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THE ULTRAVIOLET SPECTRUM OF ETA CANIS MAJORIS, B5 Ia

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ABSTRACT

A list of lines visible in OAO-3 spectrum scans of the spectrum of η CMa, B5 Ia, is presented for the regions 1008–1425 Å and 1890–3105 Å. The spectra definitely present in the ultraviolet are H I, He I, C II, C III, N I, N II, O I, O II, Mg I, Mg II, Al II, Al III, Si II, Si III, Si IV, S II, S III, S IV, Ti III, V III, Cr II, Cr III, Mn III, Fe II, Fe III, Ni II. The following spectra are probably present: B II, Si I, P II, P III, Cl I, Cl III, Ca II, Sc III, Ti IV, Cr IV, Mn IV, Ni III, and Y III. The broad resonance lines of C II, N II, Mg II and Si IV are shortward displaced on the average by 120 km s^{-1}. The C III blend at 1176 Å is undisplaced. Strong undisplaced zero-volt lines of Mg I and Mg II arise from a stationary circumstellar envelope which is shown also by the resonance lines of Ca II and Na I. The zero-volt lines of Fe II may also be formed in this circumstellar shell. Line-blocking factors for each 10 Å of spectrum from 1010 to 1420 Å are given in table 3; blocking factors for each 20 Å of spectrum between 1900 and 3080 Å are given in table 4.

Subject headings: early-type stars—line identifications—luminous stars—spectra, ultraviolet—stars, individual

I. INTRODUCTION

Low resolution spectral scans of the ultraviolet spectrum of B-type supergiants have been published by Underhill, Leckrone, and West (1972) who give a list of possible contributors to the major spectral features. Observations obtained by OAO-3 show that there are many absorption lines present in the ultraviolet spectrum of Eta Canis Majoris, B5 Ia. This paper presents a line list and an estimate of the blocking factors for that part of the ultraviolet spectrum that is well recorded by OAO-3.

Spectrum scans are available from 1008 to 1425 Å taken with the U2 spectrometer (Rogerson *et al.* 1973) at steps of 0.2 Å, and from 1890 to 3105 Å taken with the V2 spectrometer at steps of 0.4 Å. Many absorption lines are visible on the scans. The background is 200–300 counts per dwell interval (13.76 s) on the U2 scan but several thousand counts on the V2 tracing. The wavelength scale on the tracings has been derived from the positions of the carriages and it is corrected for the motion of the satellite and for the known radial velocity of the star. This scale seems to be accurate to ± 0.1 Å which is the uncertainty within which the apparent wavelength of a line can be estimated. For convenience in comparing with wavelength tables, at $\lambda > 2000$ Å the wavelengths are computed as if the observation were done in air.

The lines have been identified by comparing with the *Ultraviolet Multiplet Tables* and Finding List (Moore 1950, 1952, 1962), with *Selected Tables of Atomic Spectra* (Moore 1965, 1970), with the *Revised Multiplet Table* (Moore 1945), and with a list of *Atomic and Ionic Emission Lines Below 2000 Å—Hydrogen through Krypton* prepared by Kelly and Palumbo (1973). Once a spectrum was determined to be probably present by virtue of the presence of a significant number of strong lines, all possible coincidences generally were listed. In the case of very full spectra, such as Fe II, coincidences with the weakest lines, those of intensity 5 or less, were generally not listed.

A quantitative description of the spectrum of η CMa, B5 Ia, over the spectral range 3187–6678 Å has been given by Underhill and Fahey (1973). The spectra found by them were taken as a starting point for the identifications in the ultraviolet. That study indicates that in addition to lines of H and He I, lines of C II, N II, O II, Ne I, Na I, Mg II, Al II, Al III, Si II, Si III, P II, S II, Cl II, Ca II, Fe II, and Fe III are present.

II. THE LINE IDENTIFICATIONS

The apparent wavelength of each absorption line was estimated from the tracings to 0.1 Å. On the U2 tracings, where the spectral purity is 0.2 Å, coincidences were searched for within ± 0.3 Å of the apparent wavelength. On the V2 tracings where the spectral purity is 0.4 Å, coincidences were generally sought within ± 0.5 Å of the apparent wavelength. Somewhat wider tolerances were allowed if a blend seemed to be present to one side or the other. The absorption lines present are listed in tables 1 and 2.

The format of the wavelength tables is as follows:

Column (1).—The apparent wavelength of the center of the absorption feature.

Column (2).—The apparent depth of the absorption line relative to an adopted continuum and noise level.

Columns (3) and (4).—The spectrum and multiplet number from Moore (1945, 1950, 1952, 1962, 1970). Multiplet numbers from the *Revised Multiplet Table* are prefixed by the letter R.

Columns (5) and (6).—The laboratory wavelength and the laboratory intensity as listed by Moore. These laboratory intensities are on different scales for the different spectra, but within any one spectrum they indicate the relative intensities of the lines. No intensity

TABLE 1

UV Spectrum of η CMa: 1008 Å to 1425 Å

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
λ1000				λ1000		
08.8	80	Cl III	1	08.777	(1)	
10.0	90	C II	7	09.859	(9)	Broad
		Fe III	9	10.005	(4)	
		C II	7	10.083	(10)	
		C II	7	10.371	(10)	
12.0	82	Fe II	76	12.088	(20)	Blended with 1012.4
12.4	96	Fe II	75	12.417	(25)	
		S III	2	12.49	(3)	
14.5	92	S II	4	14.42	(2)	Broad, blended with 1015.3
15.3	98	Cl III	1	15.023	(7)	Broad
		Fe II	76	15.083	(10)	
		S III	2	15.51	(2)	
		Fe II	74	15.520	(20)	
		S III	2	15.76	(1)	
16.3	92	Cr III	18	16.41	(10)	
17.1	98	Cr III	9	17.14	(50)	Blended with 1017.5
		Fe III	12	17.254	(9)	
17.5	94	Cr III	9	17.31	(50)	Winged longward
		Cr III	9	17.57	(50)	
		Fe III	12	17.745	(8)	
18.2	98	Fe III	12	18.286	(8)	
19.4	100	S II	4	19.53	(2)	Blended with 1019.8
19.8	98	Fe III	41	19.789	(6)	Winged longward
20.5	92	Si II	5.01	20.699	(25)	
20.9	99	Cr III	18	20.94	(20)	Blended with 1021.4
21.4	85	S III	2	21.10	(1)	Broad blend
		S III	2	21.32	(2)	
		Fe III	41	21.561	(4)	
		Cr III	18	21.64	(15)	
22.8	70	—				Sharp
23.6	82	Si II	5.01	23.700	(50)	
24.0	82	Fe III	41	24.108	(3)	
25.1	86	Mn III	—	24.940		Winged shortward
25.7	90	H I	2	25.722		Lyman β
27.3	82	Cr III	3	27.46	(10)	
28.4	90	Cr III	3	28.33	(30)	
29.7	96	Cr III	3	29.57	(10)	
		Cr III	3	30.10	(20)	
31.0	93	Cr III	2	30.47	(60)	Broad, deep feature
		Cr III	2	30.89	(30)	
		Si III	33	31.169	(7)	
		Cr III	9.09	31.23		
		Cr III	2	31.60		
32.1	95	Cr III	3	32.05	(3)	
		Fe III	20	32.123	(8)	
		Cr III	2	32.42		
33.0 to 38.8	97	Cr III	2	33.23	(50)	Very broad, deep feature composed of a number of blended lines chiefly due to Cr III
		Cr III	2	33.45	(50)	
		Cr III	1,2	33.69	(100)	
		Si III	33	33.920	(8)	
		Cr III	2	33.99	(20)	
		Fe III	—	34.054		
		Cr III	—	34.20		
		Si III	33	34.287	(4)	
		Cr III	9.09	34.44		
		Cr III	—	34.86		
		Si II	13.08	34.967	(0)	
		Cr III	2	35.29	(25)	
		Cr III	2	35.57	(25)	
		Si III	33	35.657	(3)	
		Fe III	20	35.768	(6)	
		Cr III	2	35.77	(20)	
		Cr III	1	35.93	(50)	
		Cr III	1	36.03	(100)	
		C II	2	36.337	(80)	
		C II	2	37.018	(150)	
		Si III	33	37.053	(7)	
		Fe III	20	37.462		
		Cr III	1	37.80	(20)	
		Cr III	—	38.06		
		Fe III	20	38.355	(6)	
39.2	89	O I	3	39.226	(8)	Circumstellar
40.0	93	Cr III	1	40.05	(20)	
		Cr III	1	40.17	(30)	
40.4	90	Cr III	24	40.41	(25)	
		Cr III	25	40.53	(40)	
41.0	92	O I	3	40.932	(8)	Broad
		Cr III	1	41.34	(15)	
41.9	75	O I	3	41.686	(7)	Sharp
		Cr III	1	42.020	(10)	
42.8	66	Ni II	—	42.704		
		Cr III	—	42.87		
43.3	77	Cr III	—	43.39		
44.2	57	—				
45.0	86	Cr III	24	45.06	(40)	Winged shortward
		Cr III	24	45.14	(40)	

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
45.9	85	Ni II	—	45.813		
46.6	32	—				
47.4	40	—				
48.0	90	Al II	9.06	47.92		
48.5	70	Al II	9.06	48.59		
48.9	77	Ni II	—	48.936		
49.8	89	P III	—	49.824	(4)	
50.3	91	Mn III	—	50.354		
50.8	81	Ni II	—	50.718		
51.2	68	—				
52.6	96	Ni II	—	52.534		
		Mn III	—	52.718		
53.1	94	S II	—	53.210		
54.2	90	Cr III	9.11	54.10		
		Cr III	9.11	54.32		
54.6	86	Cr III	9.11	54.66		
55.2	92	Fe II	21	55.269	(25)	Possibly circumstellar
56.0	95	Cr III	—	55.89	(40)	
56.8	81	—				
57.2	86	Cr III	8	57.30		
57.8	84	Cr III	—	57.85	(30)	
58.5	70	Cr III	8	58.63		
59.1	70	Cr III	—	59.13	(60)	
59.5	66	Fe II	21	59.571	(20)	
60.2	85	Cr III	8	60.15	(60)	
61.1	97	Cr III	8	61.04	(60)	
		Fe III	40	61.245	(5)	
61.7	95	Fe III	40	61.708	(6)	
62.2	90	Fe III	40	62.272		
62.7	90	S IV	1	62.672	(6)	Sharp
		Cr III	8	62.68	(50)	
		Fe III	21	62.758	(20)	
63.2	98	Fe III	—	63.188		
		C II	12.01	63.285		
		C II	12.01	63.313		
63.9	100	Cl II	1	63.83	(10)	
		Fe III	40	63.872	(8)	
		Fe II	19	63.982	(15)	
64.4	96	Cr III	17	64.32	(30)	
		Cr III	17	64.43	(30)	
64.9	88	Cr III	17	65.12	(15)	
66.1	98	C II	12	65.891	(7)	Broad, winged longward
		C II	12	65.920	(1)	
		C II	12	66.133	(5)	
		Fe III	27	66.143	(10)	
		Fe III	26	66.181	(10)	
		Cr III	17	66.23	(50)	
67.3	94	Cr III	—	67.25		
68.1	100	Fe III	27	68.190	(5)	Broad
		Fe II	19	68.356	(30)	
		Cr III	—	68.41	(80)	
69.0	95	Fe III	27	69.019	(5)	Sharp
		Fe II	20	69.038	(15)	
69.4	65	Cr III	—	69.45		
70.4	93	Cr III	—	70.55		
		Cr IV	—	70.55		
71.0	78	Cl II	1	71.05	(20)	
71.9	94	Fe II	19	71.596	(30)	Broad
		Fe III	26	71.746	(5)	
		Cl II	1	71.76	(10)	
		Cr III	16	72.13	(20)	
73.0	79	S IV	1	72.992	(6)	
73.9	87	S IV	1	73.522	(4)	Winged shortward
		Cr III	16	73.74	(20)	
74.4	64	Mn III	—	74.46		
75.0	90	Fe III	26	75.024	(4)	
75.6	80	Ni II	—	75.551		Sharp
76.2	73	Cr III	16	76.15	(20)	
77.0	93	Cr III	32	76.74	(20)	Broad
		S III	8	77.135	(8)	
79.4	66	Cl II	1	79.08	(15)	Winged shortward
		Cr III	32	79.43	(15)	
80.2	55	Cr III	32	80.21		
80.9	39	Ni II	—	81.035		

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
82.1	73	Cr III	—	82.10		
82.8	90	Fe III	—	82.838		
83.4	100	Si III	23	83.210		
85	92	N II	1	83.977	(10)	Very broad and deep blend
		N II	1	84.568	(11)	
		N II	1	85.536	(10)	
		N II	1	85.699	(12)	
86.7	86	Fe III	—	86.748		
		Mn III	—	86.751		
87.3	82	Mn III	—	87.368		Sharp
88.3	99	Mn III	—	88.185		Broad
		Fe III	—	88.224		
		Cr III	—	88.28		
		Mn III	—	88.324		
89.7	99	Fe III	—	89.061		Broad
		Cr III	—	89.30		
		Mn III	—	89.313		
		Fe III	—	89.416		
		Fe III	—	89.617		
		Mn III	—	89.715		
		Cr III	9.12	89.76		
90.2	90	Cr III	—	90.27		
91.4	82	Ni II	—	91.407		
91.9	70	V III	9.86	91.860		
		C II	14.05	91.937		
92.6	88	Cr III	9.12	92.65		
93.2	87	Si III	42	93.105		
		Si III	42	93.133		
		Cr III	—	93.17		
		Si III	42	93.293		
94.6	72	Cr III	9.13	94.53		
95.5	72	—				
96.0	70	Cr III	31	95.96	(5)	
96.7	96	S II	3	96.57	(2)	
		Fe II	18	96.616	(20)	
		Fe II	18	96.793	(20)	
		Fe II	18	96.886	(30)	
97.6	85	Fe II	51	97.782	(2)	
98.3	84	Fe III	—	98.247		
99.0	84	Fe II	18	99.117	(25)	
99.9	80	Fe II	18	00.026	(20)	

