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**APPENDIX C**  
**Atlas of**  
**Innershell Ionization lines**

**SRON/SPEX/TRPB04c**

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**Version 1.0/Rev. 2.0**

**August 25, 1994**

prepared by

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## APPENDIX C

### INNERSHELL IONIZATION LINES

#### 1 Introduction

In this Appendix we present an extended line table (Table 1) which lists more than 400  $K\alpha$  and  $K\beta$  fluorescence lines of elements with  $Z = 6-28$  compiled from a recent publication (KM93). In the following chapters we give first the formula as derived by MG81 for the innershell ionization contribution to a line in an optically thin plasma (§2), then consider the various literature sources and the way we derive wavelengths, and finally give the line table.

#### 2 Formula for innershell ionization

Mewe and Gronenschild (MG81) and Mewe *et al.* (MSS80) have considered electron impact ionization from the inner  $1s^2$  shell of ion  $Z^{(z-1)}$  which contributes to the production in an optically thin plasma to the formation of a certain line in the next higher ion  $Z^{+z}$  (e.g. the satellites to He-like resonance lines from lower Li-, Be-, etc. like ions). On the basis of the formula of Lotz (L68) with  $\zeta = 2$  (total number of electrons in the  $1s^2$  shell) and assuming the upper line level to be populated in proportion to its statistical weight  $g_j$  MG81 obtain for the rate coefficient:

$$S_{II} = 6.49 \times 10^{-4} C_{II} T^{-1/2} \chi^{-1} E_1(\chi/kT) \text{ (cm}^3\text{s}^{-1}\text{)}, \quad (1)$$

where the fluorescence yield is given by

$$C_{II} = \frac{g_j}{\sum g_j} \frac{A_r}{A_a + \sum A_r}. \quad (1a)$$

Here  $\sum g_j$  is the total statistical weight of the configuration to which level  $j$  belongs and  $A_a, A_r$  are transition probabilities for decay by auto-ionization and radiation, where the summation is over all possible spontaneous radiative transitions from level  $j$ . The electron temperature  $T$  is here expressed in K and the ionization energy  $\chi$  of the  $1s^2$  shell in ion  $Z^{+(z-1)}$  is expressed in eV (cf. Eq. (21a) of chapter 'LINEM').

In recent work Kaastra and Mewe (KM93) have calculated the yield  $C_{II}$  for the  $K\alpha$  and  $K\beta$  lines from many ionization stages of the cosmically abundant elements. These are given in Table 1 and will replace the previously calculated yields given by MSS80 and MG81.

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### 3 Literature sources and wavelengths

#### 3.1 $K\alpha$ transitions

For the  $K\alpha$  transitions the energy and wavelength in the second and third column of Table 1 are derived by KM93 based on data of L68, whereas the (slightly more accurate) energy and wavelength in the last two columns are the data from H69 corrected by a comparison with the data from BB67 for  $K\alpha$  transitions in singly ionized atoms. In the latter case, we apply, for example for iron and calcium for all ionization stages a shift of  $-0.017 \text{ \AA}$ , i.e. we use the 'adjusted' values given by H69.

For  $Z > 13$  we take for the most abundant elements (Si, Ca, Fe) a doublet splitting equal to that derived from the BB67 data for singly ionized atoms (e.g., 0.0024, 0033, and 0.0039  $\text{\AA}$  for SiII, CaII, and FeII, respectively). We apply this splitting only up to the stage where the  $2p$  electron jumps from a full  $2p$  shell (e.g. up to Fe XVIII where L68 still gives different energies for the  $K\alpha_1$  (Kal1) and  $K\alpha_2$  (Kal2) components), thereafter we give the average-of-configuration data from H69. For  $Z \leq 13$  we give the averaged data for all more than singly ionized atoms. We note that the H69 data are in good agreement with those from MW86 calculated for  $Z = 9$  to 18.

#### 3.2 $K\beta$ transitions

For the  $K\beta$  lines we take the data from BB67 for singly ionized atoms and in the case of titanium from M83 for the higher ions. Corresponding values for other ions we approximately derived by scaling  $\lambda_H$  (lam\_H) for  $K\alpha_2$  (Kal2) with the ratio of the wavelengths of  $K\beta_3$  (Kbe3) and  $K\alpha_2$  (Kal2) from KM93 which are based on the data from L68. For the two components  $K\beta_3$  (Kbe3) and  $K\beta_1$  (Kbe1) we take the same wavelength except for iron where we apply a splitting Kbe3-Kbe1 of 0.0004  $\text{\AA}$  based on the L68 data up to the stage Fe X where the  $3p$  electron still jumps from a full  $3p$  shell and L68 gives different energy values for the two components.

### 4 Remarks and explanation of Table 1

To convert energies into wavelengths and vice versa we use a conversion factor of  $12.39842 \text{ \AA} / \text{keV}$ .

The energy and wavelength should be taken from the last two columns of Table 1 (i.e. the values for  $E_H$  and lam\_H based on BB67 and H69), and not those from the second and third column (values for  $E$  and  $\lambda$  from KM93 based on L68).

Explanation of Table 1:

$Z$  = atomic number,  $s$  = ionization stage,  $l$  = line transition (notation from KM93),  $E$  = energy,  $\lambda$  (lambda) = wavelength (from KM93), yield (=  $C_{II}$ ) = fluorescence yield (photons per ionization) (from KM93), transition = ion and line transition,  $E_H$  ( $E_H$ ) = energy,  $\lambda_H$  (lam\_H) = wavelength (from H69 and BB67) .

## 5 References

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Table 1. List of  $K\alpha$  and  $K\beta$  innershell ionization lines

