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The far UV spectrum of the Be star 88 Herculis

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Summary. — In this paper, hereafter called Paper I, we give a detailed list of line identifications of the far UV spectrum of the Be star 88 Her in the wavelength range λλ 1100-2100 Å from a spectrum recorded in 1984, May 23 with the International Ultraviolet Explorer. The spectrum is crowded by shell absorption lines, mostly those of singly ionized iron peak elements.

Key words : Be stars — UV radiation — lines : identification.

1. Introduction.

In 1960 Bidelman and Svolopoulos announced the presence of hydrogen emission and shell lines on spectrograms of 88 Herculis (HD 162732) taken in 1959 and classified the object as a Be star. Herman and Duval (1962) found that the emission was present on their low-dispersion spectrograms taken from June 1955 to September 1958. Harmanec *et al.* (1972a, 1974b) from a study of the radial velocities of the hydrogen lines suggested that 88 Her is probably a single-line spectroscopic binary with a period of 87 days. Doazan (1973) announced long-term variations of emission and shell lines of the star and published additional velocity data. All these results led to an increasing interest in the object. Svolopoulos (1973) published equivalent widths and central intensities of the HI lines measured on several spectrograms from 1970 and 1971. Haupt (1974) published three *UBV* measurements of 88 Her from 1968-1969 and appealed to photometrists to look for possible eclipses of the components. Intense *UBV* photoelectric observations of 88 Her performed from 1972 to 1977 at Brno and Hvar observatories, and from 1975 at Bologna and Chiran, showed that 88 Her is a variable star but not an eclipsing binary (Harmanec *et al.*, 1978). Hirata (1978) compared long-term variations of 88 Her to those of Pleione. Additional *UBV* measurements were published by Magalashvili and Jumsishvili (1980) and by Baldinelli *et al.* (1981). Doazan *et al.* (1982a, b) reviewed all the observational data available for the star and described quantitatively the various types of the changes observed. Barylak and Doazan (1986) and Doazan *et al.* (1986) described the luminosity and colour variations through phase changes from the far UV to the visual spectral regions.

This paper-hereafter called Paper I — is the first of a series of two papers devoted to the study of the far UV spectrum of 88 Herculis. In Paper II we will give the identification list of the spectral lines which are present in the spectral range λλ 2000-3000 Å and the general conclusions that may be derived from the measured radial velocities in the whole range λλ 1100-3000 Å.

2. Observational data and their reduction.

The high resolution far UV spectrum of 88 Her analysed in this paper (SWP 23079) has been obtained in 1984, May 23 with the International Ultraviolet Explorer satellite (IUE) by Doazan at the Villafranca Satellite Tracking Station of the European Space Agency (VILSPA).

The line-identifications were performed on the basis of the multiplet tables of Moore (1968) and Kelly and Palumbo (1979).

In this paper we present two tables.

Table I gives the list of absorption lines observed in the spectrum of 88 Her. The successive columns in table I give :

1. The measured wavelength in Å for the principal ions.

2. The laboratory wavelength.

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3. The identification of the principal ions contributing to the line.

4. The multiplet number.

5. The intensity (Kelly-Palumbo, 1979).

6. The radial velocity, measured at the line center.

7. Remarks : indicating the presence of blends and reseau marks (O).

The precision of the observed line position is limited by the IUE resolution (± 0.1 Å and more) and by the severe blending due to the crowding of the lines. Because the shell absorption lines are very narrow it is not possible to distinguish between shell and interstellar lines.

Table II gives the strong, well-defined lines which are present in the spectrum that we were not able to identify unambiguously. We also give the corresponding ions which may possibly produce these lines around these wave-lengths. A great number of these lines is unclassified.

3. Description of the spectrum.

The far UV spectrum of 88 Her presents lines arising from a broad range of ionization, CI, OI, NI, MgI to highly ionized species such as SiIV and possibly CIV. NV seems to be absent or blend with the MgII unclassified lines (λλ 1239.925 and 1240.3947 Å) and NI [5]. The singly ionized elements dominate the spectrum mainly FeII, NiII. The strongest lines of FeIII are present (multiplets 34, 52, 62 and 68). We did not detect any emission line in the far UV spectrum of 88 Her.

Broad absorption wings are observed for the SiIV resonance lines, which are blended with the lines SIλ1392.587 [1] and NiIIλ1393.33 Å. Broad absorption wings are suspected for the CIV resonance lines, which are blended with the sharp FeIII [84] lines (λλ1547.640, 1550.196, 1550.862, 1551.377 Å).

4. Conclusions.

This paper presents a complete line-list of the far UV spectrum of 88 Her in the range λλ 1100-2100 Å. Because this star is known to be variable, this list may be used as a reference for future variability studies. The detailed analysis of the radial velocities measured in the whole spectral range λλ 1100-3000 Å will be given in Paper II.