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
λ1100				λ1100		
00.6	82	Fe II	18	00.525	(20)	
		Cr III	23	00.61	(30)	
01.4	80	Cr III	23	01.43	(30)	
		Fe II	18	01.538	(20)	
02.3	94	S II	3	02.32	(3)	
		Fe II	18	02.385	(8)	
02.9	73	Cr III	23	02.88	(30)	
03.8	45	—				
04.3	79	Cr III	31	04.44	(15)	
05.4	48	—				
06.2	82	Fe II	17	06.215	(15)	Winged shortward
		Fe II	15	06.362	(5)	
06.9	66	—				
07.7	76	V III	—	07.76		
08.4	95	Si III	5	08.368	(14)	
09.0	80	Mn III	—	09.073		
10.0	93	Si III	5	09.940	(16)	Broad
		Si III	5	09.970	(16)	
11.2	85	Fe II	15	11.14	(15)	
12.2	75	Fe II	16	12.086	(35)	
13.2	97	Si III	5	13.174		Broad
		Si III	5	13.204		
		Si III	5	13.228	(18)	
		Cr III	30	13.26	(10)	
14.6	71	Mn III	—	14.530		
15.2	40	Mn III	—	15.147		
15.7	34	V III	9.90	15.71		
16.2	22	Cr III	—	16.46		
17.3	74	Cr III	22	17.19	(30)	
18.0	73	Mn III	—	18.068		
18.6	62	Cr III	30	18.55	(20)	
19.4	75	Cr III	30	19.40	(5)	
20.3	87	—				
21.3	88	—				

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
22.2	99	Fe II	12	21.987	(25)	Broad
		V III	3	22.11	(15)	
22.5	96	Cr III	22	22.43	(15)	
		Si IV	3	22.486	(8)	
		Fe III	1	22.526	(9)	
		Fe II	13	22.858	(25)	
		V III	3	23.00	(15)	
23.9	90	V III	3	23.55	(15)	
24.5	100	Fe II	14	24.134	(20)	
		S II	8	24.39	(1)	
25.0	96	Fe III	1	24.883	(9)	
		S II	8	25.00	(1)	
		Cr III	30	25.27	(10)	
25.7	90	V III	3	25.71	(30)	
		Cr III	22	25.73	(20)	
26.6	99	Fe II	13	26.425	(20)	
		Fe II	14	26.603	(20)	
		Fe III	1	26.72	(6)	
26.9	94	Fe II	12	26.850	(20)	
27.6	93	Cr III	—	27.71		
27.9	99	Fe III	1	28.02	(8)	
		Fe II	14	28.074	(25)	
28.6	100	Si IV	3	28.325		Broad
		Si IV	3	28.340	(10)	
		Fe III	1	28.72	(7)	
		Fe II	13	28.909	(20)	
29.2	98	Fe III	1	29.19	(7)	
30.4	98	Fe III	1	30.404	(5)	
		Fe II	12	30.428	(25)	
31.2	99	S II	8	31.05	(2)	
		Fe III	1	31.194	(7)	
31.9	100	S II	8	31.65	(2)	Winged shortward
		Fe III	1	31.914	(3)	
32.8	72	—				Sharp
33.7	77	Fe II	11	33.678	(25)	Possibly circumstellar
34.3	97	N I	2	34.168	(10)	Possibly circumstellar
		N I	2	34.417	(10)	
35.0	91	N I	2	34.979	(10)	Sharp
36.8	82	Cr III	—	36.67	(50)	
38.1	55	Fe II	48	38.039	(5)	
39.0	78	Fe II	11	38.642	(25)	Winged shortward
		Cr III	9.14	38.76		
		C II	14.04	38.936	(2)	
39.4	82	C II	14.04	39.332	(3)	
		C II	14.04	39.473	(0)	
39.8	75	V III	—	39.85		
40.6	69	Si III	32	40.545	(6)	
41.4	88	Fe III	—	41.272		
41.7	92	Si III	32	41.580	(7)	
42.5	95	Si III	32	42.282	(6)	
		Fe II	10,11	42.334	(25)	
		Fe III	39	42.464	(4)	
43.1	95	Fe III	39	42.955	(5)	
		Fe II	10	43.235	(25)	
43.7	94	Fe III	39	43.67	(3)	Winged longward
		Fe II	156	44.052	(5)	
44.3	85	Si III	32	44.306	(8)	
44.9	90	Si III	32	44.959	(6)	Winged longward
		Fe II	10	44.946	(35)	
		Si III	32	45.669		
46.3	75	Mn III	—	46.335		
		Cr III	—	46.34		
46.9	65	Fe II	10	46.963	(15)	
47.5	67	Fe II	10	47.413	(25)	
48.2	78	Fe II	10	48.295	(30)	
48.8	56	Fe II	155	48.693	(8)	
49.6	37	Mn III	—	49.572		
50.0	60	V III	2	49.94	(100)	Winged longward
		P II	3	49.960	(10)	
		Fe II	10	50.292	(20)	
50.5	54	Fe II	10	50.689	(20)	
51.1	74	V III	2	51.04	(90)	
		Fe II	10	51.163	(25)	

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
52.2	67	O I	6	52.129	(5)	
		V III	2	52.18	(80)	
		Fe II	10	52.440	(15)	
52.8	64	P II	3	52.803	(10)	
		Fe II	10	52.882	(20)	
53.3	65	V III	2	53.19	(70)	
		Fe II	10	53.281	(20)	
53.6	64	Cr III	29	53.60	(15)	
54.1	78	Fe II	10	53.955	(15)	
		P II	3	53.997	(10)	
		Cr III	29	54.12	(15)	
		V III	2	54.24	(70)	
54.4	79	Fe II	10	54.401	(20)	
54.7	75	V III	2	54.770	(75)	
55.1	77	Si III	31	54.998	(6)	
		P II	3	55.020	(10)	
		Fe II	157	55.273	(2)	
55.4	75	Cr III	29	55.39	(15)	
56.0	69	Si III	31	55.957	(6)	
56.6	38	Fe II	—	56.575		
57.1	66	P II	3	56.968	(10)	
		Al II	—	57.100		
58.2	75	Si III	31	58.102	(7)	Winged shortward
		Al II	—	58.240		
59.2	72	P II	3	59.085	(10)	
		Fe II	73	59.347	(20)	
59.6	72	Ni II	—	59.510		
		V III	1	59.77	(50)	
60.3	50	Si III	31	60.255	(6)	
60.8	39	Ni II	—	60.776		
61.5	75	Cr III	—	61.43	(50)	
		Si III	31	61.579	(8)	
62.0	60	V III	9.89	62.020		
62.6	53	Cr III	—	62.60		
63.3	50	V III	1	63.27	(30)	
64.0	54	N I	7	63.870	(9)	
		Mn III	—	64.019		
64.4	56	Ni II	—	64.279		Winged longward
		N I	7	64.314	(9)	
		Ni II	—	64.574		

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
65.2	27	Fe II	73	65.269	(12)	
66.2	71	Cr III	—	66.23		
		V III	9.24	66.29		
66.9	67	V III	9.87	66.86		
67.5	65	N I	6	67.442	(8)	
68.3	81	N I	9.14	68.215		Broad, winged longward
		N I	9.14	68.334		
		N I	6	68.477	(8)	
69.3	65	V III	1	69.28	(20)	
70.3	70	N I	9.10	70.276		
70.6	71	N I	9.10	70.416		
		N I	9.28	70.674		
		N I	9.28	71.086		
71.3	49	V III	1	71.270		
71.6	53	Fe II	154	71.606	(8)	
72.7	75	Si III	30	72.529	(4)	
		Mn III	—	72.721		
73.4	67	Cr III	—	73.34		
75.6	100	Si III	30	74.369	(5)	Broad, deep line
		Si III	30	74.432	(6)	
		C III	4	74.933	(3)	
		C III	4	75.263	(3)	
		C III	4	75.590	(2)	
		C III	4	75.711	(5)	
		C III	4	75.987	(3)	
		C III	4	76.370	(3)	
		N I	9.12	76.510		
		N I	9.12	76.630		
77.6	60	N I	9.12	77.695		
78.0	60	Si III	30	78.004	(8)	
78.6	50	Mn III	—	78.510		
		Cr III	—	78.55		
		Ni II	—	78.571		
79.0	54	Cr III	—	78.99		
79.4	50	Al II	—	79.34		
79.9	66	Mn III	7	79.846	(20)	
80.8	65	Cr III	—	80.81		
81.7	52	Cr III	—	81.63		
82.7	47	Mn III	—	82.825		
83.4	66	Mn III	4	83.305	(30)	

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
83.9	65	Mn III	7	83.870	(25)	
84.7	50	—				
85.4	46	—				
86.1	68	Mn III	7	86.133	(10)	
86.9	53	V III	—	86.890		
87.5	73	Cr III	—	87.65	(30)	
88.6	49	Ca III	—	88.606		
89.1	62	Al II	9.08	89.180		
90.3	89	S III Si II	1 5	90.17 90.418	(2) (100)	
91.9	73	Mn III Al II	4 —	91.726 91.812	(15)	
92.8	77	Mn III	4	92.777	(8)	
93.3	92	Si II	5	93.284	(200)	Possibly circumstellar
93.5 to 94.7	89	S III S III Si II	1 1 5	94.02 94.40 94.496	(4) (3) (250)	
95.5	45	Cr III Fe II	— —	95.42 95.46		
96.4	63	Si III Si III	40 40	96.436 96.470		Winged shortward In wing of Lyman α
97.4	90	Cr III Si II	15 5	97.37 97.389	(20) (100)	In wing of Lyman α
98.6	73	V III	9.64	98.610		In wing of Lyman α
99.5	90	N I	1	99.550	(6)	In wing of Lyman α
λ1200				λ1200		
00.2	88	N I	1	00.218	(10)	In wing of Lyman α
00.7	98	N I S III	1 1	00.707 00.97	(10) (4)	In wing of Lyman α Winged longward
02.0	89	S III S III	1 1	01.71 02.10	(2) (0)	Broad; in wing of Lyman α
03.5 to 07.3	100	Si III	2	06.510	(30)	Broad dip in wing of Lyman α at least partly due to Si III resonance line
15.0	100	H I H I	1 1	15.668 15.674		Very broad Lyman α feature
19.8	80	Mn III	6	19.792	(30)	In wing of Lyman α

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
21.1	88	Cr III	—	21.07	(40)	
22.0	80	Cr III	14	21.90	(40)	
22.7	51	Si II	8.02	22.635	(5)	
24.2	72	Si II Si II	8.02 8.02	23.907 24.252	(20) (20)	Winged shortward
25.0	60	Si II	8.02	24.972	(10)	
25.6	80	Cr III	14	25.65	(30)	
26.0	92	—				
26.9	86	S II Cr III Si II Si II Si II	7 14 8.01 8.02 8.01	26.70 26.72 26.814 26.887 26.986	(1) (20) (50) (20) (40)	
27.6	80	S II Si II	7 8.02	27.45 27.604	(1) (100)	
28.7	87	Si II Si II Cr III Si II Mn III	8.01 8.01 14 8.01 5	28.437 28.617 28.65 28.746 28.971	(10) (25) (30) (150) (100)	
29.4	74	Si II Cr III	8.01 14	29.388 29.53	(200) (15)	
30.2	72	Mn III	5	30.120	(20)	
30.7	88	Cr III	21	30.80	(20)	
31.3	50	Si II	8.01	31.406	(5)	
31.9	60	Cr III	—	31.88	(30)	
32.5	42	V III	9.33	32.49		
33.0	86	Cr III	21	32.96	(50)	
33.6	86	Fe II	275	33.660	(8)	
34.1	78	Cr III S II	21 7	33.92 34.14	(20) (3)	
35.5	35	Si III	49	35.431	(7)	
36.2	68	Cr III	21	36.20	(40)	
37.1	34	—				
37.5	28	Si II	—	37.360	(3)	
38.6	67	Cr III	21	38.51	(40)	
39.2	54	Mn III	5	39.244	(50)	

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
39.9	57	Mg II	9.11	39.925		Sharp
40.4	42	Mg II	9.11	40.395		Sharp
41.0	19	—				
41.4	20	Cr III	—	41.32		
41.9	33	Cr III	—	42.08		
42.3	26	Mn IV	—	42.246		
43.2	60	N I	5	43.170	(8)	
		N I	5	43.297	(8)	
44.2	13	—				
44.5	18	Cr III	—	44.41		
		Cr III	—	44.58		
45.2	64	Cr III	6	45.23	(15)	
45.7	50	Mn III	—	45.673		
46.0	43	Mn III	—	45.975		
46.7	40	Si II	8	46.738	(100)	
47.4	60	C III	9	47.383	(3)	
47.8	68	Cr III	6	47.86	(20)	
48.5	66	Si II	8	48.426	(150)	
50.5	90	Si II	13.05	50.089	(100)	Winged shortward
		Si II	13.05	50.433	(150)	
		S II	1	50.50	(3)	
51.3	72	Si II	8	51.164	(200)	
		Cr III	6	51.42	(15)	
52.2	40	V III	7	52.12	(40)	
52.7	70	Cr III	6	52.61	(50)	
53.8	90	S II	1	53.79	(5)	
		V III	7	53.99	(30)	
55.2	28	Mn III	—	55.210		
55.4	38	Fe II	—	55.410		
56.3	18	Cr III	—	56.18		
56.8	55	Cr III	20	56.73		
57.5	30	V III	7	57.50		
58.6	69	Cr III	6	58.55	(20)	
59.1	82	Cr III	20	59.02	(40)	
59.5	98	S II	1	59.53	(5)	Broad
		Cr III	5	59.80	(20)	
60.4	100	Si II	4	60.418	(1000)	Possibly circumstellar
		Fe II	9	60.542	(20)	
61.5	43	Cr III	—	61.53		
61.9	77	Cr III	20	61.86	(40)	
62.4	72	Cr III	5	62.34	(30)	
63.1	50	Cr III	13	63.06		
		V III	9.28	63.20		
63.7	63	Cr III	20	63.61	(35)	
64.2	83	Cr III	13	64.21	(35)	
64.7	91	Si II	4	64.730	(2000)	
64.9	95	Si II	4	65.023	(200)	
66.1	73	Cr III	5	66.14	(15)	
66.6	56	Fe II	9	66.694	(20)	
67.4	47	Fe II	9	67.437	(25)	
68.1	65	Cr III	5	68.01	(25)	
69.1	74	Cr III	13	69.11	(25)	
70.7	43	—				
71.2	37	Fe II	9	71.235	(1)	
71.9	70	Cr III	13	71.85	(20)	
		Fe II	9	72.001	(25)	
72.7	46	Fe II	19	72.638	(15)	
73.3	54	Cr III	5	73.31	(15)	
73.8	72	Ca III	—	73.775		
75.1	74	Fe II	9	75.154	(15)	
75.8	58	Fe II	9	75.801	(20)	
76.2	62	N II	9.09	76.201		
		N II	9.09	76.225		
76.8	54	Cr III	—	76.76		
77.3	63	Cr III	—	77.23		
77.6	73	Fe II	9	77.667		
78.9	70	—				Strong isolated line
80.0	60	Cr III	12	79.91	(20)	