Z	s	E (keV)	lambda (A)	yield	transition	E <sub>H</sub> (keV)											
5	1	1	0.1837	67.4942	0.0006	B II	Kal2	0.1833	15	2	2.0133	6.1584	0.0192	P II	Kal2	2.0127	
6	1	1	0.2768	44.7988	0.0026	C II	Kal2	0.277	15	3	2.0142	6.1555	0.0385	P II	Kal1	2.0137	
7	3	1	0.4006	30.9504	0.0052	F III	Kal1	0.4008	15	1	2.1375	5.8005	0.0015	P II	Kbe3	2.1390	
8	1	1	0.5243	23.6465	0.0047	O II	Kal2	0.5249	15	2	2.0272	6.1160	0.0196	P III	Kal2	2.0137	
9	2	1	0.6890	17.9956	0.0076	F III	Kal2	0.6855	15	2	2.0281	6.1132	0.0392	P III	Kal1	2.0137	
10	1	1	0.8736	14.1927	0.0116	Ne IV	Kal2	0.8608	16	2	2.1582	5.7447	0.0016	P III	Kbe3	2.1439	
11	1	1	1.0411	11.9088	0.0173	Na II	Kal1	1.0410	16	5	2.0413	6.0739	0.0200	P IV	Kal2	2.0144	
12	1	1	1.2537	9.8893	0.0224	Mg II	Kal2	1.2536	16	11	2.0422	6.0711	0.0400	P IV	Kal1	2.0144	
13	1	1	1.4866	8.3400	0.0125	Al II	Kal2	1.4863	17	3	2.1777	5.6933	0.0008	P IV	Kbe3	2.1490	
14	1	1	1.7394	7.1280	0.0140	Si II	Kal2	1.7394	17	11	2.0540	6.0362	0.0204	P V	Kal2	2.0157	
15	1	1	1.9820	6.0957	0.0150	Si V	Kal1	1.7423	18	2	2.0549	6.0335	0.0208	P V	Kal1	2.0157	
16	1	1	2.2327	5.3537	0.0157	Si VI	Kal1	1.7429	18	2	2.0682	5.9947	0.0208	P VI	Kal2	2.0167	
17	1	1	2.4853	4.6738	0.0166	Si VII	Kal1	1.7431	19	2	2.0692	5.9919	0.0416	P VI	Kal1	2.0167	
18	1	1	2.7394	4.0324	0.0173	Si VIII	Kal1	1.7435	19	2	2.0787	5.9644	0.0211	P VII	Kal2	2.0183	
19	1	1	2.9917	3.5139	0.0179	Si IX	Kal1	1.7435	19	2	2.0797	5.9616	0.0423	P VII	Kal1	2.0183	
20	1	1	3.2439	3.0850	0.0183	Si X	Kal1	1.7435	19	2	2.0907	5.9302	0.0288	P VIII	Kal2	2.0322	
21	1	1	3.4963	2.7255	0.0187	Si XI	Kal1	1.7435	19	2	2.0907	5.9302	0.0431	P VIII	Kal1	2.0322	
22	1	1	3.7487	2.4282	0.0191	Si XII	Kal1	1.7435	19	2	2.0989	5.9070	0.0416	P IX	Kal2	2.0476	
23	1	1	3.9999	2.1856	0.0194	Si XIII	Kal1	1.7435	19	2	2.0989	5.9070	0.0416	P IX	Kal1	2.0476	
24	1	1	4.2500	1.9856	0.0196	Si XIV	Kal1	1.7435	19	2	2.0903	5.9315	0.0665	P X	Kal2	2.0647	
25	1	1	4.4999	1.8126	0.0200	Si XV	Kal1	1.7435	19	2	2.0903	5.9315	0.0333	P X	Kal1	2.0647	
26	1	1	4.7487	1.6611	0.0203	Si XVI	Kal1	1.7435	19	2	2.0927	5.9247	0.1279	P XI	Kal2	2.0834	
27	1	1	4.9963	1.5282	0.0206	Si XVII	Kal1	1.7435	19	2	2.0917	5.9274	0.1102	P XII	Kal2	2.1032	
28	1	1	5.2439	1.4111	0.0209	Si XVIII	Kal1	1.7435	19	2	2.3067	5.3749	0.0258	S II	Kal2	2.3066	
29	1	1	5.4900	1.3084	0.0212	Si XIX	Kal1	1.7435	19	2	2.3078	5.3724	0.0516	S II	Kal1	2.3078	
30	1	1	5.7363	1.2187	0.0215	Si XX	Kal1	1.7435	19	2	2.4655	5.0288	0.0023	S II	Kbe3	2.4640	
31	1	1	5.9817	1.1400	0.0218	Si XXI	Kal1	1.7435	19	2	2.4655	5.0288	0.0023	S II	Kbe1	2.4640	
32	1	1	6.2263	1.0729	0.0221	Si XXII	Kal1	1.7435	19	2	2.3217	5.3403	0.0264	S III	Kal2	2.308	
33	1	1	6.4700	1.0156	0.0224	Si XXIII	Kal1	1.7435	19	2	2.3227	5.3379	0.0527	S III	Kal1	2.308	
34	1	1	6.7137	0.9673	0.0227	Si XXIV	Kal1	1.7435	19	2	2.4848	4.9896	0.0024	S III	Kbe3	2.470	
35	1	1	6.9573	0.9279	0.0230	Si XXV	Kal1	1.7435	19	2	2.4848	4.9896	0.0012	S III	Kbe1	2.470	
36	1	1	7.2000	0.8956	0.0233	Si XXVI	Kal1	1.7435	19	2	2.3356	5.3084	0.0269	S IV	Kal2	2.309	
37	1	1	7.4427	0.8695	0.0236	Si XXVII	Kal1	1.7435	19	2	2.3372	5.3048	0.0539	S IV	Kal1	2.309	
38	1	1	7.6854	0.8486	0.0239	Si XXVIII	Kal1	1.7435	19	2	2.5050	4.9496	0.0024	S IV	Kbe3	2.476	
39	1	1	7.9281	0.8321	0.0242	Si XXIX	Kal1	1.7435	19	2	2.3486	5.2792	0.0275	S V	Kal2	2.310	
40	1	1	8.1708	0.8199	0.0245	Si XXX	Kal1	1.7435	19	2	2.3502	5.2755	0.0550	S V	Kal1	2.310	
41	1	1	8.4135	0.8111	0.0248	Si XXXI	Kal1	1.7435	19	2	2.5235	4.9132	0.0012	S V	Kbe3	2.482	
42	1	1	8.6562	0.8044	0.0251	Si XXXII	Kal1	1.7435	19	2	2.3616	5.2501	0.0281	S VI	Kal2	2.311	
