ASTRONOMY & ASTROPHYSICS SUPPLEMENT SERIES

APRIL I **1999**, PAGE 35

Astron. Astrophys. Suppl. Ser. **136**, 35–52 (1999)

New catalogue of Wolf-Rayet galaxies and high-excitation extra-galactic HII regions*

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Received October 27; accepted November 24, 1998

Abstract. We present a new compilation of Wolf-Rayet (WR) galaxies and extra-galactic HII regions showing *broad* He II λ4686 emission drawn from the literature. Relevant information on the presence of other broad emission lines (N III λ4640, C IV λ5808 and others) from WR stars of WN and WC subtypes, and other existing broad nebular lines is provided.

In total we include 139 known WR galaxies. Among these, 57 objects show both broad He II λ4686 and C IV λ5808 features. In addition to the broad (stellar) He II λ4686 emission, a *nebular* He II component is well established (suspected) in 44 (54) objects. We find 19 extra-galatic HII regions without WR detections showing nebular He II λ4686 emission.

The present sample can be used for a variety of studies on massive stars, interactions of massive stars with the ISM, stellar populations, starburst galaxies etc. The data is accessible electronically and will be updated periodically.

Key words: galaxies: starburst — galaxies: stellar content — galaxies: ISM — stars: Wolf-Rayet

1. Introduction

Wolf-Rayet (WR) galaxies are extragalactic objects whose integrated spectra show direct signatures from WR stars, most commonly a broad He II λ4686 feature originating in the stellar winds of these stars. Since the first detection of such a feature in He 2-10 (Allen et al. 1976), a large number of WR galaxies have been reported, some in systematic searches (e.g. Kunth & Joubert 1985), but mostly serendipitously. For example many objects with WR features have been found in samples of high S/N spectra of low metallicity extra-galactic HII regions aimed at deriving the primordial He abundance (cf. Izotov & Thuan 1998). It must be reminded to use the term WR "galaxy" with caution. Depending e.g. on the distance of the object and the spatial extension of the observation, the region of concern may be "just" a single extra-galactic HII region with a few WR stars in a galaxy or the nucleus of a powerful starburst galaxy harbouring numerous massive stars.

Since the compilation of Conti (1991) listing 37 objects, the number of known WR galaxies has grown rapidly to more than 130 in the present catalogue. Interestingly many objects are now found showing additional features from WR stars in their spectra. E.g. the broad emission lines of N III λ4640 and/or C III λ4650 as well as C IV λ5808, among the strongest optical lines in WN and WC stars, are increasingly often being detected. Lines originating from WC stars (representing more evolved phases than WN stars) provide useful independent and complementary information on the massive star content in these regions (e.g. Schaerer et al. 1999).

By definition it is not surprising that WR galaxies do not form a homogeneous class. Indeed, WR galaxies are found among a large variety of morphological types, from low-mass blue compact dwarf (BCDs) and irregular galaxies, to massive spirals and luminous merging IRAS galaxies. Recent studies also quite convincingly show the evidence of signatures from WR stars in Seyfert 2 and LINERs (Osterbrock & Cohen 1982; Ho et al. 1995; Heckman et al. 1997; Storchi-Bergmann et al. 1998; Kunth & Contini 1998). Allen (1995) claims even the possible detection of WR stars in central cluster galaxies of two cooling flows out to a redshift of $z \sim 0.25$.

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* The catalogue is available at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/Abstract.html

Empirically all WR galaxies show nebular emission lines. The absolute scales (absolute magnitudes, ionizing fluxes etc.) of the investigated objects vary greatly; generally speaking the properties of WR galaxies overlap with those of other emission line galaxies and form a continuous extension of giant H II regions (Conti 1991).

For most "traditional" WR galaxies (e.g. H II galaxies, BCDs etc.) the nebular spectrum is likely due to photoionization of stellar origin. However, this statement does obviously not hold in general, e.g. for Seyfert 2 and LINER revealing the presence of WR stars. Among the former "class" a considerable fraction ($\sim 1/3$ in the present compilation) of objects also show *nebular* He II λ4686 emission in addition to the *broad* WR feature. This line is also present in some giant H II regions where no WR features have been detected. Except in planetary nebulae, nebular He II λ4686 emission is very rarely found in Galactic H II regions (cf. Garnett et al. 1991; Schaerer 1997). Its origin, requiring sources with sufficient photons of energy > 54 eV, has remained puzzling (see Garnett et al. 1991 and references therein). Supported by quantitative modeling, Schaerer (1996) has suggested that the origin of nebular He II λ4686 emission is intimately linked with the appearance of hot WR stars. To facilitate systematic analysis on the origin of *nebular* He II λ4686 emission we therefore also include the relevant information on objects showing this line. Such studies have a bearing on our understanding of physical processes in H II regions and related nebulae, the ionizing fluxes of starbursts and their contribution to the ionization of the intergalactic medium etc. (cf. Garnett et al. 1991; Schaerer et al. 1998; Stasińska 1998).

The minimum common property of all WR galaxies is (provided the origin of the considered line and our understanding of stellar evolution is correct) *ongoing or recent star formation* which has produced stars massive enough to evolve to the WR stage. This indicates typically ages of $\lesssim 10$ Myr and stars with initial masses $M_{\rm ini} \gtrsim 20\ M_{\odot}$ (Maeder & Conti 1994).

WR galaxies are therefore ideal objects to study the early phases of starbursts, determine burst properties (age, duration, SFR), and to constrain parameters (i.e. slope and upper mass cut-off) of the upper part of the initial mass function (see e.g. Arnault et al. 1989; Mas-Hesse & Kunth 1991, 1998; Krüger et al. 1992; Vacca & Conti 1992; Meynet 1995; Contini et al. 1995; Schaerer 1996; Schaerer et al. 1999). Conversely studies of the stellar populations in super star clusters frequently formed in starbursts and WR galaxies (Conti & Vacca 1994; Meurer et al. 1995) can also place constraints on stellar evolution models for massive stars, e.g. at extremely low metallicities, which are inaccessible in the Local Group (cf. I Zw 18: Izotov et al. 1997b; Legrand et al. 1997; de Mello et al. 1998).

As galaxies exhibiting intense star formation are being discovered in large numbers at progressively larger distances, "template" systems become increasingly important for our understanding of distant objects which cannot be studied to the same depth. As such WR galaxies represent useful templates of young starbursts which show close resemblance to recently discovered high redshift galaxies (cf. Leitherer et al. 1996; Ebbels et al. 1996; Lowenthal et al. 1997).

The present compilation should facilitate future systematic studies on some of the issues discussed above. The structure of the paper is as follows. In Sect. 2 we review the searches undertaken up to date for WR galaxies. In Sect. 3 the compilation of all known WR galaxies is presented. Brief remarks on each individual object are given in Sect. 4. The list of extra-galactic H II regions showing only *nebular* He II λ4686 is given in Sect. 5. Suspected WR galaxies are discussed in Sect. 6. A brief discussion and our main conclusions are found in Sect. 7.

2. Searches for WR galaxies

Few systematic searches for WR populations outside the Local Group (or "WR galaxies") have been undertaken. In this section we briefly summarise the studies explicitly devoted to the detection of WR signatures. A list of candidate WR galaxies resulting from some of these searches or found loosely in the literature is provided in Sect. 6. The WR galaxies issued from the searches described below are included in our list and represent the vast majority of detections. Let us now briefly summarise the properties of the spectroscopic and narrow-band imaging searches.

2.1. Spectroscopic searches

The first search for WR features in giant H II regions of nearby galaxies was carried out by D'Odorico et al. (1983). The latest update from their study is summarised by Rosa & D'Odorico (1986). Data from their work was included in the quantitative analysis by Arnault et al. (1989).

The most detailed search was undertaken by Kunth & Joubert (1985) from a sample of 45 "lazy" galaxies (blue emission-line galaxies forming stars by intermittent short bursts) from various sources. In their statistical approach they measure the excess emission above the continuum between $4600-4711$ Å (rest wavelength) after subtracting a typical nebular contamination taken as a function of the excitation level and abundance. Their search yielded 19 regions (15 different objects) with excess emission above $0.8\ \sigma$.

A systematic search for a broad WR bump in all the H II galaxies included in the catalogue of Terlevich et al. (1991) was presented by Masegosa et al. (1991). Earlier publications using a subset of the same observational data had also reported some WR detections and nebular He II λ4686 (Campbell & Smith 1986; Campbell et al. 1986). Positive detections were considered by Masegosa et al.

when the "blue bump" was at least 1 σ over the continuum level and clearly discernible from the nebular He II λ4686 line. Their search yielded 37 detections ($\sim$ 10% of the sample); 14 of these objects have spectra with a spectral resolution of $\lesssim$ 5 Å FWHM, which the authors estimate to be "good enough" to reliably detect WR stars. Only these objects (their Table 2) were included in our list as confirmed WR galaxies. The remaining objects are classified here as "candidates" (Sect. 6).

Recently Pindao (1998) and Pindao et al. (1999) have reanalysed the spectra from the Terlevich et al. catalogue and $\gtrsim$ 100 additional emission line galaxies for their WR content. Objects with a clear detection of broad He II λ4686 are retained as WR galaxies here (See Pindao 1998. The detection level corresponds to $\gtrsim 0.8\ \sigma$, i.e. category 4 of Pindao et al. 1999). Category 3 objects (WR bump detection at $\sim 0.5\ \sigma$) from Pindao et al. (1999) are classified here as "WR candidates".

Robledo-Rella & Conti (1993) presented a search for WR features in a selected sample of northern HII galaxies; candidates are given in Sect. 6.

First results from a new search for WR signatures in young starbursts have been presented by Contini (1996) and Kovo & Contini (1998).

An ongoing systematic search for WR galaxies has been mentioned by Huang et al. (1998).

According to Izotov (1998, private communication) the observational data gathered primarily for accurate determinations of the helium abundance since 1993 (see Izotov et al. 1994, 1996, 1997a; Thuan et al. 1995; Izotov & Thuan 1998) are being systematically re-analysed for their WR content (Guseva et al. 1998; Izotov et al. 1998). Adding 10 newly observed objects, their sample mostly including blue compact galaxies consists of $\sim$ 70 spectra. While the initial sample contained essentially very metal-poor objects, metallicities up to $\sim$ solar are now also included. The majority of the WR detections have been mentioned in the above papers; in total Guseva et al. (1998) and Izotov et al. (1998) find 41 WR galaxies, defined by broad emission between $\sim 4620 - 4700$ Å. Often several broad features are pointed out in the blue bump (He II λ4686, N III λ4640, but also other lines they identify as N III λ4510, N II λ4565, N V λ4605, 4620, C IV λ4658). According to their study 28 spectra also show broad C IV λ5808. Finally, few detections of broad He II λ5412, C III λ5696, and also C II λ4267 are signaled. We retain all except one WR galaxy (Mrk 1026 = NGC 848 showing no broad He II λ4686) from their study.