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
80.3	46	Si III	63	80.354	(6)	
80.8	32	—				Blended with 1280.3
82.0	44	Cr III	—	81.98		
82.5	67	Ti III	2	82.49	(3)	
83.1	40	Cr III	13	83.12		
83.6	60	Mn III	9	83.566	(500)	
84.2	84	Mn III	9	84.041	(30)	
		Cr III	12	84.09	(20)	
		V III	5	84.23	(15)	
86.5	98	Ti III	2	86.38	(40)	Broad
87.0	80	Cr III	12	87.05	(40)	
87.7	63	Mn III	9	87.583	(400)	
		V III	5	87.88	(20)	
88.7	49	Mn III	9	88.674	(50)	
89.4	86	Ti III	2	89.32	(30)	
		V III	4	89.42	(30)	
89.9	48	Cr III	—	89.81		
90.9	65	Cr III	37	90.93	(20)	
91.5	92	Cr III	37	91.53	(25)	Broad
		Fe II	87	91.594	(15)	
		Mn III	9	91.597	(300)	
		Ti III	2	91.64	(20)	
		Mn III	9	91.681	(40)	
		Cr III	37	91.77	(25)	
93.2	80	Ti III	2	93.26	(30)	Winged longward
		Mn III	9	93.649	(200)	
94.6	95	Si III	4	94.543	(17)	Broad
		Ti III	1,2	94.67	(50)	
		Fe II	87	94.914	(12)	
95.9	71	Ti III	1	95.91	(30)	
		Fe II	86	96.088	(20)	
96.7	86	Si III	4	96.726	(14)	
98.0	40	Ca III	—	98.035		
99.0	90	Ti III	1	98.67	(50)	Broad, winged shortward
		Si III	4	98.891	(15)	
		Ti III	1	98.95	(40)	
		Si III	4	98.960	(18)	

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
λ1300				λ1300		
00.1	64	Fe II	86	99.984	(0)	
01.2	81	Si III	4	01.146	(14)	
02.1	82	O I	2	02.174	(10)	Probably circumstellar
03.3	80	Si III	4	03.320	(16)	
04.4	84	Si II	3	04.369	(100)	Probably circumstellar
04.9	77	O I	2	04.859	(10)	
05.4	75	P II	2	05.53	(10)	
06.0	70	O I	2	06.023	(10)	
06.8	33	Mg II	9.08	06.714		
09.4	80	Si II	3	09.274	(200)	Broad, winged shortward
		Cr III	28	09.34	(20)	
		P II	2	09.877	(10)	
10.6	52	N I	13	10.569	(10)	
		P II	2	10.685	(10)	
10.9	51	N I	13	10.967	(10)	
11.2	45	Si II	—	11.265		
12.6	70	Si III	10	12.590	(13)	
13.3	37	V III	6	13.31	(30)	
14.3	21	—				
14.7	45	—				
15.4	35	N I	—	15.440		
16.2	80	Cr III	—	16.16		
		Cr III	28	16.40	(20)	
17.2	73	V III	6	17.25	(20)	
18.2	24	—				
19.2	37	—				
19.7	16	N I	12	19.669		
		N I	12	19.676		
22.8	45	Cr III	28	22.83	(10)	
24.0	90	C II	11	23.826	(1)	
		C II	11	23.906	(6)	
		C II	11	23.951	(9)	
		C II	11	23.996	(1)	
24.8	64	—				

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
27.6	90	Ti III	4	27.60	(15)	
		Si III	53	27.703		
29.8	66	Ti III	—	29.837		
30.3	57	—				
32.0	45	V III	9	31.99	(50)	
33.1 to 36.3	98	C II	1	34.532	(150)	Very broad feature
		C II	1	35.662	(30)	
		C II	1	35.708	(300)	
37.4	45	Ca III	—	37.466		
39.7	37	Ti III	—	39.691		
41.4	45	Si III	39	41.465	(8)	
		Si III	39	41.496	(-)	
42.4	57	Si III	39	42.351	(-)	
		Si III	39	42.392	(7)	
		Si III	39	42.432	(-)	
43.4	55	Si III	39	43.388	(6)	
44.5	75	P III	1	44.343	(15)	Broad
		Ni II	10	44.45	(00)	
44.9	76	P III	1	44.900	(10)	
45.8	50	Ni II	—	45.882		
46.8	56	Si II	7	46.873	(100)	
48.6	50	Si II	7	48.543	(100)	
50.1	54	Si II	7	50.057	(150)	
50.6	52	Si II	7	50.52	(20)	
		Si II	7	50.658	(20)	
51.5	43	—				
52.1	42	Ni II	—	52.237		
52.7	63	Si II	7	52.635	(100)	
53.7	58	Si II	7	53.718	(100)	
55.5	46	O I	1	55.605	(8)	Possibly circumstellar
55.9	50	Mn III	—	55.959		
57.2	62	Cr III	36	57.20	(15)	
57.9	55	V III	9.27	57.90		
58.9	55	O I	1	58.524	(5)	Winged shortward
		Mn III	—	58.958		
60.7	55	Mn III	8	60.704	(1000)	
61.3	75	Cr III	—	61.30		
62.4	62	Si III	38	62.366	(5)	
		B II	1	62.460	(5)	
63.4	80	Si III	38	63.459	(7)	
		Si III	38	63.504	(-)	
64.6	60	Mn III	8	64.645	(5)	Broad
65.2	63	Mn III	8	65.206	(800)	Broad
		Si III	38	65.293	(8)	
		Cr III	36	65.29	(20)	
		Si III	38	65.292	(-)	
		Si III	38	65.337	(-)	
65.9	47	Cr III	36	65.94	(7)	
66.6	56	Mn III	—	66.46		
		Cr III	—	66.63		
68.3	56	Mn III	8	68.188	(20)	
69.4	65	Mn III	8	69.419	(400)	
71.3	46	Al II	—	71.240		Broad
		Mn III	8	71.567	(5)	
		Mn III	8	71.649	(300)	
		Si III	67	71.652	(3)	
72.3	52	Cr III	—	72.27		Sharp
		V III	9.31	72.43		
73.1	45	Si III	67	73.030	(5)	
74.0	62	Ni II	9	74.075	(3)	
74.5	73	Ni III	—	74.491		
75.0	78	Si III	67	75.083	(2)	
75.7	66	Si III	67	75.688	(2)	
76.3	69	Ni III	—	76.183		Sharp
77.1	68	Si III	67	77.082	(3)	Broad
		Si III	67	77.238	(2)	
78.1	63	—				
79.0	75	—				
79.5	86	Cl I	1	79.528	(5)	May be circumstellar
79.9	77	P III	7	79.873	(5)	
80.5	54	P III	7	80.464	(10)	
80.7	62	—				

TABLE 1—*Continued*

Apparent λ	Central Absorption	Sp	Mult. No.	Laboratory λ	Laboratory int.	Remarks
81.2	68	P III	7	81.111	(10)	
		Fe II	152	81.250	(10)	
		Ni II	8	81.36	(4)	
81.7	55	P III	7	81.633	(8)	
82.6	78	Fe II	—	82.710		Broad
		Fe III	—	82.857		
83.7	80	Cr III	35	83.79	(25)	
84.1	100	Al III	—	84.132		Winged longward
87.5	66	V III	9.65	87.40		
87.9	65	Si III	37	87.948		Broad
		Si III	37	87.939		
		Si III	37	87.994		
		Si III	37	88.011		
		Si III	37	88.052		
		Si III	37	88.098		
88.6	50	Ni III	—	88.629		Sharp
89.1	32	Ni III	—	89.149		
89.9	60	Cl I	1	89.957	(4)	Broad; possibly circumstellar
90.7	40	S III	—	90.670		Sharp
91.5 to 94.3	80	Cr III	35	91.61	(15)	Broad feature, chiefly Si IV
		Cr III	—	91.78		
		Ni III	—	92.377		
		Cr III	—	92.40		
		Si IV	1	93.755	(15)	
95.2	60	Fe III	—	95.213		Sharp
		Fe III	—	95.382		
98.9	46	Cr III	—	99.05		
99.6	44	Si III	73	99.615	(-)	
λ1400				λ1400		
00.2	34	Cr III	35	00.34	(15)	
01.2 to 03.2	73	Si IV	1	02.769	(12)	
04.0	40	Si II	13.03	03.783	(5)	
		Si II	13.03	04.170	(1)	
04.5	43	Si II	13.03	04.478	(6)	
05.7	56	Cr III	9.21	05.72		
		V III	9.04	05.74		
07.0	40	Cr III	—	06.90		
08.6	53	Cr III	9.20	08.71		
09.1	45	Si II	13.02	09.073	(10)	
		Cr III	—	09.10		
		Fe II	9.07	09.27		
09.9	40	Si II	13.02	09.90	(2)	
10.2	52	Si II	13.02	10.219	(20)	
12.9	45	Fe II	47	12.834	(12)	
13.7	45	Fe II	—	13.699		
		Cr III	—	13.77		
14.3	36	Ni III	—	14.389		
14.9	33	Ni III	—	14.916		Broad
15.7	40	—				
16.8	50	Ni III	—	16.956		
		Si II	18.06	16.972	(10)	
17.3	75	Si III	9	17.237	(13)	
17.8	55	Si II	18.06	17.781	(5)	
		Si II	18.06	18.110	(0)	
19.4	65	Ni III	—	19.382		
20.0	75	Ti III	—	20.036		
20.5	68	Ni III	—	20.448		
21.8	74	Cr III	—	21.80		
24.2	72	Fe II	47	24.047	(8)	Broad
		Ti III	—	24.14		
24.7	63	Fe II	47	24.747	(12)	

TABLE 2

UV Spectrum of η CMa: 1889 Å to 3105 Å

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
λ1800				λ1800		
89.4	38	Fe III	53	89.451	(5)	
90.6	55	—				
91.8	68	—				
92.6	56	Fe III	96	92.247	(5)	
		Fe III	96	92.890	(5)	
94.2	86	Fe III	83	93.981	(11)	
95.2	70	Fe III	96	94.983	(4)	Broad feature
		Fe III	34	95.456	(20)	
		Fe II	124	95.675	(10)	
96.6	60	Fe III	83	96.803	(9)	
98.6	62	Fe II	140	98.538	(10)	
99.8	46	—				
λ1900				λ1900		
00.9	73	Fe III	95	01.096	(9)	Broad
		Fe III	96	01.540	(3)	
02.5	66	Fe III	94	02.076	(5)	Broad
04.1	73	—				Sharp
06.4	66	Fe III	108	06.457	(6)	
07.3	79	Fe III	83	07.577	(10)	
10.1	69	Fe III	57	10.401	(6)	
11.2	60	Fe II	124	10.669	(8)	
		Fe III	135	11.338	(7)	
12.6	66	Fe III	57	12.920	(4)	Blended (12.6–14.9)
13.6	100	Fe III	57	13.622	(4)	
		Fe III	34	14.056	(19)	
14.9	70	Fe III	51	15.083	(15)	
16.0	58	Fe III	57	15.750	(2)	
17.4	85	Fe III	96	17.337	(15)	
		Fe III	95	17.351	(8)	
		Fe III	101	17.453	(9)	
18.3	80	Fe III	57	18.284	(7)	
		Fe III	108	18.480	(7)	
19.9	59	Fe III	95	20.186	(4)	Sharp
21.1	65	—				
21.9	58	—				
22.7	92	Fe III	51	22.789	(15)	Sharp
23.9	62	Fe III	57	23.877	(7)	Broad
		Fe III	79	24.532	(6)	
25.7	80	—				Broad, winged longward
		Fe II	123	25.987	(20)	
		Fe III	57	26.013	(10)	
		Fe III	34	26.304	(18)	
28.2	82	Fe III	95	28.265	(5)	
29.1	71	—				
30.5	80	Fe III	51	30.387	(15)	
		Ni III	18	30.431	(20)	
31.4	75	Fe III	61	31.507	(14)	
32.5	58	Fe II	139	32.477	(15)	
		Fe III	95	32.818	(5)	
33.3	45	—				
35.3	46	Fe II	96	35.296	(15)	
36.0	50	—				
36.8	83	Fe III	96	36.781	(20)	
		Fe III	51	37.345	(14)	
38.8	72	Fe III	95	38.775	(4)	
		Fe II	188	38.899	(8)	
		Fe III	106	38.901	(10)	
39.6	59	Ni II	1	39.71	(4)	Blended (39.6–40.1)
40.1	52	Fe III	61	40.018	(8)	
40.8	62	—				
41.6	46	Fe III	79	41.633	(3)	
42.3	42	—				
43.2	86	Fe III	51	43.481	(14)	Sharp
45.1	69	Fe III	61	45.342	(12)	
46.3	26	—				
47.1	30	—				
48.3	48	Fe III	123	48.372	(10)	
49.5	66	Fe III	79	49.462	(2)	
		Fe III	95	49.666	(3)	
50.6	83	Fe III	116	50.334	(10)	Broad, winged shortward
		Fe III	68	51.007	(12)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
52.6	91	Ni III	24	52.540	(100)	
		Fe III	68	52.648	(11)	
53.4	98	Fe III	68, 82	53.322	(13)	
		Fe III	82	53.488	(10)	
54.2	95	Fe III	61	54.223	(10)	
		Fe III	116	54.975	(8)	
55.7	73	—				
56.5	70	—				
57.7	77	Fe III	147	57.938	(6)	
58.5	95	Fe III	55	58.583	(11)	Blended
59.2	86	Fe III	61	59.324	(8)	Blended
60.1	80	Fe III	82	60.318	(13)	
61.0	85	Fe III	61	61.230	(6)	
62.4	81	Fe III	61	62.717	(5)	Winged longward
63.9	95	Fe III	82	64.019	(5)	
		Fe III	82	64.169	(8)	
		Fe III	61	64.260	(7)	
64.7	92	Ni III	24	64.689	(50)	Winged longward
		Fe III	82	64.776	(8)	
		Fe III	106	65.309	(8)	
65.9	66	Fe III	61	66.201	(2)	
66.7	73	Fe III	116	66.740	(8)	
68.2	53	—				Blended
68.8	49	—				Blended
69.7	34	—				
70.5	58	—				Sharp
71.5	44	—				Blended
72.1	60	—				Blended
73.7	29	—				
75.2	50	—				Blended
76.0	85	Fe III	54	76.126	(8)	Blended
77.2	43	—				
78.3	67	—				
79.5	52	—				
80.2	51	Ni II	34	80.00	(5)	