43	1	1	8.8989	0.8008	0.0254	Si XXXIII	Kal1	1.7435	19	2	2.3632	5.2465	0.0562	S VI	Kal1	2.311	
44	1	1	9.1416	0.8008	0.0257	Si XXXIV	Kal1	1.7435	19	2	2.3768	5.2163	0.0286	S VII	Kal2	2.313	
45	1	1	9.3843	0.8018	0.0260	Si XXXV	Kal1	1.7435	19	2	2.3779	5.2139	0.0573	S VII	Kal1	2.313	
46	1	1	9.6270	0.8018	0.0263	Si XXXVI	Kal1	1.7435	19	2	2.3856	5.1972	0.0292	S VIII	Kal2	2.315	
47	1	1	9.8697	0.8018	0.0266	Si XXXVII	Kal1	1.7435	19	2	2.3873	5.1936	0.0583	S VIII	Kal1	2.315	
48	1	1	10.1124	0.8018	0.0269	Si XXXVIII	Kal1	1.7435	19	2	2.3977	5.1709	0.0393	S IX	Kal2	2.331	
49	1	1	10.3551	0.8018	0.0272	Si XXXIX	Kal1	1.7435	19	2	2.3977	5.1709	0.0590	S IX	Kal1	2.331	
50	1	1	10.5978	0.8018	0.0275	Si XL	Kal1	1.7435	19	2	2.4060	5.1531	0.0564	S X	Kal2	2.348	
51	1	1	10.8405	0.8018	0.0278	Si XLI	Kal1	1.7435	19	2	2.4060	5.1531	0.0564	S X	Kal1	2.348	
52	1	1	11.0832	0.8018	0.0281	Si XLII	Kal1	1.7435	19	2	2.3961	5.1745	0.0887	S XI	Kal2	2.367	
53	1	1	11.3259	0.8018	0.0284	Si XLIII	Kal1	1.7435	19	2	2.3961	5.1745	0.0443	S XI	Kal1	2.367	
54	1	1	11.5686	0.8018	0.0287	Si XLIV	Kal1	1.7435	19	2	2.3977	5.1721	0.1661	S XII	Kal2	2.387	
55	1	1	11.8113	0.8018	0.0290	Si XLV	Kal1	1.7435	19	2	2.3955	5.1757	0.1446	S XIII	Kal2	2.408	
56	1	1	12.0540	0.8018	0.0293	Si XLVI	Kal1	1.7435	19	2	2.6212	4.7301	0.0295	Cl II	Kal2	2.6208	
57	1	1	12.2967	0.8018	0.0296	Si XLVII	Kal1	1.7435	19	2	2.6230	4.7268	0.0591	Cl II	Kal1	2.6224	
58	1	1	12.5394	0.8018	0.0299	Si XLVIII	Kal1	1.7435	19	2	2.8158	4.4032	0.0028	Cl III	Kbe3	2.8156	
59	1	1	12.7821	0.8018	0.0302	Si XLIX	Kal1	1.7435	19	2	2.8158	4.4032	0.0041	Cl III	Kbe1	2.8156	
60	1	1	13.0248	0.8018	0.0305	Si L	Kal1	1.7435	19	2	2.6363	4.7029	0.0302				
61	1	1	13.2675	0.8018	0.0308	Si LI	Kal1	1.7435	19	2	2.6382	4.6997	0.0603				
62	1	1	13.5102	0.8018	0.0311	Si LII	Kal1	1.7435	19	2	2.8379	4.3688	0.0028				
63	1	1	13.7529	0.8018	0.0314	Si LIII	Kal1	1.7435	19	2	2.8379	4.3688	0.0028				
64	1	1	13.9956	0.8018	0.0317	Si LIV	Kal1	1.7435	19	2	2.6516	4.6759	0.0308				
65	1	1	14.2383	0.8018	0.0320	Si LV	Kal1	1.7435	19	2	2.6528	4.6738	0.0616				
66	1	1	14.4810	0.8018	0.0323	Si LVI	Kal1	1.7435	19	2	2.8563	4.3408	0.0029				
67	1	1	14.7237	0.8018	0.0326	Si LVII	Kal1	1.7435	19	2	2.8563	4.3408	0.0014				
68	1	1	14.9664	0.8018	0.0329	Si LVIII	Kal1	1.7435	19	2	2.6644	4.6534	0.0315				
69	1	1	15.2091	0.8018	0.0332	Si LVIX	Kal1	1.7435	19	2	2.6662	4.6501	0.0629				
70	1	1	15.4518	0.8018	0.0335	Si LX	Kal1	1.7435	19	2	2.8754	4.3119	0.0029				
71	1	1	15.6945	0.8018	0.0338	Si LXI	Kal1	1.7435	19	2	2.8754	4.3119	0.0029				
72	1	1	15.9372	0.8018	0.0341	Si LXII	Kal1	1.7435	19	2	2.6773	4.6309	0.0321				
73	1	1	16.1799	0.8018	0.0344	Si LXIII	Kal1	1.7435	19	2	2.6792	4.6277	0.0643				
74	1	1	16.4226	0.8018	0.0347	Si LXIV	Kal1	1.7435	19	2	2.8947	4.2832	0.0015				
75	1	1	16.6653	0.8018	0.0350	Si LXV	Kal1	1.7435	19	2	2.8915	4.6065	0.0328				
76	1	1	16.9080	0.8018	0.0353	Si LXVI	Kal1	1.7435	19	2	2.6928	4.6043	0.0657				
77	1	1	17.1507	0.8018	0.0356	Si LXVII	Kal1	1.7435	19	2	2.7052	4.5832	0.0334				
78	1	1	17.3934	0.8018	0.0359	Si LXVIII	Kal1	1.7435	19	2	2.7071	4.5800	0.0668				
79	1	1	17.6361	0.8018	0.0362	Si LXIX	Kal1	1.7435	19	2	2.7139	4.5684	0.0340				
80	1	1	17.8788	0.8018	0.0365	Si LXX	Kal1	1.7435	19	2	2.7152	4.5663	0.0679				
81	1	1	18.1215	0.8018	0.0368	Si LXXI	Kal1	1.7435	19	2	2.7258	4.5485	0.0459				
82	1	1	18.3642	0.8018	0.0371	Si LXXII	Kal1	1.7435	19	2	2.7258	4.5485	0.0688				
83	1	1	18.6069	0.8018	0.0374	Si LXXIII	Kal1	1.7435	19	2	2.7334	4.5359	0.0657				
84	1	1	18.8496	0.8018	0.0377	Si LXXIV	Kal1										