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TABLE I. — *SWP 23079.*

λmes	λlab	Ion	Mult.	Inten.	v(km·s^{-1})	Remarks
1193.00	1193.009	CI	11	700	0.00	CI[11]
1193.25	1193.240	CI	11	850	0.00	
1193.35	1193.460	CI	11	850	-27.50	
1197.30	1197.393	SiII	5	100	-23.25	
1199.50	1199.549	Ni	1	1000	-12.49	
1200.15	1200.223	NI	1	900	-17.50	
1200.70	1200.711	NI	1	700	0.00	
1239.80	1239.92	MgII	-	250		
1240.25	1240.39	MgII	-	200		
1243.05	1243.179	NI	5	550	-28.95	NI[5]
1247.65	1248.860	CrIII	6	200	-50.52	
1248.30	1248.425	SiII	8	150	-28.83	
1250.00	1250.089	SiII	13	100	-21.36	
1250.50	1250.500	SII	1	300	0.00	SiII[13]
	1251.164	SiII	8	200		0
1251.25	1251.420	CrIII	6	150	-40.74	b
1252.40	1252.610	CrIII	6	500	-50.31	
1253.65	1253.790	SII	1	500	-33.51	
1259.40	1259.530	SII	1	500	-30.96	
1260.20	1260.421	SiII	4	500	-52.38	
1260.30	1260.542	FeII	9	400	-57.12	
1260.40	1260.736	CI	9	250	-80.94	CI[59],b
1260.70	1260.927	CI	9	200	-59.52	CI[9]
1260.95	1261.122	CI	9	250	-40.44	
1261.30	1261.552	CI	9	500	-58.00	CI[9]
1261.70	1261.850	CrIII	20	400	-38.04	
1263.40	1263.610	CrIII	20	350	-49.86	
1264.15	1264.210	CrIII	13	350	-14.22	
1264.50	1264.737	SiII	4	1000	-54.57	
	1265.001	SiII	4	100		
1266.10	1266.140	CrIII	5	150	0.00	
1266.35	1266.419	CI	58	100	-23.67	
1266.50	1266.694	FeII	9	400	-45.21	b
1267.25	1267.437	FeII	9	500	-42.60	
1268.00	1268.010	CrIII	5	250	0.00	
	1269.110	CrIII	13	250	0.00	
	1269.110	CrIII	13	250		
1271.10	1271.235	FeII	9	20	-30.66	
1271.85	1272.001	FeII	9	500	-35.37	
1272.50	1272.638	FeII	9	300	-30.66	
1273.15	1273.310	CrIII	5	150	-37.68	
1274.00	1274.109	CI	8	150	-30.60	
1274.80	1274.984	CI	55	150	-42.36	b
1275.00	1275.145	FeII	9	300	-35.28	
1275.65	1275.801	FeII	9	400	-35.28	
1277.10	1277.282	CI	7	700	-39.00	CI[7]
1277.45	1277.617	CI	7	1000	-40.00	FeII[9]
1279.00	1279.056	CI	6	100	-11.70	
1279.05	1279.229	CI	6	150	-39.87	
1279.65	1279.898	CI	5	250	-56.28	
1279.95	1280.135	CI	5	200	-42.18	
1280.35	1280.333	CI	5	700	0.00	SiII[63]
1280.70	1280.892	CI	5	250	-44.52	
1282.25	1282.484	TiIII	2	125	-56.15	
1284.10	1284.090	CrIII	12	200	0.00	
1284.30	1286.365	TiIII	2	700	0.00	
1287.00	1287.050	CrIII	12	400	-11.64	
1288.40	1288.422	CI	53	500	0.00	b
1288.65	1288.710	CI	52	100	-12.00	b
1289.15	1289.299	TiIII	2	500	-39.54	
1289.75	1289.977	CI	51	300	-53.52	b
1290.00	1290.204	FeII	88	300	-46.50	
1291.35	1291.594	FeII	87	300	-55.77	MnIII[9]
1291.40	1291.640	TiIII	2	450	-55.77	
1293.20	1293.228	TiIII	2	400	0.00	
1294.55	1294.698	TiIII	1	600	-27.81	SiIII[4]
1294.75	1294.919	FeII	87	240	-37.08	
1295.75	1295.883	TiIII	1	400	-30.09	
1295.95	1296.088	FeII	86	400	-32.40	
1296.70	1296.726	SiIII	4	280	0.00	
1298.50	1298.659	TiIII	1	1000	-32.27	FeIII[87]
1298.80	1298.970	TiIII	1	800	-34.65	
1299.80	1299.984	FeII	86	10	-41.55	b
1301.10	1301.146	SiIII	4	280	0.00	b
1301.65	1301.87	PII	2	200	-50.73	b
1302.17	1302.168	OI	2	1000	0.00	0,b
1302.80	1302.863	SI	9	80	-13.80	
1303.15	1303.320	SiIII	4	320	-39.12	
1304.25	1304.47	PII	2	200	-50.80	SiII[3]
1304.85	1304.857	OI	2	600	0.00	
1305.20	1305.480	PII	2	350	-64.35	NiIII[13]
1306.00	1306.0286	OI	2	200	0.00	
1309.25	1309.276	SiII	3	200	0.00	
1309.30	1309.34	CrIII	28	200	0.00	
1310.80	1310.700	PII	2	600		NI[13],CI[49]
1311.05	1310.9429	NI	13	150	+20.61	
1313.35	1313.464	CI	45	300	-25.11	CI[45.01]
1315.00	1315.00	CrIII	33	100	0.00	b
1316.00	1315.918	CI	44	200	+22.80	CrIII[28],b
1317.05	1317.220	NiII	10	500	-38.70	
1318.85	1318.9981	NI	12	150	-31.83	b
1319.50	1319.6760	NI	12	250	-38.64	
1320.50	1320.6858	CuII	148	10	-40.90	
	1321.65	CrIII	28	30		
1322.65	1322.83	CrIII	28	100	-38.55	
1324.00	1323.951	CII	11	450	0.00	CII[11],SI[11]
1326.50	1326.643	SI	8	160	-32.00	NI[11]
1327.40	1327.592	TiIII	4	550	-45.21	
1327.85	1327.9170	NI	11	25	-13.56	
1328.60	1328.820	CI	4	150	-51.93	
1328.95	1329.099	CI	4	150	-31.59	
1329.50	1329.577	CI	4	600	-15.78	
1334.30	1334.532	CII	1	800	-51.48	
1334.60	1334.870	PII	1	650	-60.69	b
1335.50	1335.707	CII	1	1000	-44.94	
	1341.465	SiIII	39	160		
	1342.392	SiIII	39	140		
	1343.388	SiIII	39	120		
1344.30	1344.340	PIII	1	1000	0.00	b
1345.00	1344.900	PIII	1	650	+22.32	0,b
1346.65	1346.873	SiII	7	100	-49.02	
1347.10	1347.239	CII	2	500	-28.95	
1348.40	1348.543	SiII	7	100	-31.14	
1349.95	1350.057	SiII	7	150	-22.20	
1350.35	1350.580	SiII	7	150	-51.09	
	1351.6568	CII	2	350		
1352.58	1352.635	SiII	7	100	-11.07	
1353.75	1353.718	SiII	7	100	0.00	
1354.18	1354.286	CI	43	500	-22.14	b
	1355.5977	OI	1	100		
1355.65	1355.825	CI	42	750	-42.06	b
1357.02	1357	CI	41	300	-24.30	CrIII[36],b
1358.50	1358.5123	OI	1	60	0.00	b
1359.15	1359.275	CI	40	200	-26.49	
1360.50	1360.870	FeII	111	100	-81.60	
1360.70	1360.718	MnIII	8	1000	-4.30	
	1361.597	SiIII	46	160		
	1362.366	SiIII	38	100		
1362.55	1362.771	FeII	152	400	-48.45	
1363.20	1363.447	CII	2	600	-52.80	SiIII[36]
1364.00	1364.164	CI	39	600	-30.78	
1364.40	1364.575	FeII	103	240	-41.76	
1365.80	1365.94	CrIII	36	70	-30.75	CrIII[36],SiIII[38],b
	1367.049	SiIII	46	140		
1368.40	1368.60	CrIII	36	150	-43.83	
	1369.430	MnIII	8	400		SiIII[46]
1370.00	1370.200	NiII	8	500	-43.77	
1370.98	1371.024	FeII	103	500	0.00	b
	1371.647	MnIII	8	300		SiIII[67]
1373.00	1373.1163	CII	1	200		SiIII[67]
1373.95	1374.140	NiII	9	150	-41.46	
1375.05	1375.172	FeII	103	200	-26.16	SiIII[67]
1379.80	1379.870	PIII	7	500	-15.21	b
1379.30	1379.600	CII	1	900	-65.49	
	1380.460	PIII	7	1000		
1381.18	1381.111	PIII	7	1000	+15.21	FeII[152],NiII[8]
1381.50	1381.633	PIII	7	800	-28.23	
1383.65	1383.790	CrIII	35	250	-30.36	
	1387.948	SiIII	37	25		
	1387.979	SiIII	37	10		
	1387.994	SiIII	37	8		
1388.45	1388.435	SI	7	950	0.00	
	1389.6928	CII	1	1000		
1389.80	1389.957	CII	1	900	-32.37	b
1391.60	1391.61	CrIII	35	150	0.00	
1392.60	1392.587	SI	7	650	0.00	
	1393.755	SiIV	1	1000		
	1396.5267	CII	1	600		
	1399.026	NiII	8	80		
1400.25	1400.34	CrIII	35	150	-19.26	b
	1402.770	SiIV	1	800		
1407.20	1407.1689	CuII	88	15	0.00	
1409.15	1409.1336	SI	6	125	0.00	
1410.90	1411.071	NiII	8	100		
1411.90	1411.9494	NI	10	150	-10.62	
1412.65	1412.834	FeII	47	70	-38.22	
1413.50	1413.699	FeII	69	770	-42.45	
1414.20	1414.440	GaII	2	1000	-50.91	
1417.10	1417.237	SiIII	2	260	-27.51	
1417.50	1417.744	FeII	143	400	-50.79	
	1420.036	TiIII	4	300		
	1421.631	TiIII	4	280		TiIII[4]
1422.35	1422.405	TiIII	4	650	-10.53	
1423.95	1424.140	TiIII	4	700	-40.05	FeII[47]
1424.50	1424.716	FeII	47	70	-50.55	SiIII[62]
1430.55	1430.780	FeII	47	200	-48.24	
1430.70	1430.895	FeII	47	20	-39.84	MnII[22]
1431.70	1431.597	CI	65	100	-23.04	b
1432.10	1432.105	CI	65	75	0.00	b
1432.35	1432.530	CI	65	50	-37.68	b
1433.60	1433.749	CaII	7	200	-31.38	SiIII[66]
	1435.776	SiIII	61	160		
	1436.166	SiIII	52	140		
	1436.724	SiIII	66	80		
	1438.228	SiIII	66	40		0
	1438.702	SiIII	66	40		
	1439.391	SiIII	66	40		
1441.60	1441.732	SiIII	3	100	-27.00	
1447.00	1447.196	SiIII	3	100	-39.39	
1454.65	1454.852	NiII	7	200	-41.25	
1455.00	1455.194	TiIII	6	1000	-45.36	
	1457.250]	SiIII	60	100		
	1457.1759]	CuII	99	10		
1459.15	1459.311	FeII	193	300	-32.88	b
1463.05	1463.336	CI	37	600	-55.35	
1464.95	1465.043	FeII	193	400	-18.42	
1465.95	1466.070	CuII	126	70	-25.70	
1467.20	1467.450	CI	36	350	-51.12	b

