calculations [13] under the OP correspond to a 9-term eigenfunction expansion leading to 797 bound terms. In Table B, a comparison of present calculated energies with those of Ref. [13], and with observed energies, shows good agreement among the different values, generally to within 1%.

Table I lists the complete set of bound LS terms and energies among which the dipole-allowed fine-structure transitions are considered. In the Table, the calculated energies of the 24 observed terms have been replaced by the measured values, as these are used in the calculation of transition probabilities. Each LS term is prefixed by a degeneracy symbol, a letter of the alphabet, for convenience of identification. Ascending order of the alphabet is chosen for the even-parity states of a symmetry. The odd-parity states are designated in the same way but with the alphabet in descending order. No degeneracy is assigned for terms in a position 27th or higher within the symmetry.

The dipole-allowed bound–bound transitions in Fe XIII result in 64,456 transitions among LS terms. The present number of transitions is over 71% more than the number of transitions, 37,598, obtained by Butler et al. [13]. Fine-structure transitions have been derived for all LS multiplets in the present work, yielding an extensive set of 307,863 transitions. Observed energies have been used wherever available for improved accuracy.

Present f-values, both for LS multiplets and for fine-structure transitions, are compared with those in the previous calculations in Table C. With the exception of the calculation by Butler et al. [13], who carried out CC

TABLE B
Comparison of Calculated Fe XIII Binding Energies, E_c (in rydberg) with the Observed Values, E_o [1], and with Calculated Values E_c(OP) from [13]

Configuration	$SL\pi$	E_o $N_o = 24$	E_c $N_c = 1223$	E_c(OP) $N_c = 797$
$3s^23p^2$	^3P	26.414	26.393	26.345
$3s^23p^2$	^1D	26.098	26.107	26.064
$3s^23p^2$	^1S	25.702	25.701	25.643
$3s3p^3$	$^3D^o$	23.906	24.029	23.985
$3s3p^3$	$^3P^o$*	23.529	23.657	23.608
$3s3p^3$	$^1D^o$	23.234	23.339	23.301
$3s3p^3$	$^3S^o$	22.750	22.781	22.735
$3s3p^3$	$^1P^o$	22.544	22.652	22.612
$3s^23p3d$	$^3P^o$	22.061	22.029	21.976
$3s^23p3d$	$^1D^o$	21.990	22.068	22.014
$3s^23p3d$	$^3D^o$	21.901	21.935	21.881
$3s^23p3d$	$^1F^o$	21.462	21.461	21.417
$3s^23p3d$	$^1P^o$	21.336	21.348	21.286
$3s^23p4s$	$^3P^o$*	14.254	14.155	14.172
$3s^23p4s$	$^1P^o$	14.126	14.034	14.084
$3s^23p4p$	^1D	12.975	12.810	12.960
$3s^23p4p$	^1P	12.728	12.424	13.336
$3s^23p4d$	$^3D^o$	11.907	11.854	11.852
$3s^23p4d$	$^3F^o$*	11.777	11.767	11.767
$3s^23p4d$	$^1F^o$	11.677	11.705	11.695
$3s^23p4d$	$^1P^o$	11.495	11.641	11.630
$3s^23p4f$	^1D	10.673	10.644	10.641
$3s^23p4f$	^3F*	10.668	10.919	10.920
$3s^23p4f$	^1G	10.648	10.661	10.653

Note. An asterisk indicates incomplete set of observed fine-structure levels. N is the total number of bound states.

R-matrix calculations, other previous works correspond to atomic structure calculations requiring optimization of individual levels. A relatively smaller number of transitions, including both dipole allowed and intercombination, were considered in these calculations. All calculations agree better for the singlet transitions than for the triplet ones. Present *LS* oscillator strengths are consistently in good agreement with those given by Butler et al. [13] for most of the transitions. However, significant differences also exist for a few cases, such as for the transition $3s^23p^2(^3P) \rightarrow 3s^23p4s(^3P^o)$. The term energies for this transition from both calculations are in good agreement (Table B); the reason for the large difference in the *f*-value is not obvious but could be related to correlation effects in the present work. Agreement is quite good for the present fine-structure *f*-values with those obtained using multiconfiguration Dirac–Fock calculations by Huang [2] for the dipole-allowed transitions, $3s^23p^2(^1S,\ ^1D) \rightarrow 3p3d(^1P^o,\ ^1F^o)$, and for $3s^23p^2(^3P) \rightarrow 3p3d(^3P^o,\ ^3D^o)$, but the differences are considerable for the transitions $3s^23p^2(^3P) \rightarrow 3s3p^3(^3P^o,\ ^3D^o)$. The disagreement with [2] shown for the $3s^23p^2(^3P) \rightarrow 3s3p^3(^3S^o)$ transition may be spurious; rather good agreement is actually seen if the $3s3p^3(^3S^o)$ and $3s3p^3(^1P^o)$ state labels are switched in [2]. Varying degrees of agreement with the oscillator strengths are found by Fawcett and collaborators (Fawcett et al. [3], Bromage et al. [4], and Fawcett [5]). While present values agree very well with those given by Fawcett et al. [3] for transitions such as $3s^23p^2(^1D) \rightarrow 3p4s(^1P^o)$, $3p3d(^3F^o) \rightarrow 3p4p(^3D)$, the agreement is quite poor for some other transitions such as for $3s^23p^2(^3P) \rightarrow 3p4s(^3P^o)$. The Dirac–Fock calculations by Huang [2] and the Hartree–Fock calculations including relativistic effects by Fawcett and collaborators often are in good agreement with each other. The results from these atomic structure calculations can be very accurate for some transitions but they can be considerably poorer without suitable optimization. In contrast, in the CC approximation, such as that used in the present case, the results are of consistent accuracy throughout except for very weak transitions. However, for transitions where relativistic effects are more important, the atomic structure calculations including these effects are probably more accurate. This is especially the case for transitions affected by relativistic mixing between different multiplicities, such as between the singlets and triplets. In recent developments under the IP [12] it is now possible to carry out CC calculations including the relativistic effects using the Breit–Pauli approximation; this method has been used for the transition probabilities for two simple systems, Fe XXIV and Fe XXV [18]. Carrying out of such calculations for Fe XIII is planned.

As the lifetime of the $3s3p^3(^3S^o_1)$ level of Fe XIII has been measured experimentally by Träbert et al. [7], it is of considerable interest to study the decay rate from this level, namely the transition $3s^23p^2(^3P) \leftarrow 3s3p^3(^3S^o)$. The *f*-values from the three calculations, Refs. [13], and [4] and the present, agree in general for the *LS* transition (Table C), indicating similar predictions for the lifetime (Table D). However, the slight variation in the calculated energies will introduce some differences. The lifetime values from previous calculations are 16.4 ps [13], 16.4 ps [4] (from the *LS A*-value), and 16.7 ps [4] (from fine-structure components), and the value from the present calculation is 15.8 ps (as shown in Table D). The measured value is 21(4) ps with uncertainty ranging from 17 to 25 ps [7]. The calculated values agree with one another within the expected uncertainty of the various theoretical treatments, and they agree with the lower limit of the measured value, 17 ps, to within a few percent. However, it may be that all theoretical values somewhat underestimate the lifetime of the $^3S^o$ level.

Based on the accuracy of the calculated term energies in comparison with the measured values, of the present *f*-values with previous calculations and of the lifetime with the measured value, and on the general uncertainty of the CC method, it is estimated that the accuracy of the present *f*-, *S*-, and *A*-values is approximately 10–30% for most transitions. The uncertainty can be higher for weak transi-

TABLE C
Comparison of Fe XIII f-Values

Transition	Multiplet	g_i	g_f	f Present	f Others
$3s^23p^2$–$3s3p^3$	^1S–$^1P^o$	1	3	0.186	0.175 [13], 0.15 [4], 0.138 [5]
$3s^23p^2$–$3p3d$	^1S–$^1P^o$	1	3	1.10	1.12 [13], 1.1 [2], 1.2 [4], 1.26 [5]
$3s^23p^2$–$3p4d$	^1S–$^1P^o$	1	3	0.534	0.524 [13], 0.39 [6]
$3s^23p^2$–$3s3p^3$	^1D–$^1P^o$	5	3	0.183	0.179 [13], 0.18 [4], 0.189 [5]
$3s^23p^2$–$3p4s$	^1D–$^1P^o$	5	3	0.12	0.11 [13], 0.11 [3]
$3s^23p^2$–$3s3p^3$	^1D–$^1D^o$	5	5	0.0967	0.0918 [13], 0.080 [4], 0.077 [5]
$3s^23p^2$–$3p3d$	^1D–$^1D^o$	5	5	0.443	0.444 [5]
$3s^23p^2$–$3p3d$	^1D–$^1F^o$	5	7	0.578	0.582 [13], 0.55 [2], 0.58 [4], 0.58 [5]
$3s^23p^2$–$3p4d$	^1D–$^1F^o$	5	7	0.384	0.382 [13], 0.33 [3, 6]
$3p3d$–$3p4p$	$^1F^o$–^1D	7	5	0.0306	0.0301 [13], 0.22 [3]
$3p3d$–$3p4f$	$^1F^o$–^1G	7	5	0.72	0.71 [13], 0.75 [3, 6]
$3s^23p^2$–$3s3p^3$	^3P–$^3S^o$	9	3	0.196	0.194 [13], 0.19 [4]
		5	3	0.194	0.005 [2], 0.20 [4], 0.195 [5]
		3	3	0.198	0.042 [2], 0.16 [4], 0.162 [5]
		1	3	0.203	0.019 [2], 0.18 [4], 0.162 [5]
$3s^23p^2$–$3s3p^3$	^3P–$^3P^o$	9	9	0.0637	0.0591 [13], 0.057 [2]
		5	5	0.047	0.049 [2], 0.05 [5]
		5	3	0.0156	0.0083 [2], 0.0084 [5]
		3	5	0.027	0.010 [2], 0.011 [5]
		3	3	0.016	0.027 [2], 0.027 [5]
		3	1	0.021	0.020 [2], 0.020 [5]
		1	3	0.064	0.051 [2], 0.053 [5]
$3s^23p^2$–$3s^23p3d$	^3P–$^3P^o$	9	9	0.283	0.286 [13]
		5	5	0.208	0.122 [2], 0.127 [5]
		5	3	0.070	0.034 [2], 0.024 [4], 0.025 [5]
		3	5	0.118	0.213 [5]
		3	3	0.072	0.0001 [2], 0.0053 [5]
		3	1	0.097	0.098 [2], 0.104 [5]
		1	3	0.293	0.819 [2], 0.97 [4], 0.948 [5]
$3s^23p^2$–$3p4s$	^3P–$^3P^o$	9	9	0.0624	0.10 [13]
		5	5	0.0468	0.088 [3]
		5	3	0.0154	0.040 [3]
		3	5	0.0262	0.057 [3]
$3s^23p^2$–$3s3p^3$	^3P–$^3D^o$	9	15	0.052	0.048 [13], 0.046 [2]
		5	7	0.043	0.036 [2], 0.034 [5]
		5	5	0.0077	0.0010 [2]
		5	3	0.0005	0.00015 [2]
		3	5	0.040	0.048 [2], 0.046 [5]
		3	3	0.013	0.0065 [2], 0.0063 [5]
		1	3	0.055	0.069 [2], 0.067 [5]
$3s^23p^2$–$3s^23p3d$	^3P–$^3D^o$	9	15	0.707	0.704 [13], 0.65 [4]
		5	7	0.59	0.577 [2], 0.59 [4], 0.57 [2], 0.585 [5]
		5	5	0.105	0.0004 [2], 0.23 [4], 0.227 [5]
		5	3	0.007	0.047 [2], 0.06 [4], 0.057 [5]
		3	5	0.53	0.17 [2], 0.19 [4], 0.206 [5]
		3	3	0.18	0.25 [2], 0.25 [4], 0.255 [5]
		1	3	0.72	0.162 [2], 0.08 [4], 0.095 [5]
$3s^23p^2$–$3s^23p4d$	^3P–$^3D^o$	9	15	0.361	0.346 [13]
		3	5	0.27	0.23 [3]
		1	3	0.36	0.35 [3]
$3p3d$–$3p4p$	$^3F^o$–^3D	21	15	0.0478	0.0474 [13]
		9	7	0.048	0.046 [3]
		7	5	0.042	0.040 [3]
		5	3	0.040	0.034 [3]
$3p3d$–$3p4f$	$^3F^o$–^3G	21	27	0.792	0.776 [13]
		9	11	0.75	0.73 [3, 6]
		7	9	0.74	0.50 [3]

TABLE D
Lifetime (in 10^{-12} s) of the $3s3p^3(^3S^o_1)$ Level in Fe XIII

Level	Present	Theory [13]	Theory [4]	Experiment [7]
$3s3p^3(^3S^o_1)$	15.8	16.4	16.4[a], 16.7[b]	21 (4)

[a] From the LS value.
[b] From fine-structure values.

tions. However, more measured values and more accurate calculations are required for better estimation of the accuracy of the present values. The present method does not include any relativistic effects for the fine-structure transitions. For highly excited states, the relativistic effects and LSJ-mixing can be significant. These may result in stronger intercombination transitions and somewhat different strengths among the corresponding allowed fine-structure components. As discussed in the previous section, there are also uncertainties in configuration assignments for some of the states due to fact that the quantum defects are nearly the same. Hence, the identification of some of these transitions may not be exact.

The volume of results obtained for the oscillator strengths (f), line strength (S), and transition probabilities (A-values) for Fe XIII is quite large. It is impractical to publish such a large number of transitions. Hence, the table containing the complete set of f-, S-, and A-values for both LS multiplets and fine-structure transitions along with 1223 energy terms will be made available electronically. A FORTRAN code will be provided to read the file and obtain the relevant quantities, such as A-values for lifetime calculations. Table II represents a partial table presenting only those transitions for which observed energies have been used. The format corresponds to that of the complete table.

Summary and Conclusion

An extensive set of f-, S-, and A-values for 64,456 LS-multiplet transitions and 307,863 dipole-allowed fine-structure transitions in Fe XIII is obtained. This work presents the first extensive data set for fine-structure transitions for this ion. The number of bound states obtained is considerably larger than for previously measured and calculated data. Calculations are carried out in the CC R-matrix method for the LS transitions, and the fine-structure components are obtained through algebraic transformations. The observed energies are used, wherever available, for improved accuracy. The uncertainty is estimated to be 10% for strong transitions and about 10–30% for most other transitions. Inclusion of relativistic effects, which have not been considered in the present work, could lead to further improvements. Present results should be applicable to various laboratory and astronomical plasma diagnostics, such as in the detailed analysis of UV spectra.

The full table of transition probabilities and energies is available in electronic form from the author at nahar@astronomy.ohio-state.edu. A FORTRAN77 code is attached to the table to read the A-values and calculate the lifetime for any LS term or fine-structure level.

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EXPLANATION OF TABLES

TABLE I. Bound States of Fe XIII

This Table presents the bound states of Fe XIII among which the dipole-allowed transitions are considered.

Term — Electronic configuration and *LS* term. The lower *LS* terms are prefixed by a degeneracy symbol in alphabetically ascending order for successive even-parity states and descending order for successive odd-parity states of the same symmetry. No degeneracy is assigned for terms in a position 27th or higher within the symmetry.

$E(Ry)$ — *LS* binding energy (in rydberg) used in the present calculation. (Negative sign is omitted for convenience.)

TABLE II. Oscillator Strengths, Line Strengths, and Transition Probabilities for Allowed Transitions in Fe XIII

Data are given in subsets, with the first line corresponding to the *LS* transition and subsequent lines to its fine-structure components. In the complete electronic file the subsets are ordered by observed states, as given here, followed by the calculated states.

Transition — The transition $i \rightarrow j$, with states i and j in the notation of Table I.

E_i, E_j — Binding energies of the initial and final *LS* terms given in rydberg on the first line, and the excitation energies of the initial and final fine-structure levels given in cm^{-1} on the subsequent lines. (The negative sign for the *LS* term binding energy is omitted for convenience.) Asterisks in place of the fine-structure energies mean one or both levels are not observed.

E_{ji} — Transition energy (in rydberg). The transition energy for the case of unobserved levels is obtained from the f- and S-values as $E_{ji} = 3g_i(f_{ij}/S)$.

g_i, g_j — The statistical weight factors of the initial and final states (levels).

f_{ij} — Absorption oscillator strength (dimensionless).

