

**ALLOWED AND FORBIDDEN
TRANSITIONS IN Fe XIX**

**Sultana N. Nahar
The Ohio State University**

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RADIATIVE TRANSITIONS FOR EXCITATIONS AND DE-EXCITATIONS



Present f -, S , A -values for:

Allowed electric dipole (E1) transitions ($\Delta j=0,\pm 1$, parity π changes)

- Dipole allowed ($\Delta L = 0, \pm 1, \pm 2, \Delta S = 0$)
- Intercombination ($\Delta L = 0, \pm 1, \pm 2, \Delta S \neq 0$)

Forbidden transitions

- Electric quadrupole (E2) transitions ($\Delta J = 0,\pm 1,\pm 2$, parity does not change)
- Magnetic dipole (M1) transitions ($\Delta J = 0,\pm 1$, parity does not change)
- Electric octupole (E3) transitions ($\Delta J = \pm 2, \pm 3$, parity changes)
- Magnetic quadrupole (M2) transitions ($\Delta J = \pm 2$, parity changes)

Calculations:

- Breit-Pauli R-matrix (BPRM) calculations for E1 transitions
- Forbidden (E2, E3, M1, M2) transitions – SUPER-STRUCTURE

BPRM CALCULATIONS FOR E1 TRANSITIONS:

The wave function expansion in close coupling approximation:

$$\Psi_E(e + ion) = A \sum_i^N \chi_i(ion)\theta_i + \sum_j c_j \Phi_j(e + ion)$$

The target or core Fe XX wavefunction is obtained from the set of 16 configurations using SUPERSTRUCTURE (Eissner et al 1974):

$2s^22p^3$, $2s2p^4$, $2p^5$, $2s^22p^23s$, $2s^22p^23p$, $2s^22p^23d$, $2s^22p^24s$, $2s^22p^24p$, $2s^22p^24d$, $2s^22p^24f$, $2s2p^33s$, $2s2p^33p$, $2s2p^33d$, $2s2p^34s$, $2s2p^34p$, $2s2p^34d$,

The Thomas-Fermi scaling parameters for the orbitals:

$\lambda_{nl} = 1.35(1s)$, $1.25(2s)$, $1.12(2p)$, $1.07(3s)$, $1.05(3p)$, $1.0(3d)$.
 $1.0(4s)$, $1.0(4p)$, $1.0(4d)$, $1(4f)$.

Table 1. Fine structure levels and relative energies (E_t) of Fe XX.

	Term	J_t	$E_t(\text{Ry})$
1	$2s^22p^3(^4S^o)$	1.5	0.0
2	$2s^22p^3(^2D^o)$	1.5	1.2632
3	$2s^22p^3(^2D^o)$	2.5	1.6050
4	$2s^22p^3(^2P^o)$	0.5	2.3718
5	$2s^22p^3(^2P^o)$	1.5	2.9465
6	$2s2p^4(^4P)$	2.5	6.8594
7	$2s2p^4(^4P)$	1.5	7.4799
8	$2s2p^4(^4P)$	0.5	7.6796
9	$2s2p^4(^2D)$	1.5	9.5006
10	$2s2p^4(^2D)$	2.5	9.6445
11	$2s2p^4(^2S)$	0.5	10.892
12	$2s2p^4(^2P)$	1.5	11.322
13	$2s2p^4(^2P)$	0.5	12.211
14	$2p^5(^2P^o)$	1.5	17.811
15	$2p^5(^2P^o)$	0.5	18.792

- Choice of a smaller expansion - No bound state is expected with core excitation beyond the 15 levels. Next excitation is 47 Ry higher.
- The second term in $\Psi_E(e + ion)$ considers 125 configurations

RESULTS

Fine Structure Energy Levels of Fe XIX

Calculated: 1627, Observed: 62

Total angular momenta $0 \leq J \leq 7$ of even and 8 of odd parities with $2 \leq n \leq 10$, $0 \leq l \leq 9$, orbital angular momenta, $0 \leq L \leq 10$, and spin multiplicities 1, 3, 5.