2.2. Narrow-band imaging and others

Drissen et al. (1993) have conducted a search for He II λ4686 emission via narrow-band imagery in four low mass galaxies (GR8, NGC 2366, IC 2574, NGC 1569). Two of them are now confirmed WR galaxies (see above), IC 2574 remains to be studied spectroscopically, and GR8 yielded negative results (no He II).

Schmidt-Kaler & Feitzinger (1984) initiated a search for 30 Dor and NGC 604 like objects based on POSS, ESO-Blue, and SRC film. To the best of our knowledge results from this survey have not been published.

3. New catalogue of WR galaxies

In this section we present an updated list of all "WR galaxies" outside the Local Group. As pointed out earlier we remind the reader that the working definition for WR galaxies refers only to the detection of a broad WR feature in an integrated spectrum, irrespectively of the included area. This fact must be taken into account in subsequent interpretations. By this working definition we also include some nearby objects (e.g. NGC 300) which, although already known to harbour WR stars, were not included in the catalogue of Conti (1991). An inventory of the Galactic WR stars is found in the 7th catalogue of van der Hucht et al. (1998; cf. van der Hucht 1996). For individual WR stars and WR populations in the Local Group see e.g. the review of Massey (1996).

3.1. Selection criteria and procedure

During the last three years the literature was followed for any publication relating to possible or confirmed signatures from WR stars in extragalactic objects. At the end of july 1998 we also made a systematic search in the Astrophysics Data System (ADS) for the occurrence of "WR", "W-R", "Wolf-Rayet", or "Wolf Rayet" in all the included literature starting with 1970. The search yielded 1780 references to refereed papers, and 1061 other references, all of which were carefully inspected. In addition all publications from the IAU Symposia 67, 80, 83, 88, 99, 105, 116, 122, 143, 149, 163 were scanned. Although a complete inspection is not possible the present procedure should guarantee a fairly high degree of completeness.

For the inclusion in our list of "WR galaxies" the criteria are *1)* the presence of *broad* emission at 4686 Å due to He II, or *2)* a broad "WR bump" at $\sim$ 4660 Å, or *3)* other broad emission lines attributed to WR stars. The second criterion accounts for the difficulty of resolving He II λ4686 from other emission lines in medium resolution spectra (see e.g. Kunth & Joubert 1985), but may in some cases introduce objects where nebular emission lines dominate the WR bump. Implicitly both criteria *1)* and *2)* were adopted in the earlier compilation of Conti (1991). The third criterion allows for objects where broad carbon lines (e.g. C III λ5696, C IV λ5808) presumably from WR stars are detected. In practice only one case (NGC 1365 for which no blue spectrum was available) falls in this category.

The presence/absence of features and their qualification (broad and/or nebular) is generally not fully objective (see Sect. 2 for more details). Furthermore in many cases the spectra are not available for inspection. We therefore follow the procedure or judgement of the authors of the original publication.

All objects resulting from this selection are listed in Table 1. Obviously most of the objects appear in various catalogues. We have chose the following labeling priority: first the Messier number, then the NGC, the Markarian, the Zwicky lists, or finally other labels (UM, Tol, SBS, etc.). Often several regions in the same object show WR features. In this case only the main object name is listed (Col. 1); information about the different regions are given in Sect. 4.

The general properties of objects, equatorial coordinates (equinox 1950, Cols. 2 and 3), morphological type (Col. 4), apparent blue magnitude (Col. 5), and heliocentric radial velocity (Col. 6) have been extracted from NED. Column 7 gives the reference of the first publication indicating the presence of *broad* He II λ4686. "(C91)" indicates that this objects was already included in the compilation of Conti (1991). Column 8 gives information about the existence of *nebular* He II λ4686 (see footnote of the Table for the keys). The source of this information is found under the remarks on each individual object (Sect. 4). Column 9 gives the reference to the first detection of broad C IV λ5808 (exceptionally also other broad features, cf. NGC 1365).

Our current compilation (Table 1) includes 139 WR galaxies (cf. 37 WR galaxies in Conti 1991). Among them 57 objects show also broad C IV λ5808 features. In addition to the broad (stellar) He II λ4686 emission, a nebular He II component is well established (suspected) in 44 (54) objects.

The database will be made available electronically at the CDS and through the Web[1]. It is our intention to update the catalogue in the future by this means.

4. Remarks on individual WR galaxies

Below a brief comment is given for each object from Table 1 on the detected WR features and possible nebular He II λ4686. In some objects the strongest nebular lines also show broad and/or asymmetric components, attributed to gaz-flows or broad stellar emission. These finding are also reported below.

NGC 53 — Detection of He II λ4686 by Masegosa et al. (1991) from automatic search in H II galaxy catalogue of Terlevich et al. (1991).

NGC 55 — Rosa & D'odorico (1986) surveyed eight giant H II regions in NGC 55. Two were found with broad He II λ4686 and C IV λ5808 features.

[1] information at
`http://www.obs-mip.fr/omp/astro/people/schaerer`

UM 48 — Automatic detection by Masegosa et al. (1991). WR features unlikely according to the analysis of Pindao et al. (1999).

Mrk 960 — Broad features around 4700 Å were first suspected by S. Considère (private communication). A better spectrum of this galaxy confirms the presence of a broad He II λ4686 emission line (Kovo & Contini 1998).

NGC 300 — Fifteen positions were observed by D'Odorico et al. (1983) in this Sculptor group galaxy often considered as a twin of M 33. Two regions showed He II λ4686 one also C IV λ5808. Several investigations were undertaken subsequently to search for individual WR stars or small clusters. The latest work (Breysacher et al. 1997, cf. references therein) detected 12 WR stars increasing the total to 34 known WR stars.

IRAS 01003 − 2238 — Broad He II λ4686 and N III λ4640 emission has been observed by Armus et al. (1988). Other broad features are tentatively detected. Based on the equivalent withs of the WR-bump they estimate $\sim 10^5$ WR stars are present in this luminous infrared galaxy, the most distant WR galaxy known so far.

UM 311 — This H II region is possibly located in the galaxy NGC 450. Automatic detection of broad He II λ4686 by Masegosa et al. (1991). The high S/N spectrum of Izotov & Thuan (1998) shows both broad He II λ4686 and C IV λ5808 features, but no nebular He II. A nebular component is also detected by Guseva et al. (1998). Pindao (1998) confirms the presence of a broad WR bump.

Tol 0121 − 376 — Masegosa et al. (1991) and Pindao (1998) signal the presence of a broad WR bump in this galaxy.

Minkowski's Object — A weak broad He II λ4686 feature and possible nebular He II has been found by Breugel et al. (1985) in this "starburst triggered by a radio jet". They also point out a close similarity of the emission line spectrum with the NGC 7714, a prototypical starburst galaxy.

Mrk 996 — This unusual blue compact galaxy shows He II λ4686, N III λ4640 and C IV λ5808 features in the HST FOS spectra of Thuan et al. (1996).

Mrk 589 — Guseva et al. (1998) point out the presence of broad He II λ4686 and several N lines in the blue bump, as well as broad C IV λ5808. The S/N in the red appears quite low for its detection.

UM 420 — Broad He II λ4686 emission has been found by Izotov & Thuan (1998). From their reanalysis Guseva et al. (1998) signal also nebular He II and broad C IV λ5808. The S/N appears fairly low for the latter assertion.

Mrk 1039 — The presence of nebular and broad He II λ4686 and C IV λ5808 has been discovered by Huang et al. (1998) in this H II galaxy.

Tol 0226 − 390 — Masegosa et al. (1991) and Pindao (1998) signal the presence of a broad WR bump in this galaxy.

Table 1. List of WR galaxies (all WR populations outside Local Group). (C91) stands for objects included in Conti (1991) catalogue