S — Line strength (in a.u.).

A_{ji} — Transition probability from upper state j to lower state i (in s^{-1}).

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s^23p^2$	$a\ ^1S^e$	25.70221	$3p3d^24p$	$n\ ^3S^e$	4.43398
$3p^4$	$b\ ^1S^e$	20.33870	$3p3d^24p$	$o\ ^3S^e$	4.02066
$3s^23d^2$	$c\ ^1S^e$	18.57390	$3s^23p(^2P^o)7p$	$p\ ^3S^e$	3.89122
$3s3p^2(^2D^e)3d$	$d\ ^1S^e$	16.85690	$3s3p3d(^2F^o)4f$	$q\ ^3S^e$	3.84185
$3s^23p(^2P^o)4p$	$e\ ^1S^e$	12.54580	$3s^23d(^2D^e)5d$	$r\ ^3S^e$	2.96766
$3s^23d^2$	$f\ ^1S^e$	12.53420	$3s^23p(^2P^o)8p$	$s\ ^3S^e$	2.88868
$3s^23d^2$	$g\ ^1S^e$	11.77120	$3p^3(^2P^o)5p$	$t\ ^3S^e$	2.43403
$3s3p^2(^2S^e)4s$	$h\ ^1S^e$	10.61790	$3s3p^2(^2S^e)6s$	$u\ ^3S^e$	2.31419
$3s^23d^2$	$i\ ^1S^e$	10.08850	$3s^23p(^2P^o)9p$	$v\ ^3S^e$	2.27397
$3s3p^2(^2D^e)4d$	$j\ ^1S^e$	8.72829	$3s3p^2(^2D^e)6d$	$w\ ^3S^e$	2.20068
$3s^23p(^2P^o)5p$	$k\ ^1S^e$	7.87144	$3s^23p(^2P^o)10p$	$x\ ^3S^e$	1.82828
$3p^3(^2P^o)4p$	$l\ ^1S^e$	6.90315	$3s3p3d(^4P^o)5p$	$y\ ^3S^e$	1.78467
$3s^23d(^2D^e)4d$	$m\ ^1S^e$	6.69289	$3s3p^3$	$z\ ^3S^o$	22.75013
$3s^23p(^2P^o)6p$	$n\ ^1S^e$	5.28141	$3p^3(^2D^o)3d$	$y\ ^3S^o$	16.84160
$3s3p^2(^2S^e)5s$	$o\ ^1S^e$	5.12048	$3s3p^3$	$x\ ^3S^o$	15.70260
$3s3p^2(^2D^e)5d$	$p\ ^1S^e$	4.49350	$3s3p3d^2$	$w\ ^3S^o$	13.65450
$3s^23d^2$	$q\ ^1S^e$	4.04825	$3s3p^2(^4P^e)4p$	$v\ ^3S^o$	11.37000
$3s^23p(^2P^o)7p$	$r\ ^1S^e$	3.84490	$3s3p^2(^2P^e)4p$	$u\ ^3S^o$	9.43493
$3s3p3d(^2F^o)4f$	$s\ ^1S^e$	3.78293	$3p3d^24s$	$t\ ^3S^o$	8.67974
$3s3d^24s$	$t\ ^1S^e$	3.61111	$3p^3(^2D^o)4d$	$s\ ^3S^o$	6.77336
$3s^23p(^2P^o)8p$	$u\ ^1S^e$	2.90651	$3s3p^2(^4P^e)5p$	$r\ ^3S^o$	5.96824
$3s^23d(^2D^e)5d$	$v\ ^1S^e$	2.71124	$3s3p3d(^4D^o)4d$	$q\ ^3S^o$	5.67155
$3s3p^2(^2S^e)6s$	$w\ ^1S^e$	2.34167	$3s3p3d(^2D^o)4d$	$p\ ^3S^o$	5.27257
$3s^23p(^2P^o)9p$	$x\ ^1S^e$	2.25478	$3s3p^2(^2P^e)5p$	$o\ ^3S^o$	4.38684
$3s3p^2(^2D^e)6d$	$y\ ^1S^e$	2.19419	$3s3p^2(^4P^e)6p$	$n\ ^3S^o$	3.34518
$3p^3(^2P^o)5p$	$z\ ^1S^e$	2.15829	$3p3d^24s$	$m\ ^3S^o$	3.11050
$3s^23p(^2P^o)10p$	$^1S^e$	1.81444	$3p^3(^4S^o)4s$	$l\ ^3S^o$	3.07606
$3p^3(^2D^o)3d$	$z\ ^1S^o$	17.78060	$3p^3(^2D^o)5d$	$k\ ^3S^o$	2.38623
$3s3p3d^2$	$y\ ^1S^o$	15.06390	$3s3d^24p$	$j\ ^3S^o$	2.18344
$3s3p^2(^2P^e)4p$	$x\ ^1S^o$	9.89850	$3s3p^2(^4P^e)7p$	$i\ ^3S^o$	1.79494
$3p^3(^2D^o)4d$	$w\ ^1S^o$	6.74732	$3s3p^2(^2P^e)6p$	$h\ ^3S^o$	1.75493
$3s3p3d(^2D^o)4d$	$v\ ^1S^o$	5.34194	$3s3d^24p$	$g\ ^3S^o$	1.67206
$3s3p^2(^2P^e)5p$	$u\ ^1S^o$	4.48586	$3d^24s4p$	$f\ ^3S^o$	1.53061
$3p3d^24s$	$t\ ^1S^o$	2.53911	$3s3p3d(^4D^o)5d$	$e\ ^3S^o$	1.18345
$3p^3(^2D^o)5d$	$s\ ^1S^o$	2.39754	$3s3p3d(^2D^o)5d$	$d\ ^3S^o$	0.91255
$3s3d^24p$	$r\ ^1S^o$	2.18391	$3s3p^2(^4P^e)8p$	$c\ ^3S^o$	0.81287
$3s3p^2(^2P^e)6p$	$q\ ^1S^o$	1.82283	$3s3p^2(^2P^e)7p$	$b\ ^3S^o$	0.29547
$3s3p3d(^2D^o)5d$	$p\ ^1S^o$	0.93241	$3p^3(^4S^o)5s$	$a\ ^3S^o$	0.25149
$3s3p^2(^2P^e)7p$	$o\ ^1S^o$	0.31470	$3s3p^2(^4P^e)9p$	$^3S^o$	0.14484
$3d^24s4p$	$n\ ^1S^o$	0.24249	$3d^24s4p$	$^3S^o$	0.09112
$3p^3(^2D^o)6d$	$m\ ^1S^o$	0.08156	$3p^3(^2D^o)6d$	$^3S^o$	0.04805
$3s3p^2(^2D^e)3d$	$a\ ^3S^e$	19.23670	$3p^23d^2$	$a\ ^5S^e$	13.59540
$3s^23p(^2P^o)4p$	$b\ ^3S^e$	13.11400	$3s3p3d(^4P^o)4p$	$b\ ^5S^e$	7.04687
$3p^23d^2$	$c\ ^3S^e$	11.85170	$3s3p3d(^4F^o)4f$	$c\ ^5S^e$	5.02703
$3s3p^2(^2S^e)4s$	$d\ ^3S^e$	10.92440	$3s3p3d(^4P^o)5p$	$d\ ^5S^e$	1.89379
$3s3p^2(^2D^e)4d$	$e\ ^3S^e$	8.85900	$3s3p3d(^4F^o)5f$	$e\ ^5S^e$	1.20975
$3s^23p(^2P^o)5p$	$f\ ^3S^e$	7.98549	$3s3p^2$	$z\ ^5S^o$	24.73540
$3p^3(^2P^o)4p$	$g\ ^3S^e$	7.48290	$3s3p3d^2$	$y\ ^5S^o$	15.74340
$3s^23d(^2D^e)4d$	$h\ ^3S^e$	7.34698	$3s3p^2(^4P^e)4p$	$x\ ^5S^o$	10.83650
$3s3p3d(^4P^o)4p$	$i\ ^3S^e$	6.64896	$3p^3(^4S^o)4s$	$w\ ^5S^o$	8.99575
$3s^23p(^2P^o)6p$	$j\ ^3S^e$	5.37570	$3s3p^2(^4P^e)5p$	$v\ ^5S^o$	5.90001
$3s3p^2(^2S^e)5s$	$k\ ^3S^e$	5.19605	$3s3p3d(^4D^o)4d$	$u\ ^5S^o$	5.46442
$3s3p3d(^4F^o)4f$	$l\ ^3S^e$	4.75150	$3s3p^2(^4P^e)6p$	$t\ ^5S^o$	3.28447
$3s3p^2(^2D^e)5d$	$m\ ^3S^e$	4.52973	$3p^3(^4S^o)5s$	$s\ ^5S^o$	3.16295

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3p3d^2 4s$	$r\ ^5S^o$	2.42299	$3s3p^2(^2D^e)4f$	$l\ ^1P^o$	8.34900
$3s3p^2(^4P^e)7p$	$q\ ^5S^o$	1.75834	$3p3d^2 4s$	$k\ ^1P^o$	7.79647
$3s3d^2 4p$	$p\ ^5S^o$	1.57516	$3s^2 3p(^2P^o)5d$	$j\ ^1P^o$	7.26760
$3s3p3d(^4D^o)5d$	$o\ ^5S^o$	1.04084	$3s^2 3d(^2D^e)4f$	$i\ ^1P^o$	6.83244
$3s3p^2(^4P^e)8p$	$n\ ^5S^o$	0.79347	$3p^3(^2D^o)4d$	$h\ ^1P^o$	6.15627
$3p^3(^4S^o)6s$	$m\ ^5S^o$	0.29218	$3p^3(^2P^o)4d$	$g\ ^1P^o$	6.02721
$3s3p^2(^4P^e)9p$	$l\ ^5S^o$	0.15202	$3s^2 3p(^2P^o)6s$	$f\ ^1P^o$	5.62929
$3s3p^2(^2D^e)3d$	$a\ ^1P^e$	19.39130	$3s3p3d(^2D^o)4d$	$e\ ^1P^o$	5.36663
$3s3p^2(^2P^e)3d$	$b\ ^1P^e$	18.34830	$3s3p^2(^2D^e)5p$	$d\ ^1P^o$	5.15265
$3p^2 3d^2$	$c\ ^1P^e$	13.34590	$3s^2 3p(^2P^o)6d$	$c\ ^1P^o$	4.98880
$3s^2 3p(^2P^o)4p$	$d\ ^1P^e$	12.72803	$3s3p3d(^2F^o)4d$	$b\ ^1P^o$	4.82643
$3s3p^2(^2P^e)4s$	$e\ ^1P^e$	12.27910	$3s3p^2(^2S^e)5p$	$a\ ^1P^o$	4.63680
$3p^2 3d^2$	$f\ ^1P^e$	10.61200	$3s3p^2(^2P^e)5p$	$^1P^o$	4.29605
$3s3p^2(^2D^e)4d$	$g\ ^1P^e$	8.95844	$3s3p^2(^2D^e)5f$	$^1P^o$	4.04827
$3s3p^2(^2P^e)4d$	$h\ ^1P^e$	8.25976	$3s^2 3p(^2P^o)7s$	$^1P^o$	4.01057
$3p^3(^2D^o)4p$	$i\ ^1P^e$	8.14948	$3s^2 3p(^2P^o)7d$	$^1P^o$	3.66348
$3s^2 3p(^2P^o)5p$	$j\ ^1P^e$	8.00676	$3s^2 3d(^2D^e)4p$	$^1P^o$	3.54517
$3p^3(^2P^o)4p$	$k\ ^1P^e$	7.47086	$3s^2 3p(^2P^o)8s$	$^1P^o$	3.01377
$3s^2 3d(^2D^e)4d$	$l\ ^1P^e$	7.34192	$3p3d^2 4s$	$^1P^o$	2.99130
$3s3p3d(^4P^o)4p$	$m\ ^1P^e$	6.61103	$3p^3(^2P^o)5s$	$^1P^o$	2.84666
$3p^3(^2D^o)4f$	$n\ ^1P^e$	5.89068	$3s^2 3p(^2P^o)8d$	$^1P^o$	2.76561
$3s^2 3p(^2P^o)6p$	$o\ ^1P^e$	5.42480	$3s3p^2(^2D^e)6p$	$^1P^o$	2.59802
$3s3p^2(^2P^e)5s$	$p\ ^1P^e$	4.90643	$3s^2 3d(^2D^e)5f$	$^1P^o$	2.44571
$3s3p^2(^2D^e)5d$	$q\ ^1P^e$	4.57765	$3p^3(^2D^o)5d$	$^1P^o$	2.43918
$3s3d^2 4s$	$r\ ^1P^e$	4.50682	$3s^2 3p(^2P^o)9s$	$^1P^o$	2.34788
$3p3d^2 4p$	$s\ ^1P^e$	4.36147	$3s^2 3p(^2P^o)9d$	$^1P^o$	2.19125
$3s3p3d(^2D^o)4f$	$t\ ^1P^e$	4.24337	$3p3d^2 4s$	$^1P^o$	2.17356
$3s^2 3p(^2P^o)7p$	$u\ ^1P^e$	3.90643	$3s3p^2(^2S^e)6p$	$^1P^o$	2.12216
$3s3p3d(^2F^o)4f$	$v\ ^1P^e$	3.87729	$3p3d^2 4s$	$^1P^o$	2.05176
$3p3d^2 4d$	$w\ ^1P^e$	3.80934	$3p3d^2 4s$	$^1P^o$	1.99619
$3s3p^2(^2P^e)5d$	$x\ ^1P^e$	3.58056	$3s3p^2(^2D^e)6f$	$^1P^o$	1.97143
$3p^3(^2D^o)5p$	$y\ ^1P^e$	3.08545	$3p^3(^2P^o)5d$	$^1P^o$	1.91872
$3s^2 3d(^2D^e)5d$	$z\ ^1P^e$	2.99770	$3s^2 3p(^2P^o)10s$	$^1P^o$	1.88051
$3s^2 3p(^2P^o)8p$	$^1P^e$	2.92493	$3s^2 3p(^2P^o)10d$	$^1P^o$	1.75774
$3p^3(^2P^o)5p$	$^1P^e$	2.42658	$3s3d^2 4p$	$^1P^o$	1.70330
$3s^2 3p(^2P^o)9p$	$^1P^e$	2.29339	$3s3p^2(^2P^e)6p$	$^1P^o$	1.69150
$3s3p^2(^2D^e)6d$	$^1P^e$	2.22734	$3s^2 3p^2$	$a\ ^3P^e$	26.41387
$3s3p^2(^2P^e)6s$	$^1P^e$	2.00431	$3p^4$	$b\ ^3P^e$	21.22360
$3p^3(^2D^o)5f$	$^1P^e$	1.98794	$3p^2 3d^2$	$c\ ^3P^e$	20.11330
$3s^2 3p(^2P^o)10p$	$^1P^e$	1.83096	$3s3p^2(^4P^e)3d$	$d\ ^3P^e$	19.32360
$3s3p^3$	$z\ ^1P^o$	22.54429	$3s3p^2(^2D^e)3d$	$e\ ^3P^e$	18.38530
$3s^2 3p(^2P^o)3d$	$y\ ^1P^o$	21.33558	$3s3p^2(^2P^e)3d$	$f\ ^3P^e$	17.43740
$3p^3(^2D^o)3d$	$x\ ^1P^o$	16.82610	$3p^2 3d^2$	$g\ ^3P^e$	13.69680
$3p^3(^2P^o)3d$	$w\ ^1P^o$	15.42320	$3p^2 3d^2$	$h\ ^3P^e$	13.04560
$3s3p3d^2$	$v\ ^1P^o$	14.52490	$3s^2 3p(^2P^o)4p$	$i\ ^3P^e$	12.98730
$3s3p3d^2$	$u\ ^1P^o$	14.27960	$3p^2 3d^2$	$j\ ^3P^e$	12.60220
$3s^2 3p(^2P^o)4s$	$t\ ^1P^o$	14.12619	$3s3p^2(^4P^e)4s$	$k\ ^3P^e$	12.15600
$3s3p3d^2$	$s\ ^1P^o$	13.27370	$3p^2 3d^2$	$l\ ^3P^e$	11.87810
$3s^2 3p(^2P^o)4d$	$r\ ^1P^o$	11.49454	$3p^2 3d^2$	$m\ ^3P^e$	11.75940
$3s3p^2(^2D^e)4p$	$q\ ^1P^o$	10.37260	$3s3d^2 4s$	$n\ ^3P^e$	11.24910
$3s3p^2(^2S^e)4p$	$p\ ^1P^o$	9.79033	$3s3p^2(^2P^e)4s$	$o\ ^3P^e$	10.64900
$3s3p^2(^2P^e)4p$	$o\ ^1P^o$	9.18263	$3s3p^2(^4P^e)4d$	$p\ ^3P^e$	9.70739
$3p^3(^2P^o)4s$	$n\ ^1P^o$	8.64730	$3s3p^2(^2D^e)4d$	$q\ ^3P^e$	8.90153
$3s^2 3p(^2P^o)5s$	$m\ ^1P^o$	8.39159	$3p^3(^2D^o)4p$	$r\ ^3P^e$	8.21813

