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SPECTRAL CLASSIFICATION OF WOLF-RAYET STARS IN THE LARGE MAGELLANIC CLOUD

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Summary.- The spectral classification derived from slit spectroscopy is presented for the 100 Wolf-Rayet stars known in the Large Magellanic Cloud.

Key words.- Wolf-Rayet stars - spectral classification - Large Magellanic Cloud.

1. Introduction.-Since the catalogue published by Fehrenbach et al., (1976) the number of known Wolf-Rayet stars in the Large Magellanic Cloud (LMC) has changed significantly. Results concerning 23 additional LMC WR stars were recently published (Walborn, 1977 ; Melnick, 1978 ; Azzopardi and Breysacher, 1979, 1980), which means an increase of about 30 per cent of the WR population in the Large Cloud. Apart from that, the spectral classification available for the already known 78 WR stars in this system (Feast et al., 1960 ; Westerlund and Smith, 1964 ; Sanduleak, 1969 ; Fehrenbach et al., 1976) is not adequate for a detailed study of the distribution amongst the different sub-classes nor to improve our knowledge with regard to the percentage of binaries. About 50 per cent of these WR stars have been assigned a well-defined spectral type, either by Feast et al., (1960) and/or Smith (1968b) but most of the other WR stars, namely those of the WN type, are only classified as WN 3-5 by Fehrenbach et al. (1976), since a discrimination among the 3 sub-classes is not possible from the Objective Prism plates. In order to improve this situation , in the past five years the author has obtained slit spectrogrammes for 92 LMC WR stars.

After the systematic survey carried out by Azzopardi and Breysacher (1979, 1980) the census of the WR population in the LMC can be considered quite complete, which is why it seemed useful to present a new catalogue.

2. Spectrography.- 2.1. Observations.- The spectrographic observations were carried out between October 1975 and February 1980 at the ESO 1.5 m and 3.6 m telescopes on La Silla, Chile. Spectrogrammes of the brighter WR stars were obtained with the "Echelec" associated with a Lallemand-Duchesne "Caméra électronique" (CE), at the coudé focus of the 1.5 m telescope. The echelle spectrograph was used in a low dispersion mode by omitting the cross disperser (a transmission grating) and replacing the echelle grating by a first-order grating. For further instrumental details the reader is referred to the article by Baranne and Duchesne (1976). For the fainter stars, a Boller and Chivens cassegrain spectrograph which was equipped with either a Carnegie Image Tube (CIT) or an Image Dissector Scanner (IDS) was used at the 3.6 m telescope. Table I provides the necessary technical information concerning the observational material.

2.2. Spectral classification.- The spectral types were basically determined according to the classification system proposed by Smith (1968a).
However, a few remarks are necessary :

2.2.1. WN Sequence.- The discrimination between sub-classes WN3 and WN4, for those stars with spectrogrammes extending beyond λ7000, was done by using, in addition to the classification criteria given by Smith, the λλ 7109-7123 emission feature identified as due to NIV (Swings and Jose, 1950). For the stars classified WN3 this emission is completely absent from the spectrum.

The types WN9 or WN10 (previously undefined) were proposed for HDE 269227 (N°18, Table II) by Walborn (1977) and for BE-381 (N° 64, Table II) by Bohannan (1979). The spectra of these two WR stars are remarkably similar and differ from a typical WN8 spectrum : λ4686 He II is not broad, λ4058 NIV is completely absent and λ3995 N II is seen in emission at least in HDE 269227 (Walborn, 1977). An extension of the WN sequence thus appears as a logical need to classify stars of lower excitation than those belonging to the WN8 sub-class.

The denotation WN/OF ? is applied to two stars showing narrow λ4686 He II and λλ4634-4641 N III emission lines and which might possibly be considered as extreme Of stars.

2.2.2. WC Sequence.- Class WC5 is definitely predominant. Only two stars are classified WC5-6 because the λ4650 C III, IV emission has a width of ∿65 Å, i.e. a value intermediate between those characteristic of the WC5 (85 Å) and WC6 (45 Å) sub-classes (Smith, 1968a).

