2014.10.28.

近距離Ｆ型星５星および太陽のスペクトル線等価幅測定値

2013 年に測定した上記６天体のデータを備忘録として記録しておく。

１．スペクトル・データ

アメリカ合衆国テキサス大学付属マクドナルド天文台の 2.7m鏡、および ESO(European Southern Observatory)の 1.52 m鏡で得られた太陽系近傍恒星の高分散スペクトル・ライブラリー（Prieto et al. 2004) S^4N カタログ中の F 型星を対象とした。太陽についてもこのライブラリーにあるスペクトルを測定した。

ただし、プロキオンについては、大部分を Kato & Sadakane (1982) から採用し、ここに含まれていない線についてはこのライブラリーのスペクトルを測定した。

測定には蓮井隆氏制作の専用ソフト Nijiboshi を用いた。

Kato, K. & Sadakane, K. 1982, A&A, 113, 135

Prieto, C. A., Barklem, P. S., Lambert, D. L., & Cunha, K. 2004, A&A, 420, 183

蓮井隆、http://www.d1.dion.ne.jp/~yamaneco/

２．測定対象星

以下のとおりである。

No	Star	Teff	log g	[Fe/H]	VT	name	HD	V (mag)
1	HIP1599	5851	4.468	7.30	1.28	zet Tuc	1581	4.2
2	HIP64394	5910	4.436	7.54	1.29	bet Com	114710	4.26
3	HIP16852	5914	4.123	7.44	1.35	10 Tau	22484	4.28
4	HIP80686	5987	4.459	7.42	1.37	zet TrA	147584	4.91
5	HIP37279	6677	4.081	7.63	1.72	Procyon	61421	0.34

No	Star	Spectral type	Plx (mas)	e_Plx (mas)	Mv (mag)	Comments
1	HIP1599	F9V	116.38	0.64	4.529	High proper-motion Star
2	HIP64394	F9.5V	109.23	0.72	4.452	High proper-motion Star
3	HIP16852	F9IV-V	72.89	0.78	3.593	High proper-motion Star
4	HIP80686	F9V	82.61	0.57	4.495	Spectroscopic binary
5	HIP37279	F5IV-V	285.93	0.88	2.621	Spectroscopic binary

３．等価幅測定値

			EW (mA)						
atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Li I	3.00	6707.924	2.5	36.0	63.0	47.0	107.0	0.0	
C I	6.00	4770.027	15.0	10.0	18.0	18.0	14.0	19.8	
C I	6.00	4775.897	16.0	14.0	22.0	23.0	18.0	22.2	
C I	6.00	5052.167	38.0	31.0	43.0	46.0	43.0	61.2	
C I	6.00	5380.337	23.0	18.0	27.0	32.0	25.0	45.4	
C I	6.00	6587.610	16.0	12.0	25.0	23.0	19.0	42.0	
C I	6.00	6671.845	7.4	0.0	10.5	8.0	0.0	8.0	
C I	6.00	6671.845	0.0	0.0	0.0	15.0	0.0	11.2	
C I	6.00	7111.472	13.0	12.0	16.0	16.0	17.0	30.8	
C I	6.00	7113.178	24.0	17.0	28.0	32.0	27.0	48.0	
C I	6.00	7115.172	26.0	31.0	32.0	30.0	29.0	48.5	
C I	6.00	7116.991	19.0	22.0	21.0	25.0	25.0	41.2	
N I	7.00	7116.991	0.0	9.0	5.4	6.5	0.0	12.0	
N I	7.00	7468.312	4.4	14.0	5.9	7.9	0.0	18.0	
O I	8.00	5577.339	4.5	2.3	5.6	4.2	0.0	3.2	
O I	8.00	6156.778	5.4	7.0	9.6	7.8	6.5	15.0	
O I	8.00	6158.170	4.8	7.0	0.0	8.7	0.0	21.0	
O I	8.00	6300.304	6.0	7.8	7.2	7.7	4.8	3.5	
O I	8.00	7771.944	71.0	82.0	94.0	103.0	97.0	174.0	
O I	8.00	7774.166	61.0	71.0	81.0	91.0	98.0	155.0	
O I	8.00	7775.388	49.0	60.0	66.0	73.0	82.0	124.0	
Na I	11.00	4668.559	57.0	39.0	50.0	46.0	43.0	34.0	
Na I	11.00	5682.633	109.0	88.0	95.0	95.0	85.0	86.0	
Na I	11.00	5688.205	138.0	110.0	113.0	116.0	107.0	111.0	
Na I	11.00	5889.951	870.0	0.0	640.0	534.0	570.0	399.0	
Na I	11.00	5895.924	650.0	0.0	460.0	416.0	440.0	315.0	
Na I	11.00	6154.226	38.0	26.0	31.0	31.0	27.0	22.0	
Na I	11.00	6160.747	60.0	43.0	50.0	48.0	44.0	35.0	
Mg I	12.00	4571.096	112.0	99.0	97.0	99.0	87.0	66.5	
Mg I	12.00	4730.029	66.0	60.0	70.0	61.0	29.0	47.0	
Mg I	12.00	5711.088	119.0	95.0	99.0	92.0	89.0	90.0	
Mg I	12.00	6318.717	49.0	37.0	43.0	43.0	42.0	27.0	

atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Mg I	12.00	6965.409	22.0	24.0	20.0	23.0	15.0	15.0	
Mg I	12.00	6965.409	0.0	63.0	0.0	0.0	0.0	51.0	
Mg I	12.00	8213.034	163.0	136.0	150.0	145.0	140.0	100.0	
Mg II	12.01	4481.325	0.0	0.0	0.0	0.0	210.0	262.5	
Al I	13.00	6696.023	38.0	27.0	32.0	29.0	21.0	17.0	
Al I	13.00	6698.673	22.0	14.0	18.0	16.0	14.0	11.0	
Si I	14.00	5621.607	11.0	6.5	9.5	8.5	7.1	6.0	
Si I	22.01	4512.268	24.0		23.0	59.0	19.0	20.0	
Si I	14.00	5665.556	39.0	31.0	41.0	36.0	35.0	26.0	
Si I	14.00	5708.399	73.0	65.0	77.0	75.0	68.0	71.5	
Si I	14.00	5793.073	46.0	33.0	45.0	42.0	38.0	44.5	
Si I	14.00	5797.856	42.0	36.0	45.0	39.0	37.0	34.5	
Si I	14.00	5948.541	83.0	79.0	93.0	88.0	85.0	80.0	
Si I	14.00	6145.016	39.0	31.0	40.0	37.0	32.0	31.0	
Si I	14.00	6243.814	48.0	40.0	50.0	46.0	40.0	42.5	
Si I	14.00	6721.848	47.0	36.0	45.0	45.0	40.0	39.5	
Si I	14.00	7034.901	68.0	59.0	71.0	65.0	64.0	71.5	
Si II	14.01	6347.109	44.0	48.0	33.0	63.0	57.0	112.0	
Si II	14.01	6371.371	31.0	32.0	42.0	44.0	40.0	83.0	
P I	15.00	9750.750	0.0	0.0	0.0	8.3	0.0	9.0	
P I	15.00	9796.910	0.0	0.0	0.0	29.0	0.0	23.0	
S I	16.00	4694.113	17.0	9.0	0.0	19.0	14.0	20.0	
S I	16.00	4695.443	9.0	6.6	10.0	10.7	13.0	14.0	
S I	16.00	6046.026	17.0	17.0	20.0	23.0	15.0	28.0	
S I	16.00	6052.674	12.0	10.0	18.0	16.0	18.0	24.0	
S I	16.00	6743.531	10.0	9.0	14.0	13.0	7.7	25.0	
S I	16.00	6757.171	14.0	16.0	24.0	25.0	23.0	44.0	
K I	19.00	7698.974	166.0	150.0	156.0	144.0	151.0	138.0	
Ca I	20.00	4578.551	0.0	16.0	0.0	0.0	0.0	11.0	
Ca I	20.00	4578.551	83.0	77.0	85.0	78.0	77.0	68.5	
Ca I	20.00	5581.965	104.0	83.0	95.0	90.0	87.0	84.0	
Ca I	20.00	5590.113	96.0	81.0	93.0	86.0	90.0	79.0	

atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Ca I	20.00	6161.297	68.0	57.0	63.0	56.0	56.0	40.0	
Ca I	20.00	6166.439	75.0	60.0	68.0	59.0	60.0	46.0	
Ca I	20.00	6449.809	104.0	91.0	103.0	98.0	92.0	88.0	
Ca I	20.00	6471.662	94.0	86.0	90.0	90.0	94.0	77.5	
Ca I	20.00	6499.649	89.0	72.0	86.0	79.0	75.0	72.0	
Ca II	20.01	5001.479	22.0	68.0	24.0	26.0	24.0	33.0	
Ca II	20.01	5339.188	8.5	0.0	0.0	10.0	6.5	20.0	
Sc I	21.00	4023.677	51.0	36.0	42.0	41.0	34.0	19.0	
Sc II	21.01	4420.669	19.0	0.0	0.0	47.0	0.0	18.0	
Sc II	21.01	4431.352	37.0	35.0	37.0	0.0	30.0	37.0	
Sc II	21.01	5239.813	53.0	53.0	56.0	61.0	48.0	69.0	
Sc II	21.01	5318.349	15.0	13.0	14.0	17.0	11.0	17.0	
Sc II	21.01	5526.790	78.0	74.0	82.0	90.0	78.0	110.0	
Sc II	21.01	5657.896	66.0	63.0	74.0	82.0	70.0	97.0	
Sc II	21.01	5667.149	32.0	31.0	36.0	41.0	32.0	41.0	
Sc II	21.01	5669.042	35.0	35.0	38.0	47.0	36.0	53.0	
Sc II	21.01	6245.637	36.0	35.0	37.0	43.0	29.0	42.0	
Sc II	21.01	6604.601	36.0	32.0	37.0	44.0	34.0	43.0	
Ti I	22.00	4759.272	47.0	38.0	41.0	38.0	37.0	22.0	
Ti I	22.00	4820.410	43.0	31.0	35.0	35.0	29.0	15.0	
Ti I	22.00	4913.616	52.0	40.0	48.0	40.0	35.0	21.0	
Ti I	22.00	4981.732	126.0	106.0	113.0	0.0	101.0	89.0	
Ti I	22.00	5016.162	70.0	56.0	58.0	55.0	53.0	29.0	
Ti I	22.00	5022.871	74.0	61.0	65.0	0.0	0.0	38.0	
Ti I	22.00	5024.842	71.0	55.0	60.0	57.0	52.0	33.0	
Ti I	22.00	5071.472	32.0	18.0	26.0	24.0	22.0	15.0	
Ti I	22.00	5113.448	28.0	18.0	22.0	18.0	17.0	5.0	
Ti I	22.00	5145.464	39.0	25.0	30.0	27.0	21.0	10.0	
Ti I	22.00	5192.969	88.0	75.0	78.0	77.0	71.0	48.0	
Ti I	22.00	5210.386	93.0	77.0	82.0	80.0	78.0	54.0	
Ti I	22.00	5219.700	28.0	17.0	21.0	18.0	17.0	5.0	
Ti I	22.00	5866.452	49.0	34.0	39.0	35.0	30.0	17.0	
Ti I	22.00	5978.543	25.0	17.0	22.0	17.0	16.0	10.0	
Ti I	22.00	6258.104	53.0	38.0	43.0	39.0	33.0	18.0	
Ti I	22.00	6261.101	49.0	35.0	40.0	37.0	28.0	17.0	

atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Ti II	22.01	4409.516	0.0	70.0	0.0	0.0	0.0	88.0	
Ti II	22.01	4409.516	41.0	44.0	50.0	53.0	41.0	47.0	
Ti II	22.01	4444.558	66.0	68.0	76.0	77.0	69.0	79.0	
Ti II	22.01	4470.857	69.0	65.0	74.0	79.0	63.0	83.0	
Ti II	22.01	4493.513	33.0	32.0	40.0	46.0	32.0	46.0	
Ti II	22.01	4544.028	42.0	38.0	47.0	51.0	38.0	48.0	
Ti II	22.01	4568.314	34.0	28.0	32.0	38.0	30.0	31.0	
Ti II	22.01	4583.409	32.0	31.0	35.0	40.0	30.0	39.0	
Ti II	22.01	4609.264	12.0	14.0	17.0	19.0	11.0	15.0	
Ti II	20.01	5022.871	7.0		9.0	63.0	57.0	8.0	
Ti II	22.01	4708.665	51.0	50.0	55.0	62.0	52.0	61.0	
Ti II	22.01	4911.193	55.0	53.0	60.0	65.0	56.0	69.0	
Ti II	22.01	5005.157	29.0	25.0	29.0	34.0	25.0	30.0	
Ti II	22.01	5211.536	34.0	32.0	38.0	43.0	35.0	48.5	
Ti II	22.01	5418.751	50.0	45.0	52.0	58.0	47.0	65.0	
V I	23.00	4379.230	119.0	96.0	120.0	101.0	96.0	68.0	
V I	23.00	4452.006	27.0	18.0	24.0	20.0	20.0	13.5	
V I	23.00	4577.174	32.0	22.0	26.0	22.0	20.0	9.5	
V I	23.00	5727.048	39.0	23.0	28.0	24.0	19.0	11.0	
V I	23.00	6090.214	34.0	26.0	25.0	23.0	20.0	9.0	
V I	23.00	6216.354	37.0	25.0	32.0	26.0	28.0	12.0	
V II	23.01	4002.936	61.0	37.0	59.0	62.0	52.0	68.0	
V II	23.01	4036.782	35.0	36.0	39.0	48.0	12.0	39.0	
V II	23.01	4039.571	11.0	13.0	13.0	14.0	8.6	11.0	
V II	23.01	4234.256	16.0	14.0	24.0	22.0	13.0	15.0	
V II	23.01	5928.862	7.8	0.0	9.8	8.0	5.0	12.0	
Cr I	24.00	4475.347	19.0	11.0	22.0	15.0	14.0	6.0	
Cr I	24.00	4545.945	84.0	74.0	86.0	81.0	80.0	61.0	
Cr I	24.00	4616.120	95.0	76.0	88.0	83.0	83.0	67.0	
Cr I	24.00	4651.282	79.0	68.0	82.0	76.0	72.0	53.0	
Cr I	24.00	4652.152	104.0	82.0	100.0	96.0	88.0	79.0	
Cr I	24.00	4718.426	67.0	52.0	63.0	59.0	56.0	46.0	
Cr I	24.00	4801.047	51.0	39.0	50.0	42.0	42.0	31.0	
Cr I	24.00	5247.566	82.0	65.0	76.0	71.0	70.0	50.0	
Cr I	24.00	5300.744	59.0	43.0	53.0	48.0	43.0	28.0	
Cr I	24.00	5329.142	72.0	55.0	68.0	60.0	53.0	50.5	
Cr I	24.00	5787.965	46.0	34.0	44.0	40.0	37.0	25.0	

atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Cr I	24.00	6330.093	28.0	14.0	20.0	17.0	14.0	9.0	
Cr I	24.00	6661.078	13.0	0.0	14.0	8.5	9.6	7.0	
Cr I	24.00	7400.226	78.0	64.0	74.0	68.0	0.0	46.0	
Cr II	24.01	4554.988	44.0	47.0	63.0	62.0	62.0	73.0	
Cr II	24.01	4592.049	48.0	47.0	55.0	57.0	52.0	70.0	
Cr II	24.01	4616.629	47.0	43.0	55.0	57.0	51.0	65.0	
Cr II	24.01	4634.070	61.0	58.0	71.0	72.0	68.0	81.0	
Cr II	24.01	4812.337	35.0	31.0	44.0	42.0	36.0	44.0	
Cr II	24.01	5210.865	16.0	12.0	16.0	15.0	14.0	16.0	
Cr II	24.01	5246.768	17.0	14.0	23.0	23.0	19.0	28.0	
Cr II	24.01	5305.854	26.0	24.0	33.0	33.0	29.0	45.0	
Cr II	24.01	5310.688	14.0	11.0	18.0	18.0	15.0	25.0	
Cr II	24.01	5313.563	35.0	32.0	43.0	43.0	38.0	59.0	
Cr II	24.01	5334.869	35.0	29.0	40.0	43.0	34.0	56.5	
Cr II	24.01	5502.066	20.0	16.0	27.0	26.0	22.0	35.0	
Cr II	24.01	5508.606	18.0	15.0	22.0	22.0	20.0	28.0	
Mn I	25.00	4453.012	55.0	40.0	52.0	48.0	42.0	27.0	
Mn I	25.00	4502.213	59.0	48.0	58.0	54.0	48.0	33.0	
Mn I	25.00	4626.530	26.0	16.0	26.0	20.0	20.0	12.0	
Mn I	25.00	4739.087	61.0	41.0	55.0	49.0	44.0	27.0	
Mn I	25.00	4766.418	106.0	82.0	92.0	89.0	85.0	76.0	
Mn I	25.00	5399.499	40.0	23.0	35.0	27.0	24.0	17.0	
Mn I	25.00	5420.355	87.0	47.0	65.0	56.0	46.0	26.0	
Mn I	25.00	5470.637	60.0	28.0	46.0	39.0	33.0	18.5	
Mn I	25.00	6013.513	86.0	58.0	78.0	69.0	64.0	42.0	
Mn I	25.00	6016.673	97.0	69.0	88.0	79.0	74.0	61.5	
Fe I	26.00	4602.000	73.0	60.0	69.0	70.0	62.0	44.0	
Fe I	26.00	4741.529	73.0	64.0	73.0	68.0	65.0	50.0	
Fe I	26.00	4946.385	116.0	88.0	99.0	91.0	90.0	72.0	
Fe I	26.00	5049.819	166.0	134.0	140.0	126.0	140.0	117.0	
Fe I	26.00	5088.166	40.0	25.0	34.0	29.0	24.0	22.0	
Fe I	26.00	5109.650	77.0	62.0	81.0	71.0	69.0	64.5	
Fe I	26.00	5127.358	103.0	86.0	91.0	91.0	85.0	77.5	
Fe I	26.00	5164.553	45.0	36.0	51.0	42.0	42.0	25.0	
Fe I	26.00	5180.056	54.0	40.0	50.0	42.0	45.0	32.5	
Fe I	26.00	5198.711	103.0	88.0	91.0	90.0	85.0	79.0	
Fe I	26.00	5250.208	69.0	54.0	62.0	59.0	52.0	28.0	

atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Fe I	26.00	5445.042	132.0	99.0	122.0	108.0	109.0	107.0	
Fe I	26.00	5491.840	14.0	7.6	13.0	9.5	10.0	4.0	
Fe I	26.00	5506.778	122.0	11.0	115.0	110.0	116.0	109.0	
Fe I	26.00	5522.447	46.0	30.0	41.0	35.0	36.0	24.0	
Fe I	26.00	5619.587	34.0	21.0	32.0	28.0	24.0	16.0	
Fe I	26.00	5652.320	26.0	16.0	26.0	20.0	18.0	14.0	
Fe I	26.00	5661.348	23.0	16.0	22.0		18.0	12.0	
Fe I	26.00	5738.225	15.0	7.3	14.0	10.0	9.6	10.0	
Fe I	26.00	5930.173	90.0	77.0	91.0	81.0	83.0	74.0	
Fe I	26.00	5983.673	70.0	58.0	71.0	60.0	67.0	54.0	curious, wrong gf?
Fe I	26.00	6027.050	64.0	52.0	64.0	59.0	55.0	48.0	
Fe I	26.00	6078.491	78.0	66.0	79.0	70.0	71.0	62.0	
Fe I	26.00	6089.580	36.0	23.0	34.0	28.0	29.0	18.0	curious, wrong gf?
Fe I	26.00	6093.666	31.0	22.0	30.0	25.0	26.0	15.0	
Fe I	26.00	6094.364	20.0	15.0	20.0	14.0	16.0	8.0	
Fe I	26.00	6137.694	150.0	120.0	128.0	120.0	116.0	119.0	
Fe I	26.00	6246.317	133.0	103.0	112.0	103.0	103.0	89.0	
Fe I	26.00	6252.554	128.0	108.0	113.0	107.0	112.0	98.0	
Fe I	26.00	6411.646	145.0	112.0	128.0	114.0	114.0	96.0	
Fe I	26.00	6430.844	120.0	99.0	108.0	107.0	105.0	91.0	
Fe II	26.01	4491.405	76.0	74.0	87.0	89.0	82.0	112.0	
Fe II	26.01	4582.835	57.0	56.0	70.0	69.0	66.0	85.0	
Fe II	26.01	4620.521	51.0	51.0	60.0	64.0	55.0	78.0	
Fe II	26.01	4923.927	173.0	165.0	180.0	173.0	175.0	218.0	
Fe II	26.01	4993.358	40.0	34.0	0.0	0.0	40.0	56.0	
Fe II	26.01	5197.577	82.0	79.0	93.0	95.0	88.0	128.5	
Fe II	26.01	5234.625	91.0	84.0	98.0	96.0	93.0	136.5	
Fe II	26.01	5264.812	48.0	48.0	57.0	57.0	54.0	79.0	
Fe II	26.01	5325.553	45.0	41.0	52.0	54.0	48.0	74.0	
Fe II	26.01	5414.073	30.0	25.0	39.0	36.0	29.0	49.0	
Fe II	26.01	5425.257	44.0	39.0	50.0	53.0	46.0	67.0	
Fe II	26.01	5525.125	14.0	11.0	19.0	18.0	17.0	24.0	
Fe II	26.01	5534.848	58.0	58.0	71.0	73.0	68.0	103.0	
Fe II	26.01	5991.376	32.0	32.0	40.0	41.0	40.0	53.0	
Fe II	26.01	6084.111	21.0	23.0	28.0	28.0	25.0	37.0	
Fe II	26.01	6113.321	12.0	12.0	17.0	17.0	14.0	21.0	
Fe II	26.01	6149.258	37.0	37.0	46.0	49.0	42.0	67.0	
Fe II	26.01	6238.393	45.0	45.0	54.0	57.0	47.0	74.5	
Fe II	26.01	6369.462	19.0	16.0	24.0	27.0	21.0	33.0	be careful for gf

atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Fe II	26.01	6416.919	40.0	37.0	48.0	48.0	44.0	62.0	
Fe II	26.01	6432.680	41.0	41.0	52.0	54.0	46.0	66.0	
Fe II	26.01	6446.410	4.0	6.3	6.5	6.3	6.8	10.0	
Fe II	26.01	6456.383	65.0	68.0	77.0	78.0	76.0	104.0	
Co I	27.00	4020.898	81.0	62.0	71.0	72.0	57.0	36.0	
Co I	27.00	4749.669	42.0	23.0	32.0	29.0	24.0	16.5	
Co I	27.00	4792.846	33.0	21.0	28.0	25.0	22.0	13.0	
Co I	27.00	4813.467	47.0	34.0	40.0	37.0	27.0	22.0	
Co I	27.00	5212.691	21.0	13.0	16.0	15.0	12.0	8.0	
Co I	27.00	5342.695	32.0	20.0	26.0	25.0	20.0	16.0	
Co I	27.00	5352.045	26.0	15.0	20.0	19.0	14.0	9.0	
Co I	27.00	5444.588	16.0	11.0	15.0	12.0	13.0	8.5	
Co I	27.00	5454.571	15.0	9.4	13.0	10.6	11.0	7.0	
Co I	27.00	5647.234	14.0	9.1	9.2	11.0	8.0	5.0	
Ni I	28.00	4913.968	60.0	43.0	57.0	46.0	45.0	35.0	
Ni I	28.00	4935.831	64.0	52.0	60.0	59.0	52.0	41.0	
Ni I	28.00	4998.218	57.0	43.0	50.0	51.0	44.0	32.0	
Ni I	28.00	5042.182	66.0	48.0	62.0	56.0	52.0	45.0	
Ni I	28.00	5462.485	47.0	29.0	39.0	37.0	33.0	25.0	
Ni I	28.00	5589.356	29.0	18.0	27.0	23.0	23.0	14.0	
Ni I	28.00	5628.335	16.0	9.5	14.0	12.0	12.0	9.0	
Ni I	28.00	6108.106	65.0	50.0	56.0	55.0	48.0	30.0	
Ni I	28.00	6130.130	23.0	13.0	20.0	17.0	14.0	12.0	
Ni I	28.00	6223.980	29.0	20.0	26.0	23.0	21.0	14.0	
Ni I	28.00	6635.118	27.0	18.0	24.0	20.0	18.0	18.0	
Ni I	28.00	6767.768	83.0	66.0	76.0	77.0	66.0	54.0	
Cu I	29.00	5105.537	98.0	70.0	81.0	81.0	66.0	50.0	
Cu I	29.00	5218.197	56.0	39.0	49.0	49.0	41.0	36.0	
Cu I	29.00	5782.127	82.0	51.0	60.0	59.0	46.0	30.0	
Zn I	30.00	4722.153	68.0	64.0	70.0	74.0	64.0	64.0	
Zn I	30.00	4810.528	75.0	70.0	75.0	78.0	69.0	67.0	
Zn I	30.00	4810.528	0.0	27.0	0.0	0.0	0.0	22.0	
Sr I	38.00	4607.327	45.0	34.0	46.0	36.0	41.0	25.0	
Sr II	38.01	4077.709	360.0	327.0	360.0	420.0	370.0	339.0	

atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Sr II	38.01	4161.792	33.0	29.0	42.0	40.0	36.0	53.0	
Y II	39.01	4398.013	50.0	50.0	59.0	59.0	58.0	61.0	
Y II	39.01	4883.684	60.0	60.0	71.0	68.0	68.0	81.5	
Y II	39.01	4900.120	55.0	56.0	68.0	67.0	62.0	76.0	
Y II	~~20~~	6362.338	19.0	—	21.0	26.0	18.0	~~99.0~~	—
Y II	39.01	4982.129	15.0	12.0	48.0	6.3	14.0	15.0	
Y II	39.01	5087.416	50.0	44.0	55.0	54.0	50.0	68.0	
Y II	39.01	5119.112	17.0	10.0	17.0	16.0	12.0	13.0	
Y II	39.01	5123.211	0.0	31.0	45.0	41.0	41.0	34.0	
Y II	39.01	5200.406	39.0	35.0	46.0	45.0	43.0	49.0	
Y II	39.01	5402.774	13.0	9.4	18.0	14.0	13.0	18.0	
Zr II	40.01	4050.316	23.0	18.0	27.0	30.0	25.0	26.0	
Zr II	40.01	4208.977	45.0	43.0	54.0	55.0	50.0	52.0	
Zr II	40.01	4317.299	17.0	23.0	23.0	21.0	25.0	20.0	
Zr II	40.01	4379.742	32.0	24.0	34.0	31.0	41.0	34.0	
Zr II	40.01	5112.297	10.0	6.5	13.0	12.0	11.0	11.0	
Ba II	56.01	4130.645	45.0	46.0	62.0	53.0	55.0	50.0	
Ba II	56.01	4554.029	190.0	183.0	195.0	180.0	190.0	182.0	
Ba II	56.01	5853.668	65.0	64.0	73.0	73.0	79.0	79.0	
Ba II	56.01	6141.713	130.0	118.0	128.0	127.0	136.0	144.0	
Ba II	56.01	6496.897	104.0	100.0	118.0	116.0	125.0	137.0	
La II	57.01	4042.901	21.0	21.0	24.0	25.0	22.0	21.0	
La II	57.01	4662.498	10.0	7.6	12.0	10.6	10.5	7.0	
La II	57.01	4748.726	5.8	6.3	8.6	6.5	7.6	7.0	
La II	57.01	5122.988	11.0	0.0	0.0	0.0	0.0	9.0	
Ce II	58.01	4395.850	68.0	0.0	75.0	80.0	75.0	8.0	
Ce II	58.01	4042.580	13.0	12.0	16.0	16.0	13.0	9.0	
Ce II	58.01	4479.361	24.0	~~18.0~~	29.0	24.0	22.0	14.0	
Ce II	58.01	4486.909	17.0	18.0	24.0	22.0	18.0	10.0	
Ce II	58.01	4523.075	15.0	14.0	20.0	21.0	18.0	10.0	
Ce II	58.01	4562.359	21.0	22.0	28.0	27.0	29.0	18.0	
Ce II	58.01	4628.161	19.0	17.0	23.0	22.0	22.0	14.0	
Ce II	58.01	4773.941	10.0	7.5	11.0	9.2	8.3	8.0	
Ce II	58.01	5274.229	10.0	9.0	13.0	8.7	15.0	8.0	

atom	No	WL (A)	Sun(KK)	zet Tuc	bet Com	10 Tau	zet TrA	Procyon	rem
Nd II	60.01	4021.327	15.0	11.0	16.0	16.0	12.0	8.0	
Nd II	60.01	4022.976	15.0	16.0	22.0	21.0	19.0	10.0	
Nd II	60.01	4446.384	13.0	13.0	17.0	17.0	14.0	6.0	
Nd II	60.01	4462.979	18.0	21.0	0.0	0.0	0.0	10.0	
Nd II	60.01	4811.342	9.0	9.2	12.0	13.0	8.7	4.0	
Nd II	60.01	5092.794	9.1	6.5	8.8	8.5	7.7	4.0	
Nd II	~~20.01~~	~~7323.890~~	73.0	~~11.0~~	72.0	70.0	9.2	~~10.0~~	~~–~~
Nd II	60.01	5179.776	5.2	0.0	0.0	7.1	0.0	4.0	
Nd II	60.01	5319.815	12.0	11.0	15.0	13.0	13.0	7.0	
Sm II	62.01	4519.630	6.0	6.2	8.8	8.2	5.4	4.0	
Sm II	62.01	4537.941	5.2	5.0	13.0	13.0	7.0	3.0	
Sm II	62.01	4566.202	11.0	7.2	12.0	9.7	13.0	3.0	
Sm II	62.01	4719.841	7.6	0.0	0.0	0.0	4.7	3.0	
Eu II	63.01	4129.725	65.0	53.0	67.0	64.0	51.0	38.0	
Eu II	63.01	6437.641	9.4	0.0	11.0	9.3	5.3	10.0	
Eu II	63.01	6645.064	5.6	0.0	9.0	9.1	9.4	9.0	
Eu II	66.01	4073.121	8.6	11.0	17.0	9.0	7.8	8.0	
atom	No	WL (A)	Sun(KK)	S1	S2	S3	S4	Procyon	