TABLE I (*continued*)

1467.60	1467.762	NiII	6	100	-31.12	
1468.40	1468.410	CI	35	100	0.00	
1470.05	1470.094	CI	35	100	-30.60	
1472.20	1472.231	CI	34	60	0.00	
1473.65	1473.834]	FeII	193	400	-36.63	
	1473.980]	SI	3	350		
1474.20	1474.38	SI	3	125	-36.70	
1481.70	1481.763	CI	34	450	-12.15	b
	1485.024	SiII	12	90		
	1485.224	SiII	12	30		
1485.30	1485.513]	SiII	15	100	-42.42	
	1485.622]	SI	4	150		
1486.00	1486.265	FeII	85	400	-52.47	
1487.10	1487.120	SI	3	200	0.00	
	1487.86	CrIII	85	50		
	1492.100	PIII	7	500		
1492.50	1492.625	NI	4	620	-24.12	
1493.40	1493.640	FeIII	85	600	-48.21	
1494.50	1494.669	NI	4	620	-32.10	
1498.55	1498.697	TiIII	3	600	-20.01	
1500.25	1500.437	NiII	7	200	-36.00	SiIII[36]
1501.55	1501.550	PIII	6	700	0.00	
	1501.870	SiIII	36	180		
1502.00	1502.270	PIII	6	1000	-53.91	
1504.55	1504.710	PIII	6	900	-33.90	b
1505.00	1505.100	FeIII	85	650	-31.89	b
	1506.060	SiIII	72	120		
	1509.101	SiII	11	100		
1510.60	1510.859	NiII	6	75	-49.65	CI[64]
1511.90	1512.072	SiII	11	50	-33.75	
1514.70	1514.763	ZnII	5	120	-9.90	
1526.50	1526.707	SiII	2	500	-39.30	O,b
1531.10	1531.293	FeIII	84	400	-37.23	
1531.40	1531.644	FeIII	84	550	-47.01	
1531.70	1531.864	FeIII	84	450	-31.35	CIII[11],CuII[96]
	1532.51	PII	1	700		
1532.28	1533.432	SiII	2	1000	-29.34	
1535.08	1535.081	ZnII	5	200	0.00	CuII[96],b
1535.70	1535.900	PII	1	1000	-48.84	b
1536.35	1536.39	PII	1	700	0.00	
1537.30	1537.510	PII	1	700	-40.98	
1538.40	1538.632	FeIII	84	650	-44.85	b
1539.05	1539.128	FeIII	84	550	-13.62	b
1539.30	1539.480	FeIII	84	300	-35.07	
1539.70	1539.830	AlII	10	800	-25.41	b
	1540.165	FeIII	84	450		
1542.05	1542.17	CI	64	160	-23.34	
1542.15	1542.290	PII	1	1000	-27.21	
1543.10	1543.144	PII	1	400	0.00	
1543.45	1543.438	CuIII	32	250	0.00	b
	1543.610	PII	1	150		
	1545.249	CI	63	40		
	1546.120	FeIII	84	550		
	1547.640	FeIII	84	550		
	1548.185	CIV	1	1000		
1548.80	1548.867	CuIII	32	150	-11.61	
1550.10	1550.196	FeIII	84	200	-19.35	
1550.10	1550.260	FeII	45	20	-30.96	
	1550.774	CIV	1	550		
1550.60	1550.862	FeIII	84	550	-50.31	
1551.25	1551.377	FeIII	84	250	-23.19	CuII[118]
	1552.067	FeIII	84	550		
	1556.493	FeIII	84	550		
1558.40	1558.643	FeII	46	200	-26.94	
1558.50	1558.690	FeII	46	200	-38.49	
1558.95	1559.084	FeII	45	400	-28.00	
1560.10	1560.260	FeII	45	40	-30.75	
1560.30	1560.313	CI	3	250	0.00	SeI[7]
1560.65	1560.6702	CI	3	500	0.00	
1561.25	1561.438	CI	3	1000	-34.00	CI[3]
1563.50	1563.788	FeII	45	500	-55.65	
1565.25	1565.374	FeII	46	4	-23.10	
1566.70	1566.819	FeII	44	400	-22.98	
1567.95	1568.016	FeII	45	160	-8.00	
1569.50	1569.674	FeII	44	240	-32.49	
1570.08	1570.242	FeII	45	400	-32.46	
1570.80	1570.8104	SiI	41	1	0.00	
1572.50	1572.750	FeII	45	20	-47.70	
1573.60	1573.825	FeII	45	100	-43.86	CrIII[73]
	1573.870	CrIII	73	70		
1574.50	1574.768	FeII	44	10	-51.45	
1574.80	1574.923	FeII	45	400	-24.75	
1574.00	1577.166	FeII	45	20	-28.53	CrIII[73]
1580.40	1580.625	FeII	44	500	-43.65	CrIII[73]
1588.10	1581.274	FeII	44	160	-36.03	GeII[3]
1584.50	1584.600	CrIII	73	400	-18.93	
1584.80	1584.949	FeII	44	300	-28.38	NiII[6]
1586.00	1585.958	SiI	37	3	0.00	
1588.10	1588.286	FeII	44	200	-35.88	
1588.85	1588.87	CrIII	73	200	0.00	
1590.45	1590.4768	SiI	35	20	0.00	
1593.45	1593.555	CuIII	139	500	-18.81	
1593.70	1593.758	CuIII	13	500	-9.39	
1595.15	1595.597	FeIII	119	400	-82.74	
1600.15	1600.194	CuIII	13	250	0.00	
1601.40	1601.211	FeIII	118	650	+37.47	FeIII[118]
1602.05	1602.080	FeIII	119	300	0.00	
1602.30	1602.588	FeII	316	240	-52.41	GeII[2]
1602.80	1602.984	CI	63	200	-33.69	
1606.20	1606.026	FeIII	119	200	+37.50	
1606.70	1606.834	CuII	139	300	-25.00	CuIII[13]
1607.45	1607.723	FeIII	118	600	-50.40	