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
81.8	75	Fe III	54	82.076	(6)	
82.6	69	Ni III	24	82.538	(15)	
		Fe III	56	82.805	(8)	
83.7	78	Fe III	81	83.676	(2)	
		Fe III	86	84.027	(7)	
		Fe III	81	84.288	(9)	
84.9	61	Fe III	56	85.105	(3)	
86.5	58	—				
87.6	88	Fe III	50	87.503	(15)	
		Fe III	56	87.810	(3)	
90.0	86	Fe III	50	89.975	(7)	
91.8	97	Fe III	50	91.613	(14)	
		Fe III	81	92.017	(9)	
		Fe III	81	92.196	(9)	
93.1	86	Cr III	49	92.72	(25)	
		Fe III	106	92.858	(6)	
		Fe III	50	93.262	(7)	
93.9	100	Sc III	4	93.96	(4)	
		Fe III	50	94.073	(13)	
94.2	40	Fe III	50	94.073	(13)	
95.4	59	Fe III	50	95.266	(7)	
		Fe III	50	95.563	(12)	
96.2	53	Fe III	50	96.420	(12)	
99.6	81	Fe II	186, 187	99.430	(10)	
		Fe III	55, 81	99.588	(9)	
λ2000 Air				λ2000 Air		
00.2	72	Fe II	122	00.368	(30)	
01.7	72	Fe III	55	01.258	(4)	Broad
		Cr III	49	01.94	(25)	
02.5	51	—				
03.3	65	Fe III	55	03.491	(8)	
05.2	83	—				Broad
06.3	73	Fe III	55	06.262	(3)	
07.9	77	Fe II	187	07.013	(12)	Winged longward
		Fe II	83	07.452	(15)	
		Fe II	83	07.711	(12)	
		Fe III	55	07.841	(6)	
10.6	65	Sc III	4	10.48	(6)	
		Fe II	122	10.688	(25)	
11.7	85	Fe III	86	11.539	(4)	Sharp

