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A catalogue of symbiotic stars

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Abstract. We present a new catalogue of symbiotic stars. In our list we include 188 symbiotic stars as well as 30 objects suspected of being symbiotic. For each star, we present basic observational material: coordinates, V and K magnitudes, ultraviolet (UV), infrared (IR), X-ray and radio observations. We also list the spectral type of the cool component, the maximum ionization potential observed, references to finding charts, spectra, classifications and recent papers discussing the physical parameters and nature of each object. Moreover, we present the orbital photometric ephemerides and orbital elements of known symbiotic binaries, pulsational periods for symbiotic Miras, Hipparcos parallaxes and information about outbursts and flickering.

Key words: catalogues — stars: binaries: symbiotic — stars: fundamental parameters

1. Introduction

Symbiotic stars are interacting binaries, in which an evolved giant transfers material to much hotter, compact companion. In a typical configuration, a symbiotic binary comprises a red giant transferring material to a white dwarf via a stellar wind. Amongst the evidence for this predominant mass-transfer mechanism is the fact that ellipsoidal light variations, characteristic of tidally distorted stars, are rarely observed for symbiotic stars. Thus far, only four systems, T CrB ([31]), CI Cyg ([199]), EG And ([318]) and BD−21 3873 ([291]), are known to have the ellipsoidal light variations of a distorted giant. In some symbiotic systems, the red giant is replaced by a yellow giant, and the white dwarf by a main-sequence or neutron star.

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Most symbiotic stars (∼ 80%) contain a normal giant star and these, based on their near-IR colours (showing the presence of stellar photospheres, $T_{\rm eff} \sim 3000-4000$ K), are classified as S-type systems (*stellar*). The remainder contain Mira variables and their near-IR colours indicate the combination of a reddened Mira and dust with temperature of ∼ 1000 K, giving away the presence of warm dust shells; these are classified as D-type systems (*dusty*). The distinction between S and D types seems to be one of orbital separation: the binary must have enough room for the red giant/Mira variable, and yet allow it to transfer sufficient mass to its companion. In fact, all symbiotic systems with known orbital periods (of the order of a few years) belong to the S-type, while the orbital periods for D-type systems are generally unknown presumably longer than periods covered by existing observations. Although there may well be binaries consisting of normal giants and white dwarfs with very large orbital separations, however they will be never recognized as symbiotic systems because there would be no interaction giving rise to a symbiotic appearance (see next section). For a detailed review of symbiotic stars, we refer the reader to [195].

Two catalogues of symbiotic stars have been published. The first was by David Allen in 1984 ([18]); it included 129 symbiotic stars and 15 possible symbiotic objects with a concise summary of available observational data, finding charts and optical spectra for most of listed objects. The second catalogue was by Scott Kenyon in 1986 [137]; it included 133 symbiotic stars and 20 possible symbiotic objects, as well as tables describing selected observational properties of all the objects and a spectroscopic summary of a selected sample. Kenyon's work also provides the reader with an excellent overview and bibliography of selected symbiotic stars.

Since 1986, a number of papers have presented surveys of large samples of symbiotic stars, e.g. [198, 237] (optical spectra), [303, 111] (emission line profiles and radial velocity measurements) [233] (optical and IR photometry), [142, 315] (IRAS observations), [280, 279, 278, 112, 117] (radio emission), [116, 274] (searches for maser emission), [187] (IUE observations), [35, 238] (X-ray emission), [312] (symbiotic miras), [235] (symbiotic novae), [236, 215] (extragalactic symbiotics) and in-depth investigations, e.g. [109, 205, 110, 287, 83] for AX Per alone. New stars have been included in the family of symbiotic stars each year and, at the same time, better data have been collected and better data analysis has been performed for a number of well-known symbiotic stars. The aim of this work is to present the symbiotic star research community with a comprehensive compilation of existing data collected from a number of astronomical journals, electronic databases and unpublished data resources. For many objects a new classification has been necessary: some have been confirmed as symbiotic stars; some have been rejected; some new objects have been added. Our catalogue lists 188 symbiotic stars and 30 objects suspected of being symbiotic stars.