2.2.3. Binaries.- A star is denoted WR+OB when the presence of a companion is inferred from the small ratio of emission-line to continuum intensities. When an absorption spectrum is present together with the WR emission spectrum, then an MK spectral type is proposed for the companion star. The power of these two methods, often used in the detection of WR binaries (Westerlund and Smith, 1964 ; Smith, 1968a ; Kuhi, 1973) will be discussed in section 4.2.

3. The Catalogue.- Spectral classification as well as other data concerning the 100 WR stars known at present in the LMC are summarized in table II.

Column 1 : current number

Column 2 : right ascension and declination for epoch 1975. The given values come from the catalogue of Rousseau et al. (1978) and from the articles by Azzopardi and Breysacher, (1979, 1980) for the recently detected WR stars

Column 3 : Visual magnitude as given in the following sources :
a : Azzopardi and Breysacher (1979, 1980)
b : Fehrenbach et al. (1976)
c : Melnick (1978)
d : Sanduleak (1969)
e : Smith (1968b)
f : Westerlund (1961)
g : Westerlund and Smith (1964)

When available, the V photographic magnitude determined from astrographic plates (Rousseau et al., 1978) is given in brackets

Column 4 : Spectral type assigned by different authors. In chronological order :
- R : Feast et al. (1960)
- Smith (1968b)
- OM : Fehrenbach et al. (1976)
- Walborn (1977)
- Melnick (1978)
- Present Programme

Column 5 : N emission nebula number of Henize (1956) where the WR star lies

Column 6 : Identification of the star in other catalogues given in chronological order, The following abbreviations are used :

S : Henize (1956)
R : Feast et al. (1960)
W : Westerlund (1961) (Table number/Star number)
L : Lindsay (1963)
AL : Andrews and Lindsay (1964)
WS : Westerlund and Smith (1964)
HV : Hodge and Wright (1967) ("Harvard Variables" Atlas)
Sk : Sanduleak (1969)
BE : Bohannan and Epps (1974)
FD : Fehrenbach et al. (1976)
Mk : Melnick (1978)
AB : Azzopardi and Breysacher (1979, 1980)

For all the WR stars listed in table II, finding charts can be found in the reference papers mentioned above. It did not seem justified to reproduce them here. A few identification errors made by some authors are pointed out by Fehrenbach et al. (1976).

4. Discussion.- 4.1. Comments on individual stars.- Stars FD 10 and FD 41 given as Of by Fehrenbach et al. (1976) and classified O6 Iaf+ and O4 If+ respectively by Walborn (1977) are not included in table II. FD 11 which is a confirmed non-Wolf-Rayet star has also been eliminated from the present list.

N° 5 Classified O9f by Ardeberg et al. (1972). According to Walborn (1977) the broad λ4686 He II and narrow λ4058 N IV emission present, indicate a WN component.

N° 6 Unusually broad emission lines.

N°8 Fehrenbach et al. (1976) noticed that star BE-159 is identified with WS4 by Bohannan and Epps (1974) while on their finding chart the corresponding star is not WS4.

N°9 According to Feast et al. (1960) the λ4686 He II emission is possibly stronger than λ4650 C III, IV. On the contrary, little or no evidence for a contribution from the He II line is found by Walborn (1977). The star belongs to a multiple system.

N°10 Fehrenbach et al. (1976) noticed that star BE-171 is identified with WS6 by Bohannan and Epps (1974) while on their finding chart the corresponding star is not WS6.

N° 16 Unusually broad emission lines

N° 18 According to Allen and Glass (1976) a late-type supergiant component provides the near-infrared flux. Cowley and Hutchings (1978) confirmed the presence of said component spectroscopically.

N° 19 Broad emission lines

N° 21 The star is located in an apparent association which includes the compact cluster HD35342, S Doradus (HD 35343) and HDE 269357 (Walborn, 1977).

N° 29 The λ5806 CIV line is unusually strong for a WN star.

N° 45 Bohannan and Epps (1974) noticed that this star is mismarked on the finding chart given by Westerlund and Smith (1964). For correct identification see Sanduleak (1969).