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
12.8	60	Cr III	53	12.23	(12)	Winged shortward
		Sc III	4	12.30	(1)	
		Fe III	86	12.677	(4)	
13.6	61	Fe II	83	13.268	(15)	
		Cr III	53	13.79	(20)	
14.8	70	Cr III	53	14.68	(20)	Broad
		Fe III	86	15.067	(3)	
		Fe III	83	15.500	(20)	
16.4	58	Fe II	187	16.092	(10)	
17.1	80	Fe II	83	17.090	(15)	Sharp
18.7	60	Fe II	94	18.772	(25)	Broad
21.0	53	Fe II	83	20.739	(25)	
22.1	56	—				
22.9	54	—				
23.6	50	—				
25.6	85	Mg I	2	25.82	(15)	Circumstellar line
27.1	54	—				
28.2	52	Fe II	186	27.778	(5)	
29.4	56	Fe II	93	29.182	(8)	
30.6	50	—				
31.3	63	—				
32.1	69	Fe II	94	32.407	(25)	
33.3	55	Ni II	15	33.42	(3)	
34.8	76	—				Broad
36.2	81	Cr III	69	36.39	(60)	
		Fe II	137	36.435	(20)	
37.1	88	Fe III	60	36.845	(2)	Winged longward
40.6	—	Fe III	71	40.407	(3)	
		Fe II	93	40.687	(25)	
44.8	24	Fe III	60	44.970	(4)	
47.2	26	Cr III	69	47.23	(80)	
49.5	56	Fe III	71	49.384	(7)	
50.8	61	Fe III	60	50.739	(7)	
		Fe II	93	51.028	(25)	
56.0	76	Cr II	1	55.59	(200)	Broad
		Fe III	105	55.855	(6)	
		Fe III	71	56.145	(7)	
57.3	62	Fe III	78	57.058	(6)	
		Fe II	82	57.332	(12)	
58.5	74	Si II	16	58.532	(1)	
		Fe III	100	58.560	(8)	
		Si II	16	58.917	(0)	
59.6	63	Fe III	78	59.677	(7)	
61.5	88	Fe III	48	61.552	(10)	Broad
		Cr II	1	61.54	(175)	
		Fe III	78	61.751	(9)	
63.3	44	Fe II	92	63.672	(25)	
65.3	36	Cr II	1	65.46	(150)	
66.0	49	Fe II	109	66.005	(15)	
		Ni II	15	66.41	(5)	
67.7	70	Fe III	124	67.302	(6)	Broad
		Ti IV	2	67.50	(15)	
68.3	65	Fe II	137	67.917	(20)	
		Fe III	48	68.243	(12)	
70.4	59	Fe II	273	69.952	(10)	
		Fe II	273	70.330	(8)	
		Fe III	99	70.539	(8)	
71.8	48	Fe II	107	71.821	(10)	Sharp
72.5	35	Si II	9	72.016	(200)	
		Si II	9	72.701	(200)	
73.3	25	—				
74.1	21	Fe II	91	74.195	(8)	
75.6	39	Fe II	107	75.683	(5)	
76.3	29	—				
77.5	75	Fe II	136	77.507	(12)	
		Fe III	105	77.755	(4)	
78.2	93	Fe II	91	78.164	(8)	Broad
79.0	100	Fe III	48	78.989	(14)	
80.1	54	Fe II	92	80.246	(20)	
80.9	61	—				
82.0	56	—				
83.6	70	Fe III	124	83.530	(6)	
84.3	94	Fe III	67	84.349	(10)	Broad, winged longward
		Fe III	67	84.515	(3)	
		Fe III	77	84.968	(5)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
86.2	61	Fe III	105	86.128	(4)	
87.3	81	Fe III	77	87.132	(8)	Broad
		Fe II	108	87.527	(25)	
		Fe III	77	87.907	(7)	
88.8	70	Fe III	67	88.625	(5)	
		Fe III	77	89.089	(6)	
90.2	90	Fe III	124	90.053	(7)	
		Fe III	67	90.139	(12)	
		Fe III	59	90.240	(6)	
91.4	65	Fe III	77	91.312	(7)	
93.0	53	Fe III	129	92.945	(6)	Winged longward
		Fe III	77	93.504	(4)	
		Fe II	290	93.683	(35)	
95.1	60	Fe III	105	95.327	(3)	
96.4	49	Fe III	59	96.430	(6)	
97.7	73	Fe III	67	97.480	(15)	Winged shortward
		Fe II	80,120	97.512	(25)	
		Fe III	66	97.692	(12)	
99.4	63	Fe III	66	99.231	(5)	
		Fe III	129	99.332	(6)	
λ2100				λ2100		
00.9	53	Fe III	129	00.961	(8)	
		Fe II	250	00.963	(5)	
03.6	70	Ti IV	2	03.08	(10)	Broad
		Cr III	41	03.22	(20)	
		Ca II	9	03.239	(2)	
		Cr III	41	03.32	(20)	
		Fe III	66	03.647	(5)	
		Fe III	66	03.799	(12)	
05.0	62	Cr III	41	04.85	(20)	
		Fe III	146	05.020	(5)	
07.5	67	Fe III	66	07.324	(10)	Broad
		Fe II	250	07.555	(10)	
		Cr III	41	07.68	(20)	
08.8	48	Fe III	105	08.676	(5)	
		Fe II	227	08.942	(25)	
		Fe II	227, 250	09.097	(10)	
10.6	42	Fe II	290	10.240	(25)	Sharp
		Fe II	108	10.724	(15)	
12.2	39	—				Broad
		Ca II	9	12.763	(2)	
14.3	75	Cr III	41	13.73	(100)	Very broad
		Cr III	41	13.83	(100)	
		Cr III	41	14.26	(50)	
		Cr III	61	14.53	(50)	
		Cr III	41	14.87	(100)	
16.8	58	Fe III	58	16.588	(7)	
		Fe II	213	16.960	(25)	
17.8	60	Cr III	41	17.53	(100)	
18.5	53	Fe III	58	18.415	(5)	
		Fe III	58	18.567	(6)	
		Cr III	70	18.65	(20)	
20.5	50	Fe III	58	20.239	(5)	
		Cr III	41	20.35	(25)	
		Fe III	58	20.767	(4)	
21.9	43	Cr III	70	21.69	(30)	
22.6	53	Cr III	61	22.44	(40)	
		Cr III	41	22.75	(10)	
23.6	50	Cr III	61	23.53	(80)	Broad
		Fe III	104	23.59	(8)	
25.3	48	Ni II	14	25.12	(8)	Broad, winged longward
		Cr III	41	25.62	(15)	
27.9	46	Fe II	290	27.967	(10)	
		Y III	5	27.99	(100)	
28.6	40	Ni II	15	28.57	(12)	
		Ca II	3	28.733	(0)	
30.1	42	Fe II	80	30.259	(15)	Sharp
31.1	44	Ca II	3	31.43	(2)	
32.2	33	Cr III	61	31.95	(20)	
		Ca II	3	32.25	(1)	
34.9	57	Fe II	213	33.990	(8)	Winged shortward
		Fe III	98	34.861	(9)	
36.3	46	Fe III	76	36.360	(5)	
37.2	60	Fe III	59	37.009	(5)	
		Fe III	58	37.365	(8)	
39.1	59	Ni II	13	38.60	(10)	Sharp
		Cr III	48	39.11	(80)	
41.3	66	Cr III	40	41.15	(100)	Sharp
43.1	60	Fe III	76	43.045	(7)	
		Fe III	59	43.470	(8)	
44.2	70	Fe III	59	43.76	(3)	Broad and deep
		Fe III	59	43.827	(7)	
		Cr III	40	44.15	(80)	
		Fe III	58	44.282	(8)	
		Fe III	98	44.743	(7)	
46.2	60	Fe III	59	46.062	(8)	
		Fe III	59	46.339	(6)	
		Cr III	52	46.36	(10)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
47.7	64	Cr III	40	47.16	(50)	Broad
		Cr III	48	47.56	(50)	
		Fe II	213	47.719	(15)	
		Fe III	59	47.904	(7)	
48.7	49	Cr III	70	48.65	(50)	Winged longward
		Cr III	40	48.85	(40)	
		Cr III	52	49.48	(50)	
50.9	48	Fe II	135	50.618	(20)	
		Fe II	248	50.762	(10)	
		Fe II	106	51.095	(25)	
51.8	52	Fe III	112	51.776	(15)	
52.4	48	Fe II	106	52.373	(12)	Winged longward
		Fe II	151	52.488	(25)	
		Cr III	52	52.76	(50)	
		Fe II	225	53.281	(5)	
		Fe III	98	53.320	(3)	
54.7	40	Cr III	48	54.62	(30)	
56.0	40	Fe II	213	55.839	(12)	
57.0	38	Cr III	52	57.17	(100)	
58.1	45	Fe III	70	57.710	(12)	
		Fe III	145	58.452	(12)	
58.8	55	Fe II	89	58.518	(25)	
		Ni II	13	58.73	(8)	
59.1	34	Cr III	48	59.08	(40)	
61.4	67	Fe II	213, 227	61.161	(15)	
		Fe III	70	61.270	(10)	
		Fe II	227, 370	61.313	(20)	
		Fe II	119	61.582	(20)	
62.1	52	Fe II	90	62.023	(20)	
		Fe II	140	62.283	(5)	
63.3	30	Fe II	372	63.370	(20)	
64.3	43	Cr III	48	63.86	(50)	Broad
		Fe II	79, 372	64.339	(20)	
		Fe II	213, 370	64.558	(25)	
65.7	67	Ni II	13	65.55	(40)	
		Fe II	185	65.555	(10)	
66.9	63	Fe III	70	66.952	(12)	
68.1	43	Fe II	213	67.880	(12)	
		Cr III	48	68.23	(30)	
69.1	56	Fe II	247	68.925	(8)	
		Ni II	13	69.10	(30)	
		Fe II	370	69.431	(10)	
69.8	53	Fe III	140	69.709	(5)	
		Fe II	370	69.950	(12)	
71.0	67	Cr III	68	70.70	(100)	Broad
		Fe III	70	71.045	(12)	
73.1	37	Fe II	372	72.679	(8)	Broad
		Fe II	134	72.989	(15)	
		Fe II	248	73.220	(20)	
75.0	81	Fe III	70	74.658	(15)	Broad
		Ni II	14	74.67	(30)	
		Fe II	135	74.849	(8)	
		Ni II	13	75.16	(25)	
		Fe II	90	75.445	(25)	
77.1	57	Fe II	370	76.826	(20)	
		Fe II	106	77.025	(10)	
		Ni II	40	77.08	(6)	
		Ni II	40	77.36	(6)	
79.4	49	Fe III	75	79.256	(6)	
		Ni II	40	79.36	(6)	
		Ni II	12	79.46	(3)	
80.6	65	Fe II	370	80.255	(12)	
		Fe III	70	80.410	(12)	
		Ni II	40	80.46	(10)	
		Fe II	370	80.870	(12)	
81.8	47	—				
82.8	39	Fe III	75	82.889	(4)	
83.6	52	Fe II	89	83.301	(12)	Broad and shallow
		Fe II	119	83.468	(8)	
		Fe II	247	83.803	(10)	
		Fe III	65	83.960	(6)	
84.6	68	Ni II	13	84.61	(25)	
85.3	74	Cr III	51, 68	85.01	(100)	
		Ni II	140	85.51	(12)	
		Fe II	271	85.622	(8)	
		Fe III	65	85.654	(5)	
86.4	32	Fe III	75	86.207	(2)	
87.9	45	Fe II	271	87.444	(12)	Broad
		Fe II	89	87.678	(10)	
		Fe II	135	87.868	(15)	
		Ni II	12	88.05	(6)	
89.0	35	—				
90.1	50	Cr III	60	90.09	(50)	
91.1	53	Cr III	51	90.76	(100)	Broad, winged longward
		Fe III	65	91.215	(8)	
		Y III	5	91.22	(200)	
		Cr III	47	91.24	(40)	
		Cr III	51	91.58	(100)	
91.9	54	Fe II	367	91.935	(10)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
95.2	27	Fe III	123	95.081	(5)	
		Fe III	123	95.532	(6)	
96.1	20	Fe III	74	95.866	(5)	
98.4	33	Cr III	68	98.62	(100)	Broad, winged longward
		Fe II	367	98.660	(4)	
λ2200				λ2200		
01.5	48	Ni II	13	01.41	(20)	
		Cr III	60, 68	01.46	(15)	
		Fe II	367	01.595	(5)	
02.2	25	Cr III	58	01.93	(20)	
		Fe III	74	02.458	(8)	
03.3	30	Cr III	47	03.22	(100)	
04.4	10	Cr III	51	04.57	(30)	
05.5	12	—				
06.9	32	Ni II	13	06.71	(25)	
07.6	10	Cr III	47	07.46	(40)	
08.5	19	Fe II	367	08.419	(30)	
		Cr III	58	08.70	(60)	
09.1	32	Fe III	110	08.85	(10)	
		Fe II	366	09.049	(20)	
10.3	14	Fe III	110	10.073	(6)	Broad
		Ni II	13	10.38	(20)	
11.7	18	Cr III	58	11.46	(10)	
		Mn III	—	11.942	(400)	
12.4	16	Mn III	16	12.418	(600)	
13.7	39	Fe II	168	13.679	(20)	
15.4	38	Mn III	16	15.211	(800)	
		Fe II	371	15.728	(4)	
16.5	65	Ni II	12	16.479	(100)	
18.0	54	Cr III	47	17.75	(15)	
		Fe II	367	18.289	(30)	
20.5	62	Fe II	371	20.453	(6)	Broad
		Mn III	16	20.538	(900)	
		Fe III	69	20.611	(3)	
22.0	47	Fe III	69	21.830	(10)	
23.1	61	Ni II	12	22.948	(20)	
24.8	57	Ni II	12	24.88	(20)	
26.7	82	Ni II	12	26.34	(18)	Broad
		Cr III	39	26.72	(200)	
		Mn III	16	27.491	(1000)	
		Fe III	69	27.848	(7)	
29.0	42	Fe II	366	28.761	(30)	
		Fe III	128	29.267	(10)	
32.1	59	Cr III	45	31.81	(100)	
		Fe III	64	32.430	(10)	
32.8	48	Fe III	139	32.690	(10)	
34.0	61	Fe III	128	33.654	(6)	
		Cr III	45	33.81	(100)	
36.1	64	Cr III	39	35.91	(200)	
		Fe III	139	35.908	(10)	
37.8	49	Fe II	365	37.577	(20)	Broad
		Cr III	45	37.59	(150)	
		Fe III	139	38.155	(10)	
39.0	30	Fe II	365	39.047	(25)	
41.6	45	Fe II	365	41.426	(20)	
		Fe III	109	41.54	(12)	
44.4	62	Fe III	64	43.405	(8)	Winged shortward
		Cr III	39	44.10	(150)	
		Fe II	365	44.216	(8)	
45.6	34	Fe II	365	45.505	(45)	
		Fe III	128	45.776	(4)	
47.3	33	Ni II	30	47.24	(6)	
48.0	37	Fe II	365	47.692	(35)	
49.2	36	Fe II	365	49.063	(30)	
		Fe II	5, 365	49.181	(25)	
50.2	30	Fe II	4	50.171	(0)	
51.8	51	Cr III	39	51.45	(80)	Broad
		Fe II	365	51.831	(80)	
		Cr III	39	51.95	(30)	
54.0	43	Fe II	365	54.066	(8)	
56.0	60	Fe II	365	55.691	(50)	
		Cr II	49, 77	56.01	(50)	
56.8	40	Fe II	365	56.897	(10)	
57.9	87	Fe II	365	57.788	(25)	Broad
60.1	62	Fe II	4	60.078	(1)	
60.6	51	Fe III	64	60.547	(7)	
		Fe II	4	60.853	(1)	
61.8	56	Cr III	39	61.64	(40)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
63.2	40	Fe II	246	63.224	(1)	
64.7	80	Ni II	12	64.456	(30)	
		Fe II	246	64.589	(1)	
		Cr III	39	64.88	(40)	
66.2	40	Fe II	5	65.991	(0)	
67.8	50	Fe II	4	67.584	(1)	
68.6	35	Fe II	5	68.561	(0)	
		Fe II	5	68.844	(0)	
70.4	68	Ni II	12	70.209	(40)	
73.5	43	Cr III	67	73.30	(100)	
75.5	70	Cr III	67	75.43	(80)	
76.5	70	Cr III	50	76.38	(100)	
77.3	65	Cr III	67	77.47	(80)	
78.7	65	Ni II	22	78.771	(30)	
80.0	54	Fe II	4	79.918	(2)	
84.5	46	Y III	4	84.5	(100)	
87.3	63	Ni II	22	87.082	(20)	Broad
		Ni II	38	87.66	(10)	
89.4	24	Cr III	—	89.23	(50)	
90.9	46	Cr III	50	90.66	(80)	
92.7	14	Fe II	315	92.770	(0)	
93.7	23	Fe II	184	93.765	(1)	
94.4	18	Fe II	184	94.603	(1)	
96.0	40	—				
97.0	80	Ni II	21	96.553	(30)	Broad
		C III	8	96.870	(16)	
97.3	97	Ni II	11	97.140	(30)	
		Ni II	11	97.486	(20)	
98.4	57	Ni II	21	98.269	(30)	
λ2300				λ2300		
00.1	50	Ni II	27	00.10	(15)	Winged longward
		Cr II	149	00.58	(30)	
01.2	18	Ni II	39	01.01	(4)	
03.2	52	Ni II	11	02.98	(60)	
		Fe III	138	03.012	(7)	
		Fe III	138	03.203	(3)	
07.8	26	Ni II	38	07.79	(8)	Broad
08.7	25	Ni II	50	08.52	(12)	
10.1	28	Cr III	54	09.99	(50)	Sharp
13.1	36	Fe II	288	13.300	(1)	
14.8	44	Cr II	19	14.71	(40)	
		Cr II	19	14.81	(8)	
16.2	56	Ni II	11	16.034	(80)	
19.3	50	Fe III	72	19.220	(10)	Broad
		Fe III	144	19.466	(8)	
22.3	34	—				Broad
25.1	62	Cr III	44	24.88	(150)	Sharp
26.5	46	Ni II	11	26.44	(15)	
27.6	58	Fe II	3	27.391	(7)	Broad
		Y III	1	27.30	(20)	
30.0	43	Fe III	72	29.905	(9)	
31.5	67	Fe II	35	31.308	(7)	
32.9	70	Fe II	3	32.798	(8)	
34.5	53	Cr II	47	—		Seven lines blended
37.0	40	Fe III	121	36.768	(10)	
38.2	60	Fe II	3	38.005	(8)	
39.1	54	Fe III	72	38.961	(10)	
40.8	42	—				Broad
42.3	33	—				
43.5	90	Fe II	3	43.495	(8)	Winged longward
		Fe II	35	43.958	(6)	
		Fe II	3	44.278	(8)	
45.3	54	Fe II	165	45.327	(5)	
46.9	57	Fe III	72	46.961	(3)	
48.3	65	Fe II	36	48.118	(8)	
		Fe II	3	48.300	(8)	
51.2	40	Fe II	165	51.198	(5)	
53.7	34	—				
54.9	52	Fe II	165	54.473	(5)	Broad
		Fe II	35	54.884	(5)	
56.5	25	Ni II	22	56.41	(25)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
59.3	49	Fe II	3, 379	59.111	(8)	
60.2	60	Fe II	35	59.999	(8)	
		Fe II	36	60.287	(8)	
62.1	42	Fe II	35	62.014	(6)	
63.9	40	Fe II	379	63.855	(4)	
64.9	49	Fe II	3	64.825	(8)	
66.8	35	Fe II	35	66.591	(5)	Broad
		Fe II	2, 165	66.864	(1)	
		Y III	1	67.25	(200)	
		Ni II	11	67.395	(20)	
68.8	37	Fe II	36	68.593	(7)	
70.4	49	Fe II	379	69.960	(5)	Broad
		Fe II	35	70.494	(5)	
73.8	65	Fe II	2	73.733	(8)	Sharp, probably circumstellar Fe II
		Fe III	115	73.904	(5)	
75.2	49	Fe II	36	75.192	(7)	
		Ni II	21	75.426	(30)	
76.6	32	Fe II	379	76.435	(5)	
		Fe III	115	76.725	(5)	
79.4	43	Fe II	36	79.275	(7)	
80.8	48	Fe II	3	80.757	(7)	
82.2	79	Fe II	2	82.034	(9)	Probably circumstellar Fe II
		Fe II	35	82.356	(3)	
83.2	56	Fe II	2	83.060	(4)	
		Fe II	36	83.242	(7)	
84.6	39	Fe II	36	84.386	(7)	Broad
		Fe II	35	84.999	(3)	
86.4	24	—				
87.8	35	Ni II	19	87.77	(25)	
88.7	62	Fe II	2	88.629	(9)	
89.8	35	Fe III	131	89.533	(8)	
91.5	25	Fe II	35	91.475	(4)	
92.4	22	—				
93.7	23	—				
94.8	45	Fe II	116	94.892	(3)	
95.6	68	Fe II	2	95.416	(7)	
		Fe II	2	95.627	(9)	
99.3	61	Fe II	2, 36	99.237	(9)	
λ2400				λ2400		
00.3	40	Fe II	244	00.338	(4)	
02.5	36	Fe II	377	02.450	(8)	
		Fe II	36	02.597	(3)	
04.8	69	Fe II	2	04.430	(7)	Broad
		Fe II	2	04.882	(9)	
06.8	57	Fe II	2	06.660	(9)	
10.8	65	Fe II	2	10.521	(9)	
		Fe II	2	11.062	(9)	
13.6	55	Fe II	2	13.308	(9)	Winged longward
		Cr III	59	13.65	(30)	
		Ti III	9	13.97	(15)	
16.3	43	Cr II	235	16.40	(40)	
18.1	33	Fe II	244	17.859	(6)	
18.7	39	Fe III	47	18.568	(7)	
20.4	11	Fe III	103	20.405	(3)	
21.5	15	Fe III	103	21.514	(5)	
23.1	32	Fe II	301	22.688	(4)	
		Fe II	301	23.204	(4)	
24.2	51	Fe II	180	24.141	(8)	
28.4	36	Fe II	301	28.286	(4)	
		Fe II	300	28.367	(6)	
29.2	37	Fe II	375	28.970	(6)	Broad blend
		Fe II	385	29.148	(10)	
30.0	41	Cr III	59	29.75	(30)	Broad
		Fe II	180	30.073	(7)	
		Fe II	363	30.103	(6)	
		Fe II	375	30.876	(10)	
32.3	35	Fe II	180	32.259	(7)	
32.9	43	Fe II	321	32.867	(7)	
34.8	49	Fe II	321	34.733	(7)	
		Fe II	375	34.822	(5)	
		Fe II	180	34.942	(7)	
		Fe II	383	34.988	(25)	
37.0	28	Fe II	384	36.615	(20)	Broad
		Fe II	375	36.987	(10)	
		Fe II	375	37.100	(5)	
		Fe II	363	37.142	(5)	
38.1	36	Fe II	375	37.632	(20)	
		Fe III	47	38.174	(8)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
39.4	37	Fe II	209	39.301	(8)	
		Fe II	375	39.860	(8)	
40.5	28	Fe II	300	40.416	(4)	
42.2	9	—				
44.6	48	Fe II	375	43.842	(15)	Winged shortward
		Fe II	375	44.274	(10)	
		Fe II	148	44.515	(8)	
45.6	48	Fe II	375	45.114	(40)	Broad, winged longward
		Fe II	148	45.569	(7)	
		Fe II	300	45.787	(4)	
		Fe II	300	46.103	(4)	
		Fe II	375	46.405	(25)	
47.4	39	Fe II	300	47.203	(3)	
		Fe III	143	47.374	(7)	
		Fe II	320	47.753	(6)	
50.1	34	Fe II	300	49.961	(4)	
		Fe II	375	50.134	(5)	
		Fe II	300	50.196	(4)	
51.2	17	Fe II	209	51.208	(3)	
53.6	13	Fe II	375	53.747	(15)	
		Fe II	375	53.935	(25)	
54.6	29	Fe II	320	54.574	(6)	
55.8	19	Fe II	384	55.892	(10)	
57.0	21	Cr III	43	56.83	(50)	Broad
59.0	40	Fe II	209	58.782	(8)	
		Fe II	299	58.964	(5)	
60.5	24	Fe II	395	60.453	(5)	
		S III	17	60.50	(5)	
61.7	42	Fe II	209	61.282	(8)	
		Fe II	209	61.855	(8)	
63.9	36	Fe II	208	63.280	(6)	Winged shortward
		Fe II	385	63.900	(5)	
		Fe II	208	64.007	(7)	
65.1	37	Fe II	208	64.903	(7)	
		Fe II	148	65.194	(7)	
66.0	35	Fe II	208	65.911	(7)	
66.8	37	Fe II	179	66.670	(7)	
		Fe II	179	66.811	(7)	
67.7	13	Fe II	387	67.732	(6)	
68.3	20	Fe II	145	68.292	(4)	
69.7	29	Fe II	299	69.512	(6)	
		Fe II	382	69.712	(8)	