2. Classification criteria

The optical spectra of symbiotic stars are characterized by the presence of absorption features and continuum, as appropriate for a late-type M giant (often a Mira or semi-regular, SR, variable), and strong nebular emission lines of Balmer H I, He II and forbidden lines of [O III], [Ne III], [Ne V] and [Fe VII]. Some symbiotics – the yellow symbiotic stars – contain K (or even G) giants or bright giants. The spectra of many symbiotic systems also show two broad emission features at $\lambda\,6825$ Å and $\lambda\,7082$ Å. These features have never been observed in any other astrophysical objects — only symbiotic stars with high-excitation nebulae. For many years there was no plausible identification for these lines, but [262] pointed out that the $\lambda\lambda$ 6825, 7082 lines are due to Raman scattering of the O VI $\lambda\lambda$ 1032, 1038 resonance lines by neutral hydrogen.

To classify an object as symbiotic star we adopted the following criteria:

1. The presence of the absorption features of a *late-type giant*; in practice, these include (amongst others) TiO, H_2O, CO, CN and VO bands, as well as Ca I, Ca II, Fe I and Na I absorption lines;
2. The presence of strong emission lines of H I and He I and either
   - emission lines of ions with an ionization potential of at least 35 eV (e.g. [O III]), or
   - an A- or F-type continuum with additional shell absorption lines from H I, He I, and singly-ionized metals.

   The latter corresponds to the appearance of a symbiotic star in outburst;
3. The presence of the λ 6825 emission feature, even if no features of the cool star (e.g. TiO bands) are found.

Our adopted criteria represent a compromise: a collection of the classification criteria proposed in the past 70 years (see Kenyon 1986 for details), based on the examples of well-studied and widely accepted symbiotic objects. We believe that such an approach is appropriate, especially given that symbiotic stars are variables with timescales often exceeding a dozen years and that — as Kenyon very sensibly noted — "every known symbiotic star has, at one time or another, violated *all* the classification criteria invented". For those who would prefer additional or different definitions, we give the highest ionization potential ever observed in the optical and UV (for objects that have been observed at least once with the *International Ultraviolet Explorer — IUE*). We also comment on all objects for which our classification may not seem obvious (e.g. V934 Her, which some readers may consider to be symbiotic, but which in our catalogue is classified as a suspected symbiotic star).

3. The catalogue

The main catalogue is presented in Table 1. This table includes collated data for all the symbiotic stars we know of. Note that a colon indicates an uncertain measurement or an estimate. Stars are ordered by right ascension (RA) for the equinox J2000.0. The content of each column is described below.

1: Symbiotic star catalogue number. A star symbol, if present here, means that there is a classification note and/or comment for the given object. We would still advise the use of the symbiotic (or suspected symbiotic) star name, as given in the second column of Tables 1 and 2, and not the object's catalogue number.

2: Symbiotic star name. If, for a given object, a variable star name exists, then it was chosen; otherwise, the name used most often in the literature was adopted.

3,4: RA and declination (J2000.0), taken from radio VLA positions ([117, 280, 281]) if available, and if not from the SIMBAD database but corrected in a few cases were obvious mistakes have been spotted. If position was taken from somewhere else then comment is given in Sect. 4.

5,6: Galactic coordinates (not included for extragalactic objects).

7,8: Magnitudes in the V and K filters, respectively. As most (if not all) symbiotics are variable, these values are arbitrary (usually the average of published measurements) just to give the general level of an object's brightness.

9: IR type. If two IR types are given for one object, we supply references to both estimates in the notes.

10: Information on whether an *IUE* spectrum (or spectra) is (are) available (+) or not (−). The number of spectra can be readily obtained from SIMBAD (http://simbad.u-strasbg.fr/Simbad) and the spectra can be obtained from the *IUE* data archives (http://nssdca.gsfc.nasa.gov/ndads).

11: Information about whether an object was ever detected in X-rays. Plus (+) means a detection; minus (−) means that an object was observed but not detected and that only an upper limit is available. Most of the detections and upper limits came from *ROSAT* and were reported in [35] but some have also been observed by *Einstein* [15], *EXOSAT* and *ASCA*.

12: Highest ionization potential ever observed in the emission-line spectra of an object. The potential is given in electron volts (eV).

13: The symbiotic star catalogue number (repeated).

14: An estimate of the spectral type of the cool component, with references. Since the blue and visual spectral regions are often contaminated by the circumstellar nebula and/or the hot component, we have given priority to estimates made in the near-IR region and, in the case of multiple estimates, to those made at quiescence and/or near to inferior conjunction of the cool giant. The estimates based on the TiO bands are separated from those based on CO 2.3-μm bands by "/". Also, if the cool component was reported to behave as a Mira (i.e. if Mira-like pulsations have been detected or the object's position in the near-IR/*IRAS* colour diagram coincides with the region occupied by Mira variables [141, 313]) then it is noted in this column.