N° 49 Although this star was denoted WR : by Sanduleak (1969), Fehrenbach et al. (1976) indicate that they did not find it on their plates.

N° 58 The star is located in a very crowded region

N° 65 According to Walborn (1977) : the λ4686 He II emission is broad and N IV emission features are present ; the absorption spectrum appears composite, a possible alternative classification is O6-7 + BO + WN. In our spectrogramme, the λ4686 line is narrow, no N IV lines are seen but λλ4634-4641 N III is well visible in emission. Close visual triple system.

N° 73 Walborn (1980) has found in good seeing at the RC focus of the CTIO 4m telescope that this star is a ∿1.5" EW double whose E component is slightly brighter, which explains the diffuse image reported by Azzopardi and Breysacher (1979).

N° 82 Central object in 30 Doradus. Discussed as probable multiple system by Walborn (1973). Hyland et al. (1978) measured an infrared excess $(V-K)_0 = 0.08$.

N° 85 Unsually broad emission lines

N° 86 Hyland et al. (1978) detected an infrared excess $(V-K)_0 = 1.41$ for this star which is much larger than normally found in galactic WN stars.

N° 87 Very peculiar spectrum in which both typical WN and WC emission features can be identified. However, may be, this apparent binarity has no physical meaning and is purely due to a blending effect with a nearby second WR star on the slit. Hyland et al. (1978) detected an infrared excess $(V-K)_0 = 1.16$ for this star.

N° 92 Hyland et al. (1978) detected an infrared excess $(V-K)_0 = 2.10$ for this star, which is much larger than normally found in galactic WN stars.

N° 98 Fehrenbach et al. (1976) noticed that the identification of this star by Sanduleak (1969) is not correct.

4.2. Concluding remarks.- Magnitude $V = 15$ proposed by Westerlund and Smith (1964) as a real lower limit in luminosity of the LMC WR stars has to be reconsidered since 11 stars in table II have a magnitude $15.3 \leqslant V \leqslant 16.5$. With an absorption- free distance modulus of 18.5 for the LMC (Westerlund, 1974), the absolute magnitudes obtained for these WR stars are significantly fainter than the values given by Smith (1973) for the corresponding sub-classes. A local stronger absorption might explain this. However, the existence of a possible luminosity effect within the WR sub-classes should not be excluded either.

In order to understand the evolutionary history of WR stars it is extremely important to know if all of them are binaries. Up to now, the percentage of WR binaries in the LMC has hardly been investigated particularly since most of the stars are so faint that it is difficult to obtain good spectrogrammes. The modern and powerful instrumentation we used ensured that the spectra obtained for the present work were correctly exposed. Using the weakness of emission lines relative to the continuum and/or the presence of absorption lines, as indicators of duplicity, about 35 per cent of the LMC WR stars turn out to be binaries. This percentage which is surprisingly low compared to the 73 per cent rated by Kuhi (1973) for our Galaxy should still be taken cautiously. Indeed, several detailed investigations of the galactic WR stars HD 92740, HD 93131, HD 93162 (Niemela, 1973 ; Walborn, 1974 ; Moffat 1978 ; Moffat and Seggewiss, 1978 ; Conti et al. 1979) and HD 193077 (Massey, 1980) have shown that small emission-line to continuum ratios and /or absorption lines also exist in WR stars which appear to be single. For instance in HD 92740, a single-lined spectroscopic binary, the absorption spectrum is undoubtedly intrinsic to the WR star itself because absorption and emission lines move together. These results demonstrate that a radial-velocity (or in some cases, a light curve) study is the only secure method to establish a binary nature for a WR star. As a consequence, before coming to any definite conclusions with regard to the binarity problem, all WR stars on table II should be systematically investigated for radial- velocity variations and/or eclipses.

The present study confirms Smith's (1968b) observations (although in a much smaller sample), that in the distribution amongst the different sub-classes, WC 6-9 stars are absent and that WN6 stars are very rare in the LMC. The ratio WN : WC is about 4 : 1.

Concerning the number of LMC WR stars associated with nebulosity, the present figure is 65 per cent. Westerlund and Smith (1964), from an investigation based on 58 WR stars derived 64 per cent. The agreement between the two values is remarkably good.