TABLE I. Bound States of Fe XIII
See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s3p^2(^2P^e)4d$	$s\ ^3P^e$	8.00618	$3s^23p(^2P^o)5s$	$j\ ^3P^o$	8.42172
$3s^23p(^2P^o)5p$	$t\ ^3P^e$	7.95721	$3s3p^2(^2D^e)4f$	$i\ ^3P^o$	7.93301
$3p^3(^4S^o)4p$	$u\ ^3P^e$	7.54662	$3s3p3d(^4P^o)4s$	$h\ ^3P^o$	7.76536
$3s^23d(^2D^e)4d$	$v\ ^3P^e$	7.21945	$3s^23p(^2P^o)5d$	$g\ ^3P^o$	7.29486
$3p^3(^2P^o)4p$	$w\ ^3P^e$	7.19575	$3p^3(^2D^o)4d$	$f\ ^3P^o$	6.79978
$3s3p3d(^4P^o)4p$	$x\ ^3P^e$	7.11450	$3s^23d(^2D^e)4f$	$e\ ^3P^o$	6.33175
$3s3p3d(^4D^o)4p$	$y\ ^3P^e$	6.66223	$3p^3(^2P^o)4d$	$d\ ^3P^o$	6.12079
$3s3p3d(^2D^o)4p$	$z\ ^3P^e$	6.55247	$3s3p3d(^4F^o)4d$	$c\ ^3P^o$	5.88442
$3s3p^2(^4P^e)5s$	$^3P^e$	6.22370	$3s3p^2(^4P^e)5p$	$b\ ^3P^o$	5.81796
$3p^3(^2D^o)4f$	$^3P^e$	5.82144	$3s^23p(^2P^o)6s$	$a\ ^3P^o$	5.64806
$3s^23p(^2P^o)6p$	$^3P^e$	5.37877	$3s3p3d(^4P^o)4d$	$^3P^o$	5.56767
$3s3p^2(^4P^e)5d$	$^3P^e$	5.24060	$3s3p3d(^4D^o)4d$	$^3P^o$	5.42970
$3s3p^2(^2P^e)5s$	$^3P^e$	4.93857	$3s3p3d(^2D^o)4d$	$^3P^o$	5.31590
$3s3p3d(^4F^o)4f$	$^3P^e$	4.86444	$3s3p^2(^2D^e)5p$	$^3P^o$	5.18493
$3s3p3d(^4D^o)4f$	$^3P^e$	4.59704	$3s^23p(^2P^o)6d$	$^3P^o$	5.00811
$3s3p^2(^2D^e)5d$	$^3P^e$	4.56406	$3s3p3d(^2F^o)4d$	$^3P^o$	4.80345
$3p3d^24p$	$^3P^e$	4.50115	$3s3p^2(^2S^e)5p$	$^3P^o$	4.65617
$3s3p3d(^2D^o)4f$	$^3P^e$	4.39037	$3s3p^2(^2P^e)5p$	$^3P^o$	4.38487
$3p3d^24p$	$^3P^e$	4.15762	$3s3p^2(^2D^e)5f$	$^3P^o$	4.10217
$3s3p3d(^2F^o)4f$	$^3P^e$	3.94124	$3s^23p(^2P^o)7s$	$^3P^o$	4.02638
$3p3d^24p$	$^3P^e$	3.93098	$3s^23p(^2P^o)7d$	$^3P^o$	3.64166
$3s^23p(^2P^o)7p$	$^3P^e$	3.86284	$3s^23d(^2D^e)5p$	$^3P^o$	3.61553
$3s3p^2(^2P^e)5d$	$^3P^e$	3.68440	$3s3p^2(^4P^e)6p$	$^3P^o$	3.21024
$3s3p^2(^4P^e)6s$	$^3P^e$	3.48804	$3p3d^24s$	$^3P^o$	3.10670
$3p^3(^2D^o)5p$	$^3P^e$	3.03085	$3s^23p(^2P^o)8s$	$^3P^o$	3.02136
$3s^23p(^2P^o)8p$	$^3P^e$	2.93892	$3p^3(^2P^o)5s$	$^3P^o$	2.89167
$3s3p^2(^4P^e)6d$	$^3P^e$	2.90778	$3s^23p(^2P^o)8d$	$^3P^o$	2.77339
$3s^23d(^2D^e)5d$	$^3P^e$	2.86825	$3p3d^24s$	$^3P^o$	2.67737
$3p^3(^4S^o)5p$	$^3P^e$	2.57080	$3s3p^2(^2D^e)6p$	$^3P^o$	2.60483
$3p^3(^2P^o)5p$	$^3P^e$	2.39476	$3p3d^24s$	$^3P^o$	2.53394
$3s^23p(^2P^o)9p$	$^3P^e$	2.28463	$3s^23d(^2D^e)5f$	$^3P^o$	2.52056
$3s3p^2(^2D^e)6d$	$^3P^e$	2.24150	$3p^3(^2D^o)5d$	$^3P^o$	2.42465
$3s3p^2(^2P^e)6s$	$^3P^e$	2.02679	$3p3d^24s$	$^3P^o$	2.35750
$3p^3(^2D^o)5f$	$^3P^e$	1.96731	$3s^23p(^2P^o)9s$	$^3P^o$	2.34869
$3s3p3d(^4P^o)5p$	$^3P^e$	1.95218	$3s3p3d(^4P^o)5s$	$^3P^o$	2.28173
$3s3p^2(^4P^e)7s$	$^3P^e$	1.90604	$3s3d^24p$	$^3P^o$	2.22445
$3s^23p(^2P^o)10p$	$^3P^e$	1.82900	$3s^23p(^2P^o)9d$	$^3P^o$	2.17575
$3s3p3d(^4D^o)5p$	$^3P^e$	1.74657	$3s3p^2(^2S^e)6p$	$^3P^o$	2.08147
$3s3p^3$	$z\ ^3P^o$	23.52853	$3s3p^2(^2D^e)6f$	$^3P^o$	2.01950
$3s^23p(^2P^o)3d$	$y\ ^3P^o$	22.06081	$3s3d^24p$	$^3P^o$	1.98338
$3p^3(^2D^o)3d$	$x\ ^3P^o$	16.81400	$3s^23p(^2P^o)10s$	$^3P^o$	1.88559
$3p^3(^2P^o)3d$	$w\ ^3P^o$	16.70060	$3s3p^2(^2P^e)6p$	$^3P^o$	1.82325
$3s3p3d^2$	$v\ ^3P^o$	15.34900	$3s^23p(^2P^o)10d$	$^3P^o$	1.75920
$3s3p3d^2$	$u\ ^3P^o$	15.11790	$3s3p^2(^4P^e)7p$	$^3P^o$	1.73101
$3s3p3d^2$	$t\ ^3P^o$	14.80190	$3p^3(^2P^o)5d$	$^3P^o$	1.70376
$3s^23p(^2P^o)4s$	$s\ ^3P^o$	14.25442	$3s3p3d(^4F^o)5d$	$^3P^o$	1.69206
$3s3p3d^2$	$r\ ^3P^o$	14.12170	$3s3p^2(^4P^e)3d$	$a\ ^5P^e$	20.26880
$3s^23p(^2P^o)4d$	$q\ ^3P^o$	11.69680	$3p^23d^2$	$b\ ^5P^e$	13.29970
$3s3p^2(^4P^e)4p$	$p\ ^3P^o$	10.90630	$3s3p^2(^4P^e)4s$	$c\ ^5P^e$	12.25010
$3s3p^2(^2D^e)4p$	$o\ ^3P^o$	10.25060	$3s3p^2(^4P^e)4d$	$d\ ^5P^e$	9.73160
$3s3p^2(^2S^e)4p$	$n\ ^3P^o$	9.81929	$3p^3(^4S^o)4p$	$e\ ^5P^e$	7.94300
$3s3p^2(^2P^e)4p$	$m\ ^3P^o$	9.57119	$3s3p3d(^4P^o)4p$	$f\ ^5P^e$	7.06997
$3s^23d(^2D^e)4p$	$l\ ^3P^o$	8.79162	$3s3p3d(^4D^o)4p$	$g\ ^5P^e$	6.81191
$3p^3(^2P^o)4s$	$k\ ^3P^o$	8.51198	$3s3p^2(^4P^e)5s$	$h\ ^5P^e$	6.35690

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s3p^2(^4P^e)5d$	$i\ ^5P^e$	5.25024	$3s3p^2(^2S^e)4d$	$r\ ^1D^e$	8.37860
$3s3p3d(^4F^o)4f$	$j\ ^5P^e$	5.06483	$3s3p^2(^2P^e)4d$	$s\ ^1D^e$	8.10345
$3s3p3d(^4D^o)4f$	$k\ ^5P^e$	4.65208	$3s^23p(^2P^o)5p$	$t\ ^1D^e$	7.87168
$3s3p^2(^4P^e)6s$	$l\ ^5P^e$	3.53401	$3p^3(^2D^o)4p$	$u\ ^1D^e$	7.59135
$3s3p^2(^4P^e)6d$	$m\ ^5P^e$	2.92873	$3p^3(^2P^o)4p$	$v\ ^1D^e$	7.23674
$3p^3(^4S^o)5p$	$n\ ^5P^e$	2.65628	$3s^23d(^2D^e)4d$	$w\ ^1D^e$	7.18763
$3s3p^2(^4P^e)7s$	$o\ ^5P^e$	1.94556	$3s^23p(^2P^o)5f$	$x\ ^1D^e$	6.83179
$3s3p3d(^4P^o)5p$	$p\ ^5P^e$	1.91542	$3s3p3d(^2F^o)4p$	$y\ ^1D^e$	6.59886
$3s3p3d(^4D^o)5p$	$q\ ^5P^e$	1.81331	$3s3p3d(^2D^o)4p$	$z\ ^1D^e$	6.14627
$3s3p^2(^4P^e)7d$	$r\ ^5P^e$	1.53104	$3p^3(^2D^o)4f$	$^1D^e$	5.83975
$3s3p3d(^4F^o)5f$	$s\ ^5P^e$	1.22601	$3s3p^2(^2D^e)5s$	$^1D^e$	5.66113
$3s3p^2(^4P^e)8s$	$t\ ^5P^e$	0.90140	$3s^23p(^2P^o)6p$	$^1D^e$	5.34202
$3s3p3d(^4D^o)5f$	$u\ ^5P^e$	0.78227	$3p^3(^2P^o)4f$	$^1D^e$	5.00426
$3s3p^2(^4P^e)8d$	$v\ ^5P^e$	0.65237	$3s^23p(^2P^o)6f$	$^1D^e$	4.74473
$3s3d^24s$	$w\ ^5P^e$	0.24717	$3s3p^2(^2D^e)5d$	$^1D^e$	4.61774
$3s3p^2(^4P^e)9s$	$x\ ^5P^e$	0.22515	$3s3p3d(^2F^o)4f$	$^1D^e$	4.40654
$3s3p^2(^4P^e)9d$	$y\ ^5P^e$	0.05999	$3s3p3d(^2D^o)4f$	$^1D^e$	4.32953
$3p^3(^4S^o)6p$	$z\ ^5P^e$	0.00607	$3s^23d(^2D^e)5s$	$^1D^e$	4.26833
$3s3p3d^2$	$z\ ^5P^o$	16.29840	$3s3d^24s$	$^1D^e$	4.04947
$3s3p^2(^4P^e)4p$	$y\ ^5P^o$	11.17410	$3s3p^2(^2S^e)5d$	$^1D^e$	3.98115
$3s3p3d(^4P^o)4s$	$x\ ^5P^o$	8.08878	$3p3d^24p$	$^1D^e$	3.94884
$3s3p3d(^4F^o)4d$	$w\ ^5P^o$	5.99827	$3s3p^2(^2D^e)5g$	$^1D^e$	3.88870
$3s3p^2(^4P^e)5p$	$v\ ^5P^o$	5.90570	$3p3d^24p$	$^1D^e$	3.87503
$3s3p3d(^4P^o)4d$	$u\ ^5P^o$	5.77123	$3s^23p(^2P^o)7p$	$^1D^e$	3.85177
$3s3p3d(^4D^o)4d$	$t\ ^5P^o$	5.45267	$3p3d^24p$	$^1D^e$	3.74896
$3s3p^2(^4P^e)6p$	$s\ ^5P^o$	3.25801	$3s^23p(^2P^o)7f$	$^1D^e$	3.48249
$3p3d^24s$	$r\ ^5P^o$	2.95730	$3s3p^2(^2P^e)5d$	$^1D^e$	3.37759
$3s3d^24p$	$q\ ^5P^o$	2.60111	$3p^3(^2D^o)5p$	$^1D^e$	2.96443
$3s3p3d(^4P^o)5s$	$p\ ^5P^o$	2.35350	$3s^23p(^2P^o)8p$	$^1D^e$	2.92333
$3s3p^2(^4P^e)7p$	$o\ ^5P^o$	1.75684	$3s^23d(^2D^e)5d$	$^1D^e$	2.86838
$3s3p3d(^4F^o)5d$	$n\ ^5P^o$	1.63073	$3s3p^2(^2D^e)6s$	$^1D^e$	2.83864
$3d^24s4p$	$m\ ^5P^o$	1.31513	$3s^23p(^2P^o)8f$	$^1D^e$	2.66373
$3s3p3d(^4P^o)5d$	$l\ ^5P^o$	1.25526	$3s^23d(^2D^e)5g$	$^1D^e$	2.38957
$3s3p3d(^4D^o)5d$	$k\ ^5P^o$	1.15292	$3p^3(^2P^o)5p$	$^1D^e$	2.35831
$3s3p3d(^4F^o)5g$	$j\ ^5P^o$	1.07780	$3s^23p(^2P^o)9p$	$^1D^e$	2.27332
$3s3p^2(^4P^e)8p$	$i\ ^5P^o$	0.79282	$3s3p^2(^2D^e)6d$	$^1D^e$	2.26562
$3s3p^2(^4P^e)9p$	$h\ ^5P^o$	0.15647	$3s^23p(^2P^o)9f$	$^1D^e$	2.10390
$3s23p^2$	$a\ ^1D^e$	26.09807	$3p^3(^2D^o)5f$	$^1D^e$	1.96862
$3p^4$	$b\ ^1D^e$	21.08020	$3s3p^2(^2D^e)6g$	$^1D^e$	1.91910
$3s3p^2(^2D^e)3d$	$c\ ^1D^e$	18.98450	$3s^23p(^2P^o)10p$	$^1D^e$	1.82629
$3s3p^2(^2S^e)3d$	$d\ ^1D^e$	18.66270	$3s^23p(^2P^o)10f$	$^1D^e$	1.70222
$3s3p^2(^2P^e)3d$	$e\ ^1D^e$	17.77830	$3s3p^3$	$z\ ^1D^o$	23.23430
$3s^23d^2$	$f\ ^1D^e$	17.44850	$3s^23p(^2P^o)3d$	$y\ ^1D^o$	21.99006
$3p^23d^2$	$g\ ^1D^e$	13.58120	$3p^3(^2D^o)3d$	$x\ ^1D^o$	17.16500
$3s^23p(^2P^o)4p$	$r\ ^1D^e$	12.97544	$3p^3(^2P^o)3d$	$w\ ^1D^o$	16.11440
$3p^23d^2$	$i\ ^1D^e$	12.64770	$3s3p3d^2$	$v\ ^1D^o$	15.20320
$3p^23d^2$	$j\ ^1D^e$	12.05190	$3s3p3d^2$	$u\ ^1D^o$	14.31200
$3p^23d^2$	$k\ ^1D^e$	11.98520	$3s3p3d^2$	$t\ ^1D^o$	13.59580
$3s3p^2(^2D^e)4s$	$l\ ^1D^e$	11.32900	$3s^23p(^2P^o)4d$	$s\ ^1D^o$	11.87440
$3p^23d^2$	$m\ ^1D^e$	11.28040	$3s3p^2(^2D^e)4p$	$r\ ^1D^o$	10.56320
$3s^23p(^2P^o)4f$	$n\ ^1D^e$	10.67276	$3s3p^2(^2P^e)4p$	$q\ ^1D^o$	9.35663
$3p^23d^2$	$o\ ^1D^e$	10.62370	$3p^3(^2D^o)4s$	$p\ ^1D^o$	8.98673
$3s^23d(^2D^e)4s$	$p\ ^1D^e$	9.74273	$3s^23d(^2D^e)4p$	$o\ ^1D^o$	8.86781
$3s3p^2(^2D^e)4d$	$q\ ^1D^e$	9.01091	$3s3p^2(^2D^e)4f$	$n\ ^1D^o$	7.97334