15: Radio observations of symbiotics. Detections or upper limits are given. In parentheses, the wavelength of observation is reported. If more than one detection has been reported, only one is included and the priority is given to the most extensive radio survey of symbiotics at 3.6 cm [279]. Other extensive surveys of symbiotic stars which were searched for radio detection include [280, 319, 281, 112, 117].

16,17: *IRAS* fluxes at 12 and 25 μm. The fluxes are taken from pointed observations, if available, [142] or from survey observations as listed in SIMBAD. If, for some object, there was no report of observations in either of the above two sources, but *IRAS* fluxes were available from somewhere else, then the reference to reported observations is given in the notes. The upper limits are marked with capital L. The *IRAS* number is listed in Table 8 (which contains different object names for the symbiotic and suspected symbiotic stars). If the number is not there then the reference to the reported observations is given in the section containing comments.

18: Major literature references to the object. A number indicates the reference number; abbreviations in parentheses mark the subject the reference was noted for: fc – finding chart, spc – optical spectrum, class – classification, parm – the latest or the most extensive and up-to-date discussion of an object.

In Table 2, we present data for objects suspected of being symbiotic stars. The order and content of the columns is exactly the same as in Table 1. The catalogue numbers of suspected symbiotic stars are preceded by the letter "s" throughout the catalogue.

The next two tables include data on symbiotic and suspected symbiotic star orbits. In Table 3, we have put orbital photometric ephemerides, including information on the presence of eclipses if available, and references to every ephemeris estimate. In Table 4, the reader will find the orbital elements of twenty symbiotic stars as well as spectroscopic periods, radial velocity semi-amplitudes for the cool components, mass ratios, systemic velocities, eccentricities, times of inferior spectroscopic conjunctions of the giant, sizes of the giant orbits, mass functions and references to each orbital estimate.

In Table 5, we have collected the pulsation ephemerides for Miras in symbiotic and suspected symbiotic stars. Again, a reference to every estimate is given.

Table 6 includes known Hipparcos parallaxes for symbiotic stars, however for most objects uncertainities are very high and parallax estimations may not be significant.

Table 7 includes information on symbiotic and suspected symbiotic star flickering and outburst characteristics.

Table 8 includes most of different names for symbiotic and suspected symbiotic stars. Symbiotic stars appear first, then suspected symbiotic stars follow. Objects are first listed by their catalogue number, then by the name (translated to SIMBAD nomenclature, if possible — the name by which the object is known in Tables 1 or 2), then other names are given. The names are compatible with SIMBAD and general internet database nomenclature. In some cases, the catalogue name differs between Table 1 (or 2) and Table 8. This discrepancy is due the most commonly accepted name (Tables 1 or 2) *not* following SIMBAD nomenclature (Table 8).