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TABLE I.- *Instrumentation used and characteristics of the corresponding spectrogrammes.*

Telescope	Spectrograph	Detector	Dispersion (Åmm^{-1})	Widening (mm)	Spectral Range (Å)	Spectra Secured on
1.5 m	Echelec	C.E.	124	0.30	λλ 3900-5500	Kodak Industrex Type A film
3.6 m	Boller & Chivens	C.I.T.	114	0.20	λλ 3400-5500	IIIaJ baked plates
3.6 m	Boller & Chivens	I.D.S.	114	-	λλ 4000-6100	Magnetic tape
3.6 m	Boller & Chivens	I.D.S.	170	-	λλ 4000-7250	Magnetic tape

TABLE II.- *Wolf-Rayet stars in the Large Magellanic Cloud*

Nº	α (1975)	δ	V	R	Smith	OM	Walborn	Melnick	Present	Emission Nebula	Other Identification
1	$4^{h}45^{m}.8$	-70°18'	14.9[d]			WN3-5			WN3		L-10, Sk -70°1, FD1
2	4 49.8	-69 24	16.0[a]						WN4	N79	AB-14
3	4 52.9	-66 43	15.07[e] (14.6:)		(WN4)	WN3-5			WN3		WS 1, Sk -66°3, FD2
4	4 54.7	-69 15	16.4[a]						WN4	N83	AB-15
5	4 55.3	-67 13	11.8[d]				06-7n-nn+ WN5-6 A var			N9	Sk -67°18
6	4 55.5	-67 32	14.10[e] (13.9)		WNp	WN3-5?			WN3p		HD 32109, S8, AL-30, WS2, Sk -67°20, BE-5, FD3
7	4 56.1	-66 20	15.10[e] (13.72)		(WC5)	WC6-7			WC5	N11	HD 32125, WS 3, Sk -66°21, FD4
8	4 56.1	-69 30	15 13[e] (13.88)		WC5	WC5-6			WC5-6		HD 32257, L-40, WS4, Sk-69°42, FD5
9	4 56.6	-66 31	10.88[e] (10.6:)	WC6+08:	WC5+OB	WC5-6+0	09.5II:+ WC5			N11	HD 32228, R64, WS5, HV 5499, Sk -66°28, FD6
10	4 57.4	-68 27	13.95[e] (12.8)		WC5	WC5-6			WC5	N91	HD 32402, AL -37, WS6, Sk -68°15, BE - 171?, FD7
11	4 59.1	-68 50	13.4[d] (13.5:)			WN3-5			WN4+OB?		Sk -68°19, FD8
12	4 59.9	-67 59	14.36[g] (14.6)			WN3-5a			WN3	N16A	HDE 268847, AL-48, WS7, Sk -67°32. BE-185, FD9
13	5 03.2	-66 43	12.73[e] (12.60)		WN8	WN8			WN8		HD33133, S14, AL-58, WS8, Sk -66°51, FD12
14	5 04.5	-70 05	14.39[e] (14.3)		WN3	WN3-5			WN4		HDE 269015, L-101, WS9, Sk -70°54, BE-511, FD13
15	5 05.5	-70 24	13.8[d] (14.6)			WN3-5			WN4		L-115, Sk -70°64, BE-521, FD14
16	5 09.8	-68 55	13.76[e] (13.6)		WNp+OB?	WN3-5?			WN3-4p+OB?	N105	HD 34187, L-141, WS10, Sk -68°57, BE-215, FD15
17	5 13.7	-67 24	13.11[e] (13.04)		WN4+OB	WN3-5			WN4+OB	N30	HD34632, WS11, Sk -67°63, BE-26, FD16
18	5 14.0	-69 34	12.09[e] (11.6)	Pec	WN8	WN8			WN9-10		HDE 269227, S91, R84, L-163, WS12, Sk -69°79 BE-543, FD17
19	5 14.2	-69 22	14.74[e] (14.4)		(WN5)	WN3-5			WN3	N113	HD 34783, L-164, WS13, Sk -69°81, BE-229, FD18
20	5 16.6	-69 19	14.71[e] (14.3)		WN4	WN3-5a			WN4		L-174, WS14, Sk -69°86, BE-234, FD19
21	5 18.5	-69 13	11.31[e] (11.34)	W+B1:I	OB+WN	WN3-5	B1Ia+ WN3-4		B2I+WN3:	N119	HDE 269333, R87, WS15, Sk -69°95, BE-245, FD20
22	5 19.5	-69 40	11.97[g]	WC6:	WC5+OB	WC5-6			WC5+OB	N120	R90, WS16, Sk -69°106, BE-559, FD21
23	5 20.6	-65 30	14.45[g] (14.4)			WN3-5			WN3		AL-140, WS17, Sk -65°45, FD22
24	5 21.9	-65 50	13.40[e] (13.36)		WN7	WN7			WN7		S28, AL-150, WS18, Sk -65°55, FD23