Theoretical Spectroscopy of Energy Levels:

- It has been a major effort for Fe XIX with 1627 energy levels taking couple of months to identify them
- In the first choice, all levels are designated with spectroscopic identification following the most contributing channel:

$$(C_t S_t L_t J_t \pi_t n \ell [K] s) J \pi \quad (1)$$

- In case of identical dominant channel for two levels, the next dominant one or another possible channel that can complete the set of fine structure components of a LS term.
- Several assumptions are made, such as,
 - i) higher S-states lie lower
 - ii) A level with higher core and lower l may lie lower otherwise, etc.
- These assumptions may not hold for all levels for a multielectron system.

Table: Comparison of Fine Structure Energy Levels of

E_c =calculated energy, E_o =measured energy (in NIST compilation); I_J =level index for the calculated energy position in symmetry $J\pi$. The asterisk indicates incomplete set of observed energies.

Good agreement, less than 1% to a few percent.

Level	J	I_J	$E_o(\text{Ry})$	$E_c(\text{Ry})$	
2s22p4	3P	2.0	1	107.900	107.293
2s22p4	3P	1.0	1	107.085	106.482
2s22p4	3P	0.0	1	107.214	106.613
2s22p4	1D	2.0	2	106.361	105.720
2s22p4	1S	0.0	2	104.937	104.269
2s2p5	$^3P^o$	2.0	1	99.490	98.827
2s2p5	$^3P^o$	1.0	1	98.926	98.257
2s2p5	$^3P^o$	0.0	1	98.514	97.843
2s2p5	$^1P^o$	1.0	2	96.349	95.642
2p6	1S	0.0	3	88.452	87.702
2s22p3(4So)3s	$^3S^o$	1.0	3	47.027	46.328
2s22p3(2Do)3s	$^3D^o$	3.0	1	45.770	45.026
2s22p3(2Do)3s	$^3D^o$	2.0	3	46.052	45.351
2s22p3(2Do)3s	$^3D^o$	1.0	4	46.043	45.336
2s22p3(2Do)3s	$^1D^o$	2.0	4	45.624	44.851
2s22p3(2Po)3s	$^3P^o$	2.0	5	44.385	43.692
2s22p3(2Po)3s	$^3P^o$	1.0	5	44.813	44.215
2s22p3(2Po)3s	$^3P^o$	0.0	2	44.959	44.286
2s22p3(2Po)3s	$^1P^o$	1.0	6	44.248	43.552
2s22p3(4So3/2)3d	$^3D^o$	3.0*	2	41.842	41.800
2s22p3(2Do3/2)3d	$^3P^o$	2.0*	8	40.740	40.497
2s22p3(2Do5/2)3d	$^3D^o$	3.0*	4	40.503	40.376
2s22p3(2Do5/2)3d	$^3D^o$	2.0*	10	40.421	39.666
2s22p3(2Do5/2)3d	$^1F^o$	3.0	6	40.020	39.734
2s22p3(2Po1/2)3d	$^3F^o$	3.0*	7	40.011	39.255
2s22p3(2Po1/2)3d	$^3F^o$	2.0*	11	39.847	39.555
2s22p3(2Po3/2)3d	$^3D^o$	3.0	9	38.963	38.380
2s22p3(2Po3/2)3d	$^3D^o$	2.0	13	39.063	38.938
2s22p3(2Po3/2)3d	$^3D^o$	1.0	13	38.944	38.781
2s22p3(2Po3/2)3d	$^1P^o$	1.0	14	38.589	38.543
2s22p3(4So3/2)4d	$^3D^o$	3.0	19	23.626	23.487
2s22p3(4So3/2)4d	$^3D^o$	2.0	34	23.681	23.383
2s22p3(4So3/2)4d	$^3D^o$	1.0	35	23.663	23.247

BPRM fine structure levels of Fe XIX with spectroscopic identification

Table: Levels are grouped for the LS terms.