Table 1. Symbiotic star

No.	Name	$\alpha(2000)$ h m s	$\delta(2000)$ ° ′ ″	l^{II} °	b^{II} °	V [mag]	K [mag]	IR	*IUE*	X	$\mathrm{IP}_{\max}$ [eV]
001	SMC1	00 29 10.9	−74 57 38.9			16.2		S:	+		114
002	SMC2	00 42 48.1	−74 42 00.0			16.2		S:	+	−	114
003	EG And	00 44 37.1	+40 40 45.7	121.54	−22.17	7.1	2.6	S	+	+	100
004⋆	SMC3	00 48 19.9	−73 31 54.9			15.5:		S:	+	+	235
005⋆	SMC N60	00 57 12.0	−74 13 00.0			16.8	13.0	S,D	+	−	114
006	LIN 358	00 59 24.0	−75 04 59.9			15.2	11.4	S	+	+	114
007	SMC N73	01 04 42.0	−75 48 00.0			15.5	11.6	S	+	−	114
008⋆	AX Per	01 36 22.7	+54 15 02.5	129.53	−8.04	10.9	5.5	S	+	−	109.3
009⋆	V471 Per	01 58 49.6	+52 53 48.9	133.12	−8.64	13.0	9.8	D’	+	−	77.5
010⋆	o Ceti	02 19 20.7	−02 58 39.5	167.76	−57.98	6.0	−2.7		+	+	54.4
011⋆	BD Cam	03 42 09.3	+63 13 00.5	140.84	+6.44	5.1	0.2		+		77.5
012	S32	04 37 45.0	−01 19 05.9	197.48	−30.04	13.5		S	+	+	114
013	LMC S154	04 51 50.2	−75 03 36.0			15.7	10.1	D	+	−	114
014	LMC S147	04 54 04.6	−70 59 34.0			16.0	11.9	S	+		114
015	LMC N19	05 03 24.0	−67 56 35.0			16.4				−	114
016⋆	UV Aur	05 21 48.8	+32 30 43.1	174.22	−2.35	8.5	2.1	S	+	−	41.0
017⋆	V1261 Ori	05 22 18.6	−08 39 58.0	210.63	−23.72	6.8	2.1		+	+	77.5
018⋆	LMC1	05 25 01.0	−62 28 46.9			15.9	9.9	D	+		97.1
019	LMC N67	05 36 02.8	−64 43 23.9			15.9	11.4	S	+	−	77.5
020⋆	Sanduleak’s star	05 45 19.6	−71 16 09.9			16.9	13.0	D:	+	−	114
021	LMC S63	05 48 44.1	−67 36 12.9			15.2	11.3	S	+	+	97.1
022	SMP LMC 94	05 54 10.3	−73 02 39.0						+		114
023⋆	BX Mon	07 25 24.0	−03 36 00.0	220.04	+5.88	11.7	5.7	S	+	−	54.4
024⋆	V694 Mon	07 25 51.2	−07 44 08.0	223.76	+4.05	9.5	5.1	S	+	−	24.6
025	WRAY 15−157	08 06 34.8	−28 31 57.0	246.60	+1.95	13.2	9.4	D’		−	54.4
026⋆	RX Pup	08 14 12.3	−41 42 29.0	258.50	−3.93	11.5	2.8	D	+	+	114
027⋆	Hen 3−160	08 24 52.8	−51 28 36.0	267.68	−7.87	15.4	7.5	S		−	114
028⋆	AS 201	08 31 42.9	−27 45 32.0	249.08	+6.97	11.8	9.9	D’	+	−	54.4
029⋆	KM Vel	09 41 14.0	−49 22 47.0	274.19	+2.58	15.0	5.7	D		−	41.0
030	V366 Car	09 54 43.3	−57 18 52.4	280.81	−2.24	13.0	4.7	D	+	−	114
031	Hen 3−461	10 39 08.5	−51 24 11.9	282.90	+6.25	12.3	3.9	S		−	100
032⋆	SS73 29	11 08 27.4	−65 47 17.9	292.63	−5.00	14.1	10.6	S	+	−	100
033⋆	SY Mus	11 32 05.5	−65 25 08.0	294.80	−3.81	10.9	4.7	S	+	−	114
034⋆	BI Cru	12 23 26.0	−62 38 16.0	299.72	+0.06	11.1	5.0	D	+	−	75.5
035	RT Cru	12 34 54.0	−64 33 54.0	301.16	−1.75	12.6					54.4
036⋆	TX CVn	12 44 42.0	+36 45 50.6	130.93	+80.26	9.5	6.3	S	+	−	13.6
037	Hen 2−87	12 45 20.1	−63 00 39.9	302.24	−0.15	15.5	6.0	S		−	114
038⋆	Hen 3−828	12 50 58.0	−57 50 47.0	302.87	+5.03	13.4	7.1	S		−	100
039	SS73 38	12 51 26.2	−64 59 58.1	302.93	−2.13	14.5	6.1	D			108.8
040	Hen 3−863	13 07 43.8	−48 00 23.0	305.75	+14.78	11.8	8.5	S		−	54.4
041⋆	St 2−22	13 14 30.0	−58 51 47.9	305.92	+3.87		8.5	S		−	114
042	CD−36 8436	13 16 01.6	−37 00 11.9	308.37	+25.61	11.2	5.7	S		−	54.4
043⋆	V840 Cen	13 20 46.9	−55 50 35.9	307.07	+6.79	14.1	10.8				54.4
044	Hen 3−905	13 30 37.2	−57 58 18.0	308.12	+4.50	13.4	8.5	S			114
045	RW Hya	13 34 17.8	−25 22 52.1	314.99	+36.49	8.9	4.7	S	+	−	77.5
046⋆	Hen 3−916	13 35 28.9	−64 45 45.0	307.61	−2.29	12.9	7.8	S		−	114
047⋆	V704 Cen	13 54 56.2	−58 27 16.9	311.17	+3.40	13.5	8.4	D		−	54.4
048⋆	V852 Cen	14 11 52.1	−51 26 23.8	315.48	+9.46	14.0	6.9	D	+	−	100
049	V835 Cen	14 14 09.4	−63 25 46.1	312.03	−2.03	12.9	5.0	D	+	−	114
050⋆	V417 Cen	14 15 55.9	−61 53 53.9	312.71	−0.64	12.2		D’			35.1