Name	R.A. [1950]	Decl. [1950]	Morphology	m_b [mag]	V_{rad} [km s^{-1}]	Broad He II λ4686 reference	Nebular He II λ4686	C IV λ5808 reference
NGC 53	00 12 16.1	−60 36 19	(R')SB(r)ab	13.3	4568	MMO91		
NGC 55	00 12 38.0	−39 29 54	SB(s)m: sp	8.4	129	RD86		RD86
UM 228	00 18 27.2	+00 36 09		17.0	29490	MMO91, P98		
UM 48	00 33 35.8	+04 21 37	S	15.5	4907	MMO91		
Mrk 960	00 46 04.8	−12 59 21	(R)SB0 pec?	13.5	6407	KC98	–	
NGC 300	00 52 31.7	−37 57 15	SA(s)d	8.7	144	DRW83		DRW83
IRAS 01003 − 2238	01 00 23.6	−22 38 03		18.9	35310	AHM88, (C91)		
UM 311	01 13 00.5	−01 07 22			1798	MMO91	!	IT 98
Tol 0121 − 376	01 21 55.8	−37 37 55			10500	MMO91, P98		
Mink	01 23 14.2	−01 37 54	Irr	17.0	5638	B85, (C91)	UL	
Mrk 996	01 25 04.5	−06 35 08		15.5	1622	TIL96	–	TIL96
Mrk 589	02 11 08.7	+03 52 08	S?	14.5	3436	GIT98	–	GIT98
UM 420	02 18 20.4	+00 19 42	Compact	16.5	17652	IT98	!	GIT98
Mrk 1039	02 25 07.2	−10 23 19	Sc? sp; HII	15.5	2089	H98	Q	H98
Tol 0226 − 390	02 26 10.0	−39 02 39		15.3	14340	MMO91, P98		
Tol 0242 − 387	02 42 39.2	−38 47 31	HII	17.8	37807	MMO91, P98		
Mrk 598	02 43 52.2	+07 11 34		17.0	5396	P98		
NGC 1140	02 52 08.0	−10 13 49	IBm pec	12.8	1501	GIT98	–	GIT98
NGC 1156	02 56 46.8	+25 02 21	IB(s)m	12.3	375	HFW95		
NGC 1313	03 17 39.0	−66 40 42	SB(s)d	9.2	475	WR97		WR97
NGC 1365	03 31 41.8	−36 18 27	(R')SBb(s)b	10.3	1636			PC92
SBS 0335 − 052	03 35 15.1	−05 12 26		17.0	4043	I98	!	
NGC 1510	04 01 53.9	−43 32 14	SA0 pec?	13.5	913	EN84, (C91)		
NGC 1569	04 26 04.6	+64 44 23	IBm	11.9	−104	DR94		
NGC 1614	04 31 35.5	−08 40 56	SB(s)c pec	13.6	4778	P98, (C91)		
VII Zw 19	04 35 41.3	+67 38 19		16.0	4830	KJ85, (C91)		
NGC 1741 (B)	04 59 06.5	−04 20 08	SB(s)m pec	15.2	4171	KS86, (C91)	?	
H31A	04 59 09.9	−04 19 52	Sdm	15.6	4042	R90, (C91)		
Mrk 1094	05 08 17.4	−02 44 33	I0 pec?	14.1	2831	KJ85		
II Zw 40	05 53 04.9	+03 23 07	BCD;Irr	15.5	789	KS81, (C91)	!	GIT98
Tol 0633 − 415	06 33 35.0	−41 31 12		16.5	5096	MMO91		
Mrk 5	06 35 24.4	+75 40 22	I?	15.6	792	IT98		
IRAS 07164+5301	07 16 28.6	+53 01 06				H96		
Mrk 1199	07 20 28.3	+33 32 21	Sc	13.7	4107	IT98	Q	IT98
NGC 2363	07 23 23.7	+69 17 33	Sm; HII	11.6	107	G94	Q	G94
Mrk 8	07 23 36.8	+72 13 58	S?	13.8	3496	KJ85, (C91)		
NGC 2403	07 32 05.5	+65 42 40	SAB(s)cd	8.93	131	DR96		DR96
VII Zw 187	07 49 27.4	+72 24 57		17.4		KJ85		
SBS 0749+582	07 49 48.0	+58 16 00		19.0	9548	ITL97	–	
Mrk 1210	08 01 27.0	+05 15 22	S?	14.3	4046	SCS98	!	
IRAS 08208+2816	08 20 52.2	+28 15 57	Irr	15.5	14034	H98		H98
He 2 − 10	08 34 07.0	−26 14 06	I0? pec	12.4	873	AWG76, (C91)		VC92
Mrk 702	08 42 45.1	+16 16 44	Compact	15.7	15840	MMO91	–	GIT98
SBS 0907+543	09 07 31.8	+54 23 08		17.0	8124	ITL97	Q	
SBS 0926+606	09 26 20.0	+60 40 02	BCG	17.5	4122	ITL97	Q	
I Zw 18	09 30 30.2	+55 27 49	Compact	15.6	742	I97	Q	I97, L97
ESO 566 − 7	09 42 38.0	−19 29 42	SBb pec?	15.3	9890	MMO91		
NGC 3003	09 45 38.5	+33 39 19	Sbc?	12.3	1478	HFW95		
Mrk 22	09 46 03.3	+55 48 48		15.7	1499	ITL94	Q	GIT98
Mrk 1236	09 47 19.9	+00 51 01	SABcd	13.5	1829	KS86, (C91)	!	GIT98
SBS 0948+532	09 48 10.2	+53 13 41		18.0	13890	ITL94	Q	GIT98

Table 1. continued

Name	R.A. [1950]	Decl. [1950]	Morphology	$m_{\rm b}$ [mag]	$V_{\rm rad}$ [km s^{-1}]	Broad He II λ4686 reference	Nebular He II λ4686	C IV λ5808 reference
NGC 3049	09 52 10.2	+09 30 32	SB(rs)ab	13.0	1494	KS86, (C91)	–	SCK99
Mrk 712	09 53 59.1	+15 52 34	SB	14.5	4560	CDS95	?	
Tol 0957 − 278	09 57 05.0	−27 53 30	Multiple?	14.4	710	KJ85		
NGC 3125	10 04 18.2	−29 41 29	S	13.5	865	KS81, (C91)	?	SCK99
Tol 1025 − 284	10 25 12.0	−28 26 00		16.9	9593	P98		
Mrk 33	10 29 22.7	+54 39 31	Im pec	13.4	1461	KJ85, (C91)		
Mrk 1434	10 30 56.3	+58 19 20	BCG	16.5	2269	ITL97	Q	GIT98
Mrk 1259	10 36 03.0	−06 54 37	S0 pec?	13.5	2159	OTT97	–	GIT98
Mrk 724	10 38 26.8	+21 37 24	Compact	16.5	1139	KS86, (C91)	!	KS86
NGC 3353	10 42 15.8	+56 13 26	BCD/Irr	13.2	944	S96, H98	Q	S96, H98
NGC 3367	10 43 55.4	+14 00 58	SB(rs)c	12.1	3037	HFW95		
NGC 3395	10 47 02.7	+33 14 44	SAB(rs)cd	12.4	1625	W98	–	W98
NGC 3396	10 47 08.9	+33 15 18	IBm pec	12.6	1625	W98	!	W98
Mrk 1271	10 53 33.3	+06 26 24	Compact	14.8	1049	IT98	Q	?GIT98
SBS 1054+365	10 54 59.8	+36 31 30		16.0	603	ITL97	–	–
Mrk 36	11 02 15.6	+29 24 34	BCD	15.5	646	IT98	Q	
NGC 3690	11 25 42.4	+58 50 17	IBm pec	12.0	3121	HFW95		
Mrk 178	11 30 45.9	+49 30 52	pair		249	GRZ88, (C91)	!	GIT98
NGC 3738	11 33 04.2	+54 48 04	Im	12.1	229	M97		
UM 439	11 34 03.0	+01 05 36		15.1	1169	MMO91		
Mrk 182	11 34 17.7	+20 12 12	Compact	17.0	6328	GIT98	?	–-
Mrk 1450	11 35 51.3	+58 09 04	Compact	15.5	946	ITL94	Q	ITL94
Mrk 1304	11 39 38.6	+00 36 42	Sb pec	14.7	5488	MMO91	!	GIT98
Mrk 1305	11 40 24.6	−08 03 18		15.5	2997	GIT98	–	GIT98
Mrk 750	11 47 28.0	+15 18 04	BCD	15.8	754	KJ85, (C91)	Q	GIT98
Pox 4	11 48 39.0	−20 19 17		16.2	3589	KJ85	?	
UM 461	11 48 59.4	−02 05 41	BCD/Irr	16.9	899	C91		
Mrk 1307	11 50 03.8	−02 11 28	Pec;BCD	14.5	1012	IT98	Q	
Mrk 193	11 52 52.1	+57 56 26	Compact	16.5	5282	GIT98	!	
ISZ 59	11 54 54.7	−19 20 44	S0	16.8	1781	KJ85, (C91)		
NGC 3995	11 55 10.4	+32 34 24	SAm pec	12.7	3254	W98	!	W98
NGC 4038	11 59 19.0	−18 35 12	SB(s)m pec	10.9	1642	RD86		
SBS 1211+540	12 11 33.9	+54 01 58		17.8	929	GIT98	!	
NGC 4214	12 13 08.3	+36 36 22	IAB(s)m	10.2	291	SF91		SF91, MHK91
NGC 4216	12 13 21.5	+13 25 40	SAB(s)b	11.0	131	RD86		
NGC 4236	12 14 21.8	+69 44 36	SB(s)dm	10.1	0	GP94		
M 106	12 16 29.4	+47 34 53	SAB(s)bc	9.10	448	C98		
SBS 1222+614	12 22 44.5	+61 25 46		17.0	734	ITL97	Q	ITL97
NGC 4385	12 23 09.0	+00 50 57	SB(rs)0+	13.2	2140	CS86, (C91)		CS86
II Zw 62	12 23 38.4	+07 56 37		17.2	3930	KJ85, (C91)		
Mrk 209	12 23 50.5	+48 46 13	Sm pec	15.2	281	ITL97	Q	GIT98
NGC 4449	12 25 45.9	+44 22 16	IBm	10.0	207	MK97		MK97
NGC 4532	12 31 46.7	+06 44 39	IBm	12.3	2012	HFW95		
Mrk 1329	12 34 29.8	+07 12 01	SBmIII	14.4	1632	GIT98	–	?GIT98
Tol 1235 − 350	12 35 46.0	−35 02 42	S0:	17.1	2998	P98		
NGC 4670	12 42 49.8	+27 23 54	SB(s)0/a pec	13.1	1069	MHK91		
Tol 1247 − 232	12 47 39.0	−23 17 38		15.5	14400	MMO91		
SBS 1249+493	12 49 35.8	+49 19 45	BCG	17.5	7330	GIT98	!	
NGC 4861	12 56 39.7	+35 07 50	SB(s)m	12.9	847	DS86, (C91)	Q	DS86
Tol 30	13 03 03.0	−28 09 12	SB	15.5		C96	?	
Pox 120	13 04 04.7	−11 48 20		15.7	6220	KJ85, (C91)		

