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New Galactic Wolf-Rayet stars, and candidates *(Research Note)*

An annex to The VIIth Catalogue of Galactic Wolf-Rayet Stars

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ABSTRACT

This paper gathers, from the literature and private communication, 72 new Galactic Population I Wolf-Rayet stars and 17 candidate WCLd stars, recognized and/or discovered after the publication of *The VIIth Catalogue of Galactic Wolf-Rayet Stars*. This brings the total number of known Galactic Wolf-Rayet stars to 298, of which 24 (8%) are in open cluster Westerlund 1, and 60 (20%) are in open clusters near the Galactic Center.

Key words. stars: Wolf-Rayet

1. Introduction

Wolf-Rayet (WR) stars represent the final phase in the evolution of massive stars (i.e., $M_i \gtrsim 20\,M_{\odot}$), before becoming a supernova and/or stellar remnant. They are the chemically evolved descendants of OB stars (e.g., Meynet & Maeder 2005) and contribute to chemical and kinetic enrichment of their environment through their dense stellar winds and Lyman continuum photons. Some of them could be the possible progenitors of core-collapse supernovae and γ-ray bursts, especially in a low metallicity environment (e.g., Hirschi et al. 2005; Petrovic et al. 2005; Yoon & Langer 2005; Langer & Norman 2006; Woosley & Heger 2006; Fruchter et al. 2006). Where ~35% of the Galactic WR stars have wind blown bubbles, visible as ring nebulae (Marston 1997), they provide the ideal environment for a γ-ray burst afterglow (e.g., Chevalier 2005; Dwardakas 2005; Zou et al. 2005; Eldridge et al. 2006; Eldridge & Vink 2006; Hammer et al. 2006). For all practical purposes, it is important to know as many WR stars as possible. Assembling a complete catalogue of WR stars, their spectral types (and hence chemical make-up) and relative numbers is important in order to understand their impact on the Galactic environment as well as to investigate their suitability as precursors to very energetic processes in extragalactic systems.

Since the publication of *The VIIth Catalogue of Galactic Wolf-Rayet Stars* (van der Hucht 2001, henceforth 7Cat), numerous new Galactic Population I Wolf-Rayet stars have been discovered, notably near the Galactic Center (in the infrared) and in open clusters (e.g., in Westerlund 1, optically), but also as individual field stars, thanks to the advancements in sensitivity and spatial resolution. In order to list these new WR stars properly in the 7Cat numbering system, and because of the crowding and the occasional resolution of apparently single objects into multiple objects, it became necessary to have the RA/Dec(J2000) coordinates of the 26 7Cat WR stars near the Galactic Center re-determined with higher accuracy. For example, with improving spatial resolution and sensitivity, it appears that what Krabbe et al. (1995) saw as the single object GC IRS 13E (=WR 101f in 7Cat, WN9-10), has been resolved by Maillard et al. (2004) into a cluster containing 7 stars, including two WR stars (GC IRS13 E2 and GC IRS13 E4) and three candidate WCLd stars (GC IRS13 E3A, GC IRS13 E3B, and GC IRS13 E5). A critical analysis of IRS 13E has been presented recently by Paumard et al. (2006).

This paper, rather than providing a completely revised WR catalogue, presents as an annex to the 7Cat a list of new WR stars and candidate WR stars discovered in recent years, together with updated coordinates for some objects.

All of the new discoveries quoted here require confirmation by additional multi-frequency high-spectral resolution and high-angular resolution observations, which may throw new light on earlier results, e.g., Tanner et al. (2006). For example, GC IRS8, one of five GC stars suggested by Tanner et al. (2005) to be WR stars, turned out to be an O5-O6 giant or supergiant when observed by Geballe et al. (2006).

2. New data

The new Galactic WR stars listed in this annex have been discovered by the following authors:

- Some 15 possible WR stars in the Arches cluster had been recognized (in the infrared) before 2001 by Nagata et al. (1995) and Cotera et al. (1996), as noted by Blum et al. (2001), Lang et al. (2001), and Figer et al. (2002). Those objects are now included in this annex.
- Bartaya et al. (1994) discovered (in the optical) one new WN4 star (WR 159) in the OB association Cas OB 4, which has been re-discovered by Negueruela (2003).
- Figer et al. (1996) discovered (in the infrared) two WN9/Ofpe and five possible WCLd stars in the Quintuplet cluster. Tuthill et al. (2006) showed that at least two of those