Table 1. continued

No.	Cool-star spectrum	Radio [mJy]	*IRAS* F_{12}[Jy]	*IRAS* F_{25}[Jy]	References
001	C3.2:,C(236, 215)				215(fc,spc,class) 236(parm)
002	K,G-K(236, 215)				215(fc,spc,class) 236(parm)
003	M3(237)	0.54(3.6 cm)	4.5	1.25	18(fc,class) 137(spc) 318(parm)
004	M0,K-M(215, 236)				215(fc,spc,class) 122(parm)
005	C3.3(236)				18(fc,class) 236(spc,parm)
006	mid K(236)				18(fc,class) 236(spc,parm)
007	K7(236)				18(fc,class) 236(spc,parm)
008	M6(237)	0.58(3.6 cm)	0.32	0.10	18(fc,class) 205, 110(spc,parm)
009	G5(237)	0.45(3.6 cm)	1.6	2.7	18(fc,class) 36(spc,parm)
010	Mira,M2-7(313, 132)		4881	2261	320(spc) 132(parm) 1(class)
011	M3,S5.3(5, 135)	0.18(3.6 cm)	40.95	10.82	135(spc) 5(parm) 1(class)
012	C1.1CH(263)				96(fc) 67(class) 263(spc) 266(parm)
013	C2.2(236)				252(fc) 236(class,spc,parm)
014	M1,K5(236, 217)				217(fc,spc,class) 236(parm)
015	M4(216)				38(fc) 216(class,spc,parm)
016	Mira C8.1Je(242)	<0.34(3.6 cm)	65	21	18(fc,spc,class) 251(parm)
017	S4.1,M3(127, 7)	<0.1(3.6 cm)	7.98	2.01	1(class) 127(parm)
018	C4.3,C(236, 215)				215(fc,spc,class) 236(parm)
019	C3.2,C(236, 54)				97(fc) 54(spc,class) 236(parm)
020					18(fc) 1(class) 236(spc,parm)
021	C2.1J(236)				18(fc,class) 236(spc,parm)
022	M(160)				161(fc) 185(spc,class)
023	M5(237)	<0.07(3.6 cm)	0.32	0.09L	18(fc,class,spc) 71(parm)
024	M6(237)		0.84	0.36:	1(class) 243(spc,parm)
025	G5(237)	0.34(3.6 cm)	1.0	1.3	18(fc,class,spc)
026	Mira M5.5/M5(237, 14)	12.6÷69.7(3.6 cm)	220	132	18(fc,class) 202(spc,parm)
027	M7(237, 14)	<17(6 cm)	0.12	0.03L	18(fc,class,spc)
028	G5(237)	0.69(3.6 cm)	1.1	2.8	18(fc,class,spc) 273(parm)
029	Mira,M(313, 4)	1.49(3.5 cm)	11.84	7.81	64, 307(spc) 1(class) 75(parm)
030	Mira M6(237)	1.73(3.5 cm)	9.5	4.3	18(fc,class,spc) 198(spc,parm)
031	M6(237)		2.02	0.61	18(fc) 245(spc,class)
032	G/K(16,225)	<16(6 cm)	0.07	0.11L	18(fc,class,spc) 225(parm)
033	M5(237)	<12(6 cm)	1.00	0.40	18(fc,class,spc) 270(parm)
034	Mira M0-1(271)	5.11(3.5 cm)	18.3	15.5	18(fc,class,spc) 254(spc) 88(parm)
035	M4-5(48)				48(spc,class,parm)
036	early M,K5.3(138, 141)	<0.06(3.6 cm)	1.10	0.38	137(spc,class) 143(parm)
037	M5.5/M7.5(237, 14)	<12(6 cm)	0.40	1.2L	18(fc,class,spc) 198(spc,parm)
038	M6(237, 14)	<16(6 cm)	0.11	0.06	18(fc,class) 182(spc,parm)
039	Mira C9(272)	5.12(3.5 cm)	7.4	3.1	18(fc,class,spc)
040	K4:(14)	<12(6 cm)			18(fc,class,spc)
041	M4.5(237)				18(fc,class,spc) 198(spc,parm)
042	M5.5(237)	<0.24(6 cm)	0.40	0.25L	18(fc) 180(spc,class,parm)
043	K5(70)		0.03L	0.22L	184(fc) 70(spc,class,parm)
044	M3(237)	<13(6 cm)			18(fc,class) 182(spc,parm)
045	M2(237)	0.60(3.6 cm)	0.83	0.36	18(fc,class,spc) 259(parm)
046	M5/M6(237, 14)	<20(6 cm)			18, 90(fc) 18(class,spc)
047	M6.5(237)		1.43	1.16	18(fc) 245(spc) 180(class,parm)
048	Mira(313)	3.31(3.5 cm)	8.8	9.2	18(fc,spc) 1(class) 60(parm)
049	Mira ≥M5(271)	5.79(3.5 cm)	32.6	24.3	18(fc,class,spc) 179(parm)
050	G8-K2,G2(50, 304)		12.61	10.60	48(spc,class) 304(parm)