TABLE I. Bound States of Fe XIII
See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s3p3d(^2D^o)4s$	$m\ ^1D^o$	7.54170	$3s^23p(^2P^o)5f$	$w\ ^3D^e$	6.90461
$3s^23p(^2P^o)5d$	$l\ ^1D^o$	7.37343	$3s3p3d(^4P^o)4p$	$x\ ^3D^e$	6.88817
$3s3p^2(^2P^e)4f$	$k\ ^1D^o$	7.22863	$3s3p3d(^4D^o)4p$	$y\ ^3D^e$	6.67474
$3p^3(^2D^o)4d$	$j\ ^1D^o$	6.72606	$3s3p3d(^2D^o)4p$	$z\ ^3D^e$	6.53270
$3s^23d(^2D^e)4f$	$i\ ^1D^o$	6.49538	$3s3p3d(^2F^o)4p$	$^3D^e$	6.26734
$3p^3(^2P^o)4d$	$h\ ^1D^o$	6.13398	$3p^3(^2D^o)4f$	$^3D^e$	5.88064
$3s3p3d(^2D^o)4d$	$g\ ^1D^o$	5.35921	$3s3p^2(^2D^e)5s$	$^3D^e$	5.73671
$3s3p^2(^2D^e)5p$	$f\ ^1D^o$	5.26320	$3s^23p(^2P^o)6p$	$^3D^e$	5.38836
$3s^23p(^2P^o)6d$	$e\ ^1D^o$	5.04594	$3p^3(^2P^o)4f$	$^3D^e$	5.25421
$3s3p3d(^2F^o)4d$	$d\ ^1D^o$	4.93075	$3s3p^2(^4P^e)5d$	$^3D^e$	5.14982
$3s3p^2(^2P^e)5p$	$c\ ^1D^o$	4.35607	$3s3p3d(^4F^o)4f$	$^3D^e$	5.03815
$3s3p^2(^2D^e)5f$	$b\ ^1D^o$	4.11721	$3s^23p(^2P^o)6f$	$^3D^e$	4.78170
$3s^23d(^2D^e)5p$	$a\ ^1D^o$	3.69441	$3s3p^2(^2D^e)5d$	$^3D^e$	4.65663
$3s^23p(^2P^o)7d$	$^1D^o$	3.66131	$3s3p3d(^4P^o)4f$	$^3D^e$	4.61040
$3p^3(^2D^o)5s$	$^1D^o$	3.50725	$3s3p3d(^4D^o)4f$	$^3D^e$	4.50295
$3s3p^2(^2P^e)5f$	$^1D^o$	3.33646	$3s3d^24s$	$^3D^e$	4.43272
$3s3p3d^2$	$^1D^o$	3.28906	$3s3p3d(^2D^o)4f$	$^3D^e$	4.36180
$3s^23p(^2P^o)8d$	$^1D^o$	2.78469	$3s^23d(^2D^e)5s$	$^3D^e$	4.35358
$3s3p^2(^2D^e)6p$	$^1D^o$	2.67315	$3p3d^24p$	$^3D^e$	4.20242
$3s^23d(^2D^e)5f$	$^1D^o$	2.58692	$3p3d^24p$	$^3D^e$	4.15851
$3p^3(^2D^o)5d$	$^1D^o$	2.51616	$3s3p3d(^2F^o)4f$	$^3D^e$	4.02439
$3p3d^24s$	$^1D^o$	2.44803	$3s3p^2(^2S^e)5d$	$^3D^e$	3.96043
$3p3d^24s$	$^1D^o$	2.30185	$3s3p^2(^2D^e)5g$	$^3D^e$	3.91911
$3s^23p(^2P^o)9d$	$^1D^o$	2.18616	$3s^23p(^2P^o)7p$	$^3D^e$	3.88437
$3p3d^24s$	$^1D^o$	2.16471	$3s^23d(^2D^e)6s$	$^3D^e$	3.82406
$3s3p3d(^2D^o)5s$	$^1D^o$	2.07388	$3s3p^2(^2P^e)5d$	$^3D^e$	3.64685
$3s3p^2(^2D^e)6f$	$^1D^o$	2.00965	$3s^23p(^2P^o)7f$	$^3D^e$	3.50121
$3p3d^24s$	$^1D^o$	1.95240	$3p^3(^2D^o)5p$	$^3D^e$	3.08494
$3p^3(^2D^o)5g$	$^1D^o$	1.85658	$3s^23d(^2D^e)5d$	$^3D^e$	3.01591
$3s^23p(^2P^o)10d$	$^1D^o$	1.77487	$3s^23p(^2P^o)8p$	$^3D^e$	2.93094
$3p^3(^2P^o)5d$	$^1D^o$	1.76534	$3s3p^2(^2D^e)6s$	$^3D^e$	2.89570
$3s3p^2(^2P^e)6p$	$^1D^o$	1.70450	$3s3p^2(^4P^e)6d$	$^3D^e$	2.85683
$3s3p^2(^4P^e)3d$	$a\ ^3D^e$	19.70060	$3s^23p(^2P^o)8f$	$^3D^e$	2.67694
$3s3p^2(^2D^e)3d$	$b\ ^3D^e$	19.43030	$3p^3(^2P^o)5p$	$^3D^e$	2.41194
$3s3p^2(^2S^e)3d$	$c\ ^3D^e$	19.07530	$3s^23d(^2D^e)5g$	$^3D^e$	2.40210
$3s3p^2(^2P^e)3d$	$d\ ^3D^e$	18.68930	$3s3p^2(^2D^e)6d$	$^3D^e$	2.29310
$3p^23d^2$	$e\ ^3D^e$	13.59400	$3s^23p(^2P^o)9p$	$^3D^e$	2.28632
$3s^23p(^2P^o)4p$	$f\ ^3D^e$	13.23980	$3s3p3d(^4F^o)5p$	$^3D^e$	2.24956
$3p^23d^2$	$g\ ^3D^e$	13.07750	$3s^23p(^2P^o)9f$	$^3D^e$	2.11292
$3p^23d^2$	$h\ ^3D^e$	12.30190	$3p^3(^2D^o)5f$	$^3D^e$	1.98124
$3p^23d^2$	$i\ ^3D^e$	12.25130	$3s3p^2(^2D^e)6g$	$^3D^e$	1.93602
$3p^23d^2$	$j\ ^3D^e$	11.92150	$3s3p3d(^4P^o)5p$	$^3D^e$	1.85437
$3s3p^2(^2D^e)4s$	$k\ ^3D^e$	11.57790	$3s^23p(^2P^o)10p$	$^3D^e$	1.83385
$3s^23p(^2P^o)4f$	$l\ ^3D^e$	10.79310	$3s3p^2(^2S^e)6d$	$^3D^e$	1.78658
$3s^23d(^2D^e)4s$	$m\ ^3D^e$	9.84355	$3s^23p(^2P^o)10f$	$^3D^e$	1.70817
$3s3p^2(^4P^e)4d$	$n\ ^3D^e$	9.48529	$3s3p^3$	$z\ ^3D^o$	23.90564
$3s3p^2(^2D^e)4d$	$o\ ^3D^e$	9.09897	$3s^23p(^2P^o)3d$	$y\ ^3D^o$	21.90079
$3s3p^2(^2S^e)4d$	$p\ ^3D^e$	8.40825	$3s3p3d^2$	$x\ ^3D^o$	17.61890
$3p^3(^2D^o)4p$	$q\ ^3D^e$	8.20682	$3p^3(^2D^o)3d$	$w\ ^3D^o$	16.81620
$3s3p^2(^2P^e)4d$	$r\ ^3D^e$	8.10692	$3p^3(^4S^o)3d$	$v\ ^3D^o$	16.13850
$3s^23p(^2P^o)5p$	$s\ ^3D^e$	7.96023	$3p^3(^2P^o)3d$	$u\ ^3D^o$	15.91050
$3p^3(^2P^o)4p$	$t\ ^3D^e$	7.50718	$3s3p3d^2$	$t\ ^3D^o$	15.17420
$3s^23d(^2D^e)4d$	$u\ ^3D^e$	7.42121	$3s3p3d^2$	$s\ ^3D^o$	14.95520
$3s3p3d(^4F^o)4p$	$v\ ^3D^e$	7.23814	$3s3p3d^2$	$r\ ^3D^o$	14.34170

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s3p3d^2$	$q\ ^3D^o$	14.14670	$3s^23p(^2P^o)10d$	$^3D^o$	1.74917
$3s^23p(^2P^o)4d$	$p\ ^3D^o$	11.90721	$3s3p^2(^4P^e)7p$	$^3D^o$	1.72344
$3s3p^2(^4P^e)4p$	$o\ ^3D^o$	11.05500	$3p^3(^2P^o)5d$	$^3D^o$	1.69191
$3s3p^2(^2D^e)4p$	$n\ ^3D^o$	10.37970	$3s3p^2(^4P^e)3d$	$a\ ^5D^e$	20.72660
$3s3p^2(^2P^e)4p$	$m\ ^3D^o$	9.68365	$3p^23d^2$	$b\ ^5D^e$	13.75500
$3p^3(^2D^o)4s$	$l\ ^3D^o$	9.13775	$3p^23d^2$	$c\ ^5D^e$	13.25220
$3s^23d(^2D^e)4p$	$k\ ^3D^o$	8.87769	$3s3p^2(^4P^e)4d$	$d\ ^5D^e$	9.54655
$3s3p^2(^4P^e)4f$	$j\ ^3D^o$	8.71376	$3s3p3d(^4F^o)4p$	$e\ ^5D^e$	7.31467
$3s3p^2(^2D^e)4f$	$i\ ^3D^o$	8.04520	$3s3p3d(^4P^o)4p$	$f\ ^5D^e$	7.11014
$3s3p3d(^4D^o)4s$	$h\ ^3D^o$	7.78243	$3s3p3d(^4D^o)4p$	$g\ ^5D^e$	6.88149
$3s3p3d(^2D^o)4s$	$g\ ^3D^o$	7.71645	$3s3p^2(^4P^e)5d$	$h\ ^5D^e$	5.19060
$3s^23p(^2P^o)5d$	$f\ ^3D^o$	7.36864	$3s3p3d(^4F^o)4f$	$i\ ^5D^e$	5.12546
$3s3p^2(^2P^e)4f$	$e\ ^3D^o$	7.22400	$3s3p3d(^4P^o)4f$	$j\ ^5D^e$	4.86740
$3p^3(^2D^o)4d$	$d\ ^3D^o$	6.78897	$3s3p3d(^4D^o)4f$	$k\ ^5D^e$	4.66707
$3p^3(^4S^o)4d$	$c\ ^3D^o$	6.37441	$3s3p^2(^4P^e)6d$	$l\ ^5D^e$	2.87797
$3s^23d(^2D^e)4f$	$b\ ^3D^o$	6.34851	$3s3p3d(^4F^o)5p$	$m\ ^5D^e$	2.30223
$3p^3(^2P^o)4d$	$a\ ^3D^o$	6.15146	$3s3p3d(^4P^o)5p$	$n\ ^5D^e$	1.91996
$3s3p3d(^4F^o)4d$	$^3D^o$	6.03381	$3s3p3d(^4D^o)5p$	$o\ ^5D^e$	1.85577
$3s3p^2(^4P^e)5p$	$^3D^o$	5.84479	$3s3p^2(^4P^e)7d$	$p\ ^5D^e$	1.51643
$3s3p3d(^4P^o)4d$	$^3D^o$	5.70862	$3s3p3d(^4F^o)5f$	$q\ ^5D^e$	1.25173
$3s3p3d(^4D^o)4d$	$^3D^o$	5.48396	$3s3p3d(^4P^o)5f$	$r\ ^5D^e$	0.87475
$3s3p3d(^2D^o)4d$	$^3D^o$	5.36004	$3s3p3d(^4D^o)5f$	$s\ ^5D^e$	0.79698
$3s3p^2(^2D^e)5p$	$^3D^o$	5.22939	$3s3p^2(^4P^e)8d$	$t\ ^5D^e$	0.64408
$3s^23p(^2P^o)6d$	$^3D^o$	5.04658	$3p3d^24p$	$u\ ^5D^e$	0.56220
$3s3p3d(^2F^o)4d$	$^3D^o$	4.93682	$3s3p^2(^4P^e)9d$	$v\ ^5D^e$	0.04967
$3s3p^2(^4P^e)5f$	$^3D^o$	4.79026	$3p^3(^4S^o)3d$	$z\ ^5D^o$	17.54770
$3s3p^2(^2P^e)5p$	$^3D^o$	4.42021	$3s3p3d^2$	$y\ ^5D^o$	16.45810
$3s3p^2(^2D^e)5f$	$^3D^o$	4.15232	$3s3p3d^2$	$x\ ^5D^o$	16.09170
$3s^23d(^2D^e)5p$	$^3D^o$	3.70290	$3s3p^2(^4P^e)4p$	$w\ ^5D^o$	11.27290
$3s^23p(^2P^o)7d$	$^3D^o$	3.63105	$3s3p^2(^4P^e)4f$	$v\ ^5D^o$	8.80722
$3p^3(^2D^o)5s$	$^3D^o$	3.53902	$3s3p3d(^4D^o)4s$	$u\ ^5D^o$	8.04349
$3p3d^24s$	$^3D^o$	3.33873	$3p^3(^4S^o)4d$	$t\ ^5D^o$	6.39515
$3s3p^2(^2P^e)5f$	$^3D^o$	3.32588	$3s3p3d(^4F^o)4d$	$s\ ^5D^o$	6.09623
$3s3p^2(^4P^e)6p$	$^3D^o$	3.24138	$3s3p^2(^4P^e)5p$	$r\ ^5D^o$	5.91927
$3p3d^24s$	$^3D^o$	3.08515	$3s3p3d(^4P^o)4d$	$q\ ^5D^o$	5.58853
$3p3d^24s$	$^3D^o$	2.88337	$3s3p3d(^4D^o)4d$	$p\ ^5D^o$	5.50054
$3s^23p(^2P^o)8d$	$^3D^o$	2.78196	$3s3p^2(^4P^e)5f$	$o\ ^5D^o$	4.82998
$3p3d^24s$	$^3D^o$	2.68709	$3s3p^2(^4P^e)6p$	$n\ ^5D^o$	3.28185
$3s3p^2(^4P^e)6f$	$^3D^o$	2.66256	$3p3d^24s$	$m\ ^5D^o$	3.03839
$3s3p^2(^2D^e)6p$	$^3D^o$	2.65033	$3p3d^24s$	$l\ ^5D^o$	2.87658
$3s^23d(^2D^e)5f$	$^3D^o$	2.53745	$3s3p^2(^4P^e)6f$	$k\ ^5D^o$	2.68207
$3s3p3d(^4D^o)5s$	$^3D^o$	2.41181	$3s3p3d(^4D^o)5s$	$j\ ^5D^o$	2.39459
$3p^3(^2D^o)5d$	$^3D^o$	2.37271	$3s3d^24p$	$i\ ^5D^o$	2.28561
$3p3d^24s$	$^3D^o$	2.29661	$3p^3(^4S^o)5d$	$h\ ^5D^o$	1.95853
$3s3d^24p$	$^3D^o$	2.22814	$3s3p^2(^4P^e)7p$	$g\ ^5D^o$	1.76465
$3s^23p(^2P^o)9d$	$^3D^o$	2.18178	$3s3p3d(^4F^o)5d$	$f\ ^5D^o$	1.72715
$3s3d^24p$	$^3D^o$	2.15447	$3s3d^24p$	$e\ ^5D^o$	1.59234
$3s3p3d(^2D^o)5s$	$^3D^o$	2.11224	$3s3p^2(^4P^e)7f$	$d\ ^5D^o$	1.39517
$3s3p^2(^2D^e)6f$	$^3D^o$	2.03573	$3d^24s4p$	$c\ ^5D^o$	1.38366
$3s3d^24p$	$^3D^o$	1.93371	$3s3p3d(^4P^o)5d$	$b\ ^5D^o$	1.20490
$3p^3(^4S^o)5d$	$^3D^o$	1.90221	$3s3p3d(^4D^o)5d$	$a\ ^5D^o$	1.13600
$3p^3(^2D^o)5g$	$^3D^o$	1.85486	$3s3p3d(^4F^o)5g$	$^5D^o$	1.10603
$3s3p^2(^2P^e)6p$	$^3D^o$	1.80395	$3s3p^2(^4P^e)8p$	$^5D^o$	0.80195
$3s3p3d(^4F^o)5d$	$^3D^o$	1.76360	$3s3p3d(^4D^o)5g$	$^5D^o$	0.66144