$C_t(S_t L_t \pi_t)$	J_t	nl	$2J$	E(Ry)	ν	$SL\pi$	
2s22p4			2	-1.07293E+02	0.00	3 P e	
2s22p4			0	-1.06613E+02	0.00	3 P e	
2s22p4			1	-1.06482E+02	0.00	3 P e	
Nlv(c)= 3 : set complete							
Eqv electron/unidentified levels, parity: e							
2s22p4			2	-1.05720E+02	0.00	1 D e	
Nlv(c)= 1 : set complete							
Eqv electron/unidentified levels, parity: e							
2s22p4			0	-1.04269E+02	0.00	1 S e	
Nlv(c)= 1 : set complete							
Eqv electron/unidentified levels, parity: o							
2s2p5			2	-9.88274E+01	0.00	3 P o	
2s2p5			1	-9.82573E+01	0.00	3 P o	
2s2p5			0	-9.78426E+01	0.00	3 P o	
Nlv(c)= 3 : set complete							
Eqv electron/unidentified levels, parity: o							
2s2p5			1	-9.56415E+01	0.00	1 P o	
Nlv(c)= 1 : set complete							
Eqv electron/unidentified levels, parity: e							
2p6			0	-8.77017E+01	0.00	1 S e	
Nlv(c)= 1 : set complete							
Nlv= 1, $^5L^o$: S (2)							
2s22p3	(4So)	3/2	3s	2	-4.67925E+01	2.78	5 S o
Nlv(c)= 1 : set complete							
Nlv= 1, $^3L^o$: S (1)							
2s22p3	(4So)	3/2	3s	1	-4.63279E+01	2.79	3 S o
Nlv(c)= 1 : set complete							
Nlv= 3, $^3L^o$: D (3 2 1)							
2s22p3	(2Do)	5/2	3s	2	-4.53506E+01	2.77	3 D o
2s22p3	(2Do)	3/2	3s	1	-4.53358E+01	2.78	3 D o
2s22p3	(2Do)	5/2	3s	3	-4.50261E+01	2.78	3 D o
Nlv(c)= 3 : set complete							
Nlv= 1, $^1L^o$: D (2)							
2s22p3	(2Do)	3/2	3s	2	-4.48510E+01	2.80	1 D o
Nlv(c)= 1 : set complete							

Table: Sample set of fine structure levels of Fe XIX and their relative energies for which forbidden transitions have been obtained. The configuration indices (Cf) correspond to

$2s^22p^4$ (1), $2s2p^5$ (2), $2p^6$ (3), $2s^22p^33s$ (4), $2s^22p^33p$ (5), $2s^22p^33d$ (6), $2s^22p^34s$ (7), $2s^22p^34p$ (8), $2s^22p^34d$ (9), $2s^22p^34f$ (10), $2s2p^43s$ (11), $2s2p^43p$ (12), $2s2p^43d$ (13), $2s2p^44s$ (14), $2s2p^44p$ (15), and $2s^22p^23s^2$ (16).