25	5 22.2	-68 00	15.6[a]						WN3	N44	AB-16
26	5 22.8	-71 37	12.72[e] (12.9:)		WN7	WN7			WN7	N198	HD 36063, S161, L-205, WS19, Sk -71°21, BE-569, FD24
27	$5^{h}23^{m}.2$	-65°58'	14.97[g] (14.5)			WN3-5a			WN3		WS20, Sk -65°57, FD25
28	5 23.5	-71 22	12.92[e] (12.84)		WC5+OB	WC7+0			WC5-6+OB	N200	HD 36156, L-209, WS21, Sk -71°26, FD26
29	5 24.6	-68 33	14.80[e] (14.10)		(WN4)	WN3-5			WN4p	N138	HDE 269485, AL-174, WS22, Sk -68°77, BE-265, FD27
30	5 24.9	-66 15	16.5[a]						WN3:		AB-17
31	5 26.1	-67 31	11.50[e] (11.3)		WC5+OB	WC5-6+0			WC5+09	N51	HD 36402, WS23, Sk -67°104, BE-45, FD28
32	5 26.6	-68 52	12.51[e] (12.26)		WC5+OB	WC5-6			WC5+OB	N144	HD 36521, W9/17, WS24, Sk -68°80, BE 278, FD29
33	5 26.7	-68 52	14.80[a]						WN3+OB	N144	W9/32, AB-1
34	5 26.8	-68 51	9.91[e] (9.93)	B3Ip+W?	OB+WN		B4Ia+ WN:		B3I+WN3:	N144	HDE 269546, R103, W9/50, WS26, Sk -68°82, FD31
35	5 26.9	-69 08	15.00[e] (14.8)		(WN4)	WN3-5			WN4		HDE 269549, W13/5, L-228, WS25, Sk-69°133, BE-280, FD30
36	5 27.9	-69 11	13.47[e] (13.44)		WN8	WN7			WN8		S108, L-242, WS27, Sk -69°141, BE-290, FD32
37	5 27.9	-70 38	14.18[e] (14.10)		WN3	WN3-5			WN3+OB		L-241?, WS28, Sk -70°92, BE-585, FD33
38	5 28.5	-69 04	15.45[a]						WN3		AB-2
39	5 29.4	-68 46	15.36[f] (15.3:)			WN3-5			WN3	N135	HDE 269618, W16/66, AL-226, Sk -68°98, FD34
40	5 29.7	-68 55	14.80[g] (14.7)			WN3-5			WN3		HDE 269624, AL-229, WS29, Sk -68°102, BE-314, FD35
41	5 30.0	-69 02	14.45[a]						WN4.5+OB		AB-3
42	5 30.1	-68 46	15.35[e] (15.6:)		(WN4)	WN3-5			WN3		WS30, Sk -68°104, BE-319, FD36
43	5 30.3	-67 28	14.36[e] (13.6)		WC5	WC7			WC5		HD 37026, S41, AL-242, WS31, Sk -67°144, BE-74, FD37
44	5 30.9	-71 03	13.42[e] (12.83)		WC5+OB	WC5-6			WC5+OB	N206	HD 37248, WS32, Sk -71°38, BE-592, FD38
45	5 31.6	-67 18	14.36[g] (14.7)			WN3-5			WN3		AL-274, WS33, Sk -67°160, BE-90, FD39
46	5 31.7	-67 42	14.74[e] (14.5)	WN5?	(WN)	WN3-5			WN3	N57	HDE 269692, R114, AL-275, WS34, Sk -67°161, BE-337, FD40
47	5 32.3	-68 27	14.0[d] (14.8:)			WN7			WN8	N148	AL-289?, Sk -68°115, FD42
48	5 33.1	-67 44	13.01[f] (13.11)			WN3-5a			WN4+OB	N57	HDE 269748, W25/84, Sk -67°184, FD43
49	5 33.3	-69 31	14.1[d] (14.38)						WN3+OB	N135	Sk -69°183, FD 44
50	5 34.6	-69 46	14.09[e] (13.2)		WC5	WC5-6			WC5	N154	HD 37680, L-286, WS35, Sk -69°191, BE-598, FD46
51	5 34.7	-66 16	14.3[d] (14.8)			WN3-5			WN3	N62	Sk -66°156, FD45
52	5 34.9	-67 22	13.2[b] (14.5:)			WN3-5			WN4+OB	N56	HV 5947, FD47
53	5 35.3	-69 45	14.20[f] (13.9)			WN3-5			WN4+OB?	N154	W28/30, Sk -69°198, FD48
54	5 35.5	-67 08	14.3[d] (15.0)			WN3-5a			WN3		Sk -67°213, FD49
55	5 35.5	-69 06	14.2[b] (14.9)			WN3-5			WN4		FD50
56	5 35.5	-69 14	13.0[b] (13.64)			WN3-5			WN5:	N157	FD51
57	5 35.8	-69 12	13.2[b] (13.8)			WN3-5			WN6	N157	FD53
58	5 35.8	-69 13	13.70[a]						WN5-6	N157	AB-4