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
70.7	39	Fe II	208	70.406	(4)	
		Fe II	179	70.661	(7)	
		Fe II	223	70.752	(4)	
72.8	37	Fe II	179	72.426	(5)	
		Fe II	395	72.610	(4)	
		Cr III	43	72.88	(100)	
73.2	31	Fe II	148	73.314	(6)	
74.9	22	Fe II	208	74.762	(6)	
75.3	19	Al II	12	75.260	(4)	
76.3	16	Fe II	163	76.264	(3)	
		Fe II	386	76.437	(0)	
77.3	19	Fe II	162	77.342	(4)	
78.5	32	Fe II	179	78.568	(6)	
80.0	43	Cr III	43	79.77	(100)	
		Fe III	179	80.155	(8)	
81.0	20	Fe II	243	81.044	(3)	
82.3	38	Fe II	161	82.117	(8)	
82.8	45	Fe II	207	82.654	(8)	
		Cr III	43	83.06	(100)	
84.2	36	Fe II	243	84.243	(5)	
86.4	36	Fe II	208	86.343	(7)	
88.2	15	Cr III	66	88.26	(60)	
89.8	46	Fe II	161	89.485	(7)	
		S III	17	89.59	(5)	
		Fe II	207	89.826	(8)	
90.9	39	Fe II	179	90.856	(6)	Broad
		Fe II	207	91.392	(6)	
93.3	54	Fe II	161, 201	93.174	(2)	
		Fe II	161	93.269	(12)	
95.9	20	S III	17	96.24	(6)	
97.8	33	Fe II	175, 207	97.817	(7)	
99.0	41	Fe II	161	98.897	(10)	
		S III	17	99.08	(6)	
λ2500				λ2500		
00.1	4	Cr III	66	00.27	(40)	
01.0	24	Fe II	357	00.919	(5)	
		Si II	18	00.928	(3)	
02.5	33	Fe II	207	02.388	(7)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
03.8	48	Fe II	206	03.323	(7)	Winged shortward
		Fe II	161, 175	03.560	(5)	
		Fe II	285	03.870	(7)	
06.3	35	Fe II	207	06.091	(7)	Broad
		Si I	1	06.896	(150)	
09.3	26	Fe II	242	09.117	(4)	
		C II	14	09.121	(10)	
		Ni III	22	09.467	(10)	
11.7	49	Fe III	193	11.418	(6)	Broad
		C II	14	11.734	(5)	
		Fe II	161	11.759	(10)	
		C II	14	12.065	(12)	
15.0	10	Si I	1	14.315	(100)	Winged shortward
		Fe II	285	14.383	(7)	
16.1	35	Ti III	7	16.01	(20)	
		Si I	1	16.109	(250)	
17.1	17	Fe II	147	17.124	(6)	
19.1	25	Fe II	268	19.044	(7)	
		Si I	1	19.203	(100)	
20.2	16	Fe III	93	20.162	(5)	
		N II	19	20.27	(2)	
21.4	36	N II	19	20.85	(3)	Broad
		Fe II	268	21.089	(7)	
		Fe II	330	21.810	(7)	
		N II	19	22.27	(4)	
22.9	31	—				
25.3	47	Fe II	330	25.114	(4)	
		Fe II	159	25.386	(10)	
26.2	52	Fe II	159	26.071	(5)	
		Fe II	145	26.292	(9)	
27.7	48	Fe II	159	27.107	(6)	Broad, winged shortward
		Fe II	329	27.694	(5)	
		Ti III	7	27.80	(15)	
		Si I	1	28.510	(175)	
29.6	52	Fe II	357	29.078	(5)	
		Fe II	241	29.221	(5)	
		Fe II	145, 177	29.545	(10)	
31.0	21	Cr III	42	30.99	(80)	
33.7	43	Fe II	159	33.626	(10)	
34.3	41	Fe II	159	34.413	(9)	
35.4	35	Fe II	177	35.480	(7)	
36.8	46	Fe II	241	36.673	(7)	
		Fe II	159	36.822	(9)	
38.7	58	Fe II	319	38.205	(6)	Winged shortward
		Fe II	160	38.500	(5)	
		Fe II	158	38.794	(9)	
		Fe II	158	38.898	(8)	
		Fe II	158	39.003	(10)	
40.3	47	Ti III	7	40.02	(15)	
		Fe II	177, 343	40.669	(6)	
41.2	38	Fe II	177	41.096	(7)	
41.8	51	Ti IV	4	41.75	(8)	
		Fe II	158	41.831	(7)	
		Si III	6.09	41.818	(25)	
43.5	41	Fe II	159	43.382	(8)	
		Fe II	177	43.431	(5)	
		Ni III	22	43.513	(30)	
45.3	42	Fe II	147	44.972	(6)	Winged shortward
		Fe II	159	45.215	(7)	
46.7	34	Fe II	177	46.667	(8)	
		Ti IV	4	46.85	(12)	
47.5	23	Fe II	158	47.330	(5)	
48.8	53	Fe II	158	48.590	(6)	
		Fe II	319	48.925	(5)	
		Fe II	284	49.082	(7)	
49.5	54	Fe II	177	49.399	(8)	
		Fe II	177	49.453	(8)	
51.2	—	Fe II	328	51.201	(4)	
55.3	15	Fe II	177	55.066	(5)	
		Fe II	177	55.447	(5)	
57.3	12	Fe II	175	57.500	(4)	
60.3	28	Fe II	205	59.774	(5)	Winged shortward
		Fe II	267	59.921	(5)	
		Fe II	221	60.278	(7)	
62.6	41	Fe II	221	62.094	(6)	Winged shortward
		Fe II	64	62.535	(13)	
63.5	42	Ti III	6	63.42	(15)	
		Fe II	64	63.472	(12)	
65.4	32	Ti III	6	65.42	(8)	
67.0	36	Fe II	64	66.908	(9)	Winged longward
		Ti III	6	67.53	(8)	
		Fe II	145	68.292	(4)	
		Fe II	145	68.405	(6)	
70.9	21	Fe II	284	70.843	(7)	
73.1	12	Fe II	190	72.965	(3)	Broad
		Fe II	205	73.206	(4)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
74.4	30	Fe II	144	74.363	(9)	
		Fe III	80	74.838	(7)	
76.1	34	Ti III	6	76.43	(5)	
76.8	30	Fe II	326	76.859	(7)	
77.9	31	Fe II	64	77.920	(9)	
79.4	12	Fe II	239, 266	79.406	(3)	
80.4	20	Ti III	6	80.43	(5)	
82.5	40	Fe III	80	82.37	(8)	
		Fe II	64	82.582	(10)	
85.8	78	Fe II	326	85.629	(5)	Probably has a circumstellar component
		Fe II	1	85.876	(13)	
88.0	33	Fe II	326	87.945	(7)	
		Fe II	145	88.182	(3)	
90.5	15	Fe II	145	90.548	(4)	
91.6	41	Fe II	64	91.542	(10)	
92.8	39	Fe II	318	92.781	(9)	
93.6	36	Fe II	64	93.722	(7)	
95.7	22	Fe III	80	95.622	(8)	
98.4	53	Fe II	1	98.369	(14)	
99.3	75	Fe II	1	99.395	(14)	Probably has a circumstellar component
λ2600				λ2600		
05.4	45	Fe II	204	05.416	(6)	
07.0	52	Fe II	1	07.086	(13)	Broad
09.1	25	Fe II	310	09.122	(5)	Broad
11.8	60	Fe II	64	11.075	(6)	Winged shortward
		Fe II	1	11.873	(13)	
13.8	50	Fe II	1	13.820	(13)	
17.7	40	Fe II	1	17.618	(12)	
19.2	—	Fe II	171	19.071	(7)	
20.7	31	Fe II	1	20.408	(6)	Winged shortward
		Fe II	171	20.693	(7)	
21.6	35	Fe II	1	21.669	(10)	
23.7	21	Fe II	318	23.129	(4)	Winged shortward
		Fe II	171	23.721	(5)	
25.7	53	Fe II	318	25.489	(9)	Winged longward
		Fe II	1	25.664	(13)	
		Fe II	173	26.499	(6)	
28.3	44	Fe II	1	28.291	(13)	
29.8	33	Fe II	171	29.590	(8)	Broad
		Fe II	171	30.068	(8)	
31.3	62	Fe II	1, 171	31.045	(13)	
		Fe II	1	31.321	(13)	
		Fe II	171	31.607	(8)	
33.1	18	Fe II	356	33.200	(5)	
33.7	16	—				
37.7	25	Fe II	221	37.643	(6)	
39.7	22	Fe II	221	39.560	(5)	
45.4	28	Fe II	426	45.328	(3)	
46.7	17	Fe II	220	46.692	(0)	
47.8	9	—				
49.5	11	Fe II	427	49.467	(4)	
53.2	20	Cr II	330	52.78	(3)	Broad
		Cr II	330	53.25	(4)	
		Cr II	8	53.57	(85)	
58.3	20	Cr II	8	58.59	(100)	Broad
60.8	15	Mg II	4	60.755	(10)	
		Mg II	4	60.821	(10)	
61.5	9	Cr II	8	61.73	(50)	
63.5	17	Cr II	8	63.42	(75)	
		Cr II	8	63.67	(45)	
64.6	40	Fe II	263	64.665	(10)	
66.7	34	Cr II	8	66.02	(80)	
		Fe II	263	66.631	(10)	
68.7	6	Cr II	8	68.71	(70)	
70.0	8	S II	11	70.0	(3)	
70.7	7	—				
71.7	7	Cr II	8	71.80	(80)	
72.2	15	Cr II	122	72.37	(15)	Broad
		Cr II	8	72.83	(90)	
77.2	21	Cr II	8	77.13	(100)	
		Cr II	8	77.19	(125)	
		He I		77.132		$2^3S - 10^3P^0$

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
84.5	29	Fe II	283	84.752	(10)	
89.1	16	Cr II Cr II	84 85	89.03 89.20	(20) (35)	
91.0	13	Cr II	8	91.03	(90)	
92.6	33	Fe II Fe II	283 62	92.601 92.826	(10) (5)	Winged longward
96.1	16	He I		96.118		$2^3S - 9^3P^0$
97.3	21	Fe II Fe II	341 341	97.330 97.453	(4) (5)	Broad
99.0	23	Sc III	3	99.01	(3)	
λ2700				λ2700		
01.6	15	Cr II Cr II Cr II Cr II	62 186, 230 62 277	01.10 01.24 01.65 01.75	(30) (20) (15) (12)	Broad
03.9	34	Fe II	261	03.988	(10)	Sharp
06.6	21	Fe II Fe II	341 334	06.566 07.128	(7) (6)	Winged longward
09.0	16	Fe II	218	09.051	(7)	
12.0	28	Fe II Fe II	201 201	11.842 12.386	(9) (6)	Broad
14.4	40	Fe II	63	14.414	(13)	
16.3	27	Fe II	261	16.216	(9)	
19.2	13	Fe II	339	19.296	(5)	
23.2	17	He I		23.190		$2^3S - 8^3P^0$
24.8	20	Fe II	62	24.879	(9)	
27.4	40	Fe II Fe II	200 63	27.382 27.538	(8) (13)	
30.7	30	Fe II	62	30.735	(11)	
34.0	15	Sc III	3	34.02	(2)	
36.8	33	Fe II	63	36.968	(12)	
39.5	53	Fe II	63	39.545	(15)	
43.2	41	Fe II	62	43.196	(14)	
46.7	54	Fe II Fe II	62 63	46.487 46.978	(14) (14)	Broad
49.2	56	Fe II Fe II Fe II	63 62 63	49.178 49.324 49.482	(13) (14) (12)	Broad