Table 1. List of  $K\alpha$  and  $K\beta$  innershell ionization lines (continued)

18 5 1	3.0137	4.1140	0.0404	ArVI	Ka2	2.962	2014 1	3.8265	3.2402	0.1427	CaXV	Ka2	3.782
18 5 2	3.0158	4.1112	0.0808	ArVI	Ka1	2.962	2014 2	3.8265	3.2402	0.0713	CaXV	Ka1	3.782
18 5 3	3.2711	3.7902	0.0037	ArVI	Kbe3	3.213	2015 1	3.8247	3.2417	0.2478	CaXVI	Ka2	3.810
18 6 1	3.0276	4.0951	0.0412	ArVII	Ka2	2.963	2016 1	3.8186	3.2469	0.1984	CaXVII	Ka2	3.837
18 6 2	3.0297	4.0923	0.0824	ArVII	Ka1	2.963	21 1 1	4.0860	3.0344	0.0566	ScII	Ka2	4.0861
18 6 3	3.2900	3.7685	0.0019	ArVII	Kbe3	3.218	21 1 2	4.0907	3.0309	0.1131	ScII	Ka1	4.0906
18 7 1	3.0416	4.0763	0.0421	ArVIII	Ka2	2.966	21 1 3	4.4607	2.7795	0.0068	ScII	Kbe3	4.4605
18 7 2	3.0437	4.0735	0.0842	ArVIII	Ka1	2.966	21 1 4	4.4607	2.7795	0.0135	ScII	Kbe1	4.4605
18 8 1	3.0549	4.0585	0.0428	ArIX	Ka2	2.968	21 2 1	4.1020	3.0225	0.0567			
18 8 2	3.0570	4.0557	0.0856	ArIX	Ka1	2.968	21 2 2	4.1068	3.0190	0.1133			
18 9 1	3.0627	4.0482	0.0435	ArX	Ka2	2.970	21 2 3	4.4833	2.7655	0.0068			
18 9 2	3.0655	4.0445	0.0870	ArX	Ka1	2.970	21 2 4	4.4844	2.7648	0.0136			
1810 1	3.0747	4.0324	0.0579	ArXI	Ka2	2.990	21 3 1	4.1191	3.0100	0.0568			
1810 2	3.0747	4.0324	0.0868	ArXI	Ka1	2.990	21 3 2	4.1238	3.0065	0.1135			
1811 1	3.0818	4.0232	0.0812	ArXII	Ka2	3.010	21 3 3	4.5071	2.7508	0.0068			
1811 2	3.0818	4.0232	0.0812	ArXII	Ka1	3.010	21 3 4	4.5082	2.7502	0.0136			
1812 1	3.0697	4.0389	0.1229	ArXIII	Ka2	3.032	21 1 1	4.1343	2.9989	0.0568			
1812 2	3.0697	4.0389	0.0614	ArXIII	Ka1	3.032	21 1 2	4.1390	2.9955	0.1136			
1813 1	3.0690	4.0399	0.2116	ArXIV	Ka2	3.056	21 4 3	4.5300	2.7369	0.0068			
1814 1	3.0655	4.0445	0.1671	ArXV	Ka2	3.080	21 4 4	4.5300	2.7369	0.0136			
19 1 1	3.3113	3.7443	0.0347	K II	Ka2	3.3111	21 5 1	4.1495	2.9879	0.0583			
19 1 2	3.3144	3.7408	0.0693	K II	Ka1	3.3138	21 5 2	4.1543	2.9845	0.1166			
19 1 3	3.5909	3.4528	0.0037	K II	Kbe3	3.5896	21 5 3	4.5520	2.7237	0.0070			
19 1 4	3.5917	3.4520	0.0073	K II	Kbe1	3.5896	21 5 4	4.5520	2.7237	0.0105			
19 2 1	3.3274	3.7262	0.0347				21 6 1	4.1629	2.9783	0.0598			
19 2 2	3.3297	3.7236	0.0694				21 6 2	4.1677	2.9749	0.1197			
19 2 3	3.6124	3.4322	0.0037				21 6 3	4.5730	2.7112	0.0072			
19 2 4	3.6124	3.4322	0.0073				21 6 4	4.5730	2.7112	0.0072			
19 3 1	3.3435	3.7082	0.0355				21 7 1	4.1764	2.9687	0.0614			
19 3 2	3.3458	3.7057	0.0711				21 7 2	4.1812	2.9653	0.1229			
19 3 3	3.6350	3.4109	0.0038				21 7 3	4.5856	2.7037	0.0073			
19 3 4	3.6350	3.4109	0.0056				21 7 4	4.5856	2.7037	0.0037			
19 4 1	3.3581	3.6920	0.0364				21 8 1	4.1889	2.9598	0.0631			
19 4 2	3.3612	3.6886	0.0728				21 8 2	4.1937	2.9564	0.1262			
19 4 3	3.6568	3.3905	0.0039				21 8 3	4.6047	2.6926	0.0075			
19 4 4	3.6568	3.3905	0.0039				21 9 1	4.2034	2.9496	0.0648			
19 5 1	3.3713	3.6776	0.0373				21 9 2	4.2082	2.9462	0.1297			
19 5 2	3.3736	3.6751	0.0745				21 9 3	4.6249	2.6808	0.0039			
19 5 3	3.6711	3.3773	0.0039				2110 1	4.2160	2.9408	0.0666			
19 5 4	3.6711	3.3773	0.0020				2110 2	4.2209	2.9374	0.1333			
19 6 1	3.3853	3.6624	0.0382				2111 1	4.2286	2.9320	0.0679			
19 6 2	3.3877	3.6599	0.0764				2111 2	4.2325	2.9293	0.1358			
19 6 3	3.6906	3.3594	0.0040				2112 1	4.2364	2.9266	0.0691			
19 7 1	3.3994	3.6473	0.0391				2112 2	4.2413	2.9233	0.1382			
19 7 2	3.4017	3.6447	0.0782				2113 1	4.2491	2.9179	0.0922			
19 7 3	3.7102	3.3417	0.0021				2113 2	4.2491	2.9179	0.1382			
19 8 1	3.4135	3.6322	0.0401				2114 1	4.2540	2.9145	0.1298			
19 8 2	3.4159	3.6297	0.0802				2114 2	4.2540	2.9145	0.1298			
19 9 1	3.4253	3.6196	0.0409				2115 1	4.2364	2.9266	0.1986			
19 9 2	3.4277	3.6171	0.0819				2115 2	4.2364	2.9266	0.0993			