WCLd stars, Q2 and Q3, have infrared pinwheels, indicative of dust formation originating in the colliding winds of long period WCL+OB binaries.
- Clark & Negueruela (2002), Negueruela & Clark (2003), Clark et al. (2005), Negueruela & Clark (2005), Negueruela (priv. comm.), and Crowther et al. (2006), discovered (in the optical) 24 new WR stars in the open cluster Westerlund 1, extremely rich in O stars, WR stars and LBVs. Groh et al. (2006) independently discovered (in the optical) three W d1 WR stars discovered also by Crowther et al. (2006).
- Pasquali et al. (2002) discovered (in the infrared) one new WC8 star (WR 142a), in Cygnus.
- Homeier et al. (2003) discovered (in the infrared) three WC8-9 stars and one WN10 star, in the inner Galaxy.
- Drew et al. (2004) discovered (in the optical) one new WO3 star (WR 93b), located most likely in the Scutum-Crux arm of the inner Milky Way, from follow-up observations of candidate emission-line stars in the AAO/UKST Southern Galactic Plane Hα Survey (Parker et al. 2005).
- Cohen et al. (2005) discovered (in the optical and infrared) one new WN7 star (WR 75ab), from follow-up observations of candidate emission-line stars in the AAO/UKST Southern Galactic Plane Hα Survey (Parker et al. 2005).
- Hopewell et al. (2005) discovered (in the optical) five new WC9 stars in a programme of follow-up optical spectroscopy of candidate emission-line stars in the AAO/UKST Southern Galactic Plane Hα Survey (Parker et al. 2005).
- Paumard et al. (2001, 2006), Eckart et al. (2004), Horrobin et al. (2004), Maillard et al. (2004), Moultaka et al. (2005), and Tanner et al. (2002, 2005) together discovered (in the infrared) 14 new WR stars and 14 candidate WCLd stars in the Galactic Center cluster.
- Eikenberry et al. (2001, 2004) discovered (in the infrared) one new WC9 star (WR 111b) in the cluster apparently near the soft γ-ray repeater SGR 1806−20.
- Figer et al. (2005) discovered (in the optical and infrared) three new WR stars in the cluster around the soft γ-ray repeater SGR 1806−20, two of which (WR 111a and WR 111c) had been discovered independently (in the infrared) by LaVine and Eikenberry (2004, private communication).

3. The census of Population I WR stars and candidate WR stars in the Galaxy

The new Galactic WR stars and candidates are listed in Table 1, together with those WR stars from the 7Cat for which the coordinates have been re-determined. Table 1 lists:

- Galactic WR running number in the 7Cat system;
- WR discovery designation, acknowledging the authors of the discovery paper;
- additional designation(s) from the literature;
- discovery spectral type;
- revised spectral type;
- magnitude (V, or R, or K);
- RA/Dec(J2000) coordinates;
- discovery reference.

There are 72 new Galactic WR stars listed in this annex, plus 17 candidate WR stars, some possibly of the WCLd type. Of the 72 new Galactic WR stars we find: 45 WN stars, 26 WC stars, and one WO star.

Of the 72 new Galactic WR stars, in most cases the number of observations is still too small to establish which are binaries. We would expect a binary frequency of ~40% (van der Hucht 2001, Table 20). Only a few new WR stars have shown some indication of binarity (see Table 1).

There are now 60 known WR stars in the open clusters near the Galactic Center, i.e., the Galactic Center cluster (29, plus 13 candidate WR stars), the Arches Cluster (17, all WN) and the Quintuplet cluster (14, plus 3 candidate WR stars), plus 16 candidate WR stars, mostly candidate WCLd.

Together with the 226 WR stars in the 7Cat, this annex brings the total number of presently known Galactic Population I WR stars to 298, excluding the 17 candidate WR stars. The spectral subtype distribution is: 171 WN stars, 10 WN/WC stars, 113 WC stars, and 4 WO stars.

The 7Cat has 53 of its 226 WR stars in open clusters and OB associations, i.e. 23%. Together with this annex we count 137 out of the 298 known Galactic WR stars in open clusters and OB associations, i.e. 46%, of which 8% are in open cluster Westerlund 1 and 20% are in open clusters near the Galactic Center.

4. Notes on individual stars

Westerlund 1:

77b = NC-N: X-ray detection by *Chandra* (Skinner et al. 2006).

77g = NC-K: X-ray detection by *Chandra* (Skinner et al. 2006).

77j = NC-G: X-ray detection by *Chandra* (Skinner et al. 2006).

77k = NC-L = Wd1-44: X-ray detection by *Chandra* (Skinner et al. 2006).

77n = NC-F = Wd1-239: X-ray detection by *Chandra* (Skinner et al. 2006).

77o = NC-B: X-ray detection by *Chandra* (Skinner et al. 2006). Relatively high L_x, possibly colliding wind binary.

77p = NC-E = Wd1-241: X-ray detection by *Chandra* (Skinner et al. 2006).

77q = NC-R = WD1-14c: X-ray detection by *Chandra* (Skinner et al. 2006).

77r = NC-D: X-ray detection by *Chandra* (Skinner et al. 2006).

77sa = NC-W = GDTB 3: X-ray detection by *Chandra* (Skinner et al. 2006).

77sb = NC-O: X-ray detection by *Chandra* (Skinner et al. 2006).

77sc = NC-A: X-ray detection by *Chandra* (Skinner et al. 2006). Relatively high L_x, possibly colliding-wind binary.