Table 1. continued

Name	R.A. [1950]	Decl. [1950]	Morphology	m_b [mag]	V_{rad} [km s^{-1}]	Broad He II λ4686 reference	Nebular He II λ4686	C IV λ5808 reference
Pox 139	13 09 20.8	−11 47 54	SB(s)d	15.0	2107	KJ85, (C91)		
NGC 5068	13 16 13.0	−20 46 36	SB(s)d	10.7	673	RD86		
SBS 1319+579	13 19 25.2	+57 57 09		18.5	2060	ITL97	Q	GIT98
NGC 5128	13 22 31.6	−42 45 33	S0 pec	7.8	547	M 81, RD86		M 81
Pox 186	13 23 12.0	−11 22 00		17.0	1170	KJ85, (C91)		
Tol 35	13 24 20.0	−27 41 48	S?	14.4	1814	KJ85, (C91)	?	
M 83	13 34 11.5	−29 36 42	SAB(s)c	8.2	516	RD86		
NGC 5253	13 37 05.1	−31 23 13	IM pec	10.9	404	CTM86, (C91)	?	SCK99
Mrk 67	13 39 39.6	+30 46 16	BCD/Irr	16.5	958	C91		
Mrk 1486	13 58 09.4	+57 40 54			10143	ITL97	Q	
Tol 89	13 58 26.0	−32 49 20	SB(rs)dm	16.0	1216	DBB85, (C91)	?	SCK99
NGC 5430	13 59 08.5	+59 34 16	SB(s)b	12.7	3028	K82, (C91)		
NGC 5408	14 00 17.5	−41 08 19	IB(s)m	12.2	509	MMO91	!	
NGC 5457	14 01 26.3	+54 35 18	SAB(rs)cd	8.3	241	R82, DRW83		
NGC 5461	14 01 54.9	+54 33 24			298	R82		
NGC 5471	14 02 43.4	+54 38 08		15.0	297	MHK91	?	
SBS 1408+551A	14 08 14.0	+55 11 00		18.0	23190	I96	Q	I96
CGCG 219-066	14 15 03.6	+43 44 04		15.6	649	I98	!	
Mrk 475	14 37 03.6	+37 01 13	BCD	14.5	540	C91	Q	ITL94
Mrk 477	14 39 02.5	+53 43 04			11340	H97	!	
Tol 1457-262A	14 57 31.8	−26 14 40	HII		5180	C96	–	
Tol 1457-262B	14 57 32.1	−26 14 49	HII	14.7	5249	P98	?	
SBS 1533+574B	15 33 04.1	+57 27 00			3390	GIT98	!	GIT98
IC 4662	17 42 12.0	−64 37 18	IBm	11.7	308	RD86		RR91
NGC 6500	17 53 48.1	+18 20 41	SAab	13.1	3003	B97		
Fairall 44	18 09 19.3	−57 44 48	S? pec	14.8	4948	KC98	Q	KC98
NGC 6764	19 07 01.2	+50 51 08	SB(s)bc	12.6	2416	OC82, (C91)		
Tol 1924-416	19 24 29.0	−41 40 36	pec HII	13.3	2874	P98	?	
IC 4870	19 32 48.0	−65 55 30	IBm? pec Sy2	13.9	889	JK99	!	
IC 5154	22 00 41.7	−66 21 25	Irr Sy2	14.9	3118	JK99	?	JK99
ESO 108-IG 017	22 07 00.3	−67 06 59	I0? Sy2	14.4	2191	JK99	?	JK99
Mrk 309	22 50 10.0	+24 27 52	Sa	15.4	12645	OC82, (C91)		OC82
Mrk 315	23 01 35.7	+22 21 16	E1 pec?	14.8	11661	KJ85		
ESO 148-IG 02	23 12 51.0	−59 19 40	Merger	15.2	13380	JB88, (C91)		
III Zw 107	23 27 40.4	+25 15 27	Sb	15.6	6176	KJ85, (C91)		
Mrk 930	23 29 29.2	+28 40 16			5400	IT98	!	GIT98
NGC 7714	23 33 40.6	+01 52 42	SB(s)b pec	13.0	2798	B85, (C91)	Q	G97

Key to Col. 8 (nebular He II). — no entry: no information available, "–": absent, "?": possible/suspected, "!": present, but no data available, "UL": upper limit available, "Q": measurement available. Key to references. — AHM88 Armus et al. (1988), AWG76 Allen et al. (1976), B85 Breugel et al. (1985), B97 Barth et al. (1997), C91 Conti (1991), C96 Contini (1996), C98 Castellanos et al. (1998), CDS95 Contini et al. (1995), CS86 Campbell & Smith (1986), CTM86 Campbell et al. (1986), DBB85 Durret et al. (1985), DR94 Drissen & Roy (1994), DR96 Drissen & Roy (1996), DRM93 Drissen et al. (1993), DRW83 D'Odorico et al. (1983), DS86 Dinerstein & shields (1986), EN84 Eichendorf & Nieto (1984), G97 García-Vargas et al. (1997), GIT98 Guseva et al. (1998), GP94 Gonzalez-Delgado & Perez (1994), GRZ88 Gonzalez-Riestra et al. (1988), H96 Huang et al. (1996), H97 Heckman et al. (1997), H98 Huang et al. (1998), HFW95 Ho et al. (1995), I96 Izotov et al. (1996), I97 Izotov et al. (1997b), I98 Izotov et al. (1998), IT98 Izotov & Thuan (1998), ITL94 Izotov et al. (1994), ITL97 Izotov et al. (1997a), JB88 Johansson & Bergvall (1988), JK99 Joguet & Kunth (1999), K82 Keel (1982), KC98 Kovo & Contini (1998), KJ85 Kunth & Joubert (1985), KS81 Kunth & Sargent (1981), KS86 Kunth & Schild (1986), KMH94 Kunth & Mas-Hesse (1994), L97 Legrand et al. (1997), M 81 Moellenhoff (1981), M97 Martin (1997), MK97 Martin & Kennicut (1997), MMO91 Masegosa et al. (1991), MHK91 Mas-Hesse & Kunth (1991), OC82 Osterbrock & Cohen (1982), OTT97 Ohyama et al. (1997), P98 Pindao (1998), PC92 Phillips & Conti (1992), R82 Rayo et al. (1982), RR91 Richter & Rosa (1991), R90 Rubin et al. (1990), RD86 Rosa & D'Odorico (1986), S97 Schaerer et al. (1997), S96 Steel et al. (1996), SCK99 Schaerer et al. (1999), SCS98 Storchi-Bergmann et al. (1998), SF91 Sargent & Fillipenko (1991), TIL96 Thuan et al. (1996), V88 Vilchez et al. (1988), V96 Vacca (1996), VC92 Vacca & Conti (1992), W98 Weistrop et al. (1998), WR97 Walsh & Roy (1997).

Table 2. List of extragalactic H II regions with nebular He II

Name	R.A. [1950]	Decl. [1950]	Morphology	m_b [mag]	V_{rad} [km s^{-1}]	Nebular He II λ4686 reference	Comment
SBS 0749+568	07 49 37.7	+56 49 48	BCG	18.0	5471	ITL97	
Mrk 1416	09 17 25.9	+52 46 50	Irr	17.0	2305	ITL97	
Tol 4	10 08 31.0	−28 39 18	E?	14.4	4219	CTM86	also C96; P99: WR?
SBS 1116+583B	11 16 31.4	+58 20 16		19.5	9905	ITL97	
UM 469	11 54 38.6	+02 45 10		18.0	17388	C96	
SBS 1159+545	11 59 29.0	+54 32 33	BCG	18.0	3537	ITL94	
SBS 1205+557	12 05 57.5	+55 42 07	BCG	15.5	1751	ITL97	
Tol 21	12 14 42.0	−27 45 00		17.5	7795	CTM86	
Mrk 1318	12 16 36.5	+04 07 58	E pec	14.0	1526	C96	P99: WR?
Fairall 30	12 36 32.0	−39 54 42	SAB(r)0		1199	CTM86	
UM 533	12 57 25.0	+02 19 08	dIn	15.7	874	KC98	
Pox 105	13 00 00.0	−11 10 00		17.0	3405	KS83, KJ85	
Tol 1304 − 386	13 04 32.0	−38 38 48			4197	CTM86	P99: WR?
Tol 78	13 04 48.0	−35 22 00		17.0	4197	CTM86	
Tol 111	13 45 24.0	−42 06 00		16.3	2398	CTM86	
SBS 1420+544	14 20 59.1	+54 27 42	BCG	18.0	6176	TIL95	
CG 1258	14 41 50.9	+29 28 32		18.0	13614	ITL97	
SBS 1533+469	15 33 24.0	+46 59 00			5666	TIL95	
HS 1851+6933	18 51 38.6	+69 33 16		17.0	7495	I96	

Key to references. — C96 Contini (1996), CTM86 Campbell et al. (1986), I96 Izotov et al. (1996), I97c Izotov et al. (1997c), ITL94 Izotov et al. (1994), ITL97 Izotov et al. (1997a), KC98 Kovo & Contini (1998), KJ85 Kunth & Joubert (1985), KS83 Kunth & Sargent (1983), P98 Pindao (1998), P99 Pindao et al. (1999), TIL Thuan et al. (1995).

Tol 0242-387 — Masegosa et al. (1991) and Pindao (1998) signal the presence of a broad WR bump in this galaxy.

Mrk 598 — Pindao (1998) signals the presence of a broad WR bump in the western knot of this galaxy.

NGC 1140 — A broad WR bump and C IV λ5808 are detected by Guseva et al. (1998).

NGC 1156 — Emission features of WR stars and a high-excitation H II region in the nucleus are signaled by Ho et al. (1995) from their magnitude limited survey of nuclei of nearby galaxies. A close resemblance of the spectrum with NGC 4214 is pointed out. They also signal a broad Hα component.

NGC 1313 — WR features are found in two regions at large galactocentric radii of this Transition Magellanic galaxy (Walsh & Roy 1997). For region # 28 both He II λ4686 and C IV λ5808 are found. No detailed information is provided about region # 3. Pindao et al. (1999) also signal the possible detection of broad He II λ4686; exact position unknown.

NGC 1365 — The detection of broad C III λ5696 and C IV λ5808 (marginally) in this giant extragalactic H II region was made by Phillips & Conti (1992).

SBS 0335−052 — The first detection of nebular He II λ4686 in this very low metallicity object was reported by Izotov et al. (1990). Nebular and broad He II λ4686 have been found in the reanalysis of Izotov et al. (1998); no broad features had been signalled by Izotov et al. (1997c).

NGC 1510 — Eichendorf & Nieto (1984) show the presence of broad He II λ4686 in one component of this amorphous galaxy. See the discussion in Conti (1991) for more details.

NGC 1569 — Narrow-band λ4686 filter imaging of Drissen et al. (1993) revealed the possible presence of WR stars. Spectroscopy by Drissen & Roy (1994) in the outskirts of the galaxy shows broad He I λ5876 and He I λ6678 both attributed to a late WN star. According to Gonzaléz-Delgado et al. (1997) this region is located 4″ west of super star cluster (SSC) *A*. Ho et al. (1995) find the WR bump and a broad Hα component "in the nuclear spectrum". Gonzaléz-Delgado et al. (1997) find several broad features in the WR bump which are confined to SSC *A*. Broad He II λ4686 has also been detected by Martin & Kennicutt (1997).

NGC 1614 — A broad WR bump is detected by Pindao (1998). The measurement of Vacca & Conti (1992) provides an upper limit on broad He II λ4686.

VII Zw 19 — Found by Kunth & Joubert (1985) in their "survey" of 45 blue emission line galaxies for showing excess emission between 4600 and 4711 Å.