1608.25	1608.456	FeII	8	700	-37.29	
1610.70	1610.921	FeII	43	300	-42.84	O,b
1611.65	1611.763	FeII	118	450	-20.46	FeIII[118]
1612.60	1612.802	FeII	43	400	-39.06	
1616.46	1616.60	CuIII	13	150	-27.84	
1616.25	1618.470	FeII	8	500	-39.25	
1621.45	1621.685	FeII	8	600	-42.54	
1623.05	1623.102	FeII	43	160	0.00	
1625.25	1625.520	FeII	43	400	-51.69	
1625.85	1625.919	FeII	8	300	0.00	
1626.15	1626.139	CuII	13	100	0.00	
1627.05	1627.0498	SiI	29	20	0.00	
1628.25	1628.295	CuIII	13	150	-9.21	
1629.03	1629.155	FeII	8	600	-22.10	
1630.60	1630.82	VII	18	200	-40.47	
1631.00	1631.120	FeII	8	600	-22.10	
1632.15	1632.166	MiIII	17	100	0.00	
1632.40	1632.668	FeII	43	20	-49.62	
1633.35	1633.51	VII	18	250	-29.37	
1633.70	1633.907	FeII	43	300	-36.72	
1634.15	1634.345	FeII	8	400	-34.86	
1635.17	1635.389	FeII	68	700	-38.52	
1635.60	1635.860	VII	18	200	-47.70	
1636.10	1636.321	FeII	8	600	-40.32	
1637.22	1637.397	FeII	42	300	-32.97	NiII[6]
1637.55	1637.770	VII	18	500	-40.29	
1637.75	1637.930	VII	18	100	-32.97	
1638.75	1638.956	CuIII	22	150	-36.63	
1639.20	1639.403	FeII	8	600	-36.60	
1640.00	1640.167	FeII	43	240	-29.25	
1640.60	1640.860	VII	18	300	-47.55	
1641.55	1641.761	FeII	68	500	-38.50	
1642.05	1642.187	FeII	224	100	-42.00	
1642.30	1642.208	CuII	12	1000	+18.27	O,b
1643.00	1643.03	VII	18	300	0.00	
1643.38	1643.576	FeII	42	300	-36.51	
1646.04	1646.182	FeII	68	400	-25.50	
1647.00	1647.159	FeII	68	500	-29.13	
1649.30	1649.572	FeII	68	400	-50.91	FeII[42]
1650.50	1650.704	FeII	68	400	-36.36	
1652.00	1652.010	CuIII	12	150	0.00	
1652.30	1652.489	FeII	42	10	-32.67	
1654.05	1654.111	FeII	68	100	-9.06	
1654.30	1654.484	FeII	42	160	+32.67	CuIII[12]
1654.90	1655.042	FeII	68	20	-25.35	
1655.10	1656.255	CI	2	350	-28.98	
1656.75	1656.998	CI	2	1000	-43.47	CI[2]
1657.25	1657.368	CI	2	300	-21.70	
1657.80	1657.891	CI	2	300	-18.09	
1658.00	1658.113	CI	2	300	-21.69	
1658.25	1658.472	CuIII	12	100	-39.78	
1658.55	1658.771	FeII	41	300	-41.61	
1659.30	1659.483	FeII	40	300	-35.52	
1660.30	1660.53	VII	109	80	-41.55	
1661.15	1661.347	FeII	41	10	-34.40	
1662.20	1662.369	FeII	42	10	-28.86	
1663.05	1663.221	FeII	40	300	-30.66	
1663.50	1663.600	VII	109	150	-18.03	
1667.60	1667.66	VII	109	100	-10.77	MnIII[24]
	1667.88	VII	34	50		
1670.00	1670.01	VII	109	100	0.00	
1670.00	1670.140	CuIII	19	250	-25.14	
1670.55	1670.786	AlII	2	1000	-41.31	FeII[40]
	1671.1168	SiII	23	40		
1671.55	1671.680	PI	2	540	-19.74	
1671.80	1671.886	CuIII	18	250	-14.34	
1672.25	1672.440	VII	17	150	-34.08	b
1673.30	1673.462	FeII	102	300	-28.68	SiIII[58]
1674.18	1674.254	FeII	41	40	-12.54	
1674.50	1674.610	FI	2	690	-18.00	FeII[40]
1676.70	1676.871	FeII	41	200	-30.42	
1677.30	1677.373	CuIII	31	100	-12.51	
1679.20	1679.381	FeII	102	300	-32.16	
1679.70	1679.710	PI	2	900	0.00	b
1681.35	1681.481	CuIII	18	150	-23.19	
1684.45	1684.642	CuIII	12	250	-35.61	
1685.75	1685.990	PI	6	360	-42.72	FeII[41]
1686.10	1686.214	CuIII	22	150	-19.56	
1686.30	1686.457	FeII	40	160	-26.67	
1686.55	1686.692	FeII	39	40	-24.90	
1687.10	1687.134	CuIII	12	300	0.00	b
1687.72	1687.897	MiIII	25	400	-30.21	
1688.25	1688.401	FeII	41	8	-26.64	FeII[102]
1688.95	1689.051	CuIII	24	100	-17.76	
1689.85	1689.828	FeII	85	200	-30.18	
	1690.28	CrIII	71	300		
1690.65	1690.781	FeII	85	160	-23.07	
1691.05	1691.289	FeII	41	160	-40.80	
	1692.11	VII	33	100		
1692.35	1692.51	MiIII	16	1000	-28.35	
1692.70	1692.89	CrIII	71	600	-33.66	b
1693.05	1693.09	VII	33	100	0.00	
1693.35	1693.477	FeII	85	10	-21.24	VII[33]
1693.95	1693.936	FeII	41	10	0.00	
1694.35	1694.481	PI	6	120	-23.01	
1696.25	1696.463	FeII	84	10	-37.14	
1696.50	1696.640	CrIII	71	600	-24.78	
1696.60	1696.800	FeII	38	160	-35.37	

TABLE I (*continued*)