ie	SLp(cf)	2J	E(Ry)
1	3Pe(1)	4	0.00000E+00
2	3Pe(1)	0	6.85730E-01
3	3Pe(1)	2	8.15050E-01
4	1De(1)	4	1.53870E+00
5	1Se(1)	0	2.96290E+00
6	3Po(2)	4	8.41000E+00
7	3Po(2)	2	8.97360E+00
8	3Po(2)	0	9.38620E+00
9	1Po(2)	2	1.15510E+01
10	1Se(3)	0	1.94480E+01
11	5So(4)	4	6.07327E+01
12	3So(4)	2	6.08730E+01
13	3Do(4)	4	6.18480E+01
14	3Do(4)	2	6.18570E+01
15	3Do(4)	6	6.21300E+01
16	1Do(4)	4	6.22760E+01
17	5Pe(5)	2	6.28417E+01
18	5Pe(5)	4	6.28804E+01
19	5Pe(5)	6	6.30517E+01
20	3De(5)	2	6.33572E+01
21	3Po(4)	0	6.29410E+01
22	3Po(4)	2	6.30870E+01
23	3Pe(5)	4	6.35297E+01
24	3Pe(5)	0	6.36047E+01
25	3Po(4)	4	6.35150E+01
26	3Pe(5)	2	6.40530E+01
27	3Pe(5)	6	6.41000E+01
28	3Pe(5)	4	6.41000E+01
29	3Pe(5)	2	6.41000E+01
30	3Pe(5)	0	6.41000E+01
31	3Pe(5)	4	6.41000E+01
32	3Pe(5)	2	6.41000E+01
33	3Pe(5)	0	6.41000E+01
34	3Pe(5)	4	6.41000E+01
35	3Pe(5)	2	6.41000E+01
36	3Pe(5)	0	6.41000E+01
37	3Pe(5)	4	6.41000E+01
38	3Pe(5)	2	6.41000E+01
39	3Pe(5)	0	6.41000E+01
40	3Pe(5)	4	6.41000E+01
41	3Pe(5)	2	6.41000E+01
42	3Pe(5)	0	6.41000E+01
43	3Pe(5)	4	6.41000E+01
44	3Pe(5)	2	6.41000E+01
45	3Pe(5)	0	6.41000E+01
46	3Pe(5)	4	6.41000E+01
47	3Pe(5)	2	6.41000E+01
48	3Pe(5)	0	6.41000E+01
49	3Pe(5)	4	6.41000E+01
50	3Pe(5)	2	6.41000E+01
51	3Pe(5)	0	6.41000E+01
52	3Pe(5)	4	6.41000E+01
53	3Pe(5)	2	6.41000E+01
54	3Pe(5)	0	6.41000E+01
55	3Pe(5)	4	6.41000E+01
56	3Pe(5)	2	6.41000E+01
57	3Pe(5)	0	6.41000E+01
58	3Pe(5)	4	6.41000E+01
59	3Pe(5)	2	6.41000E+01
60	3Pe(5)	0	6.41000E+01
61	3Pe(5)	4	6.41000E+01
62	3Pe(5)	2	6.41000E+01
63	3Pe(5)	0	6.41000E+01
64	3Pe(5)	4	6.41000E+01
65	3Pe(5)	2	6.41000E+01
66	3Pe(5)	0	6.41000E+01
67	3Pe(5)	4	6.41000E+01
68	3Pe(5)	2	6.41000E+01
69	3Pe(5)	0	6.41000E+01
70	3Pe(5)	4	6.41000E+01
71	3Pe(5)	2	6.41000E+01
72	3Pe(5)	0	6.41000E+01
73	3Pe(5)	4	6.41000E+01
74	3Pe(5)	2	6.41000E+01
75	3Pe(5)	0	6.41000E+01
76	3Pe(5)	4	6.41000E+01
77	3Pe(5)	2	6.41000E+01
78	3Pe(5)	0	6.41000E+01
79	3Pe(5)	4	6.41000E+01
80	3Pe(5)	2	6.41000E+01
81	3Pe(5)	0	6.41000E+01
82	3Pe(5)	4	6.41000E+01
83	3Pe(5)	2	6.41000E+01
84	3Pe(5)	0	6.41000E+01
85	3Pe(5)	4	6.41000E+01
86	3Pe(5)	2	6.41000E+01
87	3Pe(5)	0	6.41000E+01
88	3Pe(5)	4	6.41000E+01
89	3Pe(5)	2	6.41000E+01
90	3Pe(5)	0	6.41000E+01
91	3Pe(5)	4	6.41000E+01
92	3Pe(5)	2	6.41000E+01
93	3Pe(5)	0	6.41000E+01
94	3Pe(5)	4	6.41000E+01
95	3Pe(5)	2	6.41000E+01
96	3Pe(5)	0	6.41000E+01
97	3Pe(5)	4	6.41000E+01
98	3Pe(5)	2	6.41000E+01
99	3Pe(5)	0	6.41000E+01
100	3Pe(5)	4	6.41000E+01

Table: Sample table of radiative decay rates in s^{-1} for the forbidden AE2, AM1, AE3, AM1 in Fe XIX. The level numbers (i, j) and configurations indices (Ci, Cj) correspond to:

$2s^22p^4(1)$, $2s2p^5(2)$, $2p^6(3)$, $2s^22p^33s(4)$, $2s^22p^33p(5)$,
 $2s^22p^33d(6)$, $2s^22p^34s(7)$, $2s^22p^34p(8)$, $2s^22p^34d(9)$,
 $2s2p^43s(10)$, $2s2p^43p(11)$, $2s2p^43d(12)$, $2s^22p^23s^2(13)$.