NGC 1741 — This well studied galaxy is part of the Hickson (1982) "compact" group # 31 and interacting with H31 (see below). Several broad components in the WR bump (He II λ4686, N III λ4640) and nebular emission of [Fe III] λ4658 and He II λ4686 have been identified by Kunth & Schild (1986). According to Conti (1991)

Table 3. List of suspected WR galaxies

Name	R.A. [1950]	Decl. [1950]	Morphology	m_b [mag]	V_{rad} [km s^{-1}]	Reference
Fairall 4	00 12 49.2	−57 31 22	(R)SA(r)b	15.1	9796	P99
Tol 0030 − 388	00 30 38.3	−38 50 29			13800	MMO91
Fairall 0007	00 42 06.0	−60 07 00				MMO91
UM 080	00 57 46.8	+04 23 46		17.8	4797	P99
EQ 0102 − 310	01 02	−31.0				MMO91
Tol 0127-397	01 27 02.4	−39 46 03			4797	P99
UM 354	01 37 11.1	+01 10 57			9294	P99
UM 377	01 52 18.8	+01 02 28			8694	P99
UM 396	02 04 51.0	+02 42 41			6296	P99
NGC 848	02 07 50.4	−10 33 25	(R')SB(s)ab	13.6	4001	GIT98
NGC 1068	02 40 07.0	−00 13 32	(R)SA(rs)b	9.6	1136	ED86
CAM 0357 − 3915	03 57 22.1	−39 14 51	HII		22545	P99
Tol 0440 − 381	04 40 23.3	−38 06 41			12300	MMO91, P99
Tol 0513 − 393	05 13 39.7	−39 20 59			15000	P99
Tol 0538 − 416	05 38 32.9	−41 38 37	HII		13491	P99
Tol 0559 − 393	05 59 04.9	−39 19 08	Irr	15.0	24915	MMO91, P99
Tol 0620 − 386	06 30 08.3	−38 39 11			20100	P99
Tol 0645 − 376	06 45 07.0	−37 40 02			7795	MMO91
NPM1G+16.0158	08 41 01.4	+16 10 38		18.3		P99
ESO 566 − 8	09 42 39.2	−19 28 55	S pec	16.3	9761	C96
Mrk 709	09 46 33.2	+17 06 44	BCD	17.0	1197	P99
Tol 1021 − 289	10 21 22.0	−28 58 30	Interacting	16.9	17658	P99
Tol 1025 − 285	10 25 06.2	−28 32 13	N	16.2	8694	P99
Abell 1068	10 37 51.3	+40 12 51	cD	16.0	41580	A95
Tol 1032 − 283	10 32 18.4	−28 19 52	E4:	14.4	3190	KS86
Mrk 1301	11 33 10.9	+35 36 43	S0/a	14.5	1603	RC93
UM 456	11 48 02.5	−00 17 21	Pec	15.9	1757	P99
Pox 52	12 00 22.9	−20 39 21		17.2		KSB87
UM 482	12 09 29.4	−00 19 43	Sm	16.2	10544	P99
UM 483	12 09 41.0	+00 21 01		16.7	2099	P99
M100	12 20 22.9	+16 05 58	SAB(s)bc	7.4	1571	WO98
NGC 4509	12 30 38.9	+32 22 02	Sab pec?	14.1	937	RC93
Tol 1258 − 363	12 58 19.0	−36 19 54			4887	P99
UM 594	13 35 32.7	+00 16 26	HII?	15.8	6653	P99
NGC 5257 (W)	13 37 19.7	+01 05 33	SAB(s)b pec	12.9	6798	MMO91
NGC 5291	13 44 33.3	−30 09 31	E pec:	15.1	4386	DM98
Tol 1345 − 419	13 45 14.2	−41 55 23	Sy2	17.0	11572	P99
UM 618	13 50 03.1	+00 16 07		18.4	4197	P99
Abell 1835	13 58 30.0	+03 06 00	cD	19.3	75690	A95
EQ 1409 − 120	14 09	+01 20				MMO91
Cam 1409+1200	14 09 14.3	+11 59 33			16800	P99
NGC 6090	16 10 24.0	+52 35 04	Sd pec	14.5	8822	RC93
Tol 2006 − 393	20 06 39.7	−39 22 32			9294	P99
Tol 2138 − 405	21 38 14.8	−40 32 35			16800	P99
Tol 2146 − 391	21 46 45.0	−39 08 10			8994	MMO91, P99
Tol 2259 − 398	22 59 34.0	−39 49 42	Compact	15.6	8858	MMO91, P99
UM 159	23 19 31.9	+01 12 24	HII		8694	P99
UM 160 W	23 21 46.0	−00 23 30			2400	P99

Key to references. — A95 Allen (1995), C91 Conti (1991), DM98 Duc & Mirabel (1998) DRM93 Drissen et al. (1993), ED86 Evans & Dopita (1986), GIT98 Guseva et al. (1998), KS86 Kunth & Schild (1986), KSB87 Kunth et al. (1987), MMO91 Masegosa et al. (1991), P99 Pindao et al. (1999), RC93 Robledo-Rella & Conti (1993), VC92 Vacca & Conti (1992), WO98 Wozniak et al. (1998).

N III λ4640 cannot be confirmed. The spectrum of Vacca & Conti (1992) of region B is shown in Conti et al. (1996) who obtained also a UV spectrum with GHRS on HST of this region. An upper limit on He II λ4686 is also given by Vacca & Conti (1992) for region A. The high S/N spectrum of Izotov & Thuan (1998) shows broad He II λ4686, whereas the C IV λ5808 is absent. No nebular He II component is present according to the reanalysis of Guseva et al. (1998).

H31A — A broad He II λ4686 feature and was pointed out by Rubin et al. (1990) in galaxy A and possibly also in H31C = NGC 1741 (see above).

Mrk 1094 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background. Broad He II λ4686 was detected by Vacca & Conti (1992) in region A. Upper limits on He II are given for two other regions.

II Zw 40 — Broad He II λ4686 was detected by Kunth & Sargent (1981) in this well studied low metallicity galaxy. See also Vacca & Conti (1992) for more recent observations and a study of its WR content. Broad He II λ4686 and possibly also C IV λ5808 are signaled by Martin (1997). An important contamination by nebular He II λ4686 has been suspected by Schaerer (1996) from its similarity with Pox 4 and on theoretical grounds. A broad asymmetric emission components of Hα has been found by Méndez & Esteban (1997). Guseva et al. (1998) find the presence of both stellar and nebular He II and broad C IV λ5808.

Tol 0633 − 415 — Automatic detection by Masegosa et al. (1991). Pindao et al. (1999) classify this as a suspected WR galaxy.

Mrk 5 — The high S/N spectrum of Izotov & Thuan (1998) shows broad He II λ4686. No nebular He II component is present according to the reanalysis of Guseva et al. (1998).

IRAS 07164+5301 — Huang et al. (1996) detect the presence of broad lines around 4686 Å suggesting N III λ4640, C III λ4650, and He II λ4686 in this IRAS source. They also indicate a tentative detection of O V λ5835 and a lack of C IV λ5808. The spectrum is of fairly low S/N.

Mrk 1199 — Izotov & Thuan (1998) signal nebular and broad He II λ4686 and C IV λ5808 features from their high S/N spectrum[2]. The latter features appears quite weakly. No nebular He II component is present according to the reanalysis of Guseva et al. (1998).

NGC 2363 — This is a well studied giant HII region consisting of two main knots and located south west of the irregular galaxy NGC 2366 (e.g. Drissen et al. 1993; Gonzaléz-Delgado et al. 1994, and references therein). Spectra of the region taken up to 1992 all show narrow He II λ4686 (see references in Drissen et al. 1993). From narrow-band imaging Drissen et al. (1993) find excess He II λ4686 emission in both knots, but much stronger in the fainter eastern knot. They argue for WR stars in this knot (B). Spectroscopy by Gonzaléz-Delgado et al. (1994) confirms the presence broad and nebular He II λ4686 in knot B, and detect also C IV λ5808 attributed to WC stars. Izotov et al. (1997a) find broad and nebular He II λ4686 emission in knot A, and nebular He II in knot B (cf. also the reanalysis by Guseva et al. 1998). Broad emission component of Hα, Hβ, and [O III] are also known (Roy et al. 1992; Izotov et al. 1997a).

Mrk 8 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background.

NGC 2403 — Drissen & Roy (1996) detect broad He II λ4686 and C IV λ5808 in two giant HII regions in this galaxy of the M 81 group.

VII Zw 187 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background.

SBS 0749+582 — Broad and nebular He II λ4686 is signaled by Izotov et al. (1997a).

Mrk 1210 — Storchi-Bergmann et al. (1998) detect the presence of a broad He II λ4686 component attributed to WR stars in the nucleus of this Seyfert 2 galaxy. A broad WR bump is also detected by Pindao (1998).

IRAS 08208+2816 — The presence of nebular and broad He II λ4686 and broad C IV λ5808 was found by Huang et al. (1998) in this luminous infrared galaxy. The WR bump luminosity is exceptionally large and rivals that of IRAS 01003 − 2238. Interestingly the authors also find essentially zero internal reddening derived from the Balmer decrement.

He 2−10 — This dwarf emission galaxy can be considered the "prototypical WR galaxy" since it was the first where He II λ4686 emission attributed to WR stars was detected (Allen et al. 1976). Abundant observational data is available for this galaxy. The detection of Allen et al. has been confirmed by Hutsemekers & Surdey (1984), who also suspected C IV λ5808 emission due to WC stars from their spectrum. Broad He II λ4686 and a weak C IV λ5808 feature were detected by Vacca & Conti (1992) in their region *A*. Both features were confirmed by Schaerer et al. (1999) from their high S/N spectra. An upper limit for He II λ4686 in region B is also given in Vacca & Conti (1992). The HST UV images of Conti & Vacca (1994) resolve this galaxy in multiple knots. Broad asymmetric emission components of Hα and [N II] λ6584 have been found by Méndez & Esteban (1997).

Mrk 702 — An incorrect object name (C 0842+163) was used for this galaxy by Masegosa et al. (1991), who report a broad WR feature. Guseva et al. (1998) detect both broad He II λ4686 and C IV λ5808 features. The S/N appears fairly low for the latter assertion.

[2] The reported nebular He II λ4686 intensity in Izotov & Thuan (1998) is erroneous according to Y. Itozov (1998, private commnication). No indication is therefore given in Col. 8 of Table 1 for this object.

SBS 0907+543 — Broad and nebular He II λ4686 has been found by Izotov et al. (1997a).

SBS 0926+606 — Broad and nebular He II λ4686 has been found by Izotov et al. (1997a) (cf. also Guseva et al. 1998). They also indicate the presence of low intensity broad components of Hα and/or [O III] λ5007.

I Zw 18 — This well-known object is the galaxy with the lowest metal content known. While nebular He II λ4686 was observed for a long time, only recently the deep spectra of Izotov et al. (1997b) and Legrand et al. (1997) revealed several broad emission components (C III λ4650, He II λ4686, C IV λ5808) attributed to WN and WC stars. The spatial distribution of He II λ4686 emission was studied by Hunter & Thronson (1995) and De Mello et al. (1998) based on WFPC2 HST observations. Izotov et al. (1997a) indicate the presence of low intensity broad components of Hα and/or [O III] λ5007.

ESO 566 – 7 — An incorrect object name C 0942 – 1929A was used by Masegosa et al. (1991) for this galaxy, where they report a broad WR feature. Pindao (1998) confirms the presence of the WR bump.