1910 1	3.4332	3.6113	0.0418				2116 1	4.2345	2.9280	0.3521			
1910 2	3.4364	3.6080	0.0835				2117 1	4.2267	2.9334	0.2963			
1911 1	3.4451	3.5989	0.0555				22 1 1	4.5051	2.7521	0.0657	TiII	Ka2	4.5049
1911 2	3.4451	3.5989	0.0836				22 1 2	4.5113	2.7483	0.1314	TiII	Ka1	4.5108
1912 1	3.4514	3.5922	0.0784				22 1 3	4.9317	2.5140	0.0080	TiII	Kbe3	4.9318
1912 2	3.4514	3.5922	0.0784				22 1 4	4.9317	2.5140	0.0159	TiII	Kbe1	4.9318
1913 1	3.4372	3.6072	0.1191				22 2 1	4.5196	2.7433	0.0658	TiIII	Ka2	4.509
1913 2	3.4372	3.6072	0.0596				22 2 2	4.5258	2.7395	0.1316	TiIII	Ka1	4.509
1914 1	3.4364	3.6080	0.2064				22 2 3	4.9545	2.5025	0.0080	TiIII	Kbe3	4.9318
1915 1	3.4316	3.6130	0.1626				22 2 4	4.9545	2.5025	0.0160	TiIII	Kbe1	4.9318
20 1 1	3.6881	3.3618	0.0413	CaII	Ka2	3.6881	22 3 1	4.5373	2.7325	0.0659	TiIV	Ka2	4.509
20 1 2	3.6923	3.3579	0.0827	CaII	Ka1	3.6917	22 3 2	4.5426	2.7294	0.1318	TiIV	Ka1	4.509
20 1 3	4.0124	3.0901	0.0047	CaII	Kbe3	4.0127	22 3 3	4.9785	2.4904	0.0080	TiIV	Kbe3	4.9318
20 1 4	4.0133	3.0893	0.0093	CaII	Kbe1	4.0127	22 3 4	4.9785	2.4904	0.0160	TiIV	Kbe1	4.9318
20 2 1	3.7051	3.3463	0.0414	CaIII	Ka2	3.6887	22 4 1	4.5530	2.7231	0.0659	TiV	Ka2	4.509
20 2 2	3.7094	3.3425	0.0828	CaIII	Ka1	3.6923	22 4 2	4.5593	2.7194	0.1319	TiV	Ka1	4.509
20 2 3	4.0365	3.0716	0.0047	CaIII	Kbe3	4.018	22 4 3	5.0026	2.4784	0.0080	TiV	Kbe3	4.9318
20 2 4	4.0374	3.0709	0.0093	CaIII	Kbe1	4.018	22 4 4	5.0026	2.4784	0.0160	TiV	Kbe1	4.9318
20 3 1	3.7205	3.3325	0.0415	CaIV	Ka2	3.6887	22 5 1	4.5677	2.7144	0.0660	TiVI	Ka2	4.507
20 3 2	3.7239	3.3294	0.0830	CaIV	Ka1	3.6923	22 5 2	4.5740	2.7106	0.1320	TiVI	Ka1	4.507
20 3 3	4.0588	3.0547	0.0047	CaIV	Kbe3	4.024	22 5 3	5.0246	2.4676	0.0080	TiVI	Kbe3	4.9370
20 3 4	4.0588	3.0547	0.0094	CaIV	Kbe1	4.024	22 5 4	5.0246	2.4676	0.0160	TiVI	Kbe1	4.9370
20 4 1	3.7359	3.3187	0.0425	CaV	Ka2	3.6909	22 6 1	4.5835	2.7050	0.0677	TiVII	Ka2	4.509
20 4 2	3.7402	3.3149	0.0850	CaV	Ka1	3.6945	22 6 2	4.5888	2.7019	0.1355	TiVII	Ka1	4.509
20 4 3	4.0813	3.0379	0.0048	CaV	Kbe3	4.031	22 6 3	5.0478	2.4562	0.0082	TiVII	Kbe3	4.9454
20 4 4	4.0813	3.0379	0.0072	CaV	Kbe1	4.031	22 6 4	5.0478	2.4562	0.0123	TiVII	Kbe1	4.9454
20 5 1	3.7506	3.3057	0.0436	CaVI	Ka2	3.6920	22 7 1	4.5973	2.6969	0.0696	TiVIII	Ka2	4.512
20 5 2	3.7540	3.3027	0.0871	CaVI	Ka1	3.6956	22 7 2	4.6026	2.6938	0.1391	TiVIII	Ka1	4.512
20 5 3	4.1020	3.0225	0.0049	CaVI	Kbe3	4.038	22 7 3	5.0687	2.4461	0.0084	TiVIII	Kbe3	4.9544
20 5 4	4.1020	3.0225	0.0049	CaVI	Kbe1	4.038	22 7 4	5.0687	2.4461	0.0084	TiVIII	Kbe1	4.9544
20 6 1	3.7636	3.2943	0.0447	CaVII	Ka2	3.6942	22 8 1	4.6100	2.6895	0.0715	TiIX	Ka2	4.515
20 6 2	3.7670	3.2913	0.0893	CaVII	Ka1	3.6978	22 8 2	4.6164	2.6858	0.1429	TiIX	Ka1	4.515
20 6 3	4.1162	3.0121	0.0050	CaVII	Kbe3	4.041	22 8 3	5.0804	2.4404	0.0087	TiIX	Kbe3	4.9629
20 6 4	4.1162	3.0121	0.0025	CaVII	Kbe1	4.041	22 8 4	5.0804	2.4404	0.0043	TiIX	Kbe1	4.9629
20 7 1	3.7775	3.2822	0.0458	CaVIII	Ka2	3.6964	22 9 1	4.6217	2.6827	0.0734	TiX	Ka2	4.517
20 7 2	3.7809	3.2792	0.0916	CaVIII	Ka1	3.7000	22 9 2	4.6281	2.6790	0.1469	TiX	Ka1	4.517
20 7 3	4.1362	2.9976	0.0052	CaVIII	Kbe3	4.048	22 9 3	5.0992	2.4315	0.0089	TiX	Kbe3	4.9744
20 8 1	3.7914	3.2701	0.0470	CaIX	Ka2	3.6997	2210 1	4.6366	2.6740	0.0755	TiXI	Ka2	4.522
20 8 2	3.7949	3.2671	0.0939	CaIX	Ka1	3.7033	2210 2	4.6419	2.6710	0.1509	TiXI	Ka1	4.522
20 8 3	4.1553	2.9838	0.0026	CaIX	Kbe3	4.055	2210 3	5.1180	2.4225	0.0046	TiXI	Kbe3	4.9853
20 9 1	3.8045	3.2589	0.0482	CaX	Ka2	3.7030	2211 1	4.6494	2.6667	0.0776	TiXII	Ka2	4.525
20 9 2	3.8080	3.2559	0.0963	CaX	Ka1	3.7067	2211 2	4.6548	2.6636	0.1552	TiXII	K	