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		E(Ry)	Term		E(Ry)
$3s3p^2(^4P^e)8f$	$^5D^o$	0.56321	$3s3p3d(^2D^o)4d$	$h\ ^1F^o$	5.38928
$3s3p^2(^4P^e)9p$	$^5D^o$	0.16217	$3s3p^2(^2D^e)5p$	$g\ ^1F^o$	5.18034
$3s3p^2(^4P^e)3d$	$a\ ^1F^e$	19.65860	$3s3p3d(^2F^o)4d$	$f\ ^1F^o$	5.05736
$3s3p^2(^2P^e)3d$	$b\ ^1F^e$	18.11920	$3s^23p(^2P^o)6d$	$e\ ^1F^o$	4.99414
$3p^23d^2$	$c\ ^1F^e$	12.84000	$3s^23p(^2P^o)6g$	$d\ ^1F^o$	4.68009
$3p^23d^2$	$d\ ^1F^e$	12.38930	$3s3p^2(^2D^e)5f$	$c\ ^1F^o$	4.16298
$3p^23d^2$	$e\ ^1F^e$	11.43910	$3s^23p(^2P^o)7d$	$b\ ^1F^o$	3.69385
$3s^23p(^2P^o)4f$	$f\ ^1F^e$	10.97690	$3s3p^2(^2S^e)5f$	$a\ ^1F^o$	3.56501
$3s3p^2(^4P^e)4d$	$g\ ^1F^e$	9.14639	$3s^23d(^2D^e)5p$	$^1F^o$	3.54845
$3p^3(^2D^o)4p$	$h\ ^1F^e$	8.22428	$3s^23p(^2P^o)7g$	$^1F^o$	3.44606
$3s3p^2(^2P^e)4d$	$i\ ^1F^e$	7.94341	$3p3d^24s$	$^1F^o$	3.27131
$3s^23d(^2D^e)4d$	$j\ ^1F^e$	7.56019	$3s3p^2(^2P^e)5f$	$^1F^o$	3.20068
$3s^23p(^2P^o)5f$	$k\ ^1F^e$	6.97708	$3s^23p(^2P^o)8d$	$^1F^o$	2.76996
$3s3p3d(^2D^o)4p$	$l\ ^1F^e$	6.72357	$3s3p^2(^2D^e)6p$	$^1F^o$	2.67052
$3s3p3d(^2F^o)4p$	$m\ ^1F^e$	6.42546	$3p3d^24s$	$^1F^o$	2.64539
$3p^3(^2D^o)4f$	$n\ ^1F^e$	5.72414	$3s^23p(^2P^o)8g$	$^1F^o$	2.64003
$3p^3(^2P^o)4f$	$o\ ^1F^e$	5.24671	$3s^23d(^2D^e)5f$	$^1F^o$	2.52205
$3s^23p(^2P^o)6f$	$p\ ^1F^e$	4.81725	$3p3d^24s$	$^1F^o$	2.31610
$3s3p^2(^2D^e)5d$	$q\ ^1F^e$	4.64923	$3p^3(^2D^o)5d$	$^1F^o$	2.29670
$3s3d^24s$	$r\ ^1F^e$	4.40081	$3s^23p(^2P^o)9d$	$^1F^o$	2.17581
$3s3p3d(^2D^o)4f$	$s\ ^1F^e$	4.37566	$3s^23p(^2P^o)9g$	$^1F^o$	2.08243
$3s3p3d(^2F^o)4f$	$t\ ^1F^e$	4.10868	$3s3p^2(^2D^e)6f$	$^1F^o$	2.03714
$3p3d^24p$	$u\ ^1F^e$	4.03506	$3s3p^2(^2D^e)6h$	$^1F^o$	1.95276
$3s3p^2(^2D^e)5g$	$v\ ^1F^e$	3.92337	$3s3p3d(^2F^o)5s$	$^1F^o$	1.91807
$3s3p^2(^2P^e)5d$	$w\ ^1F^e$	3.54548	$3p^3(^2D^o)5g$	$^1F^o$	1.84873
$3s^23p(^2P^o)7f$	$x\ ^1F^e$	3.50448	$3p^3(^2P^o)5d$	$^1F^o$	1.81718
$3s3p^2(^2P^e)5g$	$y\ ^1F^e$	3.19556	$3s^23p(^2P^o)10d$	$^1F^o$	1.75071
$3p^3(^2D^o)5p$	$z\ ^1F^e$	3.06425	$3s3p^2(^4P^e)3d$	$a\ ^3F^e$	20.49370
$3s^23d(^2D^e)5d$	$^1F^e$	3.03121	$3s3p^2(^2D^e)3d$	$b\ ^3F^e$	19.45930
$3s^23p(^2P^o)8f$	$^1F^e$	2.69068	$3s3p^2(^2P^e)3d$	$c\ ^3F^e$	19.03570
$3s^23d(^2D^e)5g$	$^1F^e$	2.45098	$3s^23d^2$	$d\ ^3F^e$	17.81980
$3s3p^2(^2D^e)6d$	$^1F^e$	2.30302	$3p^23d^2$	$e\ ^3F^e$	13.68870
$3s^23p(^2P^o)9f$	$^1F^e$	2.12184	$3p^23d^2$	$f\ ^3F^e$	13.40800
$3s3p^2(^2D^e)6g$	$^1F^e$	1.97372	$3p^23d^2$	$g\ ^3F^e$	12.84200
$3p^3(^2D^o)5f$	$^1F^e$	1.88994	$3p^23d^2$	$h\ ^3F^e$	12.41720
$3s^23p(^2P^o)10f$	$^1F^e$	1.71598	$3p^23d^2$	$i\ ^3F^e$	12.22430
$3s^23p(^2P^o)3d$	$z\ ^1F^o$	21.46152	$3p^23d^2$	$j\ ^3F^e$	11.62970
$3p^3(^2D^o)3d$	$y\ ^1F^o$	16.34310	$3s^23p(^2P^o)4f$	$k\ ^3F^e$	10.66829
$3p^3(^2P^o)3d$	$x\ ^1F^o$	16.22130	$3s3p^2(^4P^e)4d$	$l\ ^3F^e$	9.62352
$3s3p3d^2$	$w\ ^1F^o$	15.31410	$3s3p^2(^2D^e)4d$	$m\ ^3F^e$	9.09772
$3s3p3d^2$	$v\ ^1F^o$	14.13020	$3s3p^2(^2P^e)4d$	$n\ ^3F^e$	8.29615
$3s3p3d^2$	$u\ ^1F^o$	13.77260	$3p^3(^2D^o)4p$	$o\ ^3F^e$	7.97935
$3s^23p(^2P^o)4d$	$t\ ^1F^1$	11.67652	$3s3p3d(^4F^o)4p$	$p\ ^3F^e$	7.48616
$3s3p^2(^2D^e)4p$	$s\ ^1F^o$	10.48330	$3s^23d(^2D^e)4d$	$q\ ^3F^e$	7.38146
$3s^23d(^2D^e)4p$	$r\ ^1F^o$	8.72465	$3s^23p(^2P^o)5f$	$r\ ^3F^e$	6.95822
$3s3p^2(^2D^e)4f$	$q\ ^1F^o$	8.07117	$3s3p3d(^4D^o)4p$	$s\ ^3F^e$	6.76607
$3s3p3d(^2F^o)4s$	$p\ ^1F^o$	7.43020	$3s3p3d(^2D^o)4p$	$t\ ^3F^e$	6.67936
$3s^23p(^2P^o)5d$	$o\ ^1F^o$	7.33385	$3s3p3d(^2F^o)4p$	$u\ ^3F^e$	6.36615
$3s3p^2(^2S^e)4f$	$n\ ^1F^o$	7.29288	$3p^3(^2D^o)4f$	$v\ ^3F^e$	5.95086
$3s3p^2(^2P^e)4f$	$m\ ^1F^o$	7.05261	$3p^3(^4S^o)4f$	$w\ ^3F^e$	5.40230
$3p^3(^2D^o)4d$	$l\ ^1F^o$	6.73390	$3p^3(^2P^o)4f$	$x\ ^3F^e$	5.24573
$3s^23p(^2P^o)5g$	$k\ ^1F^o$	6.65311	$3s3p^2(^4P^e)5d$	$y\ ^3F^e$	5.18848
$3s^23d(^2D^e)4f$	$j\ ^1F^o$	6.31803	$3s3p3d(^4F^o)4f$	$z\ ^3F^e$	5.10814
$3p^3(^2P^o)4d$	$i\ ^1F^o$	6.09574	$3s^23p(^2P^o)6f$	$^3F^e$	4.80669

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s3p3d(^4P^o)4f$	$^3F^e$	4.78834	$3s3p^2(^4P^e)5f$	$^3F^o$	4.65925
$3s3p^2(^2D^e)5d$	$^3F^e$	4.67276	$3s3p^2(^2D^e)5f$	$^3F^o$	4.21575
$3s3p3d(^4D^o)4f$	$^3F^e$	4.60032	$3s^23d(^2D^e)5p$	$^3F^o$	3.68188
$3s3p^2(^4P^e)5g$	$^3F^e$	4.52284	$3s^23p(^2P^o)7d$	$^3F^o$	3.64602
$3s3p3d(^2D^o)4f$	$^3F^e$	4.41192	$3s3p^2(^2S^e)5f$	$^3F^o$	3.59999
$3s3p3d(^2F^o)4f$	$^3F^e$	4.35532	$3s^23p(^2P^o)7g$	$^3F^o$	3.45864
$3s3d^24s$	$^3F^e$	4.20702	$3p3d^24s$	$^3F^o$	3.34457
$3s3d^24s$	$^3F^e$	4.13834	$3s3p^2(^2P^e)5f$	$^3F^o$	3.29370
$3s3p^2(^2D^e)5g$	$^3F^e$	3.95527	$3s3p3d(^4F^o)5s$	$^3F^o$	2.87940
$3s3p^2(^2P^e)5d$	$^3F^e$	3.71707	$3p3d^24s$	$^3F^o$	2.80081
$3s^23p(^2P^o)7f$	$^3F^e$	3.51678	$3s^23p(^2P^o)8d$	$^3F^o$	2.77504
$3s3p^2(^2P^e)5g$	$^3F^e$	3.19863	$3p3d^24s$	$^3F^o$	2.70309
$3p^3(^2D^o)5p$	$^3F^e$	3.06681	$3s^23p(^2P^o)8g$	$^3F^o$	2.65551
$3s^23d(^2D^e)5d$	$^3F^e$	2.96701	$3s3p^2(^2D^e)6p$	$^3F^o$	2.62412
$3s3p^2(^4P^e)6d$	$^3F^e$	2.89190	$3s^23d(^2D^e)6f$	$^3F^o$	2.61639
$3s^23p(^2P^o)8f$	$^3F^e$	2.68678	$3s3p^2(^4P^e)6f$	$^3F^o$	2.59553
$3s3p^2(^4P^e)6g$	$^3F^e$	2.58813	$3p^3(^2D^o)5d$	$^3F^o$	2.40565
$3s^23d(^2D^e)5g$	$^3F^e$	2.44619	$3p3d^24s$	$^3F^o$	2.35271
$3s3p3d(^4F^o)5p$	$^3F^e$	2.39463	$3s3d^24p3p3$	$^3F^o$	2.30647
$3s3p^2(^2D^e)6d$	$^3F^e$	2.29745	$3s^23p(^2P^o)9d$	$^3F^o$	2.17767
$3s^23p(^2P^o)9f$	$^3F^e$	2.11925	$3s^23p(^2P^o)9g$	$^3F^o$	2.08767
$3p^3(^2D^o)5f$	$^3F^e$	2.01162	$3s3p^2(^2D^e)6f$	$^3F^o$	2.06810
$3s3p^2(^2D^e)6g$	$^3F^e$	1.95718	$3p^3(^2P^o)5d$	$^3F^o$	2.05439
$3s3p3d(^4D^o)5p$	$^3F^e$	1.82815	$3s3p3d(^2F^o)5s$	$^3F^o$	2.02846
$3s^23p(^2P^o)10f$	$^3F^e$	1.71368	$3s3p^2(^2D^e)6h$	$^3F^o$	1.95243
$3s^23p(^2P^o)3d$	$z\ ^3F^o$	22.56580	$3s3d^24p$	$^3F^o$	1.89710
$3p^3(^2D^o)3d$	$y\ ^3F^o$	17.65550	$3p^3(^2D^o)5g$	$^3F^o$	1.85249
$3p^3(^2P^o)3d$	$x\ ^3F^o$	16.71850	$3s^23p(^2P^o)10d$	$^3F^o$	1.75752
$3s3p3d^2$	$w\ ^3F^o$	16.08660	$3s^23p(^2P^o)10g$	$^3F^o$	1.69336
$3s3p3d^2$	$v\ ^3F^o$	15.39550	$3s3p^2(^4P^e)3d$	$a\ ^5F^e$	20.86860
$3s3p3d^2$	$u\ ^3F^o$	15.06640	$3p^23d^2$	$b\ ^5F^e$	13.77510
$3s3p3d^2$	$t\ ^3F^o$	14.57740	$3s3p^2(^4P^e)4d$	$c\ ^5F^e$	9.66792
$3s^23p(^2P^o)4d$	$s\ ^3F^{o*}$	11.77721	$3s3p3d(^4F^o)4p$	$d\ ^5F^e$	7.44495
$3s3p^2(^2D^e)4p$	$r\ ^3F^o$	10.57410	$3s3p3d(^4D^o)4p$	$e\ ^5F^e$	6.94902
$3s3p^2(^4P^e)4f$	$q\ ^3F^o$	8.86677	$3p^3(^4S^o)4f$	$f\ ^5F^e$	5.61422
$3s^23d(^2D^e)4p$	$p\ ^3F^o$	8.42911	$3s3p3d(^4F^o)4f$	$g\ ^5F^e$	5.29792
$3s3p3d(^4F^o)4s$	$o\ ^3F^o$	8.21781	$3s3p^2(^4P^e)5d$	$h\ ^5F^e$	5.22041
$3s3p^2(^2D^e)4f$	$n\ ^3F^o$	8.19751	$3s3p3d(^4P^o)4f$	$i\ ^5F^e$	4.84926
$3s3p^2(^2S^e)4f$	$m\ ^3F^o$	7.52718	$3s3p3d(^4D^o)4f$	$j\ ^5F^e$	4.71487
$3s3p3d(^2F^o)4s$	$l\ ^3F^o$	7.42196	$3s3p^2(^4P^e)5g$	$k\ ^5F^e$	4.54236
$3s^23p(^2P^o)5d$	$k\ ^3F^o$	7.36212	$3s3p^2(^4P^e)6d$	$l\ ^5F^e$	2.90611
$3s3p^2(^2P^e)4f$	$j\ ^3F^o$	7.21785	$3s3p^2(^4P^e)6g$	$m\ ^5F^e$	2.59601
$3p^3(^2D^o)4d$	$i\ ^3F^o$	6.80941	$3s3p3d(^4F^o)5p$	$n\ ^5F^e$	2.37188
$3s^23p(^2P^o)5g$	$h\ ^3F^o$	6.71994	$3s3p3d(^4D^o)5p$	$o\ ^5F^e$	1.87854
$3s^23d(^2D^e)4f$	$g\ ^3F^o$	6.55566	$3p^3(^4S^o)5f$	$p\ ^5F^e$	1.62437
$3p^3(^2P^o)4d$	$f\ ^3F^o$	6.13286	$3s3p^2(^4P^e)7d$	$q\ ^5F^e$	1.52349
$3s3p3d(^4F^o)4d$	$e\ ^3F^o$	6.10406	$3s3p^2(^4P^e)7g$	$r\ ^5F^e$	1.33692
$3s3p3d(^4P^o)4d$	$d\ ^3F^o$	5.60905	$3s3p3d(^4F^o)5f$	$s\ ^5F^e$	1.30899
$3s3p3d(^4D^o)4d$	$c\ ^3F^o$	5.43327	$3s3p3d(^4P^o)5f$	$t\ ^5F^e$	0.86765
$3s3p3d(^2D^o)4d$	$b\ ^3F^o$	5.36782	$3s3p3d(^4D^o)5f$	$u\ ^5F^e$	0.78293
$3s3p^2(^2D^e)5p$	$a\ ^3F^o$	5.23830	$3p3d^24p$	$v\ ^5F^e$	0.74646
$3s3p3d(^2F^o)4d$	$^3F^o$	5.08009	$3s3p^2(^4P^e)8d$	$w\ ^5F^e$	0.64571
$3s^23p(^2P^o)6d$	$^3F^o$	4.99297	$3s3p^2(^4P^e)8g$	$x\ ^5F^e$	0.52287
$3s^23p(^2P^o)6g$	$^3F^o$	4.69622	$3s3p^2(^4P^e)9d$	$y\ ^5F^e$	0.05720