i- j	$T_i C_i - T_j C_j$	$g_i - g_j$	$\lambda(\text{\AA})$	$E_i(\text{Ry})$	$E_j(\text{Ry})$	AE2	AM1
E2 and M1, $N_{tr} = 48219$							
1- 2	3Pe 1- 3Pe 1	5- 1	1328	0.00E+00	6.86E-01	5.02E-01	0.00E+00
1- 3	3Pe 1- 3Pe 1	5- 3	1118	0.00E+00	8.15E-01	6.35E-01	1.46E+04
2- 3	3Pe 1- 3Pe 1	1- 3	7046	6.86E-01	8.15E-01	0.00E+00	4.10E+01
1- 4	3Pe 1- 1De 1	5- 5	592.23	0.00E+00	1.54E+00	6.00E+00	1.67E+04
2- 4	3Pe 1- 1De 1	1- 5	1068	6.86E-01	1.54E+00	7.28E-02	0.00E+00
3- 4	3Pe 1- 1De 1	3- 5	1259	8.15E-01	1.54E+00	2.27E-02	6.51E+02
1- 5	3Pe 1- 1Se 1	5- 1	307.56	0.00E+00	2.96E+00	8.32E+00	0.00E+00
3- 5	3Pe 1- 1Se 1	3- 1	424.27	8.15E-01	2.96E+00	0.00E+00	1.41E+05
4- 5	1De 1- 1Se 1	5- 1	639.84	1.54E+00	2.96E+00	4.92E+01	0.00E+00
6- 7	3Po 2- 3Po 2	5- 3	1616	8.41E+00	8.97E+00	1.09E-01	5.15E+03
6- 8	3Po 2- 3Po 2	5- 1	933.48	8.41E+00	9.39E+00	2.32E+00	0.00E+00
7- 8	3Po 2- 3Po 2	3- 1	2208	8.97E+00	9.39E+00	0.00E+00	4.86E+03
6- 9	3Po 2- 1Po 2	5- 3	290.12	8.41E+00	1.16E+01	1.75E+01	2.78E+04
7- 9	3Po 2- 1Po 2	3- 3	353.56	8.97E+00	1.16E+01	1.97E+01	8.79E+03
8- 9	3Po 2- 1Po 2	1- 3	420.95	9.39E+00	1.16E+01	0.00E+00	7.31E+03
1- 10	3Pe 1- 1Se 3	5- 1	46.86	0.00E+00	1.94E+01	7.85E+04	0.00E+00
3- 10	3Pe 1- 1Se 3	3- 1	48.91	8.15E-01	1.94E+01	0.00E+00	2.49E+04
4- 10	1De 1- 1Se 3	5- 1	50.88	1.54E+00	1.94E+01	5.50E+05	0.00E+00
6- 11	3Po 2- 5So 4	5- 5	17.42	8.41E+00	6.07E+01	3.11E+05	1.06E+03
7- 11	3Po 2- 5So 4	3- 5	17.61	8.97E+00	6.07E+01	1.15E+05	1.57E+02
8- 11	3Po 2- 5So 4	1- 5	17.75	9.39E+00	6.07E+01	1.18E+04	0.00E+00
9- 11	1Po 2- 5So 4	3- 5	18.53	1.16E+01	6.07E+01	1.03E+04	2.87E+00
6- 12	3Po 2- 3So 4	5- 3	17.37	8.41E+00	6.09E+01	3.98E+05	6.62E+02
7- 12	3Po 2- 3So 4	3- 3	17.56	8.97E+00	6.09E+01	1.50E+05	5.45E+01