Galactic Center cluster:

WR 101b = AF-NW: tentative association with X-ray source CXOGC/J174539.4−2900310 (Baganoff et al. 2003).

WR 101db = GC IRS 34W: irregular variable ($\Delta K = 1.5$ mag), possibly indicative for LBV phase (Trippe et al. 2006).

WR 101fa = GC IRS 3: an ESO VLTI-MIDI observation by Pott et al. (2005) shows a N-band (8–12 μm) size of ≤40 mas, i.e., ≤300 AU, compatible with the typical dust envelope size of WCd stars (Williams et al. 1987). However, Pott et al. argue that the WC5-6 spectrum may be associated with a faint star ~120 mas east of IRS 3. See also Viehmann et al. (2006).

WR 101k = GC IRS 16SW: periodic IR variable, K-band light curve, $P = 9.725$ d, $M \simeq 100\,M_\odot$ (Ott et al. 1999; De Poy et al. 2004).

WR 101nd = GC IRS 16NE: RV variable, may be SB (Tanner et al. 2006).

Table 1. New Galactic Wolf-Rayet stars. *Data quoted from 7Cat are listed in italics*, revised and new data are listed in roman font.

WR	WR discovery designation	Other designation(s)	Discovery spectral type	Revised spectral type	ref.	m (mag)	ref.	RA(J2000)	Dec(J2000)	ref.	WR discovery ref.
75aa	HBD 1	SHS J162620.2−455946	WC9d			I = 14.18	HB05	16 26 20.2	−45 59 46	HB05	HB05
75ab	CPG 1		WN7h			K_s = 8.91	CP05	16 33 48.74	−49 28 43.5	CP05	CP05
75c	HBD 2	SHS J163403.6−434025	WC9			I = 13.12	HB05	16 34 03.6	−43 40 25	HB05	HB05
75d	HBD 3	SHS J163417.5−460852	WC9			I = 12.30	HB05	16 34 17.5	−46 08 52	HB05	HB05
open cluster Westerlund 1											
77aa	HBD 4, NC-T	SHS J164646.3−454758	WC9d			J = 10.04	2MASS	16 46 46.3	−45 47 58	HB05	HB05
77a	NC-Q		WN6-7	WN6	CH06	J = 11.72	CH06	16 46 55.55	−45 51 35.0	CH06	NC05
77b	NC-N		WC8	WC9d	CH06	J = 9.69	2MASS	16 46 59.9	−45 55 26	2MASS	NC05
77c [1]	NC-I		WN6-8	WN8	CH06	J = 10.89	CH06	16 47 00.88	−45 51 20.8	CH06	CN02, NC03
77d	NC-P	Wd1-57c	WN8	WN7	CH06	J = 11.06	CH06	16 47 01.59	−45 51 45.5	CH06	NC05
77e [2]	NC-J		WNL	WN5	CH06	J = 11.7:	CH06	16 47 02.47	−45 51 00.1	CH06	CN02, NC03
77f	NC-S	Wd1-5	WNVL	WN10-11:	CH06	J = 9.81	CH06	16 47 02.98	−45 50 20.0	CH06	NC05
77g [3]	NC-K		WC	WC8	CH06	J = 11.81	CH06	16 47 03.25	−45 50 43.8	CH06	NC03
77h	NC-V		WN8			J = 10.47	CH06	16 47 03.81	−45 50 38.8	CH06	Ne05
77i	NC-M	Wd1-66	WC9	WC9d	CH06	J = 10.13	CH06	16 47 03.96	−45 51 37.8	CH06	NC05
77j [4]	NC-G		WN6-8	WN7	CH06	J = 11.35	CH06	16 47 04.01	−45 51 25.2	CH06	CN02, NC03
77k	NC-L	Wd1-44	WN9	WN9:	CH06	J = 9.08	CH06	16 47 04.19	−45 51 07.4	CH06	NC05
77l [5]	NC-H		WC9	WC9d	CH06	J = 10.3:	CH06	16 47 04.22	−45 51 20.2	CH06	CN02, NC03
77m [6]	NC-C		WC8	WC9d	NC05	J = 11.26	CH06	16 47 04.40	−45 51 03.8	CH06	CN02, NC03
77n [7]	NC-F	Wd1-239	WC9	WC9d	CH06	J = 9.85	CH06	16 47 05.22	−45 52 25.0	CH06	CN02, NC03
77o [8]	NC-B		WNL	WN7	CH06	J = 10.91	CH06	16 47 05.36	−45 51 05.0	CH06	CN02, NC03
77p [9]	NC-E	Wd1-241	WC9			J = 10.12	CH06	16 47 06.05	−45 52 08.2	CH06	CN02, NC03
77q	NC-R	Wd1-14c	WN6-7	WN5	CH06	J = 11.92	CH06	16 47 06.07	−45 50 22.6	CH06	NC05
77r [10]	NC-D		WN6-8	WN7	CH06	J = 11.63	CH06	16 47 06.24	−45 51 26.5	CH06	CN02, NC03
77s {	NC-U GDTB 1		WN4 WN5-7	WN6	CH06	J = 10.76 K = 9.19	CH06 GD06	16 47 06.55 16 47 06.6	−45 50 39.0 −45 50 38.6	CH06 GD06	Ne05 GD06
77sa {	NC-W GDTB 3		WN5-6: WN7	WN6	CH06	J = 12.11 K = 9.70	CH06 GD06	16 47 07.58 16 47 07.6	−45 49 22.2 −45 49 21.7	CH06 GD06	CH06 GD06
77sb	NC-O		WN6			J = 11.00	CH06	16 47 07.66	−45 52 35.9	CH06	NC05
77sc [11]	NC-A	Wd1-72	WN4-5	WN7	CH06	J = 10.34	CH06	16 47 08.32	−45 50 45.5	CH06	CN02, NC03
77sd {	NC-X GDTB 2		WN4-5: WN4-5	WN5	CH06	J = 12.36 K = 9.99	2MASS GD06	16 47 14.1 16 47 14.2	−45 48 32 −45 48 31.4	2MASS GD06	CH06 GD06
77t	HBD 5	SHS J165057.6−434028	WC9d			I = 13.00	HB05	16 50 57.6	−43 40 28	HB05	HB05
93b	DBU 1		WO3			K = 10.17	DB04	17 32 03.30	−35 04 32.5	DB04	DB04