TABLE I. Bound States of Fe XIII
See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s3p3d^2$	$z\ ^5F^o$	16.39390	$3s^23p(^2P^o)10h$	$I\ ^1G^e$	1.69038
$3s3p^2(^4P^e)4f$	$y\ ^5F^o$	8.74722	$3p^3(^2D^o)3d$	$z\ ^1G^o$	17.07500
$3s3p3d(^4F^o)4s$	$x\ ^5F^o$	8.51606	$3s3p3d^2$	$y\ ^1G^o$	15.26960
$3s3p3d(^4F^o)4d$	$w\ ^5F^o$	6.22411	$3s3p3d^2$	$x\ ^1G^o$	14.04160
$3s3p3d(^4P^o)4d$	$v\ ^5F^o$	5.71943	$3s3p^2(^2D^e)4f$	$w\ ^1G^o$	8.16237
$3s3p3d(^4D^o)4d$	$u\ ^5F^o$	5.56736	$3s3p^2(^2P^e)4f$	$v\ ^1G^o$	7.30298
$3s3p^2(^4P^e)5f$	$t\ ^5F^o$	4.79981	$3p^3(^2D^o)4d$	$u\ ^1G^o$	6.81251
$3p3d^24s$	$s\ ^5F^o$	3.25576	$3s^23p(^2P^o)5g$	$t\ ^1G^o$	6.76071
$3s3d^24p$	$r\ ^5F^o$	3.07932	$3s^23d(^2D^e)4f$	$s\ ^1G^o$	6.60602
$3s3p3d(^4F^o)5s$	$q\ ^5F^o$	2.77126	$3s3p3d(^2D^o)4d$	$r\ ^1G^o$	5.39592
$3s3p^2(^4P^e)6f$	$p\ ^5F^o$	2.66604	$3s3p3d(^2F^o)4d$	$q\ ^1G^o$	5.03421
$3s3p3d(^4F^o)5d$	$o\ ^5F^o$	1.83091	$3s^23p(^2P^o)6g$	$p\ ^1G^o$	4.72349
$3d^24s4p$	$n\ ^5F^o$	1.58764	$3s3p^2(^2D^e)5f$	$o\ ^1G^o$	4.19515
$3s3p^2(^4P^e)7f$	$m\ ^5F^o$	1.38624	$3s^23p(^2P^o)7g$	$n\ ^1G^o$	3.49711
$3s3p3d(^4P^o)5d$	$l\ ^5F^o$	1.25320	$3s3p^2(^2P^e)5f$	$m\ ^1G^o$	3.28148
$3s3p3d(^4D^o)5d$	$k\ ^5F^o$	1.19476	$3p3d^24s$	$l\ ^1G^o$	3.14076
$3s3p3d(^4F^o)5g$	$j\ ^5F^o$	1.14171	$3s^23d(^2D^e)5f$	$k\ ^1G^o$	2.67473
$3s3p3d(^4P^o)5g$	$i\ ^5F^o$	0.71201	$3s3d^24p$	$j\ ^1G^o$	2.66467
$3s3p3d(^4D^o)5g$	$h\ ^5F^o$	0.63022	$3s^23p(^2P^o)8g$	$i\ ^1G^o$	2.62977
$3s3p^2(^4P^e)8f$	$g\ ^5F^o$	0.55688	$3p^3(^2D^o)5d$	$h\ ^1G^o$	2.25697
$3s3p^2(^2D^e)3d$	$a\ ^1G^e$	19.68440	$3s^23p(^2P^o)9g$	$g\ ^1G^o$	2.09523
$3s^23d^2$	$b\ ^1G^e$	17.52760	$3s3p^2(^2D^e)6f$	$f\ ^1G^o$	2.05146
$3p^23d^2$	$c\ ^1G^e$	13.59030	$3s3p^2(^2D^e)6h$	$e\ ^1G^o$	1.97666
$3p^23d^2$	$d\ ^1G^e$	12.76820	$3p^3(^2D^o)5g$	$d\ ^1G^o$	1.83164
$3p^23d^2$	$e\ ^1G^e$	11.94650	$3s^23p(^2P^o)10g$	$c\ ^1G^o$	1.69807
$3p^23d^2$	$f\ ^1G^e$	11.26780	$3s3p^2(^2D^e)3d$	$a\ ^3G^e$	19.83320
$3s^23p(^2p^o)4f$	$g\ ^1G^e$	10.64852	$3p^23d^2$	$b\ ^3G^e$	13.47890
$3s3p^2(^2D^e)4d$	$h\ ^1G^e$	8.90584	$3p^23d^2$	$c\ ^3G^e$	12.66430
$3s3d^24s$	$i\ ^1G^e$	7.23462	$3p^23d^2$	$d\ ^3G^e$	12.45730
$3s^23p(^2P^o)5f$	$j\ ^1G^e$	6.83898	$3s^23p(^2P^o)4f$	$e\ ^3G^e$	10.91020
$3s3p3d(^2F^o)4p$	$k\ ^1G^e$	6.04576	$3s3p^2(^2D^e)4d$	$f\ ^3G^e$	8.99603
$3p^3(^2D^o)4f$	$l\ ^1G^e$	5.72207	$3s^23d(^2D^e)4d$	$g\ ^3G^e$	7.50435
$3s^23d(^2D^e)4d$	$m\ ^1G^e$	5.15630	$3s3p3d(^4F^o)4p$	$h\ ^3G^e$	7.12864
$3s^23p(^2P^o)6f$	$n\ ^1G^e$	4.74972	$3s^23p(^2P^o)5f$	$i\ ^3G^e$	6.93770
$3s^23p(^2P^o)6h$	$o\ ^1G^e$	4.69656	$3s3p3d(^2F^o)4p$	$j\ ^3G^e$	6.48123
$3s3p^2(^2D^e)5d$	$p\ ^1G^e$	4.62351	$3p^3(^2D^o)4f$	$k\ ^3G^e$	5.99790
$3p^3(^2P^o)4f$	$q\ ^1G^e$	4.39107	$3p^3(^2P^o)4f$	$l\ ^3G^e$	5.29692
$3s3p3d(^2D^o)4f$	$r\ ^1G^e$	4.25690	$3s3p3d(^4F^o)4f$	$m\ ^3G^e$	5.21179
$3s3p3d(^2F^o)4f$	$s\ ^1G^e$	4.18962	$3s^23p(^2P^o)6f$	$n\ ^3G^e$	4.80442
$3s3p^2(^2D^e)5g$	$t\ ^1G^e$	3.93569	$3s3p3d(^4P^o)4f$	$o\ ^3G^e$	4.74469
$3s^23p(^2P^o)7h$	$u\ ^1G^e$	3.48865	$3s^23p(^2P^o)6h$	$p\ ^3G^e$	4.69718
$3s^23p(^2P^o)7f$	$v\ ^1G^e$	3.48384	$3s3p3d(^4D^o)4f$	$q\ ^3G^e$	4.67920
$3s3p^2(^2S^e)5g$	$w\ ^1G^e$	3.40954	$3s3p^2(^2D^e)5d$	$r\ ^3G^e$	4.59952
$3s3p^2(^2P^e)5g$	$x\ ^1G^e$	3.12347	$3s3p3d(^2D^o)4f$	$s\ ^3G^e$	4.47174
$3s^23d(^2D^e)5d$	$y\ ^1G^e$	2.89080	$3s3d^24s$	$t\ ^3G^e$	4.34432
$3s^23p(^2P^o)8f$	$z\ ^1G^e$	2.66599	$3s3p^2(^4P^e)5g$	$u\ ^3G^e$	4.27336
$3s^23p(^2P^o)8h$	$^1G^e$	2.63697	$3s3p3d(^2F^o)4f$	$v\ ^3G^e$	4.20779
$3s^23d(^2D^e)5g$	$^1G^e$	2.45294	$3s3p^2(^2D^e)5g$	$w\ ^3G^e$	3.98997
$3s3p^2(^2D^e)6d$	$^1G^e$	2.25806	$3s^23p(^2P^o)7f$	$x\ ^3G^e$	3.51604
$3s^23p(^2P^o)9f$	$^1G^e$	2.10519	$3s^23p(^2P^o)7h$	$y\ ^3G^e$	3.49377
$3s^23p(^2P^o)9h$	$^1G^e$	2.08402	$3s3p^2(^2S^e)5g$	$z\ ^3G^e$	3.41471
$3s3p^2(^2D^e)6g$	$^1G^e$	1.99869	$3s3p^2(^2P^e)5g$	$^3G^e$	3.13319
$3p^3(^2D^o)5f$	$^1G^e$	1.88894	$3s^23d(^2D^e)5d$	$^3G^e$	3.00098
$3s^23p(^2P^o)10f$	$^1G^e$	1.70366	$3s^23p(^2P^o)8f$	$^3G^e$	2.68572

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s^23p(^2P^o)8h$	$^3G^e$	2.63723	$3s3p^2(^4P^e)7g$	$j\ ^5G^e$	1.32628
$3s3p^2(^4P^e)6g$	$^3G^e$	2.54401	$3s3p3d(^4P^o)5f$	$k\ ^5G^e$	0.89532
$3s^23d(^2D^e)5g$	$^3G^e$	2.46713	$3s3p3d(^4D^o)5f$	$l\ ^5G^e$	0.82960
$3s3p^2(^2D^e)6d$	$^3G^e$	2.30203	$3s3p^2(^4P^e)8g$	$m\ ^5G^e$	0.51444
$3s3p3d(^4F^o)5p$	$^3G^e$	2.22865	$3s3p3d^2$	$z\ ^5G^o$	16.89900
$3s^23p(^2P^o)9f$	$^3G^e$	2.11821	$3s3p^2(^4P^e)4f$	$y\ ^5G^o$	8.87429
$3s^23p(^2P^o)9h$	$^3G^e$	2.08465	$3s3p3d(^4F^o)4d$	$x\ ^5G^o$	6.11853
$3p^3(^2D^o)5f$	$^3G^e$	2.03449	$3s3p3d(^4D^o)4d$	$w\ ^5G^o$	5.68388
$3s3p^2(^2D^e)6g$	$^3G^e$	1.97165	$3s3p^2(^4P^e)5f$	$v\ ^5G^o$	4.85622
$3s^23p(^2P^o)10f$	$^3G^e$	1.71310	$3p3d^24s$	$u\ ^5G^o$	3.25171
$3s^23p(^2P^o)10h$	$^3G^e$	1.69069	$3s3p^2(^4P^e)6f$	$t\ ^5G^o$	2.69517
$3p^3(^2D^o)3d$	$z\ ^3G^o$	17.39280	$3s3p^2(^4P^e)6h$	$s\ ^5G^o$	2.59150
$3s3p3d^2$	$y\ ^3G^o$	15.75620	$3s3d^24p$	$r\ ^5G^o$	1.75293
$3s3p3d^2$	$x\ ^3G^o$	15.54140	$3s3p3d(^4F^o)5d$	$q\ ^5G^o$	1.68045
$3s3p3d^2$	$w\ ^3G^o$	14.73050	$3p^3(^4S^o)5g$	$p\ ^5G^o$	1.46836
$3s3p^2(^4P^e)4f$	$v\ ^3G^o$	8.64909	$3s3p^2(^4P^e)7f$	$o\ ^5G^o$	1.40213
$3s3p^2(^2D^e)4f$	$u\ ^3G^o$	8.19833	$3s3p^2(^4P^e)7h$	$n\ ^5G^o$	1.30334
$3s3p^2(^2P^e)4f$	$t\ ^3G^o$	7.42746	$3s3p3d(^4D^o)5d$	$m\ ^5G^o$	1.21944
$3p^3(^2D^o)4d$	$s\ ^3G^o$	6.81757	$3s3p3d(^4F^o)5g$	$l\ ^5G^o$	1.16983
$3s^23p(^2P^o)5g$	$r\ ^3G^o$	6.82942	$3s3p3d(^4P^o)5g$	$k\ ^5G^o$	0.72527
$3s^23d(^2D^e)4f$	$q\ ^3G^o$	6.39959	$3s3p3d(^4D^o)5g$	$j\ ^5G^o$	0.65496
$3s3p3d(^4F^o)4d$	$p\ ^3G^o$	6.17846	$3s3p^2(^4P^e)8f$	$i\ ^5G^o$	0.56775
$3s3p3d(^4D^o)4d$	$o\ ^3G^o$	5.57773	$3s3p^2(^4P^e)8h$	$h\ ^5G^o$	0.51268
$3s3p3d(^2D^o)4d$	$n\ ^3G^o$	5.37055	$3p^23d^2$	$a\ ^1H^e$	12.84600
$3s3p3d(^2F^o)4d$	$m\ ^3G^o$	5.07115	$3p^3(^2D^o)4f$	$b\ ^1H^e$	5.94271
$3s3p^2(^4P^e)5f$	$l\ ^3G^o$	4.75893	$3s^23p(^2P^o)6h$	$c\ ^1H^e$	4.72086
$3s^23p(^2P^o)6g$	$k\ ^3G^o$	4.71440	$3s3p3d(^2D^o)4f$	$d\ ^1H^e$	4.60691
$3s3p^2(^2D^e)5f$	$j\ ^3G^o$	4.22335	$3s3p3d(^2F^o)4f$	$e\ ^1H^e$	4.06806
$3s^23p(^2P^o)7g$	$i\ ^3G^o$	3.49889	$3s3p^2(^2D^e)5g$	$f\ ^1H^e$	3.98884
$3s3p^2(^2P^e)5f$	$h\ ^3G^o$	3.34232	$3s^23p(^2P^o)7h$	$g\ ^1H^e$	3.48060
$3p3d^24s$	$g\ ^3G^o$	3.30557	$3s3p^2(^2P^e)5g$	$h\ ^1H^e$	3.17621
$3p3d^24s$	$f\ ^3G^o$	2.96634	$3s^23p(^2P^o)8h$	$i\ ^1H^e$	2.64822
$3s^23p(^2P^o)8g$	$e\ ^3G^o$	2.66422	$3s^23d(^2D^e)5g$	$j\ ^1H^e$	2.47389
$3s3p^2(^4P^e)6f$	$d\ ^3G^o$	2.64610	$3s^23p(^2P^o)9h$	$k\ ^1H^e$	2.09098
$3s3p^2(^4P^e)6h$	$c\ ^3G^o$	2.59132	$3p^3(^2D^o)5f$	$l\ ^1H^e$	2.04219
$3s^23d(^2D^e)5f$	$b\ ^3G^o$	2.55790	$3s3p^2(^2D^e)6g$	$m\ ^1H^e$	1.94256
$3p^3(^2D^o)5d$	$a\ ^3G^o$	2.53666	$3s^23p(^2P^o)10h$	$n\ ^1H^e$	1.69401
$3p3d^24s$	$^3G^o$	2.26268	$3s3p3d^2$	$z\ ^1H^o$	14.82730
$3s^23p(^2P^o)9g$	$^3G^o$	2.09518	$3s3p^2(^2D^e)4f$	$y\ ^1H^o$	7.98613
$3s3p^2(^2D^e)6f$	$^3G^o$	2.07027	$3s^23p(^2P^o)5g$	$x\ ^1H^o$	6.85377
$3s3p^2(^2D^e)6h$	$^3G^o$	1.97746	$3s^23d(^2D^e)4f$	$w\ ^1H^o$	6.12924
$3p^3(^2D^o)5g$	$^3G^o$	1.84765	$3s3p3d(^2F^o)4d$	$v\ ^1H^o$	4.96909
$3s3d^24p$	$^3G^o$	1.83444	$3s^23p(^2P^o)6g$	$u\ ^1H^o$	4.67814
$3s3p3d(^4F^o)5d$	$^3G^o$	1.78008	$3s3p^2(^2D^e)5f$	$t\ ^1H^o$	4.12563
$3s^23p(^2P^o)10g$	$^3G^o$	1.69699	$3s^23p(^2P^o)7g$	$s\ ^1H^o$	3.45268
$3p^23d^2$	$a\ ^5G^e$	14.13040	$3s^23p(^2P^o)7i$	$r\ ^1H^o$	3.44831
$3s3p3d(^4F^o)4p$	$b\ ^5G^e$	7.55521	$3s^23p(^2P^o)8g$	$q\ ^1H^o$	2.66510
$3s3p3d(^4F^o)4f$	$c\ ^5G^e$	5.33883	$3s^23p(^2P^o)8i$	$p\ ^1H^o$	2.64105
$3s3p3d(^4P^o)4f$	$d\ ^5G^e$	4.97816	$3s^23d(^2D^e)5f$	$o\ ^1H^o$	2.50417
$3s3p3d(^4D^o)4f$	$e\ ^5G^e$	4.79917	$3p3d^24s$	$n\ ^1H^o$	2.44288
$3s3p^2(^4P^e)5g$	$f\ ^5G^e$	4.53770	$3s^23p(^2P^o)9i$	$m\ ^1H^o$	2.08751
$3s3p^2(^4P^e)6g$	$g\ ^5G^e$	2.56580	$3s^23p(^2P^o)9g$	$l\ ^1H^o$	2.07891
$3s3p3d(^4F^o)5p$	$h\ ^5G^e$	2.36628	$3s3p^2(^2D^e)6f$	$k\ ^1H^o$	2.01933
$3s3p3d(^4F^o)5f$	$i\ ^5G^e$	1.33794	$3s3p^2(^2D^e)6h$	$j\ ^1H^o$	1.99377