1698.10	1698.190	FeII	40	10	-15.90	NiIII[25]
1699.00	1699.190	FeII	85	40	-35.28	
1700.10	1700.29	CrIII	34	200	-33.51	
1700.95	1701.023	CuIII	31	200	-12.33	
1701.25	1701.480	CrIII	71	600	-40.56	
1701.95	1702.043	FeII	38	500	-17.61	0,b
1702.90	1702.994	CuIII	11	250	-15.84	
1703.20	1703.408	NiII	5	25	-35.22	
1704.40	1704.652	FeII	39	10	-44.01	
	1705.333	CuIII	21	150		
1705.95	1706.142	FeII	38	20	-38.67	
1707.20	1707.390	FeII	84	40	-34.95	
1707.25	1707.346	NiIII	25	200	-17.55	CrIII[71]
1708.00	1708.250	FeII	84	20	-43.89	
1708.45	1708.627	FeII	38	160	-29.85	NiIII[25]
1709.00	1709.036	CuIII	11	350	0.00	CuIII[21]
1709.40	1709.670	FeII	84	300	-47.87	FeII[37],NiII[4]
	1710.60	CrIII	34	20		
1711.05	1711.296	SiII	10	20	-22.77	
1711.55	1711.63	CrIII	34	200	-14.01	
1712.80	1712.997	FeII	38	400	-35.01	
1715.25	1715.303	NiIII	16	650	-8.73	b
1715.50	1715.507	FeII	84	240	0.00	b
1715.80	1715.931	NiIII	15	100	-22.74	b
1716.35	1716.577	FeII	39	40	-36.69	b
1717.95	1718.123	FeII	38	40	-29.67	
1719.20	1719.44	AlII	6	800	-41.88	NiIII[16]
1719.95	1720.042	FeII	84	200	-15.69	
1720.45	1720.616	FeII	38	400	-29.64	
1721.00	1721.271	AlII	6	900	-47.04	AlII[6],CI[14]
1722.18	1722.283	NiII	16	400	-17.04	
1722.15	1722.379	CuII	11	500	-38.31	
1722.30	1722.534	SiIV	10	400	-40.05	
1722.50	1722.620	VII	129	200	-20.88	
1724.10	1724.291	NiIII	28	75	-33.06	
1724.70	1724.963	AlII	6	900	-48.00	AlII[6],FeII[39]
1725.20	1725.402	FeII	346	100	-34.77	
1726.20	1726.394	FeII	38	240	-33.00	MnII[13]
1727.15	1727.377	SiIV	10	300	-39.93	
1728.00	1728.139	CuIII	18	100	-22.56	
1730.20	1730.483	NiIII	15	75	-48.54	
1730.90	1731.038	FeII	110	200	-22.53	
1731.95	1732.253	FeII	420	300	-51.96	
1733.05	1733.129	NiIII	15	250	-12.09	FeII[110]
1736.95	1737.252	NiIII	15	500	-50.00	FeII[37],MnII[73],h
1738.75	1738.785	FeIII	28	200	0.00	
1741.30	1741.547	NiII	5	1000	-41.34	
1741.80	1741.963	FeIII	21	300	-27.57	
1745.10	1745.2482	PI	9	150	-24.00	
	1746.8181	FeII	101	300		
	1747.0111	NiIII	15	550		
1748.10	1748.285	NiII	5	500	-30.99	
	1750.391	CuIII	17	250		
1751.80	1751.911	NiII	4	300	-18.84	
1751.75	1751.900	CI	62	800	-25.68	NIII[19]
1752.30	1752.427	NiIII	21	300	-20.52	
1753.10	1753.101	SiI	77.02	15	0.00	
1754.60	1754.808	NiII	4	50	-34.20	
1760.05	1760.104	AlII	5	350	-8.52	
1760.10	1760.395	CII	10	450	-49.41	CoIII[21]
1760.40	1760.415	FeII	100	400	0.00	NiIII[21]
1760.80	1760.810	CII	10	500	0.00	
1761.20	1761.379	FeII	101	500	-30.66	
1761.80	1761.975	AlII	5	300	-28.95	
1763.75	1763.95	AlII	5	700	-34.02	AlII[5]
1764.50	1764.683	NiIII	14	800	-31.95	NiIII[28]
1765.05	1765.0296	SiI	14	990	0.00	
1765.60	1765.815	AlII	5	300	-35.67	
1767.50	1767.738	AlII	5	400	-35.64	NiIII[14]
1769.40	1769.643	NiIII	14	1000	-40.00	FeII[100],FeIII[116]
1771.35	1771.492	NiIII	14	100	-23.70	
1772.35	1772.509	FeII	99	300	-28.00	
1773.75	1773.949	NiII	3	25	-33.89	
1774.75	1774.942	PI	1	750	-32.13	FeIII[118]
1776.40	1776.661	FeII	99	20	-43.89	
1779.25	1779.442	NiIII	21	30	-32.04	
1781.20	1781.279	NiIII	21	50	-13.47	0,b
1781.60	1781.702	FeII	67	40	-16.83	b
1782.45	1782.747	NiIII	14	60	-48.81	
1782.75	1782.830	PI	1	600	-13.44	b
1783.20	1783.2315	SiI	73	25	0.00	b
1785.10	1785.262	FeII	191	800	-26.88	
1786.50	1786.738	FeII	191	800	-38.61	
1787.45	1787.680	PI	1	540	-38.61	
1787.80	1787.997	FeII	191	700	-31.89	
1788.25	1788.485	NiII	5	100	-41.94	
1790.40	1790.402	NiII	27	250	0.00	
1791.40	1791.644	NiIII	14	200	-40.20	
1793.20	1793.371	FeII	99	200	-30.30	
1794.85	1794.904	NiIII	14	200	-8.34	
1797.95	1798.163	FeII	142	200	-35.01	
1801.35	1801.506	NiIII	20	50	-24.96	
	1803.023	SiIII	51	60		
1804.30	1804.473	NiII	30	2	-28.33	
1807.90	1808.011	SiII	1	150	-18.24	
1808.50	1808.51	ClIII	7	400	0.00	
1809.18	1809.316	FeII	142	200	-21.54	ClIII[7]
1811.90	1812.065	NiII	24	30	-28.33	