Arches cluster:

WR 102aa = NWS 1 = AR6: non-thermal radio source (Lang et al. 2001). X-ray detection (Wang et al. 2006). Maybe WN8+OB colliding wind binary.

WR 102ad = NWS 4 = AR3: moderately variable (29%) radio source, possibly indicative of a colliding wind binary (Lang et al. 2005).

WR 102ae = NWS 5: source A2 in X-ray detection by Law & Yusef-Zadeh (2004) and Wang et al. (2006).

WR 102ah = NWS 8 = AR1: source A1S in X-ray detection by Law & Yusef-Zadeh (2004) and Wang et al. (2006). Non-thermal and moderately variable (12%) radio source, possibly indicative of a colliding wind binary (Lang et al. 2005).

WR 102ai = NWS 9 = AR8: moderately variable (25%) radio source, possibly indicative of a colliding wind binary (Lang et al. 2005).

WR 102aj = NWS 10 = AR4: source A1N in X-ray detection by Law & Yusef-Zadeh (2004) and Wang et al. (2006). Moderately variable (30%) radio source, possibly indicative of a colliding wind binary (Lang et al. 2005).

WR 102b = Sgr A-A: X-ray detection (Muno et al. 2006).

Quintuplet cluster:

WR 102dc = Q2 = GCS3-2 = qF231 = QR7: variable at K (Glass et al. 1999, 2001), indicative of WCLd+OB colliding wind binary. Detection in X-rays (Law & Yusef-Zadeh 2004; Wang et al. (2006). IR pinwheel discovered (Tuthill et al. 2006), proving a WCLd+OB colliding wind binary.

WR 102ha = Q3 = GCS4 = qF211: variable at K (Glass et al. 1999, 2001), indicative of WCLd+OB colliding wind binary. X-ray detection (Wang et al. (2006). Rotating IR pinwheel discovered (Tuthill et al. 2006), proving WC7-8d+OB colliding wind binary with $P = 850 \pm 110$ d.

Notes to Table 1

Revised WR numbers of stars in 7Cat:

[1] : WR 77c: formerly WR 77b in NC03.
[2] : WR 77e: formerly WR 77a in NC03.
[3] : WR 77g: formerly WR 77c in NC03.
[4] : WR 77j: formerly WR 77e in NC03.
[5] : WR 77l: formerly WR 77d in NC03.
[6] : WR 77m: formerly WR 77f in NC03.
[7] : WR 77n: formerly WR 77g in NC03.

Table 1. continued.