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3p^3(^2D^o)5g$	$i\ ^1H^o$	1.83167	$3s3p^2(^4P^e)6h$	$y\ ^5H^o$	2.56361
$3s^23p(^2P^o)10i$	$h\ ^1H^o$	1.69126	$3s3p3d(^4F^o)5d$	$x\ ^5H^o$	1.71740
$3p^23d^2$	$a\ ^3H^e$	13.62250	$3s3p^2(^4P^e)7h$	$w\ ^5H^o$	1.32699
$3p^23d^2$	$b\ ^3H^e$	12.89100	$3s3p3d(^4F^o)5g$	$v\ ^5H^o$	1.18451
$3p^3(^2D^o)4f$	$c\ ^3H^e$	5.97902	$3s3p3d(^4P^o)5g$	$u\ ^5H^o$	0.71322
$3s3p3d(^4F^o)4f$	$d\ ^3H^e$	5.23226	$3s3p3d(^4D^o)5g$	$t\ ^5H^o$	0.66117
$3s3p3d(^4D^o)4f$	$e\ ^3H^e$	4.86606	$3s3p^2(^4P^e)8h$	$s\ ^5H^o$	0.49520
$3s^23p(^2P^o)6h$	$f\ ^3H^e$	4.72084	$3p^23d^2$	$a\ ^1I^e$	12.93450
$3s3p3d(^2D^o)4f$	$g\ ^3H^e$	4.60816	$3s^23p(^2P^o)6h$	$b\ ^1I^e$	4.70152
$3s3p^2(^4P^e)5g$	$h\ ^3H^e$	4.39426	$3s3p^2(^2D^e)5g$	$c\ ^1I^e$	4.11118
$3s3p3d(^2F^o)4f$	$i\ ^3H^e$	4.21676	$3s3p^2(^2D^e)6g$	$d\ ^1I^e$	3.90583
$3s3p^2(^2D^e)5g$	$j\ ^3H^e$	3.97312	$3s^23p(^2P^o)7h$	$e\ ^1I^e$	3.45007
$3s^23p(^2P^o)7h$	$k\ ^3H^e$	3.48022	$3s^23p(^2P^o)8h$	$f\ ^1I^e$	2.65351
$3s3p^2(^2P^e)5g$	$l\ ^3H^e$	3.17908	$3s^23p(^2P^o)8k$	$g\ ^1I^e$	2.64035
$3s^23p(^2P^o)8h$	$m\ ^3H^e$	2.64844	$3s^23d(^2D^e)5g$	$h\ ^1I^e$	2.39908
$3s3p^2(^4P^e)6g$	$n\ ^3H^e$	2.57711	$3s^23p(^2P^o)9k$	$i\ ^1I^e$	2.08623
$3s^23d(^2D^e)5g$	$o\ ^3H^e$	2.46675	$3s^23p(^2P^o)9h$	$j\ ^1I^e$	2.08176
$3s^23p(^2P^o)9h$	$p\ ^3H^e$	2.09068	$3s3p^2(^2D^e)7g$	$k\ ^1I^e$	1.95185
$3p^3(^2D^o)5f$	$q\ ^3H^e$	2.02947	$3s^23p(^2P^o)7i$	$z\ ^1I^o$	3.45551
$3s3p^2(^2D^e)6g$	$r\ ^3H^e$	1.97611	$3s^23p(^2P^o)8i$	$y\ ^1I^o$	2.64583
$3s^23p(^2P^o)10h$	$s\ ^3H^e$	1.69381	$3s^23p(^2P^o)9i$	$x\ ^1I^o$	2.09175
$3s3p3d^2$	$z\ ^3H^o$	15.91400	$3s3p^2(^2D^e)6h$	$w\ ^1I^o$	1.98721
$3s3p^2(^2D^e)4f$	$y\ ^3H^o$	8.13356	$3p^3(^2D^o)5g$	$v\ ^1I^o$	1.85550
$3s^23d(^2D^e)4f$	$x\ ^3H^o$	6.92029	$3s^23p(^2P^o)10i$	$u\ ^1I^o$	1.69273
$3s^23p(^2P^o)5g$	$w\ ^3H^o$	6.52399	$3s3p3d(^4F^o)4f$	$a\ ^3I^e$	4.92032
$3s3p3d(^4F^o)4d$	$v\ ^3H^o$	5.89446	$3s^23p(^2P^o)6h$	$b\ ^3I^e$	4.70214
$3s3p3d(^2F^o)4d$	$u\ ^3H^o$	5.04326	$3s3p3d(^2F^o)4f$	$c\ ^3I^e$	4.31338
$3s^23p(^2P^o)6g$	$t\ ^3H^o$	4.69858	$3s3p^2(^2D^e)5g$	$d\ ^3I^e$	3.94389
$3s3p^2(^2D^e)5f$	$s\ ^3H^o$	4.18792	$3s^23p(^2P^o)7h$	$e\ ^3I^e$	3.45130
$3s^23p(^2P^o)7g$	$r\ ^3H^o$	3.45858	$3s^23p(^2P^o)8h$	$f\ ^3I^e$	2.65546
$3s^23p(^2P^o)7i$	$q\ ^3H^o$	3.44836	$3s^23p(^2P^o)8k$	$g\ ^3I^e$	2.64035
$3p3d^24s$	$p\ ^3H^o$	2.74712	$3s^23d(^2D^e)5g$	$h\ ^3I^e$	2.42910
$3s^23p(^2P^o)8g$	$o\ ^3H^o$	2.69002	$3s^23p(^2P^o)9k$	$i\ ^3I^e$	2.08623
$3s^23p(^2P^o)8i$	$n\ ^3H^o$	2.64111	$3s^23p(^2P^o)9h$	$j\ ^3I^e$	2.08392
$3s^23d(^2D^e)5f$	$m\ ^3H^o$	2.60333	$3s3p^2(^2D^e)6g$	$k\ ^3I^e$	1.95844
$3s3p^2(^4P^e)6h$	$l\ ^3H^o$	2.56302	$3s^23p(^2P^o)7i$	$z\ ^3I^o$	3.45551
$3s^23p(^2P^o)9g$	$k\ ^3H^o$	2.09457	$3s^23p(^2P^o)8i$	$y\ ^3I^o$	2.64582
$3s^23p(^2P^o)9i$	$j\ ^3H^o$	2.08753	$3s3p^2(^4P^e)6h$	$x\ ^3I^o$	2.58408
$3s3p^2(^2D^e)6f$	$i\ ^3H^o$	2.05065	$3s^23p(^2P^o)9i$	$w\ ^3I^o$	2.09175
$3s3p^2(^2D^e)6h$	$h\ ^3H^o$	1.99502	$3s3p^2(^2D^e)6h$	$v\ ^3I^o$	1.98625
$3p^3(^2D^o)5g$	$g\ ^3H^o$	1.84701	$3p^3(^2D^o)5g$	$u\ ^3I^o$	1.85808
$3s^23p(^2P^o)10g$	$f\ ^3H^o$	1.69297	$3s^23p(^2P^o)10i$	$t\ ^3I^o$	1.69272
$3s^23p(^2P^o)10i$	$e\ ^3H^o$	1.69123	$3s3p3d(^4F^o)4f$	$a\ ^5I^e$	5.44905
$3s3p3d(^4F^o)4f$	$a\ ^5H^e$	5.30278	$3s3p3d(^4F^o)5f$	$b\ ^5I^e$	1.37288
$3s3p3d(^4D^o)4f$	$b\ ^5H^e$	5.01252	$3s3p^2(^4P^e)7i$	$c\ ^5I^e$	1.32111
$3s3p^2(^4P^e)5g$	$c\ ^5H^e$	4.57582	$3s3p^2(^4P^e)8i$	$d\ ^5I^e$	0.51433
$3s3p^2(^4P^e)6g$	$d\ ^5H^e$	2.59460	$3s3p^2(^4P^e)6h$	$z\ ^5I^o$	2.58448
$3s3p^2(^4P^e)7g$	$e\ ^5H^e$	1.34865	$3s3p^2(^4P^e)7h$	$y\ ^5I^o$	1.33917
$3s3p^2(^4P^e)7i$	$f\ ^5H^e$	1.32923	$3s3p3d(^4F^o)5g$	$x\ ^5I^o$	1.17423
$3s3p3d(^4F^o)5f$	$g\ ^5H^e$	1.31495	$3s3p3d(^4D^o)5g$	$w\ ^5I^o$	0.68953
$3s3p3d(^4D^o)5f$	$h\ ^5H^e$	0.87954	$3s3p^2(^4P^e)8k$	$v\ ^5I^o$	0.51704
$3s3p^2(^4P^e)8g$	$i\ ^5H^e$	0.52408	$3s3p^2(^4P^e)8h$	$u\ ^5I^o$	0.50162
$3s3p^2(^4P^e)8i$	$j\ ^5H^e$	0.51985	$3s^23p(^2P^o)8k$	$a\ ^1K^e$	2.64200
$3s3p3d(^4F^o)4d$	$z\ ^5H^o$	6.17884	$3s^23p(^2P^o)9k$	$b\ ^1K^e$	2.08789

TABLE I. Bound States of Fe XIII

See page 137 for Explanation of Tables

Term		$E(Ry)$	Term		$E(Ry)$
$3s^23p(^2P^o)10k$	$c\ ^1K^e$	1.69126	$3s3p3d(^4F^o)5g$	$z\ ^5K^o$	1.13140
$3s^23p(^2P^o)7i$	$z\ ^1K^o$	3.44933	$3s3p^2(^4P^e)8k$	$y\ ^5K^o$	0.51518
$3s^23p(^2P^o)8i$	$y\ ^1K^o$	2.64151	$3s^23p(^2P^o)8k$	$a\ ^1L^e$	2.64055
$3s^23p(^2P^o)9i$	$x\ ^1K^o$	2.08831	$3s^23p(^2P^o)9k$	$b\ ^1L^e$	2.08642
$3s^23p(^2P^o)9l$	$w\ ^1K^o$	2.08630	$3s^23p(^2P^o)10k$	$c\ ^1L^e$	1.68999
$3s3p^2(^2D^e)6h$	$v\ ^1K^o$	1.94969	$3s^23p(^2P^o)9l$	$z\ ^1L^o$	2.08661
$3s^23p(^2P^o)10i$	$u\ ^1K^o$	1.69035	$3s^23p(^2P^o)10l$	$y\ ^1L^o$	1.69028
$3s^23p(^2P^o)8k$	$a\ ^3K^e$	2.64200	$3s^23p(^2P^o)8k$	$a\ ^3L^e$	2.64055
$3s^23p(^2P^o)9k$	$b\ ^3K^e$	2.08789	$3s^23p(^2P^o)9k$	$b\ ^3L^e$	2.08642
$3s^23p(^2P^o)10k$	$c\ ^3K^e$	1.69126	$3s^23p(^2P^o)10k$	$c\ ^3L^e$	1.68999
$3s^23p(^2P^o)7i$	$z\ ^3K^o$	3.44934	$3s^23p(^2P^o)9l$	$z\ ^3L^o$	2.08661
$3s^23p(^2P^o)8i$	$y\ ^3K^o$	2.64153	$3s^23p(^2P^o)10l$	$y\ ^3L^o$	1.69028
$3s^23p(^2P^o)9i$	$x\ ^3K^o$	2.08835	$3s3p^2(^4P^e)8k$	$z\ ^5L^o$	0.51679
$3s^23p(^2P^o)9l$	$w\ ^3K^o$	2.08630	$3s^23p(^2P^o)10m$	$a\ ^1M^e$	1.69002
$3s3p^2(^2D^e)6h$	$v\ ^3K^o$	1.95031	$3s^23p(^2P^o)9l$	$z\ ^1M^o$	2.08639
$3s^23p(^2P^o)10i$	$u\ ^3K^o$	1.69035	$3s^23p(^2P^o)10m$	$a\ ^3M^e$	1.69002
$3s3p^2(^4P^e)7i$	$a\ ^5K^e$	1.32790	$3s^23p(^2P^o)9l$	$z\ ^3M^o$	2.08639
$3s3p^2(^4P^e)8i$	$b\ ^5K^e$	0.51880			

TABLE II. Oscillator Strengths, Line Strengths, and Transition Probabilities for Allowed Transitions in Fe XIII