1815.45	1815.761	FeII	66	4	-51.23	
1816.75	1816.927	SiII	1	200	-28.08	
1817.80	1817.73	ClIII	7	400	+11.55	
1818.35	1818.509	FeII	66	40	-24.75	
1820.80	1820.840	CrII	18	80	0.00	
1822.00	1822.150	FeII	66	20	-24.69	
1822.50	1822.50	ClIII	7	600	0.00	b
1823.05	1823.061	NiIII	20	800	0.00	
1824.60	1824.59	ClIII	7	300	0.00	
1825.00	1825.021	SiI	12	1	0.00	
1826.95	1826.991	FeII	65	20	0.00	
1827.50	1827.736	FeII	66	4	-27.74	
1828.40	1828.400	ClIII	7	500	0.00	b
1830.05	1830.006	NiIII	20	400	+8.19	NiIII[20]
	1830.683	FeIII	117	200		
1830.60	1830.861	FeII	66	4	-42.60	
1831.50	1831.724	FeII	66	20	-26.03	
1832.05	1832.08	ClIII	7	400	0.00	
1832.25	1832.494	FeII	65	6	-39.30	
1833.00	1833.071	FeII	66	10	-11.43	
1833.15	1833.310	ClIII	7	400	-26.16	
1835.65	1835.869	FeII	98	300	-34.32	
	1836.23	CrII	18	240		
	1838.309	FeIII	117	450		
1841.45	1841.701	FeII	65	200	-40.71	
1842.20	1842.256	FeII	65	10	-8.13	
	1842.547	SiIII	20	180		
1842.70	1842.927	FeIII	97	300	-32.55	
	1843.502	FeIII	117	150		
1844.35	1844.590	FeII	397	100	-39.03	FeIII[117]
1844.70	1844.942	FeIII	97	200	-39.03	
1845.45	1845.521	FeIII	97	450	-11.37	FeIII[117]
1846.35	1846.581	FeII	98	240	-37.35	
1847.05	1847.275	NiIII	19	650	-35.73	
1848.20	1848.231	FeII	7	100	0.00	
1848.50	1848.771	FeII	141	240	-43.83	
1849.50	1849.407	FeIII	97	450	+16.20	
1849.95	1849.960	FeIII	53	300	0.00	FeIII[63]
1850.25	1850.20	FeIII	97	300	+8.10	
	1850.650	FeIII	53	70		
1851.50	1851.517	FeII	65	20	0.00	
1852.15	1852.13	CrII	33	500	0.00	
1853.95	1854.149	NiIII	19	800	-30.72	
1854.20	1854.384	FeIII	97	200	-29.10	
1854.45	1854.716	AlIII	1	1000	-43.68	FeIII[63],FeIII[63],b
1855.70	1855.920	AlII	4	300	-35.55	
1856.50	1856.690	FeIII	63	450	-30.69	
1857.90	1858.026	AlII	4	700	-20.34	MnII[12],FeII[7]
1858.45	1858.542	FeIII	63	300	-22.59	
1859.70	1859.741	FeII	65	300	0.00	0
1859.95	1860.040	FeII	97	400	-14.49	FeIII[63]
1861.65	1861.665	FeIII	63	200	0.00	
1862.20	1862.311	AlII	4	1000	-17.70	
1862.50	1862.790	AlIII	1	600	-46.71	
1863.30	1863.317	FeIII	52	250	0.00	
1864.50	1864.743	FeII	126	400	-40.73	FeII[126]
1865.00	1865.202	FeIII	151	450	-32.16	
1866.10	1866.305	FeIII	52	600	-32.13	CrII[156]
1866.70	1866.815	FeI	39	40	-17.68	
1869.60	1869.928	FeIII	52	650	-35.31	
1870.85	1871.152	FeIII	52	600	-48.09	
1875.00	1875.536	FeII	345	300	-34.78	
1876.00	1876.181	FeII	141	160	-27.12	
1876.70	1876.335	FeII	97	300	-20.76	
1877.25	1877.462	FeII	125	400	-33.54	
1878.15	1877.989	FeIII	63	800	+27.15	CrII[156]
1879.95	1880.046	FeII	141	40	-15.00	
1880.95	1880.976	FeII	126	400	0.00	
1881.95	1882.047	FeIII	62	650	-14.34	
1882.75	1882.979	FeIII	62	250	-43.02	
1883.75	1883.816	FeIII	62	200	-9.54	b
1884.55	1884.596	FeIII	62	550	0.00	b
1884.80	1885.125	FeIII	96	600	-50.91	b
1885.95	1885.947	FeIII	96	300	0.00	b
1886.50	1886.757	FeIII	52	800	-39.75	FeIII[52]
1886.96	1887.197	FeIII	53	550	-36.54	FeIII[62]
1887.45	1887.471	FeIII	52	550	0.00	
1888.50	1888.729	FeII	125	400	-34.95	
1889.35	1889.451	FeIII	53	300	-15.87	
1890.50	1890.669	FeIII	52	900	-26.82	CrII[42],AsI[1]
	1892.247	FeIII	96	300		
	1892.073	FeIII	96	300		
1891.90	1892.140	FeIII	52	300	-38.00	
1892.75	1892.890	FeIII	96	300	-22.17	
1893.90	1894.006	FeII	125	200	-15.81	FeIII[83]
1895.00	1894.983	FeIII	96	250	0.00	
1895.25	1895.456	FeIII	34	1000	-31.65	
1895.60	1895.675	FeII	122	200	-11.07	
1896.55	1896.803	FeIII	83	600	-39.54	
1897.15	1897.379	FeIII	83	200	-36.36	
1897.80	1897.850	ClIII	8	300	0.00	
1898.40	1893.538	FeII	140	200	-20.52	
	1899.318	FeIII	96	300		
	1898.92	CrII	40	700		
1900.50	1900.667	FeII	362	10	-25.26	
1901.20	1901.096	FeIII	95	600	+17.34	
	1901.337	FeIII	57	400		
1901.54	1901.540	FeIII	96	200	0.00	ClIII[8]
1902.25	1902.459	SiII	18	100	-31.53	
1903.10	1903.370	FeII	139	20	-42.54	