WR	WR discovery designation	Other designation(s)	in PG06	Discovery spectral type	Revised spectral type	ref.	m (mag)	ref.	RA(J2000)	Dec(J2000)	ref.	WR discovery ref.
Galactic Center cluster												
100a		GC AF NW NW	E81	WN7			K = 12.6	PG06	17 45 39.306	−29 00 30.68	*a*	PG06
101a	*BSD 1*	*MPE−8.3−5.7*	E82	*WC9*	WC8-9	PG06	K = 13.0	PG06	17 45 39.382	−29 00 33.43	*a*	*BS95*
101b	*KGE 1*	*AF NW*	E74	*WN9-11*	WN8	PG06	K = 11.7	PG06	17 45 39.458	−29 00 31.67	*a*	*KG95*
101c	*KGE 2*	*AF*	E79	*WN9-11*	Ofpe/WN9	PG06	K = 10.8	PG06	17 45 39.541	−29 00 35.01	*a*	*KG95*
101d	*KGE 3*	*GC IRS 6E*		*WC9*			K = 9.55	OE99	17 45 39.643	−29 00 27.33	*b*	*KG95*
101da	PGM 1		E60	WN7?			K = 12.4	PG06	17 45 39.708	−29 00 29.75	*a*	PG06
101db	PGM 2	GC IRS 34W	E56	Ofpe/WN9			K = 11.4	PG06	17 45 39.731	−29 00 26.51	*a*	PG06
101dc	MES-WR 1	GC IRS 7SW	E66	WN8-9	WN8	PG06	K = 12.0	PG06	17 45 39.739	−29 00 23.17	*a*	ME05
101dd	PGM 3	GC IRS 34NW	E61	WN7			K = 12.8	PG06	17 45 39.756	−29 00 25.25	*a*	PG06
101de	MPS 1	GC IRS 13E5		WCLd?			K = 11.90	MP04	17 45 39.780	−29 00 29.65	*c*	MP04
101df	MPS 2	GC IRS 13E3B		WCLd?			K = 13.07	MP04	17 45 39.792	−29 00 29.59	*c*	MP04
101dg	TGM05-1	GC IRS 2 , BSD96-45		WCLd?			K = 10.34	BS96	17 45 39.792	−29 00 34.99	*i*	TG05
101dh	MPS 3	GC IRS 13E3A	E49	WCLd?	?	PG06	K = 13.0	PG06	17 45 39.796	−29 00 29.63	*c*	MP04
101di	MPS 4	GC IRS 13E4	E48	WC8-9	WC9	PG06	K = 11.7	PG06	17 45 39.797	−29 00 29.52	*a*	MP04
101e [12]	*KGE 5*	*GC IRS 13E2*, MPS 5	E51	*WN9-10 +?*	WN8	PG06	K = 10.8	PG06	17 45 39.801	−29 00 29.84	*a*	*KG95*
101ea	EML 1	GC IRS 13E3c		WCLd?			K = 12.49	MP04	17 45 39.808	−29 00 29.48	EM04	EM04
101f [13]	*KGE 4*	*GC IRS 7W*, MES-WR2	E68	*WN9-10*	WC9	PG06	K = 13.1	PG06	17 45 39.853	−29 00 22.11	*a*	*KG95*
101fa	HET 1	GC IRS 3E	E58	WC5-6d	WC5-6d?	PE05	K = 15.0	PG06	17 45 39.868	−29 00 24.30	*a*	HE04
101g	*KGE 6*	*GC IRS 29N*	E31	*WC9*			K = 10.0	PG06	17 45 39.918	−29 00 26.69	*a*	*KG95*
101h [14]	*KGE 8*	*GC IRS 15SW*, MES-WR3	E83	*WN9-11*	WN8-WC9	PG06	K = 12.0	PG06	17 45 39.920	−29 00 18.08	*a*	*KG95*
101i [15]	*KGE 7*	*GC IRS 29NE1, MPE−1.0−3.5*	E35	*WC9*	WC8-9	PG06	K = 11.7	PG06	17 45 39.965	−29 00 26.04	*a*	*KG95*
101j	*KGE 9*	*GC IRS 16NW*	E19	*WN9-11*	Ofpe/WN9	PG06	K = 10.0	PG06	17 45 40.042	−29 00 26.89	*a*	*KG95*
101ja	PGM 4	GC IRS 33E	E41	Ofpe/WN9			K = 10.1	PG06	17 45 40.090	−29 00 31.22	*a*	PG06
101k	*KGE 10*	*GC IRS 16SW*	E23	*WN9-11 +?*	Ofpe/WN9	PG06	K = 9.61v	GP00	17 45 40.120	−29 00 29.08	*a*	*KG95*
101l	*KGE 11*	*GC IRS 16C*	E20	*WN9-11*	Ofpe/WN9	PG06	K = 9.7	PG06	17 45 40.126	−29 00 27.62	*a*	*KG95*
101m	*KGE 12*	*GC IRS 15NE*	E88	*WN9-11*	WN8-9	PG06	K = 11.8	PG06	17 45 40.145	−29 00 16.42	*a*	*KG95*
101ma	PGM 5		E71	WC8-9?			K = 14.1	PG06	17 45 40.161	−29 00 21.61	*a*	PG06
101n	*KGE 13*	*GC IRS 16SE1, MPE+1.6−6.8*	E32	*WC9*	WC8-9	PG06	K = 10.9	PG06	17 45 40.181	−29 00 29.25	*a*	*KG95*
101na	TGM02-1	GC IRS 21 , BSD96-81		WCLd?			K = 10.55	CR01	17 45 40.221	−29 00 30.84	*i*	TG02
101nb	PGM 6	GC IRS 7SE2		WC?			K = 13.7	PG06	17 45 40.245	−20 00 24.23	*k*	PG06
101nc	PGM 7	GC IRS 9W	E65	WN8			K = 12.1	PG06	17 45 40.257	−29 00 33.72	*a*	PG06
101nd	PGM 8	GC IRS 16NE	E39	Ofpe/WN9			K = 8.9	PG06	17 45 40.259	−29 00 27.07	*a*	PG06
101o	*KGE 14*	*GC IRS 16SE2, MPE+2.7−6.9*	E40	*WC9*	WN5-6	HE04	K = 12.0	PG06	17 45 40.264	−29 00 29.29	*a*	*KG95*