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E3 and M2, $N_{tr} = 18400$

i- j	$T_i C_i - T_j C_j$	$g_i - g_j$	$\lambda(\text{\AA})$	$E_i(\text{Ry})$	$E_j(\text{Ry})$	AE3	AM2
2- 6	3Pe 1- 3Po 2	1- 5	117.97	6.86E-01	8.41E+00	0.00E+00	6.80E+01
5.33E+00							
1- 8	3Pe 1- 3Po 2	5- 1	97.09	0.00E+00	9.39E+00	0.00E+00	9.17E+01
4- 8	1De 1- 3Po 2	5- 1	116.12	1.54E+00	9.39E+00	0.00E+00	3.56E+02
6- 10	3Po 2- 1Se 3	5- 1	82.56	8.41E+00	1.94E+01	0.00E+00	3.56E+03
2- 11	3Pe 1- 5So 4	1- 5	15.18	6.86E-01	6.07E+01	0.00E+00	7.45E+04
5- 11	1Se 1- 5So 4	1- 5	15.77	2.96E+00	6.07E+01	0.00E+00	1.83E+02
10- 11	1Se 3- 5So 4	1- 5	22.07	1.94E+01	6.07E+01	0.00E+00	3.60E+01
2- 13	3Pe 1- 3Do 4	1- 5	14.90	6.86E-01	6.18E+01	0.00E+00	4.86E+04
5- 13	1Se 1- 3Do 4	1- 5	15.48	2.96E+00	6.18E+01	0.00E+00	8.00E+04
10- 13	1Se 3- 3Do 4	1- 5	21.49	1.94E+01	6.18E+01	0.00E+00	1.69E+02
2- 15	3Pe 1- 3Do 4	1- 7	14.82	6.86E-01	6.21E+01	1.22E+05	0.00E+00

Table 5. Sample table of dipole allowed and intercombination E1 transitions in Fe XIX, grouped as fine structure components of LS multiplets. The calculated energies have been replaced by the observed energies.