Table 1. List of  $K\alpha$  and  $K\beta$  innershell ionization lines (continued)

2216 1	4.6677	2.6562	0.2279	TiXVII Kal2	4.614	2411 1	5.5501	2.2339	0.0938				
2216 2	4.6677	2.6562	0.1139	TiXVII Kal1	4.614	2411 2	5.5590	2.2303	0.1875				
2217 1	4.6644	2.6581	0.4016	TiXVII Kal2	4.645	2411 3	6.1617	2.0122	0.0116				
2218 1	4.6559	2.6630	0.3438	TiXIX Kal2	4.677	2412 1	5.5642	2.2283	0.0953				
23 1 1	4.9442	2.5076	0.0751	V II Kal2	4.9446	2412 2	5.5731	2.2247	0.1926				
23 1 2	4.9522	2.5036	0.1502	V II Kal1	4.9522	2412 3	6.1816	2.0057	0.0060				
23 1 3	5.4263	2.2849	0.0092	V II Kbe3	5.4273	2413 1	5.5770	2.2231	0.0990				
23 1 4	5.4275	2.2844	0.0184	V II Kbe1	5.4273	2413 2	5.5860	2.2196	0.1980				
23 2 1	4.9602	2.4996	0.0753			2414 1	5.5898	2.2180	0.1006				
23 2 2	4.9682	2.4956	0.1506			2414 2	5.5976	2.2150	0.2013				
23 2 3	5.4500	2.2749	0.0092			2415 1	5.5989	2.2145	0.1023				
23 2 4	5.4513	2.2744	0.0185			2415 2	5.6079	2.2109	0.2045				
23 3 1	4.9751	2.4921	0.0753			2416 1	5.6144	2.2083	0.1346				
23 3 2	4.9831	2.4881	0.1507			2416 2	5.6144	2.2093	0.2019				
23 3 3	5.4727	2.2655	0.0092			2417 1	5.6169	2.2073	0.1865				
23 3 4	5.4739	2.2650	0.0185			2417 2	5.6169	2.2073	0.1865				
23 4 1	4.9911	2.4841	0.0754			2418 1	5.5937	2.2165	0.2797				
23 4 2	4.9992	2.4801	0.1508			2418 2	5.5937	2.2165	0.1398				
23 4 3	5.4967	2.2556	0.0092			2419 1	5.5886	2.2185	0.4826				
23 4 4	5.4979	2.2551	0.0185			2420 1	5.5783	2.2226	0.4214				
23 5 1	5.0073	2.4761	0.0755			25 1 1	5.8884	2.1056	0.0928	MnII	Kal2	5.8877	
23 5 2	5.0153	2.4721	0.1509			25 1 2	5.8993	2.1017	0.1855	MnII	Kal1	5.8988	
23 5 3	5.5208	2.2458	0.0093			25 1 3	6.4893	1.9106	0.0116	MnII	Kbe3	6.5352	
23 5 4	5.5220	2.2453	0.0185			25 1 4	6.4908	1.9101	0.0231	MnII	Kbe1	6.5352	
23 6 1	5.0223	2.4687	0.0755			25 2 1	5.9034	2.1002	0.0929				
23 6 2	5.0304	2.4647	0.1510			25 2 2	5.9156	2.0959	0.1858				
23 6 3	5.5437	2.2365	0.0093			25 2 3	6.5133	1.9036	0.0116				
23 6 4	5.5450	2.2360	0.0185			25 2 4	6.5148	1.9031	0.0232				
23 7 1	5.0362	2.4619	0.0775			25 3 1	5.9197	2.0944	0.0930				
23 7 2	5.0443	2.4579	0.1550			25 3 2	5.9306	2.0906	0.1860				
23 7 3	5.5667	2.2272	0.0095			25 3 3	6.5373	1.8966	0.0116				
23 7 4	5.5667	2.2272	0.0143			25 3 4	6.5388	1.8961	0.0232				
23 8 1	5.0513	2.4545	0.0796			25 4 1	5.9334	2.0896	0.0931				
23 8 2	5.0582	2.4511	0.1591			25 4 2	5.9443	2.0858	0.1861				
23 8 3	5.5873	2.2190	0.0098			25 4 3	6.5599	1.8900	0.0116				
23 8 4	5.5973	2.2190	0.0098			25 4 4	6.5615	1.8896	0.0232				
23 9 1	5.0641	2.4483	0.0817			25 5 1	6.9470	2.0848	0.0931				
23 9 2	5.0711	2.4449	0.1634			25 5 2	5.9580	2.0810	0.1863				
23 9 3	5.5989	2.2145	0.0100			25 5 3	6.5842	1.8831	0.0116				
23 9 4	5.5989	2.2145	0.0050			25 5 4	6.5857	1.8826	0.0232				
2310 1	5.0757	2.4427	0.0839			25 6 1	5.9635	2.0791	0.0932				
2310 2	5.0828	2.4393	0.1679			25 6 2	5.9745	2.0752	0.1864				
2310 3	5.6169	2.2073	0.0103			25 6 3	6.6100	1.8757	0.0116				
2311 1	5.0898	2.4359	0.0862			25 6 4	6.6115	1.8753	0.0232				
2311 2	5.0968	2.4326	0.1725			25 7 1	5.9786	2.0738	0.0933				
2311 3	5.6377	2.1992	0.0053			25 7 2	5.9896	2.0700	0.1866				
2312 1	5.1027	2.4298	0.0886			25 7 3	6.6328	1.8692	0.0116				
2312 2	5.1098	2.4264	0.1773			25 7 4	6.6344	1.8688	0.0233				
2313 1	5.1145	2.4242	0.0902			25 8 1	5.9924	2.0690	0.0933				
2313 2	5.1215	2.4208	0.1803			25 8 2	6.0034	2.0652	0.1867				
2314 1	5.1239	2.4197	0.0917			25 8 3	6.6558	1.8628	0.0116				
2314 2	5.1310	2.4164	0.1834			25 8 4	6.6573	1.8624	0.0233				
2315 1	5.1381	2.4131	0.1212			25 9 1	6.0062	2.0643	0.0958				
2315 2	5.1381	2.4131	0.1818			25 9 2	6.0173	2.0605	0.1915				
2316 1	5.1404	2.4119	0.1689			25 9 3	6.6788	1.8564	0.0119				
2316 2	5.1404	2.4119	0.1689			25 9 4	6.6788	1.8564	0.0179				
2317 1	5.1204	2.4214	0.2550			2510 1	6.0200	2.0595	0.0983				
2317 2	5.1204	2.4214	0.1275			2510 2	6.0311	2.0557	0.1966				
2318 1	5.1145	2.4242	0.4442			2510 3	6.7004	1.8504	0.0123				
2319 1	5.1062	2.4281	0.3838			2510 4	6.7004	1.8504	0.0123				
24 1 1	5.4063	2.2933	0.0840	CrII Kal2	5.4055	2511 1	6.0339	2.0548	0.1009				
24 1 2	5.4150	2.2896	0.1679	CrII Kal1	5.4147	2511 2	6.0437	2.0515	0.2018				
24 1 3	5.9457	2.0853	0.0104	CrII Kbe3	5.9467	2511 3	6.7112	1.8474	0.0126				
24 1 4	5.9470	2.0848	0.0208	CrII Kbe1	5.9467	2511 4	6.7112	1.8474	0.0063				
24 2 1	5.4213	2.2870	0.0841			2512 1	6.0464	2.0505	0.1037				
24 2 2	5.4313	2.2828	0.1681			2512 2	6.0576	2.0468	0.2073				
24 2 3	5.9704	2.0767	0.0104			2512 3	6.7313	1.8419	0.0129				
24 2 4	5.9704	2.0767	0.0208			2513 1	6.0604	2.0458	0.1065				
24 3 1	5.4363	2.2807	0.0841			2513 2	6.0716	2.0421	0.2129				
24 3 2	5.4463	2.2765	0.1683			2513 3	6.7499	1.8368	0.0066				
24 3 3	5.9924	2.0690	0.0104			2514 1	6.0730	2.0416	0.1094				
24 3 4	5.9938	2.0686	0.0208			2514 2	6.0842	2.0378	0.2188				
24 4 1	5.4513	2.2744	0.0842			2515 1	6.0856	2.0374	0.1112				
24 4 2	5.4601	2.2707	0.1684			2515 2	6.0954	2.0341	0.2223				
24 4 3	6.0173	2.0605	0.0104			2516 1	6.0954	2.0341	0.1129				
24 4 4	6.0187	2.0600	0.0208			2516 2	6.1066	2.0303	0.2257				
24 5 1	5.4664	2.2681	0.0843			2517 1	6.1122	2.0285	0.1479				
24 5 2	5.4765	2.2639	0.1685			2517 2	6.1122	2.0285	0.2219				
24 5 3	6.0409	2.0524	0.0104			2518 1	6.1136	2.0280	0.2038				
24 5 4	6.0423	2.0519	0.0208			2518 2	6.1136	2.0280	0.2038				
24 6 1	5.4828	2.2613	0.0843			2519 1	6.0884	2.0364	0.3035				
24 6 2	5.4916	2.2577	0.1686			2519 2	6.0884	2.0364	0.1517				
24 6 3	6.0646	2.0444	0.0104			2520 1	6.0813	2.0388	0.5184				
24 6 4	6.0660	2.0439	0.0208			2521 1	6.0716	2.0421	0.4562				
24 7 1	5.4967	2.2556	0.0844			26 1 1	6.3915	1.9398	0.1013	FeII	Kal2	6.3910	
24 7 2	5.5055	2.2520	0.1688			26 1 2	6.4047	1.9358	0.2026	FeII	Kal1	6.4040	
24 7 3	6.0884	2.0364	0.0104			26 1 3	7.0567	1.7570	0.0127	FeII	Kbe3	7.0568	
24 7 4	6.0884	2.0364	0.0209			26 1 4	7.0583	1.7566	0.0254	FeII	Kbe1	7.0582	
24 8 1	5.5106	2.2499	0.0866			26 2 1	6.4077	1.9349	0.1014	FeIII	Kal2	6.3934	
24 8 2	5.5195	2.2463	0.1732			26 2 2	6.4195	1.9314	0.2028	FeIII	Kal1	6.4064	
24 8 3	6.1108	2.0289	0.0107			26 2 3	7.0811	1.7509	0.0127	FeIII	Kbe3	7.0682	
24 8 4	6.1108	2.0289	0.0161			26 2 4	7.0827	1.7505	0.0255	FeIII	Kbe1	7.0698	
24 9 1	5.5246	2.2442	0.0889			26 3 1	6.4224	1.9305	0.1015	FeIV	Kal2	6.3927	
24 9 2	5.5335	2.2406	0.1778			26 3 2	6.4343	1.9269	0.2030	FeIV	Kal1	6.4057	
24 9 3	6.1320	2.0219	0.0110			26 3 3	7.1056	1.7449	0.0127	FeIV	Kbe3	7.0758	
24 9 4	6.1320	2.0219	0.0110			26 3 4	7.1072	1.7445	0.0255	FeIV	Kbe1	7.0774	
2410 1	5.5386	2.2385	0.0913			26 4 1	6.4358	1.9265	0.1016	FeV	Kal2	6.3920	
2410 2	5.5475	2.2349	0.1825			26 4 2	6.4491	1.9225	0.2032	FeV	Kal1	6.4050	
2410 3	6.1433	2.0182	0.0113			26 4 3	7.1285	1.7393	0.0128	FeV	Kbe3	7.0809	
2410 4	6.1433	2.0182	0.0056			26							