[8] : WR 77o: formerly WR 77h in NC03.
[9] : WR 77p: formerly WR 77i in NC03.
[10]: WR 77r: formerly WR 77j in NC03.
[11]: WR 77sc: formerly WR 77k in NC03.
[12]: *WR 101e*: formerly *WR 101f* in 7Cat.
Erratum: for GC IRS 13E1 in 7Cat, read GC IRS 13E2.
[13]: *WR 101f*: formerly *WR 101e* in 7Cat.
[14]: *WR 101h*: formerly *WR 101i* in 7Cat.
[15]: *WR 101i*: formerly *WR 101h* in 7Cat.
[16]: *WR 102bd*: formerly *WR 101q* in HB03.
[17]: *WR 102j*: formerly *WR 102k* in 7Cat.
[18]: *WR 102k*: formerly *WR 101j* in 7Cat.

Magnitudes:
For each object the most recently published magnitude has been quoted, unless the new observation only confirms the earlier observation. CS99 used $K'(\lambda_c = 2.11\,\mu$m). FN02 used m_{F205W}. HB03 used K_s (narrow continuum filter $\lambda_c = 2.248\,\mu$m) from 2MASS.

Coordinates:
Coordinates from reference in last column, unless indicated otherwise (p.c. = private communication):
a: coordinates from F. Martins, 11 August 2005, p.c.; also PG05.
b: revised coordinates from T. Paumard, October 2004, p.c.
c: coordinates from T. Paumard, August 2004, p.c.
d: coordinates from CDS-Simbad.
e: coordinates from J. Moultaka, August 2005, p.c.
f: coordinates from A. S. Cotera, July 2005, p.c.
g: coordinates from R. D. Blum, August 2004, p.c.
h: coordinates from D. F. Figer, August 2004, p.c.
i: coordinates from F. Martins, 30 August 2005, p.c.; also PG05.
j: coordinates from D. F. Figer, April 2006, p.c.
k: coordinates from F. Martins, May 2006, p.c.

Reference abbreviations:
AR: Lang et al. (2001); Lang (2003), Lang et al. (2005).
BC94 = BCC: Bartaya et al. (1994).
BS01 = B = BSP: Blum et al. (2001).
BS95 = BSD: Blum et al. (1995).
BS96 = BSD96: Blum et al. (1996).
CE96 = C = CEC: Cotera et al. (1996).
CH06: Crowther et al. (2006).
CN02: Clark & Negueruela (2002).
CP05 = CPG: Cohen et al. (2005).
CR01: Clénet et al. (2001).
CS99: Cotera et al. (1999).
DB04 = DBU: Drew et al. (2004).
E: running number in Paumard et al. (2006), Table 2.
EG01: Eikenberry et al. (2001).
EM04: Eckart et al. (2004).
EML = EML04: Eikenberry et al. (2004).
F: Figer et al. (2002).

Table 1. continued.