NGC 3003 — A complex broad WR-bump was signaled by Ho et al. (1995), who also note the absence of a broad Hα component in contrast to their spectra of other WR galaxies (cf. NGC 1156, NGC 1569, NGC 4214).

Mrk 22 — Broad and nebular He II λ4686 has been found by Izotov et al. (1994). Their spectrum appears noisy to detect C IV λ5808. Its detection is, however, signaled by Guseva et al. (1998).

Mrk 1236 — Kunth & Schild (1986) point out the presence of broad He II λ4686 in this galaxy. Broad He II λ4686 was detected in region A by Vacca & Conti (1992). Observations of Guseva et al. (1998) signal the presence of nebular and broad He II, broad C IV λ5808 and possibly also C III λ5696. A broad emission feature is identified as C II λ 4267.

SBS 0948+532 — Broad and nebular He II λ4686 has been found by Izotov et al. (1994). Also C IV λ5808 is present according to the reanalysis of Guseva et al. (1998), although the S/N appears fairly low.

NGC 3049 — This Virgo Cluster galaxy shows broad [N II] λ5755 and He II λ4686 (Kunth & Schild 1986). The WR bump is confirmed by Mas-Hesse & Kunth (1991, 1998), Masegosa et al. (1991), and Pindao (1998). Broad He II λ4686 was detected in region *A* by Vacca & Conti (1992); an upper limit is given for region *B*. The high S/N observations of Schaerer et al. (1999) reveal broad features of N III λ4640, He II λ4686, C III λ5696, and C IV λ5808 testifying of the presence of late-type WN and late-type WC stars. These features are confirmed by Guseva et al. (1998).

Mrk 712 — Contini et al. (1995) and Contini (1996) signal the presence of broad N III λ4640 and He II λ4686 in a giant HII region of this IRAS barred spiral galaxy. A nebular contribution to He II may be present (Contini 1996).

Tol 0957 – 278 — Kunth & Joubert (1985) list this object (=Tol 2) as having a broad He II λ4686 excess above 0.8 σ of the background in the NE component. Upper limits of He II λ4686 are given for 2 regions by Vacca & Conti (1992). Possible detection of broad He II λ4686 according to Pindao et al. (1999).

NGC 3125 — Broad He II λ4686 emission was found by Kunth & Sargent (1981; cf. also Kunth & Joubert 1985) in this dwarf galaxy. They also note narrow [Fe III] λ4658 emission. Broad He II λ4686 was detected in two regions by Masegosa et al. (1991) and Vacca & Conti (1992). Pindao (1998) reconfirms the detections of Masegosa et al.. The high S/N observations of Schaerer et al. (1999) reveal broad features of N III λ4640, He II λ4686, and C IV λ5808 in both regions, testifying of the presence of late WN and early WC stars.

Tol 1025 – 284 — Pindao (1998) signals the presence of a broad WR bump in this galaxy.

Mrk 33 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background. The WR bump is confirmed by the spectra of Mas-Hesse & Kunth (1991, 1998).

Mrk 178 — The SE knot of this galaxy shows broad He II λ4686 according to González-Riestra et al. (1984). He II emission was already noted by Sargent (1972). Guseva et al. (1998) signal the presence of nebular and broad He II, and C IV λ5808.

Mrk 1434 — Broad and nebular He II λ4686 has been found by Izotov et al. (1997a). They also indicate the presence of low intensity broad components of Hα and/or [O III] λ5007. The reanalysis of Guseva et al. (1998) also shows C IV λ5808 emission.

Mrk 1259 — Ohyama et al. (1997) detect broad N III λ4640 and He II λ4686 lines in the nuclear spectrum of this nearby starburst galaxy. Their study suggests the existence of a superwind seen nearly pole-on (see also Ohyama & Taniguchi 1998). Guseva et al. (1998) signal also the presence of C IV λ5808 and no nebular He II. A broad feature identified as N III λ4510 is also indicated.

Mrk 724 — Kunth & Schild (1984) find broad He II λ4686 and a broad feature close to C IV λ5808, as well as additional nebular lines "contaminating" the WR bump ([Fe III] λ4658, He II λ4686, [Ar IV] λ4711). The identification of C IV λ5808 is not well established (see Kunth & Schild 1984; Conti 1991).

NGC 3353 — Steel et al. (1996) report the presence of a broad WR bump and a possible detection of C IV λ5808 in region *A*. These signatures are confirmed by Huang et al. (1998) who also find indications for nebular He II λ4686.

NGC 3367 — The presence of a broad WR bump in the LINER nucleus has been signaled by Ho et al. (1995), who also note unusually broad and asymmetric emission lines (e.g. Hβ).

NGC 3395 — Weistrop et al. (1998) signal the presence of broad He II λ4686 and C IV λ5808.

NGC 3396 — Weistrop et al. (1998) signal the presence of broad He II λ4686 and C IV λ5808, as well as nebular He II λ4686.

Mrk 1271 — The spectrum of Izotov & Thuan (1998) shows weak nebular and broad He II λ4686 features. Although very weak, C IV λ5808 could also be present according to Guseva et al. (1998). Contini (1996) only finds nebular emission lines.

SBS 1054+365 — Broad He II λ4686 has been detected by Izotov et al. (1997a). This is confirmed by the reanalysis of Guseva et al. (1998).

Mrk 36 — The spectrum of Izotov & Thuan (1998) shows nebular and broad He II λ4686 features. No WR signature was detected by Campbell et al. (1986) and Mas-Hesse & Kunth (1991, 1998).

NGC 3690 — Ho et al. (1995) signaled the presence of WR features in several regions of this galaxy (=Arp 299); they exclude WR features in the nucleus. Vacca (1996, private communication) signals the presence of broad He II λ4686 in Arp 299B and Arp 299C which are part of this complex system.

NGC 3738 — Martin (1997) points out the presence of broad He II λ4686.

UM 439 — Automatic detection by Masegosa et al. (1991). Also listed as WR candidate by Pindao et al. (1999).

Mrk 182 — Broad He II λ4686 is pointed out by Guseva et al. (1998). The spectrum may be too noisy to establish the presence/absence of a nebular component.

Mrk 1450 — Nebular and broad He II λ4686, and C IV λ5808 have been found by Izotov et al. (1994) (cf. also Guseva et al. 1998).

Mrk 1304 — Automatic detection of He II by Masegosa et al. (1991), later confirmed by Pindao (1998). Nebular and broad He II λ4686, and C IV λ5808 have been found by Guseva et al. (1998). The S/N appears fairly low for the latter assertion.

Mrk 1305 — Broad He II λ4686 and C IV λ5808 have been found by Guseva et al. (1998). The S/N appears fairly low for the latter assertion.

Mrk 750 — He II λ4686 emission was first signaled by Kunth & Joubert (1985). According to Conti (1991) N III λ4640 is also detected in a spectrum of Salzer. These detections are consistent with the spectrum of Izotov & Thuan (1998) showing a broad WR bump and nebular He II. The reanalysis of Guseva et al. (1998) also reveals C IV λ5808 emission.

Pox 4 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background. This object is also included in the studies of Campbell et al. (1986) and Masegosa et al. (1991)[3], which signal a possible WR feature in one or two regions. The reanalysis of Pindao (1998) confirms the WR bump in one region. Broad He II λ4686 has been measured by Vacca & Conti (1992) in two regions. The existence of a broad component is not well established (e.g. Kunth & Sargent 1981). Nebular He II λ4686 is most likely present in region *A* (see spectrum of Vacca & Conti 1992). A broad asymmetric emission component of [O III] λ5007 has been found by Méndez & Esteban (1997).

UM 461 — Conti (1991) reports the presence of broad He II λ4686 and relatively strong nebular [Ar IV] lines in a spectrum from Salzer.

Mrk 1307 — Izotov & Thuan (1998) indicate the presence of broad He II λ4686 and nebular He II (cf. Guseva et al. 1998). The presence of a broad component appears somewhat marginal (see also Contini 1996).

Mrk 193 — The analysis of Guseva et al. (1998) indicates the presence of broad and nebular He II λ4686 in this object; the broad component was not signaled by Izotov et al. (1994).

ISZ 59 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background.

NGC 3995 — Weistrop et al. (1998) signal the presence of broad He II λ4686 and C IV λ5808, as well as nebular He II λ4686.

NGC 4038 — From ten giant HII regions surveyed by Rosa & D'Odorico (1986) in this galaxy of the Antennae, one exhibits a broad emission feature at the blue WR bump.

SBS 1211+540 — The reanalysis of Guseva et al. (1998) shows nebular and broad He II λ4686; Izotov et al. (1994) only signaled nebular emission.

NGC 4214 — WR signatures in this galaxy were found independently by Mas-Hesse & Kunth (1991; cf. also 1998) and Sargent & Fillippenko (1991). The observations of the former show a broad WR bump around 4650 Å and C IV λ5808 due to WC stars. The latter detect WR signatures of N III λ4640, C III λ4650, possibly also C III λ4658, and He II λ4686 in two knots. From the C lines they also suspected the presence of WC stars. Broad He II λ4686 and C IV λ5808 in several regions has also been signaled by Martin & Kennicutt (1997). A broad Hα component, attributed to WN stars, was also detected by Sargent & Fillippenko in one knot. Recent UV spectroscopy of NGC 4214 with HST was obtained by Leitherer et al. (1996). Detailed spectroscopic spatial mapping by Maíz-Apellániz et al. (1998) shows the presence of He II λ4686 (broad and narrow) in several regions of NGC 4214.

NGC 4216 — From five giant HII regions surveyed by Rosa & D'Odorico (1986) in this galaxy two exhibit a broad emission feature at the blue WR bump.

[3] Campbell et al. refer to C 1148 − 203. In Masegosa et al. the name C 1148 − 2020 (see their Table 1) and erroneously Tol 1148 − 202 (Table 2) is used. The proper identification of this Cambridge object (see Telles et al. 1997) is IRAS 11485 − 2018 = Pox 4 according to NED.

NGC 4236 — González-Delgado & Perez (1994) report the presence of broad N III λ4640 and He II λ4686 features in their H II region III.

M 106 — Castellanos et al. (1998) point out the presence of broad He II λ4686 in the brightest H II region of this Seyfert 2 galaxy.

SBS 1222+614 — Nebular and broad He II λ4686, and C IV λ5808 have been found by Izotov et al. (1997a) (cf. Guseva et al. 1998).

NGC 4385 — WR signatures of N III λ4640, He II λ4686 and possibly also C IV λ5808 have been detected by Campbell & Smith (1986). The first two lines are also found in the spectrum of Durret & Tarrab (1988), who signal also a possible detection of C III λ4658. The findings are confirmed by Conti (1991) according to a spectrum of Salzer; according to Conti C III λ4658 has more likely to be identified with [Fe III] λ4658.