Table 1. List of  $K\alpha$  and  $K\beta$  innershell ionization lines (continued)

26 5 1	6.4491	1.9225	0.1017	FeVI	Ka2	6.3913	2713 1	7.0876	1.7493	0.1179			
26 5 2	6.4625	1.9185	0.2034	FeVI	Ka1	6.4043	2713 2	7.1023	1.7457	0.2358			
26 5 3	7.1515	1.7337	0.0128	FeVI	Kbe3	7.0868	2713 3	7.9232	1.5648	0.0148			
26 5 4	7.1532	1.7333	0.0255	FeVI	Kbe1	7.0884	2713 4	7.9232	1.5648	0.0074			
26 6 1	6.4640	1.9181	0.1018	FeVII	Ka2	6.3906	2714 1	7.1007	1.7461	0.1211			
26 6 2	6.4774	1.9141	0.2035	FeVII	Ka1	6.4036	2714 2	7.1154	1.7425	0.2421			
26 6 3	7.1763	1.7277	0.0128	FeVII	Kbe3	7.0951	2714 3	7.9433	1.5609	0.0152			
26 6 4	7.1796	1.7269	0.0255	FeVII	Kbe1	7.0967	2715 1	7.1154	1.7425	0.1243			
26 7 1	6.4789	1.9137	0.1018	FeVIII	Ka2	6.3899	2715 2	7.1302	1.7389	0.2486			
26 7 2	6.4923	1.9097	0.2037	FeVIII	Ka1	6.4029	2715 3	7.9634	1.5569	0.0078			
26 7 3	7.2028	1.7213	0.0128	FeVIII	Kbe3	7.1039	2716 1	7.1285	1.7393	0.1277			
26 7 4	7.2044	1.7209	0.0256	FeVIII	Kbe1	7.1055	2716 2	7.1433	1.7357	0.2554			
26 8 1	6.4938	1.9093	0.1019	FeIX	Ka2	6.3892	2717 1	7.1400	1.7365	0.1296			
26 8 2	6.5073	1.9053	0.2038	FeIX	Ka1	6.4022	2717 2	7.1548	1.7329	0.2591			
26 8 3	7.2244	1.7162	0.0128	FeIX	Kbe3	7.1083	2718 1	7.1515	1.7337	0.1314			
26 8 4	7.2277	1.7154	0.0256	FeIX	Kbe1	7.1099	2718 2	7.1664	1.7301	0.2628			
26 9 1	6.5088	1.9049	0.1020	FeX	Ka2	6.3886	2719 1	7.1713	1.7289	0.1710			
26 9 2	6.5208	1.9014	0.2040	FeX	Ka1	6.4016	2719 2	7.1713	1.7289	0.2565			
26 9 3	7.2494	1.7103	0.0128	FeX	Kbe3	7.1165	2720 1	7.1713	1.7289	0.2339			
26 9 4	7.2510	1.7099	0.0256	FeX	Kbe1	7.1181	2720 2	7.1713	1.7289	0.2339			
2610 1	6.5223	1.9009	0.1046	FeXI	Ka2	6.3905	2721 1	7.1417	1.7361	0.3451			
2610 2	6.5343	1.8974	0.2092	FeXI	Ka1	6.4035	2721 2	7.1417	1.7361	0.1726			
2610 3	7.2728	1.7048	0.0131	FeXI	Kbe3	7.1271	2722 1	7.1335	1.7381	0.5839			
2610 4	7.2728	1.7048	0.0197	FeXI	Kbe1	7.1271	2723 1	7.1203	1.7413	0.5267			
2611 1	6.5358	1.8970	0.1074	FeXII	Ka2	6.3964	28 1 1	7.4611	1.6618	0.1226	NiIII	Ka2	7.4609
2611 2	6.5494	1.8931	0.2147	FeXII	Ka1	6.4096	28 1 2	7.4793	1.6579	0.2451	NiIII	Ka1	7.4782
2611 3	7.2946	1.6997	0.0135	FeXII	Kbe3	7.1388	28 1 3	8.2623	1.5066	0.1544	NiIII	Kbe3	8.2647
2611 4	7.2946	1.6997	0.0135	FeXII	Kbe1	7.1388	28 1 4	8.2642	1.5003	0.0309	NiIII	Kbe1	8.2647
2612 1	6.5509	1.8926	0.1102	FeXIII	Ka2	6.3407	28 2 1	7.4748	1.6587	0.1227	NiIII	Ka2	7.4743
2612 2	6.5630	1.8892	0.2204	FeXIII	Ka1	6.4137	28 2 2	7.4920	1.6549	0.2454	NiIII	Ka1	7.4743
2612 3	7.3047	1.6973	0.0138	FeXIII	Kbe3	7.1391	28 2 3	8.2871	1.4961	0.0155	NiIII	Kbe3	8.286
2612 4	7.3047	1.6973	0.0069	FeXIII	Kbe1	7.1391	28 2 4	8.2909	1.4954	0.0309	NiIII	Kbe1	8.286
2613 1	6.5630	1.8892	0.1132	FeXIV	Ka2	6.4055	28 3 1	7.4886	1.6556	0.1228	NiIV	Ka2	7.473
2613 2	6.5766	1.8852	0.2264	FeXIV	Ka1	6.4186	28 3 2	7.5059	1.6518	0.2456	NiIV	Ka1	7.473
2613 3	7.3249	1.6926	0.0142	FeXIV	Kbe3	7.1492	28 3 3	8.3119	1.4916	0.0155	NiIV	Kbe3	8.295
2614 1	6.5781	1.8848	0.1162	FeXV	Ka2	6.4107	28 3 4	8.3138	1.4913	0.0309	NiIV	Kbe1	8.295
2614 2	6.5902	1.8813	0.2325	FeXV	Ka1	6.4238	28 4 1	7.5041	1.6522	0.1229	NiV	Ka2	7.473
2614 3	7.3451	1.6880	0.0073	FeXV	Kbe3	7.1592	28 4 2	7.5214	1.6484	0.2458	NiV	Ka1	7.473
2615 1	6.5902	1.8813	0.1194	FeXVI	Ka2	6.4164	28 4 3	8.3368	1.4872	0.0155	NiV	Kbe3	8.303
2615 2	6.6024	1.8779	0.2389	FeXVI	Ka1	6.4295	28 4 4	8.3407	1.4865	0.0310	NiV	Kbe1	8.303
2616 1	6.6024	1.8779	0.1213	FeXVII	Ka2	6.4209	28 5 1	7.5180	1.6492	0.1230	NiVI	Ka2	7.473
2616 2	6.6145	1.8744	0.2425	FeXVII	Ka1	6.4340	28 5 2	7.5353	1.6454	0.2459	NiVI	Ka1	7.473
2617 1	6.6130	1.8748	0.1231	FeXVIIKa2		6.4259	28 5 3	8.3618	1.4827	0.0155	NiVI	Kbe3	8.313