TABLE II.- *(continued)*

Nº	α (1975)	δ	V	SPECTRAL TYPE						Emission	Other Identification
				R	Smith	OM	Walborn	Melnick	Present	Nebula	
59	$5^{h}35^{m}.9$	-67°04'	14.50^{g} (14.5)			WN3-5			WN3		AL-348, WS37, Sk -67°218, BE-133, FD52
60	5 35.9	-69 00	14.90^{a}						WN3		AL-351?, AB-5
61	5 35.9	-69 00	15.45^{a}						WN3-5		AL-351?, AB-6
62	5 35.9	-69 12	14.3^{g} (14.5*)			WC5-6			WC5	N157	HDE 269818, WS36, Sk -69°207, BE-379, FD54
63	5 36.0	-68 54	14.75^{a}						WN4.5+OB		W27/22, AB-7
64	5 36.1	-69 00	13.30^{f} (13.37)			WN8			WN9-10		W27/23, BE-381, FD56
65	5 36.1	-69 13	11.6^{g}		OB+WN	WN3-5	O8:+WN5-6		WN/Of?	N157	HDE 269828, WS38, Sk -69°209a, BE-383, FD55
66	5 36.7	-69 10	15.90^{a}						WN3	N157	AB-8
67	5 37.1	-69 13	11.75^{e} (13.5:)		WC5+OB	WC5-6			WC5+OB	N157	HD 38029, WS40, Sk -69°223, BE-400, FD58
68	5 37.1	-69 27	13.34^{e} (12.71)		WC5+OB	WC5-6			WC5+OB		HD38030, WS39, Sk -69°222, BE-399, FD57
69	5 37.4	-69 08	16.20^{a}						WN4	N157	AB-9
70	5 37.7	-69 22	13.55^{g} (13.31)		WC5+OB	WC5-6			WC5+OB		WS41, Sk -69°231, BE-404, FD59
71	5 37.8	-69 09	14.1^{d} (13.67)			WN7			WN7	N157	HDE 269883, AL-369, Sk -69°233 FD60
72	5 37.9	-69 06	11.51^{e} (11.37)	B0:+W?	OB+WN		B0.7-1I +WN		B1I+WN3:	N157	HDE 269891, R130, WS43, Sk -69°235, BE-410, FD62
73	5 37.9	-69 10	12.20^{a}						WN4.5+OB	N157	AL-369, AB-10
74	5 37.9	-69 15	15.58^{e} (14.07)			WC5-6			WC5	N157	HDE 269888, WS42, Sk -69°234, BE-409, FD61
75	5 38.5	-69 07	12.36^{g}	WN7				WN5	WN6	N157	R134, FD63
76	5 38.5	-69 07	12.5^{c}					WN7		N157	Mk-A
77	5 38.5	-69 07	$14.^{c}$					WN+O?		N157	Mk-G
78	5 38.5	-69 07	13.0^{c}					WN7		N157	Mk-H
79	5 38.5	-69 07	13.70^{a}					WN5	WN6	N157	Mk-J, AB-12
80	5 38.6	-69 06	13.15^{g} (12.8*)	WN7					WN7	N157	R135, FD64