TABLE I (*continued*)

1904.65	1904.784	FeII	139	300	-20.46	
1906.30	1906.457	FeIII	118	400	-23.58	TiII[3]
1907.60	1907.577	FeIII	83	650	0.00	
	1907.741	FeIII	83	250		
1908.10	1908.32	VII	80	400	-34.59	
1909.15	1909.36	VII	80	400	-33.00	TiII[3]
1910.45	1910.669	FeII	124	160	-32.97	FeIII[37]
1911.15	1911.338	FeIII	135	450	-28.23	MnII[10],CrII[155]
1911.80	1911.88	VII	80	400	-12.54	
1912.40	1912.39	VII	80	400	0.00	GeI[1],FeII[124]
1912.95	1913.10	VII	80	200	-7.83	ClIII[80],0,b
1913.95	1914.056	FeIII	34	1000	-25.07	
1914.95	1915.083	FeIII	51	750	-20.34	MnII[10]
1915.50	1915.750	FeIII	57	150	-39.15	
1916.50	1916.507	FeIII	95	300	0.00	
1917.25	1917.337	FeII	96	300	-12.51	FeIII[95]
1917.95	1918.114	FeII	138	40	-25.02	
1918.00	1918.284	FeIII	57	450	-43.77	
1918.35	1918.480	FeIII	108	450	-20.31	
1919.35	1919.572	FeIII	107	250	-34.38	
1920.05	1920.186	FeIII	95	250	-20.31	
1922.55	1922.797	FeII	138	400	-37.44	
1922.50	1922.789	FeIII	51	1000	-43.68	
1922.95	1923.003	FeIII	35	450	-7.80	CIII[12], b
1923.60	1923.877	FeII	57	450	-42.12	
1924.50	1924.532	FeIII	79	400	0.00	
1925.90	1925.987	FeII	123	400	-15.27	FeIII[57]
1926.10	1926.304	FeII	34	1000	-31.14	
1927.45	1927.481	FeII	140	20	0.00	
1928.10	1928.265	FeIII	95	300	-24.87	
1935.15	1935.296	FeII	96	300	-21.69	
1935.60	1935.580	CrII	39	500	0.00	
1936.50	1936.799	FeII	96	400	-43.38	
1937.20	1937.345	FeIII	51	950	-21.66	
1938.50	1938.899	FeII	188	160	-60.00	
	1938.901	FeIII	106	650		
1939.95	1940.018	FeIII	61	550	-9.27	FeIII[106]
1941.75	1941.653	FeIII	79	200	+18.54	
1943.40	1943.481	FeIII	51	950	-12.33	
1946.00	1945.980	CrII	136	200	0.00	b
1946.90	1946.983	FeI	36	600	-12.77	
1948.15	1948.372	FeII	123	200	-33.87	
1949.50	1949.462	FeIII	79	150	0.00	
	1950.334	FeIII	116	650		SII[1],FeIII[79],0
1950.85	1951.007	FeIII	68	800	-23.04	
1952.35	1952.648	FeIII	68	700	-44.55	
1953.20	1953.322	FeIII	68	900	-18.42	
1953.20	1953.488	FeIII	82	650	-42.99	FeIII[82]
1954.40	1954.223	FeIII	61	650	+33.75	CoI[95]
1955.60	1955.690	FeI	36	400	-13.84	
1962.50	1962.717	FeIII	61	300	-32.10	
1963.10	1963.110	FeII	169	500	0.00	FeII[170]
1964.00	1964.260	FeIII	51	450		
	1964.169	FeIII	82	550	-30.00	
	1964.019	FeIII	82	300		
1964.35	1964.342	FeII	170	240	0.00	
1965.20	1965.309	FeIII	106	550	-15.24	
1965.80	1966.201	FeIII	61	150	-61.02	b
1966.70	1966.74	FeIII	116	550	0.00	
	1970.860	SII	1	400		0
	1970.8796	GeI	6	500		0
1976.00	1976.126	FeIII	54	550	-18.21	
1976.40	1976.62	VII	127	600	-33.39	
1978.40	1978.417	FeIII	54	250	0.00	
1979.80	1980.04	VII	127	400	-36.36	CuII[17]
1980.45	1980.590	VII	127	250	-21.21	
1981.85	1982.076	FeIII	54	400	-34.81	
1982.20	1982.41	VII	127	80	-31.77	
1982.80	1982.805	FeIII	56	550	0.00	
1983.40	1983.676	FeIII	81	150	-40.83	
1992.20	1992.196	FeIII	81	600	0.00	
1992.75	1992.852	FeIII	106	400	-15.06	
1993.10	1993.289	FeII	95	160	-27.00	
	1993.262	FeIII	50	450		
1993.90	1994.073	FeII	50	900	-25.56	
	1994.857	FeII	228	400		0
1995.40	1995.563	FeIII	50	800	-24.06	FeIII[50]
1996.20	1996.420	FeIII	50	800	-33.06	
1999.30	1996.430	FeII	187	200	-40.00	FeII[86],FeIII[55]
2000.15	2000.368	FeII	122	300	-33.00	FeIII[81]
2001.00	2001.262	FeIII	55	40	-38.98	
2006.05	2006.265	FeIII	55	25	-31.38	
2006.85	2007.013	FeII	187	120	-23.91	
2007.40	2007.452	FeII	83	150	0.00	
2007.55	2007.711	FeII	83	120	-23.91	
2010.65	2010.688	FeII	122	250	0.00	
2022.60	2022.776	FeII	361	10	-24.10	
2023.25	2023.480	PI	10	100	-34.08	
2023.50	2023.715	FeII	187	10	-31.14	
2024.30	2024.520	PI	10	70	-32.50	
2025.25	2025.486	ZnII	1	300	-34.05	
2027.55	2027.778	FeII	186	50	-32.52	
2029.00	2029.182	FeII	93	80	-26.61	
2032.20	2032.407	FeII	94	250	-29.52	
2033.25	2033.470	PI	10	150	-35.46	
2034.30	2034.461	FeII	186	10	-23.58	
2036.25	2036.435	FeII	137	200	-26.52	CrIII[69]
2039.50	2039.664	CrIII	69	350	-23.58	MgIII[6]
2055.05	2055.270	FeII	109	200	-32.10	
2057.15	2057.332	FeII	82	120	-26.25	FeIII[78]
2058.55	2058.560	FeIII	100	150	0.00	
2059.50	2059.577	FeIII	78	120	-39.33	
2061.35	2061.552	FeIII	48	250	-29.10	
2061.70	2061.751	FeIII	78	200	-7.26	
2061.80	2062.016	ZnII	1	300	-29.07	
2063.45	2063.672	FeII	92	250	-31.98	
2064.15	2064.228	ZnII	4	200	-11.61	
2065.25	2065.460	CrII	1	150	-30.48	
2065.80	1066.005	FeII	109	150	-29.04	
2068.00	2068.243	FeIII	48	350	-34.80	FeIII[37]
2088.60	2088.625	FeIII	67	60	0.00	
2088.85	2089.089	FeIII	77	90	-34.44	
2089.95	2090.139	FeIII	67	350	-25.83	FeIII[124]
2091.15	2091.312	FeIII	77	120	-22.95	
	2091.34	GeII	1	1000		
	2093.504	FeIII	77	40		0
2094.45	2094.641	FeII	107	10	-27.21	

0 = blend with reseau marks.

b = Very weak, diffuse and severely blended lines. The error for these measurements is much larger than for well-defined, unblended lines.