WR	WR discovery designation	Other designation(s)	in PG06	Discovery spectral type	Revised spectral type	ref.	m (mag)	ref.	RA(J2000)	Dec(J2000)	ref.	WR discovery ref.
Galactic Center cluster (continued)												
101oa	PMM 1	HeI N3	E59	WR	WC9	PG06	$K = 13.0$	PG06	17 45 40.264	−29 00 24.64	*a*	PM01
101ob	PGM 9	GC IRS 9SW	E76	WC9			$K = 13.1$	PG06	17 45 40.366	−29 00 36.13	*a*	PG06
101oc	PMM 2	GC IRS 7E2 (ESE)	E70	WR	Ofpe/WN9	PG06	$K = 12.9$	PG06	17 45 40.369	−29 00 22.76	*b*	PM01
101od	TGM05-3	GC IRS 5		WCLd?					17 45 40.4	−29 00 16	*d*	TG05
101oe	MEV 1	GC IRS 1W, BSD96-92		WCLd?			$K = 8.72$	CR01	17 45 40.442	−29 00 27.53	*i*	ME04
101of	PGM 10	GC IRS 9SE	E80	WC9			$K = 11.7$	PG06	17 45 40.471	−29 00 36.27	*a*	PG06
101og	TGM05-4	GC IRS 10W, BSD96-94		WCLd?			$K = 10.25$	BS96	17 45 40.49	−29 00 22.8	OE99	TG05
101oh	PGM 11		E72	WC9?			$K = 13.6$	PG06	17 45 40.551	−29 00 28.60	*a*	PG06
101oi	PMM 3	ID 180, HeI N1	E78	WR	WC9	PG06	$K = 13.0$	PG06	17 45 40.760	−29 00 27.79	*c*	PM01
101p	HBP 1			WC8-9			$K_s = 11.20$	HB03	17 45 42.47	−28 52 53.3	HB03	HB03
Arches cluster												
102a	*CSE 1*	*“ near G 0.10+0.20”*		*WN8*			$K' = 10.22$	CS99	17 45 48.560	−28 50 06.08	*f*	*CS99*
102aa	NWS 1	C13, AR6, B34, F2		WN9	WN9+OB?	LG01	$K' = 10.7$	CE96	17 45 49.76	−28 49 26.0	LJ05	NW95
102ab	BSP 30	B30, F10		WN7			$K' = 11.46$	FNO2	17 45 50.08	−28 49 26.2	*g*	BS01
102ac	BSP 29	B29, F17		WN7			$K' = 12.15$	FN02	17 45 50.15	−28 49 26.9	*g*	BS01
102ad	NWS 4	C9, AR3, B28, F1		WN9	WN9+OB?	LJ05	$K' = 10.2$	CE96	17 45 50.20	−28 49 22.3	LJ05	NW95
102ae	NWS 5	C1, B26, F9		WN9			$K' = 10.6$	CE96	17 45 50.31	−28 49 11.5	*g*	NW95
102af	NWS 6	C3, AR16, B25, F12		WN9			$K' = 10.6$	CE96	17 45 50.31	−28 49 17.0	*g*	NW95
102ag	NWS 7	C6, AR2, B24, F8		WN9			$K' = 10.76$	FN02	17 45 50.39	−28 49 21.3	LJ05	NW95
102ah	NWS 8	C8, AR1, B23, F6		WN9	WN9+OB?	LJ05	$K' = 10.1$	CE96	17 45 50.42	−28 49 22.3	LJ05	NW95
102ai	NWS 9	AR8, B22, F5		WN9	WN9+OB?	LJ05	$K' = 10.86$	FN02	17 45 50.45	−28 49 31.9	LJ05	NW95
102aj	NWS 10	C5, AR4, B21, F7		WN9	WN9+OB?	LJ05	$K' = 9.7$	CE96	17 45 50.47	−28 49 19.5	LJ05	NW95
102ak	BSP 19	B19, F16		WN6-7			$K' = 11.40$	FN02	17 45 50.55	−28 49 20.5	*g*	BS01
102al	NWS 11	C2, AR5, B17, F4		WN9	WN8	La03	$K' = 10.2$	CE96	17 45 50.57	−28 49 17.5	LJ05	NW95
102b	*CSE 2*	*“ near Sgr A East region A”*		*WN6*			$K' = 10.97$	CS99	17 45 50.626	−28 59 19.61	*f*	*CS99*
102ba	CEC 7	B12, F14		WN7			$K' = 11.22$	FN02	17 45 50.69	−28 49 22.5	*g*	CE96
102bb	NWS 14	C11, AR7, B3, F3		WN9	WN9/Ofpe	La03	$K' = 10.3$	CE96	17 45 50.83	−28 49 26.4	LJ05	NW95
102bc	CEC 10	B1		WN7			$K' = 11.3$	CE96	17 45 51.46	−28 49 26.0	*g*	CE96

FM95: Figer et al. (1995).
FM96: Figer et al. (1996).
FM99a = FMM = FMM99: Figer et al. (1999a).
FM99b = FMG99: Figer et al. (1999b).
FN05 = FNG: Figer et al. (2005).
GCS: Nagata et al. (1995).
GD06 = GDTB: Groh et al. (2006).
GM99: Glass et al. (1999).
GP00 = GPE: Genzel et al. (2000).
HB03 = HBP: Homeier et al. (2003).
HB05 = HBD: Hopewell et al. (2005).
HE04 = HET: Horrobin et al. (2004).
KG95 = KGE: Krabbe et al. (1995).
La03: Lang (2003).
LG01: Lang et al. (2001).
LJ05: Lang et al. (2005).
ME04 = MEV: Moultaka et al. (2004).
ME05 = MES: Moultaka et al. (2005).
MP04 = MPS: Maillard et al. (2004).
NC03: Negueruela & Clark (2003).
NC05 = NC: Negueruela & Clark (2005).
Ne03: Negueruela (2003).
Ne05: Negueruela, priv. comm.: VLT-FORS spectroscopy.
NW95 = NWS: Nagata et al. (1995).
OE99: Ott et al. (1999).
Pa04: Paumard (2004, private communication.
PC02 = PCG: Pasquali et al. (2002).
PE05: Pott et al. (2005).
PG04: Paumard et al. (2004).
PG05: Paumard et al. (2005).
PG06 = PGM: Paumard et al. (2006).
PM01 = PMM: Paumard et al. (2001).
PM03: Paumard et al. (2003).
Q = GMM = GM90: Glass et al. (1990) (see also Moneti et al. 2001).
QR: Lang et al. (1999); Lang (2003); Lang et al. (2005).
TG02 = TGM02: Tanner et al. (2002).
TG05 = TGM05: Tanner et al. (2005).
TM06: Tuthill et al. (2006).