See page 137 for Explanation of Tables

Transition	E_i Ry/cm^{1}	E_j Ry/cm^{1}	E_{ji} Ry	g_i	g_j	f_{ij}	S	A_{ji} s^{1}
a $^1S^e$ z $^1P^o$	25.7022	22.5443	3.158E+00	1	3	1.858E-01	1.765E-01	4.962E+09
	91508.000	438050.00	3.158E+00	1	3	1.858E-01	1.765E-01	4.962E+09
a $^1S^e$ y $^1P^o$	25.7022	21.3356	4.367E+00	1	3	1.097E+00	7.539E-01	5.602E+10
	91508.000	570690.00	4.367E+00	1	3	1.097E+00	7.539E-01	5.602E+10
a $^1S^e$ t $^1P^o$	25.7022	14.1262	1.158E+01	1	3	8.512E-02	2.206E-02	3.054E+10
	91508.000	1361830.00	1.158E+01	1	3	8.512E-02	2.206E-02	3.054E+10
a $^1S^e$ r $^1P^o$	25.7022	11.4945	1.421E+01	1	3	5.337E-01	1.127E-01	2.884E+11
	91508.000	1650620.00	1.421E+01	1	3	5.337E-01	1.127E-01	2.884E+11
d $^1P^e$ r $^1P^o$	12.7280	11.4945	1.233E+00	3	3	2.019E-06	1.473E-05	2.467E+04
	515260.000	1650620.00	1.233E+00	3	3	2.019E-06	1.473E-05	2.467E+04
a $^1D^e$ z $^1P^o$	26.0981	22.5443	3.554E+00	5	3	1.834E-01	7.743E-01	3.101E+10
	48068.000	438050.00	3.554E+00	5	3	1.834E-01	7.743E-01	3.101E+10
a $^1D^e$ y $^1P^o$	26.0981	21.3356	4.762E+00	5	3	5.767E-05	1.816E-04	1.751E+07
	48068.000	570690.00	4.762E+00	5	3	5.767E-05	1.816E-04	1.751E+07
a $^1D^e$ t $^1P^o$	26.0981	14.1262	1.197E+01	5	3	1.184E-01	1.483E-01	2.272E+11
	48068.000	1361830.00	1.197E+01	5	3	1.184E-01	1.483E-01	2.272E+11
a $^1D^e$ r $^1P^o$	26.0981	11.4945	1.460E+01	5	3	3.279E-03	3.368E-03	9.362E+09
	48068.000	1650620.00	1.460E+01	5	3	3.279E-03	3.368E-03	9.362E+09
a $^1D^e$ z $^1D^o$	26.0981	23.2343	2.864E+00	5	5	9.670E-02	5.065E-01	6.370E+09
	48068.000	362330.00	2.864E+00	5	5	9.670E-02	5.065E-01	6.370E+09
a $^1D^e$ y $^1D^o$	26.0981	21.9901	4.108E+00	5	5	4.432E-01	1.618E+00	6.007E+10
	48068.000	498870.00	4.108E+00	5	5	4.432E-01	1.618E+00	6.007E+10
a $^1D^e$ z $^1F^o$	26.0981	21.4615	4.637E+00	5	7	5.776E-01	1.869E+00	7.124E+10
	48068.000	556870.00	4.637E+00	5	7	5.776E-01	1.869E+00	7.124E+10
a $^1D^e$ t $^1F^o$	26.0981	11.6765	1.442E+01	5	7	3.842E-01	3.996E-01	4.584E+11
	48068.000	1630650.00	1.442E+01	5	7	3.842E-01	3.996E-01	4.584E+11
h $^1D^e$ r $^1P^o$	12.9754	11.4945	1.481E+00	5	3	1.628E-02	1.649E-01	4.780E+08
	488110.000	1650620.00	1.481E+00	5	3	1.628E-02	1.649E-01	4.780E+08
h $^1D^e$ t $^1F^o$	12.9754	11.6765	1.299E+00	5	7	3.687E-01	4.258E+00	3.569E+09
	488110.000	1630650.00	1.299E+00	5	7	3.687E-01	4.258E+00	3.569E+09
z $^1P^o$ d $^1P^e$	22.5443	12.7280	9.816E+00	3	3	5.816E-05	5.332E-05	4.501E+07
	438050.000	1515260.00	9.816E+00	3	3	5.816E-05	5.332E-05	4.501E+07
z $^1P^o$ h $^1D^e$	22.5443	12.9754	9.569E+00	3	5	9.330E-06	8.775E-06	4.117E+06
	438050.000	1488110.00	9.569E+00	3	5	9.330E-06	8.775E-06	4.117E+06
z $^1P^o$ n $^1D^e$	22.5443	10.6728	1.187E+01	3	5	6.219E-02	4.714E-02	4.224E+10
	438050.000	1740800.00	1.187E+01	3	5	6.219E-02	4.714E-02	4.224E+10
y $^1P^o$ d $^1P^e$	21.3356	12.7280	8.608E+00	3	3	5.440E-05	5.688E-05	3.237E+07
	570690.000	1515260.00	8.608E+00	3	3	5.440E-05	5.688E-05	3.237E+07
y $^1P^o$ h $^1D^e$	21.3356	12.9754	8.360E+00	3	5	2.196E-03	2.364E-03	7.398E+08
	570690.000	1488110.00	8.360E+00	3	5	2.196E-03	2.364E-03	7.398E+08
y $^1P^o$ n $^1D^e$	21.3356	10.6728	1.066E+01	3	5	6.704E-01	5.659E-01	3.674E+11
	570690.000	1740800.00	1.066E+01	3	5	6.704E-01	5.659E-01	3.674E+11
t $^1P^o$ d $^1P^e$	14.1262	12.7280	1.398E+00	3	3	1.050E-03	6.762E-03	1.649E+07
	361830.000	1515260.00	1.398E+00	3	3	1.050E-03	6.762E-03	1.649E+07
t $^1P^o$ h $^1D^e$	14.1262	12.9754	1.151E+00	3	5	3.362E-01	2.629E+00	2.145E+09
	361830.000	1488110.00	1.151E+00	3	5	3.362E-01	2.629E+00	2.145E+09
t $^1P^o$ n $^1D^e$	14.1262	10.6728	3.453E+00	3	5	5.080E-03	1.324E-02	2.920E+08
	361830.000	1740800.00	3.453E+00	3	5	5.080E-03	1.324E-02	2.920E+08
r $^1P^o$ n $^1D^e$	11.4945	10.6728	8.218E-01	3	5	1.944E-01	2.129E+00	6.326E+08
	650620.000	1740800.00	8.218E-01	3	5	1.944E-01	2.129E+00	6.326E+08
z $^1D^o$ d $^1P^e$	23.2343	12.7280	1.051E+01	5	3	9.473E-05	1.352E-04	1.400E+08
	362330.000	1515260.00	1.051E+01	5	3	9.473E-05	1.352E-04	1.400E+08
z $^1D^o$ h $^1D^e$	23.2343	12.9754	1.026E+01	5	5	1.201E-02	1.757E-02	1.016E+10
	362330.000	1488110.00	1.026E+01	5	5	1.201E-02	1.757E-02	1.016E+10
z $^1D^o$ n $^1D^e$	23.2343	10.6728	1.256E+01	5	5	2.961E-02	3.535E-02	3.752E+10
	362330.000	1740800.00	1.256E+01	5	5	2.961E-02	3.535E-02	3.752E+10
y $^1D^o$ d $^1P^e$	21.9901	12.7280	9.262E+00	5	3	7.506E-04	1.216E-03	8.620E+08
	498870.000	1515260.00	9.262E+00	5	3	7.506E-04	1.216E-03	8.620E+08
y $^1D^o$ h $^1D^e$	21.9901	12.9754	9.015E+00	5	5	3.975E-03	6.614E-03	2.594E+09
	498870.000	1488110.00	9.015E+00	5	5	3.975E-03	6.614E-03	2.594E+09
y $^1D^o$ n $^1D^e$	21.9901	10.6728	1.132E+01	5	5	3.959E-02	5.247E-02	4.073E+10
	498870.000	1740800.00	1.132E+01	5	5	3.959E-02	5.247E-02	4.073E+10
z $^1F^o$ h $^1D^e$	21.4615	12.9754	8.486E+00	7	5	3.059E-02	7.570E-02	2.477E+10
	556870.000	1488110.00	8.486E+00	7	5	3.059E-02	7.570E-02	2.477E+10
z $^1F^o$ n $^1D^e$	21.4615	10.6728	1.079E+01	7	5	1.129E-03	2.197E-03	1.477E+09
	556870.000	1740800.00	1.079E+01	7	5	1.129E-03	2.197E-03	1.477E+09
z $^1F^o$ g $^1G^e$	21.4615	10.6485	1.081E+01	7	9	7.214E-01	1.401E+00	5.270E+11
	556870.000	1743460.00	1.081E+01	7	9	7.214E-01	1.401E+00	5.270E+11
t $^1F^o$ n $^1D^e$	11.6765	10.6728	1.004E+00	7	5	2.038E-03	4.265E-02	2.310E+07
	630650.000	1740800.00	1.004E+00	7	5	2.038E-03	4.265E-02	2.310E+07
t $^1F^o$ g $^1G^e$	11.6765	10.6485	1.028E+00	7	9	2.550E-01	5.209E+00	1.683E+09
	630650.000	1743460.00	1.028E+00	7	9	2.550E-01	5.209E+00	1.683E+09
a $^3P^e$ z $^3S^o$	26.4139	22.7501	3.664E+00	9	3	1.961E-01	1.445E+00	6.342E+10
	18561.000	415462.00	3.617E+00	5	3	1.936E-01	8.028E-01	3.390E+10

TABLE II. Oscillator Strengths, Line Strengths, and Transition Probabilities for Allowed Transitions in Fe XIII

See page 137 for Explanation of Tables

Transition	E_i Ry/cm^{-1}	E_j Ry/cm^{-1}	E_{ji} Ry	g_i	g_j	f_{ij}	S	A_{ji} s^{-1}
	9302.500	415462.00	3.701E+00	3	3	1.981E-01	4.817E-01	2.179E+10
	0.000	415462.00	3.786E+00	1	3	2.026E-01	1.606E-01	7.776E+09
a $^3P^e$ z $^3P^o$	26.4139	23.5285	2.885E+00	9	9	6.367E-02	5.958E-01	4.258E+09
	18561.000	330279.00	2.841E+00	5	5	4.701E-02	2.483E-01	3.047E+09
	18561.000	329647.00	2.835E+00	5	3	1.564E-02	8.275E-02	1.682E+09
	9302.500	330279.00	2.925E+00	3	5	2.689E-02	8.275E-02	1.109E+09
	9302.500	329647.00	2.919E+00	3	3	1.610E-02	4.965E-02	1.102E+09
	*		2.885E+00	3	1	2.122E-02	6.620E-02	4.258E+09
	*		2.885E+00	1	3	6.367E-02	6.620E-02	1.419E+09
a $^3P^e$ y $^3P^o$	26.4139	22.0608	4.353E+00	9	9	2.826E-01	1.753E+00	4.302E+10
	18561.000	486358.00	4.263E+00	5	5	2.076E-01	7.304E-01	3.030E+10
	18561.000	494942.00	4.341E+00	5	3	7.046E-02	2.435E-01	1.778E+10
	9302.500	486358.00	4.347E+00	3	5	1.176E-01	2.435E-01	1.071E+10
	9302.500	494942.00	4.425E+00	3	3	7.183E-02	1.461E-01	1.130E+10
	9302.500	503340.00	4.502E+00	3	1	9.743E-02	1.948E-01	4.758E+10
	0.000	494942.00	4.510E+00	1	3	2.928E-01	1.948E-01	1.595E+10
a $^3P^e$ s $^3P^o$	26.4139	14.2544	1.216E+01	9	9	6.237E-02	1.385E-01	7.407E+10
	18561.000	1354680.00	1.218E+01	5	5	4.684E-02	5.771E-02	5.578E+10
	18561.000	1336220.00	1.201E+01	5	3	1.540E-02	1.924E-02	2.972E+10
	9302.500	1354680.00	1.226E+01	3	5	2.620E-02	1.924E-02	1.898E+10
	9302.500	1336220.00	1.209E+01	3	3	1.551E-02	1.154E-02	1.821E+10
	*		1.216E+01	3	1	2.079E-02	1.539E-02	7.407E+10
	*		1.216E+01	1	3	6.237E-02	1.539E-02	2.469E+10
a $^3P^e$ z $^3D^o$	26.4139	23.9056	2.508E+00	9	15	5.231E-02	5.631E-01	1.586E+09
	18561.000	290210.00	2.475E+00	5	7	4.336E-02	2.628E-01	1.525E+09
	18561.000	287360.00	2.449E+00	5	5	7.662E-03	4.692E-02	3.693E+08
	18561.000	287205.00	2.448E+00	5	3	5.105E-04	3.128E-03	4.096E+07
	9302.500	287360.00	2.534E+00	3	5	3.963E-02	1.408E-01	1.226E+09
	9302.500	287205.00	2.532E+00	3	3	1.320E-02	4.692E-02	6.801E+08
	0.000	287205.00	2.617E+00	1	3	5.458E-02	6.256E-02	1.001E+09
a $^3P^e$ y $^3D^o$	26.4139	21.9008	4.513E+00	9	15	7.075E-01	4.233E+00	6.945E+10
	18561.000	509176.00	4.471E+00	5	7	5.888E-01	1.975E+00	6.752E+10
	18561.000	509250.00	4.471E+00	5	5	1.052E-01	3.527E-01	1.689E+10
	18561.000	506502.00	4.446E+00	5	3	6.971E-03	2.352E-02	1.845E+09
	9302.500	509250.00	4.556E+00	3	5	5.357E-01	1.058E+00	5.358E+10
	9302.500	506502.00	4.531E+00	3	3	1.776E-01	3.527E-01	2.928E+10
	0.000	506502.00	4.616E+00	1	3	7.236E-01	4.703E-01	4.127E+10
a $^3P^e$ p $^3D^o$	26.4139	11.9072	1.451E+01	9	15	3.612E-01	6.722E-01	3.663E+11
	18561.000	1606800.00	1.447E+01	5	7	3.027E-01	3.137E-01	3.638E+11
	18561.000	1604220.00	1.445E+01	5	5	5.396E-02	5.602E-02	9.050E+10
	18561.000	1603770.00	1.445E+01	5	3	3.597E-03	3.735E-03	1.005E+10
	9302.500	1604220.00	1.453E+01	3	5	2.714E-01	1.681E-01	2.763E+11
	9302.500	1603770.00	1.453E+01	3	3	9.044E-02	5.602E-02	1.534E+11
	0.000	1603770.00	1.461E+01	1	3	3.639E-01	7.469E-02	2.081E+11
z $^3D^o$ k $^3F^e$	23.9056	10.6683	1.324E+01	15	21	7.996E-02	2.718E-01	8.039E+10
	290210.000	1741290.00	1.322E+01	7	9	7.336E-02	1.165E-01	8.013E+10
	*		1.320E+01	7	7	6.346E-03	1.010E-02	8.881E+09
	*		1.337E+01	7	5	1.813E-04	2.848E-04	3.645E+08
	*		1.324E+01	5	7	7.108E-02	8.051E-02	7.151E+10
	*		1.320E+01	5	5	8.885E-03	1.010E-02	1.243E+10
	*		1.324E+01	3	5	7.996E-02	5.437E-02	6.753E+10
y $^3D^o$ k $^3F^e$	21.9008	10.6683	1.123E+01	15	21	6.934E-01	2.778E+00	5.019E+11
	509176.000	1741290.00	1.123E+01	7	9	6.365E-01	1.190E+00	5.013E+11
	*		1.120E+01	7	7	5.503E-02	1.032E-01	5.545E+10
	*		1.135E+01	7	5	1.572E-03	2.910E-03	2.276E+09
	*		1.124E+01	5	7	6.163E-01	8.227E-01	4.464E+11
	*		1.120E+01	5	5	7.704E-02	1.032E-01	7.763E+10
	*		1.123E+01	3	5	6.934E-01	5.555E-01	4.216E+11
p $^3D^o$ k $^3F^e$	11.9072	10.6683	1.239E+00	15	21	2.716E-01	9.864E+00	2.392E+09
	606800.000	1741290.00	1.226E+00	7	9	2.467E-01	4.228E+00	2.315E+09
	*		1.235E+00	7	7	2.155E-02	3.664E-01	2.642E+08
	*		1.251E+00	7	5	6.158E-04	1.033E-02	1.085E+07
	*		1.239E+00	5	7	2.414E-01	2.922E+00	2.127E+09
	*		1.235E+00	5	5	3.018E-02	3.664E-01	3.699E+08
	*		1.239E+00	3	5	2.716E-01	1.973E+00	2.009E+09
s $^3F^o$ k $^3F^e$	11.7772	10.6683	1.109E+00	21	21	1.982E-02	1.126E+00	1.958E+08
	*		1.110E+00	9	9	1.859E-02	4.520E-01	1.840E+08
	*		1.108E+00	9	7	1.239E-03	3.019E-02	1.571E+07
	619600.000	1741290.00	1.109E+00	7	9	1.594E-03	3.019E-02	1.225E+07
	*		1.108E+00	7	7	1.666E-02	3.157E-01	1.643E+08
	*		1.111E+00	7	5	1.573E-03	2.973E-02	2.186E+07
	*		1.111E+00	5	7	2.203E-03	2.973E-02	1.561E+07
	*		1.109E+00	5	5	1.762E-02	2.383E-01	1.742E+08