$C_i - C_k$	$T_i - T_k$	$g_i:l-g_j:k$	E_{ik} (\AA)	f	S	A (s^{-1})
$2s22p4 - 2s2p5$	${}^3P^e - {}^3P^o$	1: 1- 3: 1	109.96	5.75E-02	2.08E-02	1.06E+10
$2s22p4 - 2s2p5$	${}^3P^e - {}^3P^o$	3: 1- 1: 1	106.32	2.96E-02	3.11E-02	5.25E+10
$2s22p4 - 2s2p5$	${}^3P^e - {}^3P^o$	3: 1- 3: 1	111.69	2.05E-02	2.26E-02	1.10E+10
$2s22p4 - 2s2p5$	${}^3P^e - {}^3P^o$	3: 1- 5: 1	119.98	3.27E-02	3.88E-02	9.10E+09
$2s22p4 - 2s2p5$	${}^3P^e - {}^3P^o$	5: 1- 3: 1	101.55	1.55E-02	2.59E-02	1.67E+10
$2s22p4 - 2s2p5$	${}^3P^e - {}^3P^o$	5: 1- 5: 1	108.36	5.88E-02	1.05E-01	3.34E+10
<i>LS</i>	${}^3P^e - {}^3P^o$	9- 9		7.53E-02	2.44E-01	4.19E+10
$2s22p4 - 2s2p5$	${}^3P^e - {}^1P^o$	1: 1- 3: 2	83.87	2.87E-02	7.92E-03	9.07E+09
$2s22p4 - 2s2p5$	${}^3P^e - {}^1P^o$	3: 1- 3: 2	84.88	8.59E-04	7.20E-04	7.95E+08
$2s22p4 - 2s2p5$	${}^3P^e - {}^1P^o$	5: 1- 3: 2	78.89	1.91E-02	2.48E-02	3.41E+10
$2s22p4 - 2s22p34So3s$	${}^3P^e - {}^3S^o$	1: 1- 3: 3	15.14	8.24E-02	4.11E-03	7.99E+11
$2s22p4 - 2s22p34So3s$	${}^3P^e - {}^3S^o$	3: 1- 3: 3	15.17	3.25E-02	4.87E-03	9.41E+11
$2s22p4 - 2s22p34So3s$	${}^3P^e - {}^3S^o$	5: 1- 3: 3	14.97	3.08E-02	7.58E-03	1.53E+12
<i>LS</i>	${}^3P^e - {}^3S^o$	9- 3		3.71E-02	1.66E-02	3.27E+12
$2s22p4 - 2s22p32Do3s$	${}^3P^e - {}^3D^o$	1: 1- 3: 4	14.90	4.54E-02	2.23E-03	4.55E+11
$2s22p4 - 2s22p32Do3s$	${}^3P^e - {}^3D^o$	3: 1- 3: 4	14.93	2.25E-02	3.32E-03	6.75E+11
$2s22p4 - 2s22p32Do3s$	${}^3P^e - {}^3D^o$	3: 1- 5: 3	14.93	5.03E-02	7.42E-03	9.03E+11
$2s22p4 - 2s22p32Do3s$	${}^3P^e - {}^3D^o$	5: 1- 3: 4	14.73	2.50E-03	6.05E-04	1.28E+11
$2s22p4 - 2s22p32Do3s$	${}^3P^e - {}^3D^o$	5: 1- 5: 3	14.73	1.44E-03	3.50E-04	4.44E+10
$2s22p4 - 2s22p32Do3s$	${}^3P^e - {}^3D^o$	5: 1- 7: 1	14.67	4.97E-02	1.20E-02	1.10E+12
<i>LS</i>	${}^3P^e - {}^3D^o$	9- 15		5.91E-02	2.59E-02	1.08E+12
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^3P^o$	1: 1- 3: 5	14.60	6.20E-04	2.98E-05	6.46E+09
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^3P^o$	3: 1- 1: 2	14.67	1.04E-02	1.50E-03	9.65E+11
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^3P^o$	3: 1- 3: 5	14.63	7.49E-03	1.08E-03	2.33E+11
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^3P^o$	3: 1- 5: 5	14.53	6.47E-04	9.29E-05	1.23E+10
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^3P^o$	5: 1- 3: 5	14.44	1.32E-02	3.13E-03	7.01E+11
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^3P^o$	5: 1- 5: 5	14.35	1.76E-02	4.16E-03	5.71E+11
<i>LS</i>	${}^3P^e - {}^3P^o$	9- 9		2.34E-02	9.99E-03	7.47E+11
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^1P^o$	1: 1- 3: 6	14.47	2.56E-03	1.22E-04	2.72E+10
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^1P^o$	3: 1- 3: 6	14.50	1.21E-03	1.73E-04	3.84E+10
$2s22p4 - 2s22p32Po3s$	${}^3P^e - {}^1P^o$	5: 1- 3: 6	14.32	1.85E-03	4.36E-04	1.00E+11
$2s22p4 - 2s22p32Po3d$	${}^3P^e - {}^3D^o$	1: 1- 3:13	13.35	3.74E-01	1.64E-02	4.67E+12
$2s22p4 - 2s22p32Po3d$	${}^3P^e - {}^3D^o$	3: 1- 3:13	13.37	1.35E-01	1.78E-02	5.04E+12
$2s22p4 - 2s22p32Po3d$	${}^3P^e - {}^3D^o$	3: 1- 5:13	13.40	1.30E-01	1.73E-02	2.91E+12
$2s22p4 - 2s22p32Po3d$	${}^3P^e - {}^3D^o$	5: 1- 3:13	13.22	1.24E-01	2.70E-02	7.90E+12
$2s22p4 - 2s22p32Po3d$	${}^3P^e - {}^3D^o$	5: 1- 5:13	13.24	5.92E-02	1.29E-02	2.25E+12
$2s22p4 - 2s22p32Po3d$	${}^3P^e - {}^3D^o$	5: 1- 7: 9	13.22	3.14E-02	6.83E-03	8.56E+11
<i>LS</i>	${}^3P^e - {}^3D^o$	9- 15		2.49E-01	9.82E-02	5.63E+12

Table 6. Comparison of present radiative decay rates, A-values, (in units of s^{-1}) for Fe XIX with those from previous calculations. The letter in the second column gives NIST accuracy rating.

Agreement good to fair.