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
53.2	35	Fe II	235	53.289	(12)	
55.7	50	Fe II	62	55.733	(15)	
61.8	25	Fe II	63	61.813	(9)	
63.7	15	He I		63.798		$2^3S - 7^3P^0$
67.5	34	Fe II	235, 373	67.500	(13)	
68.7	17	Fe II	63	68.940	(8)	
69.2	27	Fe II	200	69.153	(6)	
79.3	27	Fe II	234	79.302	(11)	
80.0	18	Fe II Fe II	348 348	79.906 80.035	(4) (3)	
83.7	24	Fe II	234	83.690	(12)	
85.2	20	Fe II	372	85.213	(8)	
90.7	55	Mg II	3	90.768	(40)	
94.5	73	Mg II	1	95.523	(50)	Displaced component
95.3	100	Mg II	1	95.523	(50)	Partly circumstellar
97.9	56	Mg II	3	97.989	(40)	
λ2800				λ2800		
01.6	63	Mg II	1	02.698	(50)	Displaced component
02.6	100	Mg II	1	02.698	(50)	Partly circumstellar
29.0	28	He I	12	29.073	(4)	$2^3S - 6^3P^0$
31.6	30	Fe II	217	31.562	(11)	
35.7	34	Cr II Fe II	5 216	35.63 35.716	(200) (9)	
36.6	37	C II	13	36.710	(8)	
37.6	31	C II	13	37.602	(7)	
38.2	16	Fe II	380	38.235	(4)	
39.5	20	Fe II Fe II	391 380	39.535 39.819	(7) (6)	
40.6	34	Fe II Fe II	217 280	40.644 40.756	(9) (8)	
43.3	24	Cr II Fe III	5 126	43.24 43.779	(100) (4)	Broad
47.9	26	S II	10	47.74	(3)	
49.6	23	Cr II	5	49.83	(100)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
52.1	56	Mg I	1	52.120	(300)	Circumstellar
55.7	20	Cr II	5	55.67	(100)	
56.3	20	Fe II	380	56.392	(5)	
58.5	23	Fe III	126	58.664	(7)	
		Cr II	5	58.91	(75)	
60.9	8	Cr II	5	60.92	(85)	Broad
62.5	10	Cr II	5	62.57	(125)	
63.6	6	S III	15	63.53	(5)	
64.8	6	Fe II	294	64.968	(4)	
65.2	8	Cr II	5	65.10	(150)	
68.1	10	Fe III	155	68.136	(5)	
71.4	7	Cr II	295	71.45	(20)	
72.6	8	—				
73.3	19	Cr II	5	73.46	(65)	
		Fe III	155	73.795	(4)	
76.2	12	Cr II	5	76.24	(60)	
77.8	6	Cr II	5	77.97	(60)	
78.4	9	Cr II	5	78.45	(50)	
79.4	11	Fe III	230	79.543	(2)	
80.8	20	Fe II	61	80.750	(9)	
		S II	10	81.01	(1)	
83.8	24	Fe II	230	83.709	(10)	
95.1	26	Fe II	230	94.776	(7)	Broad
		Fe III	125	95.076	(8)	
97.3	21	Cr II	287, 290	97.24	(10)	Broad
		Fe II	254	97.264	(8)	
		Cr II	212	97.67	(30)	
98.7	17	Fe II	352	98.738	(1)	
λ2900				λ2900		
02.7	17	Fe II	278	02.459	(5)	
		Cr II	275	02.60	(7)	
		Cr II	291	02.86	(10)	
04.3	18	Si II	17	04.283	(300)	
		S III	15	04.31	(6)	
		Fe III	125	04.431	(12)	
06.2	16	Si II	17	05.692	(500)	Broad
		Cr II	227	06.17	(10)	

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
07.7	20	Fe III	88	07.497	(10)	
		Fe III	125	07.701	(12)	
08.5	15	Fe III	125	08.651	(5)	
15.2	4	Cr II	227	15.22	(10)	
23.6	11	Cr II	286	23.46	(30)	
		Cr II	286	23.67	(40)	
26.8	18	Fe II	60	26.584	(12)	
28.6	38	Mg II	2	28.625	(35)	
36.6	45	Mg II	2	36.496	(35)	
39.5	21	Fe II	60	39.506	(5)	
44.9	33	Fe II	78	44.399	(13)	
		He I	11	45.050		$2^3S - 5^3P^0$
47.7	26	Fe II	78	47.658	(13)	
49.3	21	Fe II	277	49.178	(10)	
50.1	12	S III	18	50.23	(3)	
53.7	21	Fe II	60	53.774	(11)	
55.0	10	Fe III	87	55.060	(4)	
59.7	13	Fe II	254	59.601	(7)	
63.0	9	Fe III	87	63.230	(8)	
64.0	10	Fe II	252	64.131	(7)	
64.5	11	Fe II	78	64.629	(9)	
65.2	16	Fe II	78	65.036	(10)	
		Mg II	7	65.19	(0)	
66.2	7	Cr II	94	66.03	(40)	
67.8	2	Mg II	7	67.87	(1)	
69.0	4	Mg II	6	69.02	(0)	
69.9	8	Fe II	277	69.934	(8)	
70.8	9	Fe II	60	70.510	(10)	
		Fe II	276	70.682	(5)	
71.9	7	Mg II	6	71.70	(1)	
74.2	6	Fe III	87	73.896	(5)	
76.3	9	Fe II	60	75.938	(5)	
77.7	11	Fe III	102	77.572	(5)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
79.9	16	Fe II Cr II	60 80	79.349 79.73	(8) (80)	Broad
82.4	19	C III	13	82.20	(5)	
85.0	49	Ti III Fe II Cr II Fe II S III	8 78 80 78 18	84.76 84.831 85.32 85.545 85.98	(10) (15) (75) (13) (6)	Broad
89.10	13	Cr II	80	89.18	(70)	
91.1	12	Fe II	252	91.244	(0)	
92.6	15	Cr II	80	92.42	(10)	
94.6	13	Cr II	80	94.74	(20)	
97.4	15	Fe II	335	97.298	(7)	
λ3000				λ3000		
01.7	16	Fe III	87	01.589	(12)	
02.8	23	Fe II Fe III	78 87	02.650 02.99	(13) (5)	
07.2	11	Fe III	R116	07.2	(20)	
07.8	12	Fe III	88	07.802	(6)	
08.3	9	Fe III	87	08.506	(5)	
13.3	13	Fe III	87	13.125	(20)	Broad
15.6	9	Fe III	87	15.230	(7)	
17.3	8	—				
18.7	5	Fe III	88	18.744	(6)	
21.4	25	Fe II	251	21.407	(1)	
22.4	15	—				Broad
23.5	34	Fe III	88	23.85	(8)	
24.5	40	—				Broad
26.6	51	Al II Al II Cr II	R13 R13 R41	26.776 26.781 26.85	(P) (P) (20)	
27.3	39	Fe III	88	27.46	(3)	
29.6	39	Fe II	R124	29.681	(0)	
31.7	47	Fe II	R138	31.63	(P)	
32.4	38	Ni II	R3	32.44	(2)	

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	Laboratory int.	Remarks
33.2	42	Fe II	R181	33.445	(2)	
34.0	47	Cr II	R74	34.05	(5)	
34.9	49	Si III	R10	34.732	(6)	
36.2	40	—				
37.1	50	Si III	R10	37.287	(8)	Winged shortward
37.9	42	Cr II	R154	38.04	(6)	
38.7	41	Cr II	R41	38.52	(3)	
39.4	42	O II	R72	39.51	(1)	
39.9	41	O II	R72	39.76	(1)	
41.0	46	Cr II Si III	R65 R10	40.92 40.933	(70) (9)	
44.2	32	Cr II	R154	44.24	(10)	
45.7	37	—				
46.5	28	Fe III	R92	46.714	(4)	
47.3	23	—				
48.6	25	—				
50.3	42	Cr II Fe III	R65 88	50.137 50.463	(100) (5)	
51.1	35	—				
52.7	22	—				
54.3	27	Fe III	88	54.134	(6)	
55.3	25	Fe II Fe III	R181 88	55.368 55.55	(4) (5)	
56.8	24	Fe II	R109	56.802	(5)	
57.8	13	Cr II	R65	57.86	(12)	
58.8	19	—				
59.4	17	—				
60.1	16	Fe III	R92	60.162	(3)	
60.7	17	—				
61.2	11	—				
62.5	36	Fe II	R108	62.234	(9)	
63.8	10	Ni II	R3	63.93	(2)	
65.3	19	Fe II	R97	65.315	(6)	

TABLE 2—*Continued*

Apparent λ	Central Absorption	Sp.	Mult. No.	Laboratory λ	int.	Remarks
66.6	27	—				
67.4	23	—				
68.0	21	—				
68.6	20	Fe II	R122	68.757	(2)	
70.2	18	Fe III	R30	70.072	(5)	
70.8	19	Fe II	R68	70.092	(4)	
71.5	23	Cr II	R47	71.58	(7)	
72.5	18	Cr II	R32, 116	72.47	(8)	
73.2	24	Cr II	R47	73.25	(15)	
76.0	5	—				
77.4	10	Fe II	R108	77.168	(10)	
78.8	5	Fe II	R181	78.698	(8)	
80.2	5	Fe II	R108	80.405	(2)	
86.6	15	Si III Si III	R1 R1	86.236 86.46	(25) (6)	
88.3	8	Al II	R20	88.523	(3)	
93.8	17	Si III Si III	R1 R1	93.424 93.65	(20) (5)	
96.7	6	Si III	R1	96.826	(16)	
97.3	10	S IV	R1	97.46		
λ3100				λ3100		
05.2	17	Fe II Fe II	R82, 122 R82	05.166 05.548	(5) (5)	

is listed when the line is from the finding list by Kelly and Palumbo because these authors list the intensities on a different scale to Moore.

Column (7).—Remarks about the appearance of the lines on the U2 and V2 tracings. Those lines noted as circumstellar in origin are probably formed in a circumstellar shell of gas. η CMa is too nearby and too unreddened to have strong interstellar lines.

Many of the lines listed by Kelly and Palumbo are unclassified or they belong to multiplets not listed in the tables due to Moore. For these lines it was impossible to check that the multiplet structure is well represented in the spectrum of η CMa and the selection is made solely on the basis of wavelength coincidence.

The central absorption of the lines was estimated relative to a continuum which was drawn through the highest points on the tracings. The amount of stray light in the U2 tracings was estimated in the manner given by York *et al.* (1973) and it was subtracted from the apparent number of counts before calculating the central absorption. The background on the V2 tracings was put equal to 4500 counts which is the count at the center of the deepest lines. We assume that this background is independent of wavelength because it is believed to be due to noise generated in the photomultipliers by the particle flux encountered in orbit. In principle this background flux will vary with position of the satellite in orbit. Since we do not have enough information to evaluate a variation (very few very deep lines) we are adopting a constant value at all times for evaluating the central absorption as an index of the line strength.

Spectra identified in the ultraviolet spectrum of η CMa are as follows:

H I.—Broad strong absorptions are present at Lα and Lβ. These may be partly interstellar in origin.

He I.—Six lines of the $2\ ^3S$–$n\ ^3P^o$ series with $5 \leq n \leq 10$ are present.

B II.—There is a weak line at 1362.4 Å. It could be due to a blend of a Si III line and the resonance line of B II.

C II, III.—The resonance lines of C II and the 1176 Å blend of multiplet 4 of C III are present as strong broad lines, see figure 1.

N I, II.—The lowest multiplets of N I are definitely present and the resonance lines of N II form a wide deep blend; N II is strong in the visible spectrum, see figure 2.

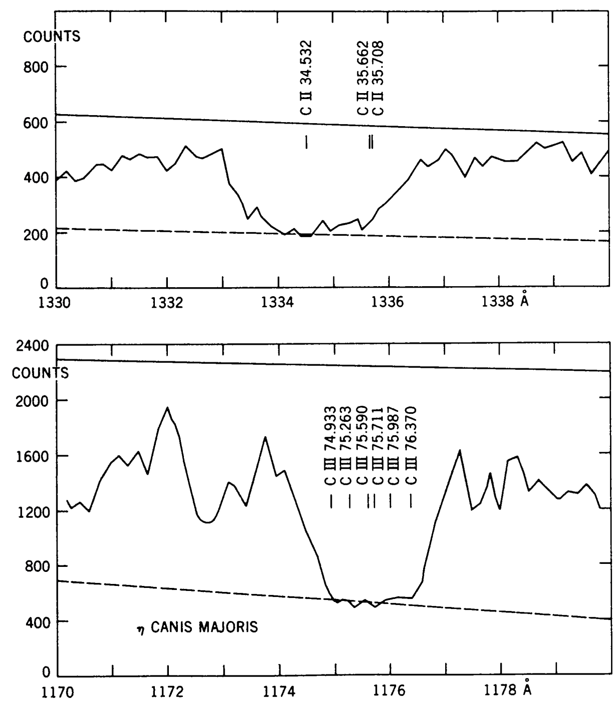

FIG. 1.—The resonance lines of C II and the C III multiplet at 1176 Å. The thin solid line gives the adopted continuum and the broken line the adopted stray light or noise level. The counts are per integration time.

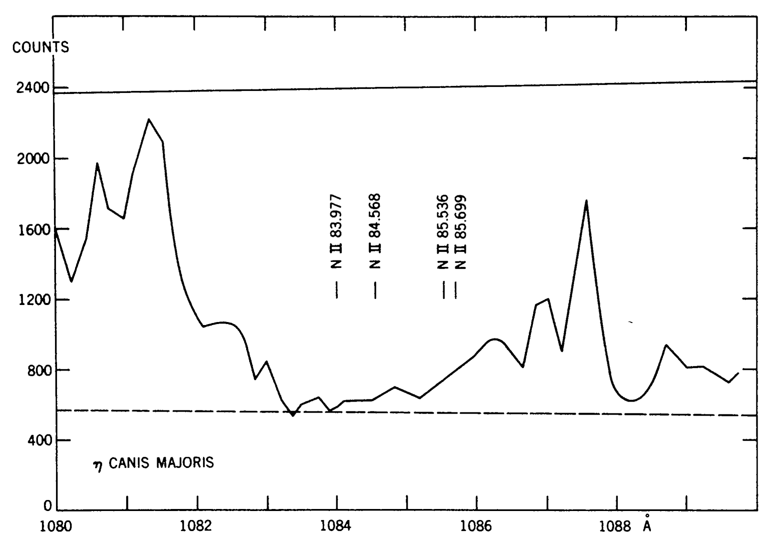

FIG. 2.—The blended N II resonance multiplet in the spectrum of η CMa

O I, II.—The lowest multiplets of O I are definitely present; lines of O II are present only at $\lambda > 3000$ Å.