TABLE II. — *SWP 23079.*

λmes	λlab	Ion	Mult.	Int.
1206.25	1206.24	NiII	-	7
1228.35	1228.41	NI	-	18
1249.65	1249.82	PII	-	200
1255.20	1255.27	SiI	41	10
1283.30	1283.58]	MnIII	9	500
	1283.39]	NiII	-	12
1290.60	1290.97	SeII	14	800
	1290.93	MnII	6	10
1297.80	-	?	-	-
1299.30	1299.56	CrIII	-	40
1325.30	1325.35]	NiII	-	100
	1325.61]	FeII	-	2
1327.00	1327.10]	FeII	-	0
	1327.31]	NiII	-	20
1329.80	1329.85	MiII	-	13
1330.75	1330.61	MnII	79	12
1345.60	1345.88	MiII	-	50
1351.20	1351.28	NiII	-	10
1358.60	1358.77	CuII	3	30
1358.75	1359.00	CuII	173	20
1361.20	1361.37	FeII	-	85
1366.50	1366.72	FeII	-	85
1367.90	1368.09]	FeII	-	50
	1367.95]	CuII	2	25
1370.30	1370.54	MiII	-	25
1372.10	1372.29	FeII	-	1
1373.60	1373.65]	AsII	-	800
	1373.71]	FeII	-	120
1374.70	1373.71	FeII	-	120
1375.70	1375.78	AsII	-	750
1376.45	1376.67	FeII	-	10
1376.70	1377.00	MiII	-	10
1377.80	1377.93	PI	-	60
1378.10	?	?	-	?
1383.40	1383.57	FeII	-	20
1386.20	1386.47	FeII	-	0
1387.10	1387.22	FeII	-	4
1392.00	1392.14	FeII	-	3
1393.20	1393.33	NiII	-	100
1403.00	1403.24	FeII	-	1
1409.90	?	?	-	?
1405.55	1405.60	FeII	-	2
1408.30	1408.47	FeII	-	80
1411.30	1411.47	FeII	-	1
1415.50	1415.72	MiII	-	20
1416.50	1416.62]	FeII	-	0
	1416.66]	MiII	-	0
	1416.73]	FeII	-	0
1418.65	1418.85	FeII	-	10
1419.10	1419.30	FeII	-	0
1419.50	1419.61	MnII	78	40
1420.75	1420.91	FeII	-	30
1423.10	1423.21	MiII	-	16
1424.10	1423.31	FeII	-	0
1425.45	1425.57	NiII	-	6
1427.55	1427.78]	NiII	-	10
	1427.82]	CuII	126	20
1429.90	1430.13	PI	-	20
1429.90	1430.13	PI	-	150
1431.15	1431.49	NiII	-	25
1432.70	1432.78]	MnII	40	86
	1432.87]	FeII	2	-
1434.80	1434.99	FeII	-	40
1440.80	?	?	-	-
1442.20	1442.42	FeII	-	2
1444.90	1445.04	ZnII	-	700
1445.25	1445.39]	FeII	-	1
	1445.46]	MiII	-	14
1445.70	1445.98	CuII	86	20
1446.40	1446.58	NiII	-	20
1447.80	1448.08	MnII	-	15
1448.25	1448.39	FeII	-	70
1449.90	1450.00	NiII	-	14
1451.80	1452.05	MnII	-	6
1454.20	1454.30	FeII	-	20
1455.80	?	?	-	-
1456.30	1456.31]	SeI	8	240
	1456.47]	FeII	-	1
1461.10	1461.55	CuII	84	15
1469.10	1469.38	FeII	-	0
1470.20	1470.45	ZnII	-	15
1477.20	1477.01	ZnII	-	400
1477.95	1478.00]	MgII	-	250
	1478.21]	ZnII	-	300
1480.65	1480.87	MgII	-	200
1480.85	1480.87	MgII	-	200
1482.20	1482.24	MgII	-	100
1482.90	1482.89	MgII	-	300
1483.45	1483.55]	NiII	-	15
	1483.68]	MnII	-	10
1487.45	1487.86	MnII	85	50
1489.10	1489.49	ZnII	-	10
1489.90	1490.26	NiII	-	7
1493.10	1493.27]	CI	64	10
	1493.34]	PI	-	45
1496.30	1496.52	FeII	-	40
1500.70	1500.91	SeI	7	300
1502.95	1503.21	NiII	-	12
1504.00	1504.20]	AsII	-	150
	1504.27]	FeII	-	3
1504.15	1504.37	PI	-	36
1506.80	1506.96]	MiII	-	10
	1506.98]	PI	-	18
1508.10	1508.22	FeII	-	0
1508.60	1508.81	MiII	-	100
1511.20	1511.61	FeIII	-	300
1514.10	1514.33]	FeII	-	1
	1514.37]	MiII	-	80
	1514.49]	CuII	115	200
1515.70	1515.82	MiII	-	40
1519.25	1519.49	CuII	82	100
1520.15	1520.29]	NiII	-	10
	1520.39]	NiII	-	30
	1520.46]	NiII	-	40
1521.60	1521.62	PII	-	300
1522.45	1522.69]	FeII	-	2
	1522.69]	MiII	-	10
1523.20	1523.44]	PII	-	10
	1523.58]	FII	-	40
1524.50	1524.66	FeIII	-	300
1534.15	1534.48	NiII	-	12
1536.80	1537.04	NiII	-	12
1537.90	1538.09	GeII	3	100
1553.65	1553.89	CuII	114	90
1554.25	1554.33]	NiII	-	8
	1554.50]	NiII	-	6
1555.50	1555.70	CuII	113	300
1562.05	1562.28	SiI	41	-
1578.00	1578.25	SiI	37	-
1583.00	1583.20	FeIII	-	200
1588.40	1588.71	NiII	-	9
1597.60	1597.72	SiI	33	25
1599.80	1600.02	FeII	-	2
1603.20	1603.32	ZnII	-	100
1605.65	1605.84	SiI	33	20
1613.65	1613.94	ZnII	-	25
1614.60	1614.56]	SiI	30	30
	1614.63]	SiI	32	25
1616.90	1617.09	NiII	-	50
	1617.14	NiII	-	40
1618.70	1619.09	SiI	30	8
1619.65	1619.53]	SiI	29	15
	1619.85]	NiII	-	20
1621.25	1621.42	CuII	157	300
1623.45	1623.49]	SiI	29	10
	1623.58]	SiI	3	450
1643.85	1643.77	CaII	5	200
1644.90	1645.03	CIII	11	100
1647.50	1647.76	FeII	-	2
1648.30	1648.37	MnIII	25	100
1650.25	1650.29	GeI	-	4
1664.15	1664.51	SiI	25	35
1665.30	1665.27	GeI	-	5
1677.70	1677.84	FeII	-	10
1681.00	1681.18	FeII	-	1
1682.15	1682.67	SiI	21	70
1683.25	?	?	-	-
1683.80	1684.00	FeII	-	2
1702.55	1702.87	SiI	16	70
1706.60	?	?	-	-
1717.55	1717.72	CuII	110	15
1718.80	1718.98	FeII	-	20
1725.80	?	?	-	-
1726.60	1726.90	FeII	-	1
1728.70	1728.82	FeII	-	4
1729.00	?	?	-	-
1731.10	1731.37	FeII	-	20
1733.75	1733.87	FeII	-	4
1740.10	1740.15]	MnII	13	200
	1740.29]	SiI	80	20
1742.50	1742.73	NI	9	350
1743.15	1743.34	MnII	13	100
1744.35	1744.52	FeII	-	3
1748.70	1748.91	FeII	-	6
1756.00	?	?	-	-
1771.70	1771.93	FeII	-	0
1776.80	1776.82	SiI	13	150
1777.70	1777.90	FeII	-	4
1778.24	1778.59]	MnII	100	20
	1778.69]	MnII	-	100
1780.15	?	?	-	-
1783.20	?	?	-	-
1789.30	?	?	-	-
1789.65	1789.83	FeII	-	2
1789.95	1790.25	SiI	72	25
1792.00	?	?	-	-
1794.50	1794.77	FeII	-	1
1796.75	1796.93	FeII	-	40
1800.35	1800.45	FeII	-	0
1800.85	1801.00]	SiI	69	-
	1801.13]	FeII	-	1
1802.55	1802.62	GeI	7	40
1804.30	1804.45	GeI	-	50
1804.80	1804.98	FeII	-	1
1815.25	1815.40	FeII	-	10

TABLE II (*continued*)

1816.00	1816.28	MnII	99	25
1817.20	1817.53	MnII	99	150
1818.70	1818.89	CrII	-	20
1823.60	1823.88	FeII	-	20
1825.20	1825.22	FeII	66	8
1835.15	1835.42	FeII	-	2
1839.75	1840.04	SiI	65	8
1860.70	1861.09	CeI	-	9
1870.40	1870.72	FeII	-	1
1872.25	1872.36	FeI	39	160
1904.00	1904.25	FeIII	-	150
1909.65	1909.85	FeIII	-	150
1921.00	1921.25	MnII	-	800
1929.10	1929.41	FeIII	-	250
1940.55	1940.77	FeIII	-	250
1941.10	1941.07	ArII	13	300
1955.80	1956.03	FeI	35	500
1967.70	1967.93	VI	54	400
1968.65	1968.87	FeII	-	20
1974.30	1974.49	FeII	-	1
1975.35	1975.54	FeII	-	20
1977.25	1977.59	SiI	7	400
1978.70	?	?	-	-
1980.80	?	?	-	-
1997.65	1997.80]	GeI	-	150
	1997.90]	CrI	48	600