λ Å	A:Ac Others	A Present	$C_i - C_j$	$SL\pi_i - SL\pi_j$	$g_i - g_j$
E1					
13.424	4.8e+12 ^a :E	4.20e+12	$2s^22p^4 - 2s^22p^3(^2P_{5/2}^o)3d$	$^3P - ^3F^o$	5-7
13.52	2.0e+13 ^b : D	2.37e+12	$2s^22p^4 - 2s^22p^3(^2D_{5/2}^o)3d$	$^3P - ^3D^o$	5-7
13.735	1.0e+13 ^a :D	8.23e+12	$2s^22p^4 - 2s^22p^3(^2P_{5/2}^o)3d$	$^1D - ^3F^o$	5-7
14.668	1.1e+12 ^b : C	1.10e+12	$2s^22p^4 - 2s^22p^3(^2D^o)3s$	$^3P - ^3D^o$	5-7
14.668	1.1e+12 ^b :C	9.65e+11	$2s^22p^4 - 2s^22p^3(^2P^o)3s$	$^3P - ^3P^o$	3-1
14.671	1.1e+12 ^b : D	1.08e+12	$2s^22p^4 - 2s^22p^3(^2P^o)3s$	$^1D - ^1P^o$	5-3
14.70	6.8e+11 ^a : E	9.0e+11	$2s^22p^4 - 2s^22p^3(^2P^o)3s$	$^1D - ^3P^o$	5-5
84.874	9.3e+08 ^c :E	7.95e+08	$2s^22p^4 - 2s^2p^5$	$^3P - ^1P^o$	3-3
86.999	1.2e+10 ^c : E	1.09e+10	$2s^2p^5 - 2p^6$	$^3P^o - ^1S$	3-1
108.355	3.9e+10 ^a : C	3.34e+10	$2s^22p^4 - 2s^2p^5$	$^3P - ^3P^o$	5- 5
109.952	1.6e+10 ^c : C	1.06e+10	$2s^22p^4 - 2s^2p^5$	$^3P - ^3P^o$	1-3
111.695	1.26e+10 ^c : C	1.09e+10	$2s^22p^4 - 2s^2p^5$	$^3P - ^3P^o$	3- 3
115.396	1.61e+11 ^c : C	1.35e+11	$2s^2p^5 - 2p^6$	$^1P^o - ^1S$	3-1
119.983	1.04e+10 ^a : C	9.10e+9	$2s^22p^4 - 2s^2p^5$	$^3P - ^3P^o$	3- 5
132.63	2.2e+09 ^a : E	1.95e+9	$2s^22p^4 - 2s^2p^5$	$^1D - ^3P^o$	5-5
151.607	7.9e+08 ^c :E	1.88e+9	$2s^22p^4 - 2s^2p^5$	$^1S - ^3P^o$	1-3
E2,M1					
424.26	1.50e+05 ^c : C	1.41e+5	$2s^22p^4 - 2s^22p^4 : M1$	$^3P - ^1S$	3- 1
592.234	6.0e+00 ^c : E	6.0	$2s^22p^4 - 2s^22p^4 : E2$	$^3P - ^1D$	5- 5
592.234	1.73e+04 ^c : C	1.67e+4	$2s^22p^4 - 2s^22p^4 : M1$	$^3P - ^1D$	5-5
639.84	4.9e+01 ^c :E	4.92e+1	$2s^22p^4 - 2s^22p^4 : E2$	$^1D - ^1S$	5-1
1118.06	6.1e-01 ^c : E	0.635	$2s^22p^4 - 2s^22p^4 : E2$	$^3P - ^3P$	5-3
1118.06	1.45e+04 ^c : C	1.46e+4	$2s^22p^4 - 2s^22p^4 : M1$	$^3P - ^3P$	5-3
1259.27	6.70e+02 ^c : D	6.51e+2	$2s^22p^4 - 2s^22p^4 : M1$	$^3P - ^1D$	3- 5
1328.90	4.9e-01 ^c : E	0.502	$2s^22p^4 - 2s^22p^4 : E2$	$^3P - ^3P$	5- 1
2207.8	4.820e+03 ^d :C	4.96e+03	$2s^2p^5 - 2s^2p^5 : M1$	$^3P^o - ^3P^o$	3- 1
7045	4.0e+01 ^c : C	41.0	$2s^22p^4 - 2s^22p^4 : M1$	$^3P - ^3P$	1- 3
353.532	9.4e+03 ^d : D	8.79e+03	$2s^2p^5 - 2s^2p^5 : M1$	$^3P^o - ^1P^o$	3-3
420.911	7.7e+03 ^d :D	7.31e+03	$2s^2p^5 - 2s^2p^5 : M1$	$^3P^o - ^1P^o$	1-3

a - Shirai et al (2000), b - Fawcett 1984, c - Cheng et al. 1979, d - Loulergue et al (1985)