II Zw 62 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background.

Mrk 209 — Nebular and broad He II λ4686 have been found by Izotov et al. (1997a); the reanalysis of Guseva et al. (1998) also reveals C IV λ5808 emission, although very weak.

NGC 4449 — Martin & Kennicutt (1997) indicate the presence of broad He II λ4686 and C IV λ5808 in several regions of this object.

NGC 4532 — The presence of a weak broad WR bump has been signaled by Ho et al. (1995), who also note a very weak broad Hα component.

Mrk 1329 — Broad He II λ4686 and a possible detection of C IV λ5808 are signaled by Guseva et al. (1998). He II λ5412 emission is also pointed out.

Tol 1235 − 350 — Pindao (1998) signals the presence of a broad WR bump in this galaxy.

NGC 4670 — Mas-Hesse & Kunth (1991, 1998) report the presence of a WR bump in this galaxy; the latter publication provides only an upper limit.

Tol 1247 − 232 — Automatic detection of broad He II λ4686 by Masegosa et al. (1991) confirmed by the analysis of Pindao (1998).

SBS 1249+493 — The reanalysis of Guseva et al. (1998) indicates the presence of nebular and broad He II λ4686; previously only a narrow component was detected (Thuan et al. 1995).

NGC 4861 — The spectrum of Dinerstein & Shields (1986) shows a broad WR feature centered at 4686 Å and a possible detection of C IV λ5808 (but cf. Conti 1991). The WR bump is confirmed by Mas-Hesse & Kunth (1991, 1998), Motch et al. (1994) who also find nebular He II, and by Martin & Kennicutt (1997) who possibly also find C IV λ5808. The spectrum of Izotov et al. (1997a) shows broad and nebular He II, as well as C IV λ5808 (cf. Guseva et al. 1998).

Tol 30 — Broad N III λ4640, He II λ4686, and probably also nebular He II have been found by Contini (1996). The exact region is not specified. Pindao et al. (1999) signal the possible presence of the WR bump in the H II region Tol 1303–281 NW associated with this galaxy.

Pox 120 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background.

Pox 139 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background. This finding is confirmed by the observations of Vacca & Conti (1992).

NGC 5068 — From five giant H II regions surveyed by D'Odorico et al. (1983) in this galaxy, two exhibit a broad emission feature at the blue WR bump.

SBS 1319+579 — Nebular and broad He II λ4686 have been found by Izotov et al. (1997a) In their reanalysis Guseva et al. (1998) also detect C IV λ5808.

NGC 5128 — The observations of six H II regions in the elliptical galaxy Cen A (classified as Seyfert 2 in NED) by Möllenhoff (1981) revealed several WR features in one region (# 13) near the rim of the dust disk of this well studied galaxy. Broad lines of N III λ4640, He II λ4686, C III λ4650, and C IV λ5808 are identified. According to Rosa & D'Odorico (1986), WR features are found in two (including # 13) out of six surveyed regions.

Pox 186 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background.

Tol 35 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background. Campbell et al. (1986) indicate only nebular He II. The WR feature is confirmed by the spectrum of Campbell & Smith (1986), by Masegosa et al. (1991), Vacca & Conti (1992), and Pindao (1998). Broad asymmetric emission components of Hα and [O III] λ5007 have been found by Méndez & Esteban (1997).

M 83 — From eight giant H II regions surveyed by Rosa & D'Odorico (1986) in this galaxy, three exhibit a broad emission feature at the blue WR bump.

NGC 5253 — This is a well studied amorphous galaxy. WR features have not been detected by Rosa & D'Odorico (1986); four regions surveyed. The first reports of a broad WR bump in this galaxy are from Campbell et al. (1986) and Walsh & Roy (1987). The high S/N observations of Schaerer et al. (1997) reveal broad features of N III λ4640, He II λ4686, and C IV λ5808 in two regions, testifying of the presence of late-type WN and early-type WC stars. Nebular He II λ4686 is very likely present in their region *A*; a region of exceptionally strong He II λ4686 (probably nebular) was also found (see Schaerer et al. 1999). The WR bump was also detected by Kobulnicky et al. (1997), Martin & Kennicutt (1997), Mas-Hesse & Kunth (1998) and Pindao (1998).

Mrk 67 — Conti (1991) reports a possible detection of a weak and broad He II λ4686 emission feature from a spectrum of Salzer.

Mrk 1486 — Nebular and broad He II λ4686 have been found by Izotov et al. (1997a).

Tol 89 — Durret et al. (1985) report the detection of a broad WR bump (likely N III λ4640 and He II λ4686) in this giant HII region of NGC 5398. IUE spectra also indicate the presence of WR stars (see Durret et al. 1985; Conti 1991), possibly also of the WC type. Pindao (1998) also signals the presence of the WR bump. The high S/N observations of Schaerer et al. (1999) reveal broad features of N III λ4640, He II λ4686, and exceptionally strong C IV λ5808, testifying of the presence of late-type WN and early-type WC stars. These authors also suspect a contribution from nebular He II λ4686.

NGC 5430 — Keel (1982) reports a broad WR bump (likely N III λ4640 and He II λ4686) in the spectrum of a bright HII region, SE of the nucleus of this barred galaxy.

NGC 5408 — WR features have not been detected by Rosa & D'Odorico (1986); two regions surveyed. Masegosa et al. (1991) signal a possible detection of broad He II λ4686 in their region *B*. According to Motch et al. (1994) the He II emission is only nebular and is mostly found in two regions (their # 3 and 4). Kovo & Contini (1998) report both broad and nebular He II λ4686 in two HII regions of this galaxy with a faint broad N III λ4640 in one of them. The nebular lines of [Fe III] λ4658 [Ar IV] λ4711, and [Ar IV] λ4740 are strong.

NGC 5457 = M 101 — Rosa & D'Odorico (1986) report of seven surveyed HII regions with five detections of WR features from the spectra of D'Odorico et al. (1983). According to the latter, however, only two regions, Hodge 40 and NGC 5461 (see below), show clear broad He II λ4686 features; the remaining objects required confirmation with spectra at higher resolution. Although uncertain, broad He II λ4686 emission in Hodge 40 was also pointed out by Rayo et al. (1982).

NGC 5461 — The presence of broad N III λ4640 and He II λ4686 in this giant HII region of M101 was first pointed out by Rayo et al. (1982) and later confirmed by D'Odorico et al. (1983).

NGC 5471 — Rayo et al. (1982) find a weak He II λ4686 feature in this HII region of M 101. No information on its width is given. D'Odorico et al. (1983) detect unbroadened lines identified as C III λ4658 [Fe III] λ4658, He II λ4686, He I + [Ar IV] λ4711 and [Ar IV] λ4740, whose origin is likely nebular. Mas-Hesse & Kunth (1991, 1998) mention the presence of a WR bump.

SBS 1408+551A — Nebular and broad He II λ4686, and C IV λ5808 have been found by Izotov et al. (1996).

CGCG 219 − 066 — Nebular and broad He II λ4686 emission is found according to Izotov et al. (1998); no broad features had been signaled by Thuan et al. (1995).

Mrk 475 — Conti (1991) reports a detection of a moderately strong He II λ4686 emission feature and possible N III λ4640 from a spectrum of Salzer. The similarity with the spectrum of Mrk 750 is pointed out. Nebular and broad He II λ4686, and C IV λ5808 have been found by Izotov et al. (1994) (cf. Guseva et al. 1998). Their spectrum also show the presence of an unidentified broad feature at $\sim$ 4200 Å.

Mrk 477 — Heckman et al. (1997) detect the presence of a broad He II λ4686 component attributed to WR stars together with several other stellar signatures in the nucleus of this powerful Seyfert 2 galaxy.

Tol 1457 − 262A — A broad He II λ4686 emission line has been reported by Contini (1996) in one of the members of the galaxy pair Tol 1457 − 262. A broad WR bump is also detected by Pindao (1998).

Tol 1457 − 262B — Whereas Contini (1996) signals the presence of a purely nebular He II λ4686 emission, a broad WR bump is detected by Pindao (1998).

SBS 1533+574B — Nebular and broad He II λ4686, and also C IV λ5808 have been found in the reanalysis of Guseva et al. (1998); no broad features had been signaled by Izotov et al. (1997a).

IC 4662 — From two giant HII regions surveyed by Rosa & D'Odorico (1986) in this nearby galaxy, two exhibit a broad emission feature at the blue WR bump. This is also confirmed by the study of Heydari-Malayeri et al. (1991). Richter & Rosa (1991) detect He II λ4686 and C IV λ5808 in one cluster. The WR bump was also detected by Mas-Hesse & Kunth (1998).

NGC 6500 — Broad He II λ4686 may be tentatively detected in the LINER nucleus of this galaxy (Barth et al. 1997).

Fairall 44 — Broad He II λ4686 C IV λ5808 and N III λ4640 emission lines are detected in this dwarf galaxy (Kovo & Contini 1998).

NGC 6764 — Osterbrock & Cohen (1982) point out the presence of broad N III λ4640 and He II λ4686 in the spectrum of the nucleus of this barred spiral galaxy also classified as LINER or Seyfert 2. Conti (1991) argues that the line at 4660 Å in their spectrum is likely [Fe III] λ4658. The spectrum of Eckart et al. (1996) confirms the broad features of Osterbrock & Cohen. They also signal excessive widths of He I λ5876 and Hα which they attribute to emission from WR stars. Broad C III λ5696 and C IV λ5808 lines from WC stars are reported in the nucleus of this galaxy by Kunth & Contini (1998).

Tol 1924 − 416 — Pindao (1998) signals the presence of a broad WR bump in this galaxy. Kovo & Contini (1998) indicate only nebular He II λ4686.

IC 4870 — The presence of a broad WR bump is signalled by Joguet & Kunth (1999) in this galaxy classified as starburst or Seyfert 2. The spectral range at $\lambda >$ 5300 Å was not covered.

IC 5154 — Joguet & Kunth (1999) note the presence of broad He II λ4686, N III λ4640, and C IV λ5808 in one of the two nuclei of this galaxy which they classify as starburst although previously known as Seyfert 2.

ESO 108 − IG 01 — The presence of broad He II λ4686 and C IV λ5808 is signalled by Joguet & Kunth (1999) in this galaxy classified as starburst or Seyfert 2.

Mrk 309 — Osterbrock & Cohen (1982) point out the presence of broad N III λ4640 and He II λ4686 in this Seyfert 2 galaxy. Conti (1991) argues that the line at 4660 Å is likely [Fe III] λ4658. C IV λ5808 and C III λ5696 emission, attributed to WC stars, is also tentatively detected by Osterbrock & Cohen.