Ne I.—Lines of Ne I are present in the visible range but not in the ultraviolet.

Na I.—No lines are found in the ultraviolet although the resonance lines are present in the visible spectrum.

Mg I, II.—The resonance line of Mg I is present as a circumstellar line; the lines of Mg II are strong, see figures 3 and 4.

Al II, III.—Both spectra are present in the visible spectrum; a few Al II lines are listed in the ultraviolet and one unclassified line of Al III.

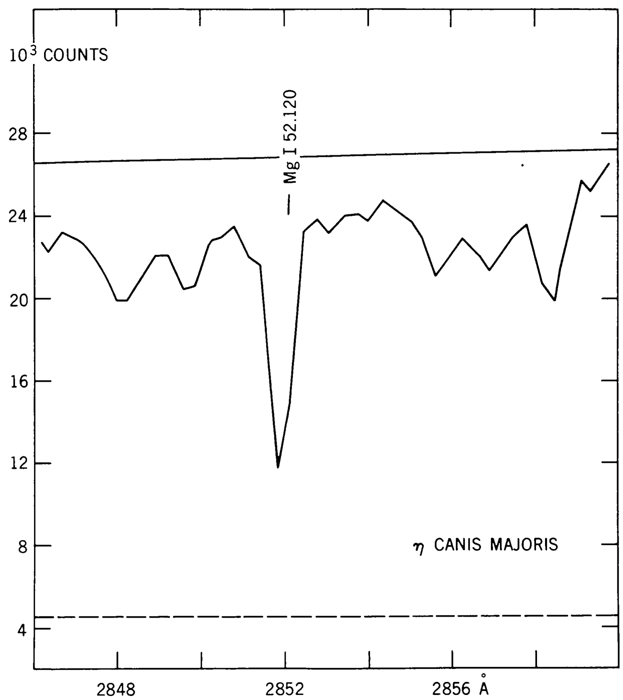

FIG. 3.—The Mg I resonance line, probably circumstellar in origin.

Si I, II, III, IV.—The resonance lines of Si I are possibly present; lines of Si II and Si III are definitely present and the resonance lines of Si IV appear, see figure 5.

P II, III.—Some P II lines are listed in the visible spectrum; P II and P III are possibly present in the ultraviolet spectrum.

S II, III, IV.—Some S II lines are listed in the visible spectrum. The resonance lines of S II, S III, and S IV are definitely present in the ultraviolet.

Cl I, II, III.—The resonance lines of Cl I are probably present; those of Cl II are definitely present; those of Cl III probably present. Only one Cl II line is listed in the visible spectral range.

Ca II.—Some Ca II lines may be weakly present in the ultraviolet; H and K are present in the visible spectrum. Lines of Ca III are not probable as their excitation potentials are high.

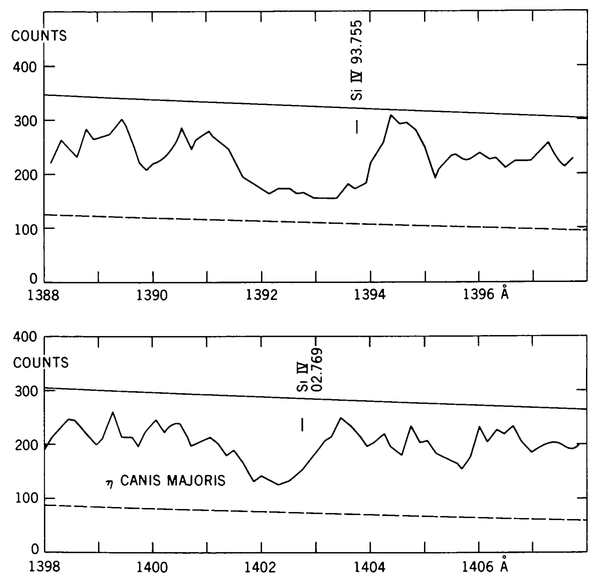

FIG. 5.—The shortward displaced resonance lines of Si IV in the spectrum of η CMa.

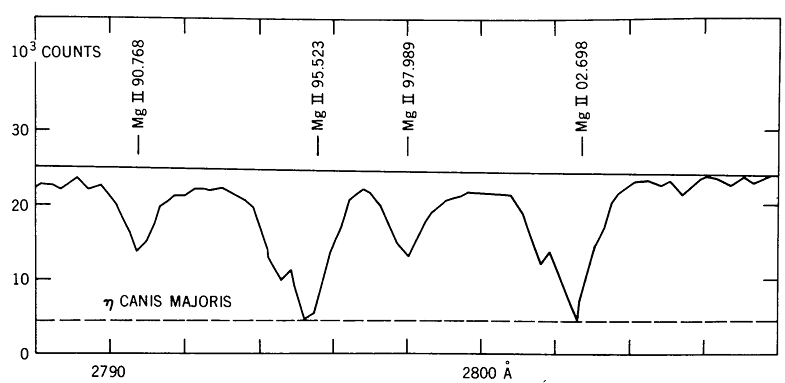

FIG. 4.—The spectrum of η CMa in the region of the Mg II resonance lines. Note the strong circumstellar lines separated from the displaced stellar lines.

Sc III.—Lines of Sc III are probably present in the ultraviolet.

Ti III, IV.—Lines of Ti III are definitely present in the ultraviolet; lines of Ti IV are possibly present.

V III.—Lines of V III are definitely present.

Cr II, III, IV.—Multiplets from the ground configurations of Cr II and Cr III are definitely present; coincidences with Cr II are not generally listed; one coincidence with Cr IV is listed.

Mn III, IV.—The Mn III resonance lines are not accessible; other lines of Mn III seem to be present and some lines are listed; one unclassified line of Mn IV is listed.

Fe II, III.—The lines of Fe II and Fe III are weak in the visible spectrum; they dominate the region 1890 to 3000 Å. Lines of laboratory strength 5 or greater are listed.

Co III.—The strongest lines are out of the available spectral range; this spectrum was not searched for.

Ne II, III.—Lines of Ni II are probably present, some coincidences are listed; the Ni III resonance lines are not available but some coincidences are listed; Ni III is probably present.

Y III.—Coincidences with half the possible lines suggest Y III is possibly present. There is no evidence for Y II.

III. LINE DISPLACEMENTS

Shortward displacements of strong resonance lines indicating the presence of an expanding atmosphere were sought with the results given in the table below.

Spectrum	Laboratory λ	Remarks	Displacement (km s^{-1})
C II......	1334.523 Å	Two lines blended	− 83
	1335.708	...	...
N II......	1083.977	Four lines blended	−138
	1084.568	...	...
	1085.536	...	...
	1085.699	...	...
Mg II....	2795.523	Shortward displaced dip	−104
Mg II....	2802.698	Shortward displaced dip	−112
Si IV.....	1393.755	...	−196
Si IV.....	1402.769	...	−100

An unweighted mean wavelength was adopted for the C II and N II blends.

The C III blend at 1176.6 Å from the metastable 2 $^3P^o$ level is undisplaced. In the wavelength ranges studied, there are 18 lines of Fe II and one of Fe III which have an excitation potential of zero volts. These lines are not displaced. Some of them appear to be sharper than the average line and they may be circumstellar in origin. No firm evidence of displaced components beside the Fe II circumstellar components exists as is the case for the Mg II resonance lines, see table 2 and figure 4. The expanding shell of η CMa does not have an appropriate density and level of excitation to show up in the Fe II spectrum.

The Mg II resonance lines are double, consisting of a strong undisplaced component, which dips to the noise level and which is probably circumstellar in origin, and a displaced component. Since η CMa is unreddened, strong interstellar lines are not expected. The undisplaced components of the Mg II and Mg I zero-volt lines are very strong and they probably originate in a stationary circumstellar shell rather than from the interstellar gas. The Mg I resonance line is sharp (see fig. 3) and because of its strength is probably circumstellar rather than interstellar in origin. This star has moderately strong Ca II and Na I resonance lines which are circumstellar in origin (Underhill and Fahey 1973).

In tables 1 and 2 it is noted that some zero-volt lines may be circumstellar in origin. Probably these lines come predominantly from the circumstellar shell which is visible in the Mg I, Mg II, Ca II, and Na I resonance lines and which seems to be stationary with respect to the main atmosphere of the star. Since the shortward displaced absorption lines, in particular those due to Si IV, are broad, it is suggested that they are formed in a moving layer which is below the stationary circumstellar layer. The undisplaced C III 1176 Å multiplet may be formed in the circumstellar shell. The present observations do not have sufficient resolution to show the individual lines which one would expect to see if they originated in the circumstellar shell.

IV. LINE BLOCKING

The absorption of light from the spectrum, particularly at wavelengths shortward of 1400 Å, due to blended absorption lines is considerable. The line-blocking fraction was measured by integrating the equivalent width absorbed between the adopted continuum and the star spectrum. These blocking factors are listed in tables 3 and 4 and shown plotted against wavelength in figures 6 and 7. On the U2 tracings the

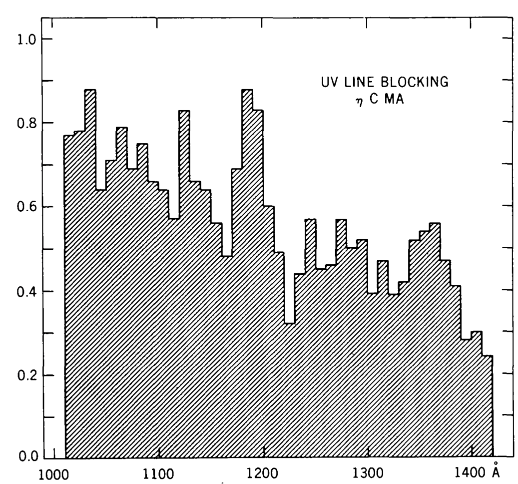

FIG. 6.—The ultraviolet line blocking in 10 Å wide strips from 1010 to 1440 Å.

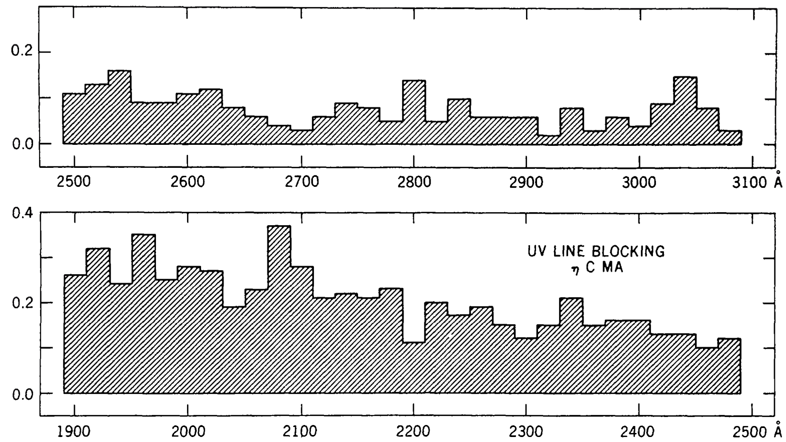

FIG. 7.—Ultraviolet line blocking in 20 Å wide strips from 1900 to 3100 Å

TABLE 3

η CMA BLOCKING FACTORS 1010–1440 Å FOR STRIPS 10 Å WIDE

Central Wavelength	Blocking Factor	Central Wavelength	Blocking Factor
1015	0.77	1235	0.49
1025	0.78*	1245	0.32
1035	0.88	1255	0.44
1045	0.64	1265	0.57
1055	0.71	1275	0.45
1065	0.79	1285	0.46
1075	0.69	1295	0.57
1085	0.75	1305	0.50
1095	0.66	1315	0.52
1105	0.64	1325	0.39
1115	0.57	1335	0.47
1125	0.83	1345	0.39
1135	0.66	1355	0.42
1145	0.64	1365	0.52
1155	0.56	1375	0.54
1165	0.48	1385	0.56
1175	0.59	1395	0.47
1185	0.48	1405	0.41
1195	0.69	1415	0.28
1205	0.88†	1425	0.30
1215	0.83†	1435	0.24
1225	0.60†		

* Includes interstellar Lβ. † Includes interstellar Lα.

TABLE 4

η CMa BLOCKING FACTORS 1900–3080 Å FOR STRIPS 20 Å WIDE

Central Wavelength	Blocking Factor	Central Wavelength	Blocking Factor
1900	0.26	2500	0.11
1920	0.32	2520	0.13
1940	0.24	2540	0.16
1960	0.35	2560	0.09
1980	0.25	2580	0.09
2000	0.28	2600	0.11
2020	0.27	2620	0.12
2040	0.19	2640	0.08
2060	0.23	2660	0.06
2080	0.37	2680	0.04
2100	0.28	2700	0.03
2120	0.21	2720	0.06
2140	0.22	2740	0.09
2160	0.21	2760	0.08
2180	0.23	2780	0.05
2200	0.11	2800	0.14
2220	0.20	2820	0.05
2240	0.17	2840	0.10
2260	0.19	2860	0.06
2280	0.15	2880	0.06
2300	0.12	2900	0.06
2320	0.15	2920	0.02
2340	0.21	2940	0.08
2360	0.15	2960	0.03
2380	0.16	2980	0.06
2400	0.16	3000	0.04
2420	0.13	3020	0.09
2440	0.13	3040	0.15
2460	0.10	3060	0.08
2480	0.12	3080	0.03

line-blocking factor averages about 0.5. On the V2 tracings it decreases from about 0.23 at 1900 Å to about 0.05 at 3000 Å. To some extent these blocking factors are arbitrary for they depend sensitively on the level of the adopted continuum. This level was drawn as a smooth line joining the highest spots on the tracing. Windows indicating the level of the continuum occur at intervals of about 20 Å on the U2 tracings and at about 50 Å on the V2 tracings. The resulting blocking factors are probably correct to within ±20 percent. The amount of line blocking found here for a supergiant is roughly the same as that found by Underhill (1973) from OAO-2 spectrum scans for main-sequence B stars with respect to a theoretical continuum.

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