2617 2	6.6267	1.8710	0.2461	FeXVIIKa1		6.4390	28 5 4	8.3637	1.4824	0.0310	NiVI	Kbe1	8.313
2618 1	6.6313	1.8697	0.1606	FeXIX	Ka2	6.468	28 6 1	7.5318	1.6461	0.1231	NiVII	Ka2	7.473
2618 2	6.6313	1.8697	0.2409	FeXIX	Ka1	6.468	28 6 2	7.5492	1.6424	0.2461	NiVII	Ka1	7.473
2619 1	6.6313	1.8697	0.2202	FeXX	Ka2	6.5028	28 6 3	8.3869	1.4783	0.0155	NiVII	Kbe3	8.322
2619 2	6.6313	1.8697	0.2202	FeXX	Ka1	6.502	28 6 4	8.3888	1.4780	0.0310	NiVII	Kbe1	8.322
2620 1	6.6054	1.8770	0.3258	FeXXI	Ka2	6.536	28 7 1	7.5457	1.6431	0.1232	NiVIII	Ka2	7.473
2620 2	6.6054	1.8770	0.1629	FeXXI	Ka1	6.536	28 7 2	7.5631	1.6393	0.2463	NiVIII	Ka1	7.473
2621 1	6.5963	1.8796	0.5521	FeXXII	Ka2	6.574	28 7 3	8.4120	1.4739	0.0155	NiVIII	Kbe3	8.331
2622 1	6.5857	1.8826	0.4903	FeXXIIKa2		6.574	28 7 4	8.4140	1.4736	0.0310	NiVIII	Kbe1	8.331
27 1 1	6.9151	1.7929	0.1084	CoII	Ka2	6.9153	28 8 1	7.5596	1.6401	0.1232	NiIX	Ka2	7.473
27 1 2	6.9295	1.7879	0.2168	CoII	Ka1	6.9303	28 8 2	7.5770	1.6363	0.2465	NiIX	Ka1	7.473
27 1 3	7.6472	1.6213	0.0136	CoII	Kbe3	7.6494	28 8 3	8.4353	1.4698	0.0155	NiIX	Kbe3	8.339
27 1 4	7.6489	1.6209	0.0272	CoII	Kbe1	7.6494	28 8 4	8.4392	1.4692	0.0311	NiIX	Kbe1	8.339
27 2 1	6.9295	1.7892	0.1085				28 9 1	7.5753	1.6367	0.1233	NiX	Ka2	7.469
27 2 2	6.9454	1.7851	0.2171				28 9 2	7.5928	1.6329	0.2467	NiX	Ka1	7.469
27 2 3	7.6718	1.6161	0.0136				28 9 3	8.4606	1.4654	0.0155	NiX	Kbe3	8.342
27 2 4	7.6736	1.6157	0.0273				28 9 4	8.4645	1.4648	0.0311	NiX	Kbe1	8.342
27 3 1	6.9454	1.7851	0.1086				2810 1	7.5893	1.6337	0.1234	NiXI	Ka2	7.469
27 3 2	6.9599	1.7814	0.2172				2810 2	7.6068	1.6299	0.2468	NiXI	Ka1	7.469
27 3 3	7.6966	1.6109	0.0136				2810 3	8.4859	1.4611	0.0156	NiXI	Kbe3	8.351
27 3 4	7.6984	1.6105	0.0273				2810 4	8.4899	1.4604	0.0311	NiXI	Kbe1	8.351
27 4 1	6.9599	1.7814	0.1087				2811 1	7.6033	1.6307	0.1235	NiXII	Ka2	7.469
27 4 2	6.9777	1.7777	0.2174				2811 2	7.6209	1.6269	0.2470	NiXII	Ka1	7.469
27 4 3	7.7215	1.6057	0.0137				2811 3	8.5114	1.4567	0.0156	NiXII	Kbe3	8.361
27 4 4	7.7232	1.6053	0.0273				2811 4	8.5133	1.4564	0.0311	NiXII	Kbe1	8.361
27 5 1	6.9727	1.7781	0.1088				2812 1	7.6190	1.6273	0.1266	NiXIII	Ka2	7.473
27 5 2	6.9888	1.7741	0.2176				2812 2	7.6366	1.6236	0.2533	NiXIII	Ka1	7.473
27 5 3	7.7446	1.6009	0.0137				2812 3	8.5369	1.4523	0.0160	NiXIII	Kbe3	8.374
27 5 4	7.7464	1.6005	0.0273				2812 4	8.5369	1.4523	0.0239	NiXIII	Kbe1	8.374
27 6 1	6.9871	1.7745	0.1089				2813 1	7.6331	1.6243	0.1299	NiXIV	Ka2	7.478
27 6 2	7.0016	1.7708	0.2177				2813 2	7.6507	1.6206	0.2597	NiXIV	Ka1	7.478
27 6 3	7.7696	1.5958	0.0137				2813 3	8.5585	1.4487	0.0164	NiXIV	Kbe3	8.384
27 6 4	7.7714	1.5954	0.0274				2813 4	8.5585	1.4487	0.0164	NiXIV	Kbe1	8.384
27 7 1	7.0016	1.7708	0.1089				2814 1	7.6472	1.6213	0.1332	NiXV	Ka2	7.487
27 7 2	7.0162	1.7671	0.2179				2814 2	7.6648	1.6176	0.2665	NiXV	Ka1	7.487
27 7 3	7.7929	1.5910	0.0137				2814 3	8.5684	1.4470	0.0168	NiXV	Kbe3	8.399
27 7 4	7.7965	1.5903	0.0274				2814 4	8.5684	1.4470	0.0084	NiXV	Kbe1	8.389
27 8 1	7.0162	1.7671	0.1090				2815 1	7.6613	1.6183	0.1367	NiXVI	Ka2	7.491
27 8 2	7.0307	1.7635	0.2181				2815 2	7.6771	1.6150	0.2735	NiXVI	Ka1	7.491
27 8 3	7.8181	1.5859	0.0137				2815 3	8.5882	1.4437	0.0172	NiXVI	Kbe3	8.398
27 8 4	7.8217	1.5851	0.0274				2816 1	7.6754	1.6153	0.1403	NiXVII	Ka2	7.496
27 9 1	7.0307	1.7635	0.1091				2816 2	7.6913	1.6120	0.2807	NiXVII	Ka1	7.496
27 9 2	7.0453	1.7598	0.2182				2816 3	8.6099	1.4400	0.0088	NiXVII	Kbe3	8.409
27 9 3	7.8433	1.5808	0.0137				2817 1	7.6878	1.6127	0.1441	NiXVIII	Ka2	7.505
27 9 4	7.8451	1.5804	0.0274				2817 2	7.7055	1.6090	0.2883	NiXVIII	Ka1	7.505
2710 1	7.0453	1.7598	0.1092				2818 1	7.7002	1.6102	0.1461	NiXIX	Ka2	7.510
2710 2	7.0599	1.7562	0.2184				2818						