Mrk 315 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background.

ESO 148-IG 02 — WR features (N III λ4640, He II λ4686) in this infrared galaxy have been reported by Johansson & Bergvall (1988).

III Zw 107 — Kunth & Joubert (1985) list this object as having a broad He II λ4686 excess above 0.8 σ of the background in the southern component.

Mrk 930 — Broad He II λ4686 has been found by Izotov & Thuan (1998). The reanalysis of Guseva et al. (1998) also reveals a nebular He II component and broad C IV λ5808. The quality of the spectrum appears fairly low for the latter assertion.

NGC 7714 — Van Breugel et al. (1985) reported weak WR features near 4686 Å and possible nebular He II emission in the nucleus of this "prototypical starburst" galaxy, and call attention to the similarity with Minkowski's object (above) and extragalactic HII regions. New long-slit observations at several position angles were obtained by González-Delgado et al. (1995), confirming the presence of broad He II λ4686 in the nucleus. Nebular emission can also be suspected from their spectrum. From the same observations García-Vargas et al. (1997) find broad WR bumps ($\sim$ 4660 Å) in three extra-nuclear giant HII regions. One of them shows a definite detection of C IV λ5808; for the remaining regions upper limits on C IV λ5808 are given. Pindao (1998) also signals the presence of a broad WR bump; no information about the observed location given.

5. HII galaxies showing only nebular He II emission

HII regions ("local" or extragalactic objects) and HII galaxies showing nebular He II λ4686 are considered to be quite rare (e.g. Garnett et al. 1991). Although not intended as a complete inventory these authors quote only 17 objects drawn from the studies of dwarf emission-line galaxies by Kunth & Sargent (1983) and Campbell et al. (1986). Many new observations revealing nebular He II λ4686 emission have since been found, mostly in the sample of Izotov and collaborators (see Sect. 2).

In Table 2 we list extragalactic HII regions showing He II λ4686 emission which is entirely attributed to nebular emission processes. In some cases, however, WR signatures are suspected by some authors; see Col. 8 for references. We restrict ourself to objects from the Terlevich et al. (1991) catalogue analysed by various authors and the sample of Izotov and collaborators, since these constitute the largest available samples of such objects. All except one object (Pox 105) from Kunth & Sargent (1983) showing He II λ4686 emission was later classified as a WR galaxy (Kunth & Joubert 1985 and references in Sect. 3). From the four emission line galaxies with narrow He II λ4686 emission listed by Conti (1991, his Table 2) three are now classified as WR galaxies (see Table 1); the presence of a broad He II λ4686 component due to WR stars is suspected in the Seyfert 2 galaxy Pox 52 (Kunth et al. 1987).

From the 12 objects of Campbell et al. (1986) for which a measurement is available, six remain in this category, although two additional objects are suspected to show broad He II. In the other objects from Campbell et al., WR features have been found by other investigators (see Sect. 3), in part also in re-analysis of the same observational data (e.g. Masegosa et al. 1991).

From the sample of Izotov and collaborators (including 60 objects published up to 1998, i.e. including Izotov & Thuan 1998), 40 show nebular He II. However only 9 objects (listed in Table 2) reveal no broad 4686 component according to these studies and the reanalysis of Guseva et al. (1998).

6. Suspected WR galaxies and galaxies without He II λ4686

6.1. Suspected WR galaxies

Candidate WR galaxies resulting from some of the searches discussed in Sect. 2 or found loosely in the literature are listed in Table 3. The reader is referred to the original papers for the justification of the possible presence of WR stars.

Most of the suspected WR galaxies come from the spectrophotometric catalogue of HII galaxies of Terlevich et al. (1991), following the analysis of Masegosa et al. (1991) or Pindao et al. (1999) which also includes new objects. As stated earlier, from Masegosa et al. (1991) we take the subset of objects included in their Table 1 but not in Table 2 as candidates. Although partly based on the same observations the analysis of Masegosa et al. (1991) and Pindao et al. (1999) do not always yield the same candidates. We have retained all objects classified as "candidate" by either one of these studies. New observations will be necessary to establish the definite presence or absence of WR features.

Few objects from Vacca & Conti (1992) have only an upper limit on broad He II λ4686. For most of them independent observations are now available. Otherwise these objects are retained as suspected WR galaxies.

In some studies of IUE spectra strong UV P-Cygni lines of N and C (N V λ1240, C IV λ1550) have been interpreted as signatures of WR stars in theses objects (e.g. Durret et al. 1985; Lamb et al. 1990). However, these lines are also strong in O stars and hence cannot be used as a clear diagnostic for WR stars (cf. Leitherer et al. 1995). Therefore, objects suspected on these grounds have not been included in Table 3.

In rare cases, WR stars have also been suspected on indirect grounds (e.g. M100: Wozniak et al. 1998).

Interestingly, a broad WR bump is suggested to be present in the optical spectrum of two distant central cluster galaxies with strong cooling flows (Abell 1068 and 1835; Allen 1995). The recent study of Contini et al. (1998), however, casts serious doubt about the reality of a broad feature in Abell 1835. If true, these objects with redshifts $z \sim 0.14$ and 0.25 respectively, represent the most distant objects known to date where WR stars have been detected from (rest-frame) optical spectra. High redshift galaxies ($z \sim 3$) may, however, also show WR signatures (see Sect. 7).

6.2. Emission line galaxies without HeII

Conti (1991, his Table 3) lists a sample of emission line galaxies which have properties similar to WR galaxies, and where a search for He II λ4686 emission (broad or narrow) has been made with negative results. For obvious reasons such a list is necessarily incomplete and the inclusion in such a list also strongly depends on the sensitivity (S/N, resolution etc.) of the data. We therefore renounce on such a compilation. However, few updates are appropriate on some objects from Table 3 of Conti (1991).

Mrk 1087 — While Vacca & Conti (1992) provide only an upper limit on He II λ4686, a detection is provided in the recent spectra of Vaceli et al. (1997). No information on the width of this line is given. Retained as suspected WR galaxy.

Mrk 1094 — We have retained the criteria of Kunth & Joubert (1985) and hence included this object in Table 1. No new observations published.

0833+652 = IRAS 08339+6517 — From their spectrum Veilleux et al. conclude that no WR features are present in this galaxy (=0833+652 in Conti 1991).

Tol 2 = Tol 0957 – 278 — Same comment as for Mrk 1094.

Tol 9 = Tol 1032 – 283 — Although no broad He II λ4686 feature seems present in this object (Kunth & Schild 1986) we list in the category of suspected WR galaxies based on the possible detection of other broad features shortward of 5876 Å (Kunth & Schild 1986).

Other objects for which an upper limit on broad WR features is given or where a non-detection is signaled are found in publications issued from the systematic searches discussed in Sect. 2.

7. Discussion and conclusion

We have presented an up-to-date and presumably quite complete compilation of WR galaxies from the literature. The number of such objects has considerably increased in the last years and now totals 139 (Table 1). In addition to *broad* He II λ4686, the basic "classification line" for WR galaxies, we include, for the first time, relevant information about the presence of various other broad emission lines. In particular the presence of C IV λ5808 emission originating essentially from WC stars is now detected in many objects.

A large fraction of WR galaxies also show *nebular* He II λ4686 emission, indicative of high excitation. Where available we also include information about this line. Conversely, few objects are known which show *only nebular* He II emission, i.e. no apparent signs of broad stellar emission features. A list of these extra-galactic HII regions is provided in Table 2. This may in particular be used to investigate the possible link between the phenomenon of high excitation and the presence of WR stars as suggested e.g. by Schaerer (1996).

We have also compiled a list of objects suspected to harbour WR stars (Table 3). This could serve for future follow-up spectroscopy.

Most of the work on WR galaxies and related objects discussed above is based on spectroscopy in the visible. *Are populations of WR stars also detectable at other wavelengths?*

In the infrared no direct signature of WR populations have been detected to the best of our knowledge. The most likely explanations are that *1)* many strong features of WR stars coincide with strong nebular lines (e.g. He I 2.06 μm, Brγ), and *2)* WR features in the IR are strongly diluted by cool stars, which contribute the bulk of the emission at these wavelengths.

The strongest indicator of WR stars in UV is the presence of broad He II λ1640 emission which is not seen in emission in other stars. Predictions of its strength and the expected line profile for integrated populations are given by Leitherer et al. (1995) and Schaerer & Vacca (1998). The use of this line is, however, not straightforward for several reasons. Potential difficulties specific to IUE spectra have been discussed by Leitherer et al. (1995). He II λ1640 is detected in the average spectra of $\sim$ 20 starbursts (including several WR galaxies) of low and high metallicity of Heckman et al. (1998). In particular the spectra illustrate also the presence of multiple stellar and interstellar absorption lines in this wavelength range, which complicates the quantitative use of this line for diagnostics.

UV high resolution and high S/N spectra obtained with HST indeed show the presence of this emission line in known WR galaxies (e.g. NGC 4214, NGC 1741; Conti et al. 1996; Leitherer et al. 1996). Interestingly these objects show a close resemblance with recently discovered high redshift galaxies (cf. Steidel et al. 1996; Ebbels et al. 1996; Lowenthal et al. 1997). In addition to the strongest stellar UV lines (Si IV, C IV wind lines) the average spectrum of Lowenthal et al. of 11 objects with $z \sim 3$ also shows the He II λ1640 emission line! Quantitative studies of stellar populations including possibly WR stars should be possible in the future using these lines.

The numerous recent findings of massive stars in Seyfert 2 and LINERs, as well as detections of high redshift galaxies exhibiting signatures of massive stars further stress the need to deepen our understanding of the physical processes in "local objects", and illustrate the interest of studies on massive stars and their interactions with the ISM, stellar populations, and starbursts in a wider context. It is the hope that our compilation will provide a useful basis for such undertakings.

Acknowledgements. We thank Rosa González-Delgado, Daniel Kunth, Cristal Martin, and Bill Vacca for useful communications and discussions, and Peter Conti, Daniel Kunth, Claus Leitherer and Yuri Izotov for comments on an earlier version of the manuscript. Yuri Izotov, Benoit Joguet, Bill Vacca, and Donna Weistrop, kindly provided results before publication. Some comments and corrections were made during the IAU Symposium 193 by several colleagues. We thank them here for their help. This research has made extensive use of the NASA Extragalactic Database (NED), the NASA Astrophysics Data System (ADS) Article Service, and SIMBAD, which is operated by the CDS in Strasbourg, France. DS acknowledges a grant from the Swiss National Foundation of Scientific Research.

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