5. Conclusion

The past five years have seen the number of known Galactic WR stars increasing by ~30% to close to 300 objects. It is to be expected that, with the advance of observing capabilities, that number will continue to increase. Whether the expected number of ~1600 WR stars in our observable quadrant of the Galaxy (van der Hucht 2001) will be reached remains to be seen.

Discovering and monitoring WR star in the Galaxy and in the Local Group is important for the study of Galactic structure and chemical evolution, and it is likely that some WR

Table 1. continued.

WR	WR discovery designation	Other designation(s)	Discovery spectral type	Revised spectral type	ref.	*m* (mag)	ref.	RA(J2000)	Dec(J2000)	ref.	WR discovery ref.
102bd [16]	HBP 2		WC8-9			K_s= 11.49	HB03	17 45 57.78	−28 54 46.1	HB03	HB03
Quintuplet cluster											
102c	*FMM96-1*	*qF353E*	*WN6*			K = 11.53	FM99	*17 46 11.2*	*−28 49 05.6*	7Cat	*FM95*
102ca	HBP 3		WC8-9			K_s=10.40	HB03	17 46 13.04	−28 49 25.4	HB03	HB03
102d	*FMM95-1*	*qF320*, QR8	*WN9*			K = 10.50	FM99	17 46 14.067	−28 49 17.28	*h*	*FM95*
102da	FMM-d1	GCS 3-4, qF243, Q1	WCLd?			K = 7.61	GM99	17 46 14.151	−28 49 37.42	*h*	FM96
102db	FMM-d2	GCS 3-3, qF258, Q9	WCLd?			K = 8.98	GM99	17 46 14.336	−28 49 32.17	*h*	FM96
102dc	FMM-d3	GCS 3-2, qF231, Q2, QR7	WCLd?	WC7-8d+OB	TM06	K = 6.28v	GM99	17 46 14.721	−28 49 41.46	*h*	FM96
102dd	FMM-d4	GCS 3-1, qF251, Q4	WCLd?			K = 7.66	GM99	17 46 14.810	−28 49 35.02	*h*	FM96
102e	*FMM96-2*	*qF151*	*WC8*			K = 10.44	FM99	17 46 14.827	−28 50 01.17	*h*	*FM96*
102ea	FMM96-7	qF241, Q10, QR5	WN9/Ofpe			K = 8.83	GM99	17 46 15.129	−28 49 37.82	*j*	FM96
102f	*FMM96-3*	*qF235N*	*WC < 8 + ?*					17 46 15.168	−28 49 40.25	*h*	*FM96*
102g	*FMM99-1*	*qF235S*	*WC<8*					17 46 15.182	−28 49 42.40	*h*	*FM99*
102h	*FMM95-2*	*qF76*	*WC9*			K = 11.44	FM99	17 46 15.572	−28 50 18.89	*h*	*FM95*
102ha	FMM-d5	GCS 4, qF211, Q3	WCLd?	WCLd+OB	TM06	K = 6.91v	GM99	17 46 15.884	−28 49 46.27	*h*	FM96
102hb	FMM96-8	qF240, Q8	WN9/Ofpe			K = 9.01	GM99	17 46 15.954	−28 49 38.60	*j*	FM96
102i	*FMM96-4*	*qF256*	*WN9 + ?*			K = 11.38	FM99	17 46 16.560	−28 49 32.53	*h*	*FM96*
102j [17]	*FMM96-6*	*qF309*	*WC<8*			K = 11.52	FM99	17 46 17.522	−28 49 19.41	*h*	*FM96*
102k [18]	*FMM96-5*	*qF274*	*WN9*			K = 11.41	FM99	17 46 17.548	−28 49 29.52	*h*	*FM96*
102ka	HBP 4		WN10			K_s = 8.84	HB03	17 46 18.12	−29 01 36.5	HB03	HB03
“SGR 1806−20” cluster											
111a	FNG 1	FNG-1	WC8			K = 11.76	FN05	18 08 38.32	−20 24 33.5	FN05	FN05
111b	EGH 1	FNG-B	WC9d			K = 10.50	FN05	18 08 39.24	−20 24 42.50	FN05	EG01, EML04
111c	FNG 2	FNG-2	WN6			K = 12.16	FN05	18 08 39.42	−20 24 42.57	FN05	FN05
111d	FNG 3	FNG-3	WN7?			K = 12.87	FN05	18 08 39.50	−20 24 35.88	FN05	FN05
142a	PCG 1	NGC 6910-MS 21	WC8			K_s = 7.09	PC02	20 24 06.2	+41 25 33	PC02	PC02
159	BCC 1	BD+62°2296B	WN4			V_T = 11.20	Ne03	23 47 20.4	+63 13 14	Ne03	BC94, Ne03

stars are Type Ib/c supernova progenitors and/or GRB progenitors. Identifying even one such object before it explodes could contribute greatly to our understanding of these energetic phenomena.

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