81	5 38.6	-69 08	14.50^{a}						WN8	N157	AB-11
82	5 38.7	-69 07	9.44^{e}	O+WN	OB+WN		OB(n)?+ WN5-A(B)	WN+O	OB+WN5-6:	N157	HD 38268, R136, Sk -69°243, FD66
83	5 38.7	-69 07	12.5^{c}					WN6		N157	Mk-E
84	5 38.7	-69 07	13.5^{c}					WN+OB		N157	Mk-C
85	5 38.7	-69 31	14.72^{g} (14.5:)			WN3-5			WN4p	N158	HDE 269908, L-305, WS44, Sk -69°241, BE-609 FD65
86	5 38.8	-69 06	11.87^{g} (12.5*)	WN7:+O:	WN7:+OB			WN7+O	WN/Of?	N157	R 139, FD67
87	5 38.8	-69 06	11.82^{g} (12.4*)	WN6				WN6	(WN4+WC5)?	N157	R 140, FD68
88	5 39.0	-69 01	12.99^{e} (12.70)	WN5	WN4+OB	WN3-5			WN4+OB	N157	HDE 269926, R146, WS45, Sk -69°245, BE-418, FD69
89	5 39.0	-69 03	11.15^{e} (11.15)	WN7	WN7	WN7	WN6-A(B)		WN7	N157	HD38282, S133, R144, AL-375, WS46, Sk -69°246, BE-420, FD70
90	$5^{h}39^{m}.1$	-69°07'	12.16^{e} (12.1*)	WN6-7	WN7	WN3-5		WN5	WN7	N157	HDE 269928, R145, W7/25, AL-376, WS47, Sk -69°248, BE-421, FD71
91	5 39.2	-69 30	12.05^{a}						WN9-10:	N158	W3/8, AB-13
92	5 39.4	-69 03	13.06^{e} (12.85)	WN5+	WN6:+OB	WN3-5			WN6	N157	HD 38344, R147, AL-383, WS48, Sk -69°251, BE-423, FD72
93	5 39.7	-68 44	14.3^{d} (14.5*)			WC6-7					Sk -68°145, FD73
94	5 40.1	-69 25	13.41^{e} (12.75)		WC5+OB	WC5-6			WC5+OB	N158	HD 38448, W4/7, WS49, Sk -69°255, BE-433, FD74
95	5 40.4	-69 25	13.35^{e} (13.05)		WN4+OB	WN3-5			WN4+OB	N158	HD 38472, HDE 269956, W4/16, WS50, Sk -69°258, BE-435, FD75
96	5 41.0	-69 27	14.3^{d} (14.8)			WN3-5			WN3	N158	Sk -69°266, FD76
97	5 42.1	-70 35	13.2^{b} (14.7)			WN3-5			WN4+OB		FD77
98	5 45.1	-67 11	14.28^{g} (14.33)			WN3-5			WN4	N74	AL-412, WS51, Sk -67°259, BE-151?, FD78
99	5 45.4	-67 07	14.67^{g} (14.7)			WN3-5			WN4		AL-414, WS52, Sk -67°263, FD79
100	5 46.7	-67 11	14.63^{e} (14.5)		(WN5)	WN3-5			WN3-4	N74	HDE 270149, AL-421, WS53, Sk -67°268, FD80