Table 1. continued

No.	Name	α(2000) h m s	δ(2000) ° ′ ″	l^{II} °	b^{II} °	V [mag]	K [mag]	IR	*IUE*	X	IP_{max} [eV]
051	BD−21 3873	14 16 34.3	−21 45 50.2	327.88	+36.95	10.7	7.2	S	+	−	77.5
052	Hen 2−127	15 24 49.8	−51 49 52.6	325.53	+4.19	16.0	8.1	D		−	114
053	Hen 3−1092	15 47 10.6	−66 29 16.0	319.22	−9.35	13.5	7.8	S	+	−	114
054	Hen 3−1103	15 48 28.5	−44 19 00.9	333.21	+7.90	13.0	8.4	S		−	114
055⋆	HD 330036	15 51 15.9	−48 44 58.5	330.78	+4.15	11.0	7.6	D’	+	−	77.5
056⋆	Hen 2−139	15 54 45.4	−55 29 36.9	326.91	−1.40	16.8	5.9	D		−	35.1
057	T CrB	15 59 30.1	+25 55 12.6	42.37	+48.16	10.1	4.8	S	+	+	77.5
058⋆	AG Dra	16 01 40.5	+66 48 09.5	100.29	+40.97	9.1	6.2	S	+	+	114
059	WRAY 16−202	16 06 56.8	−49 26 39.0	332.28	+1.96		6.8	S		−	114
060⋆	V347 Nor	16 14 00.3	−56 59 26.0	327.92	−4.30	16.6	5.0	D	+	−	54.4
061	UKS Ce−1	16 15 29.2	−22 12 15.9	353.02	+20.25	15.0	11.3	S		−	54.4
062	QS Nor	16 21 07.9	−42 23 53.9	338.94	+5.36	13.3	8.1	S		−	35.1
063	WRAY 15−1470	16 23 21.6	−27 40 13.0	350.06	+15.24	12.9	7.8	S		−	54.4
064	Hen 2−171	16 34 03.9	−35 05 32.8	346.03	+8.55	14.8	6.7	D	+	−	235
065⋆	Hen 3−1213	16 35 15.3	−51 42 24.0	333.87	−2.81	10.4	6.7	S	+	−	97.1
066⋆	Hen 2−173	16 36 24.1	−39 51 52.4	342.77	+5.01	13.8	6.8	S		−	54.4
067⋆	Hen 2−176	16 41 31.2	−45 13 04.7	339.39	+0.74	15	5.7	S,D		−	114
068⋆	KX TrA	16 44 35.2	−62 37 14.0	326.41	−10.94	12.4	6.0	S	+	−	114
069	AS 210	16 51 20.4	−26 00 27.1	355.51	+11.55	12.2	6.5	D	+	−	114
070	HK Sco	16 54 39.0	−30 23 30.0	352.48	+8.27	13.5	7.9	S	+	−	114
071⋆	CL Sco	16 54 51.9	−30 37 18.0	352.32	+8.09	13.3	7.9	S	+	−	54.9
072	MaC 1−3	17 01 27.9	−47 45 33.9	339.62	−3.52	18.2		D		−	114
073⋆	V455 Sco	17 07 21.5	−34 05 21.0	351.17	+3.90	13.7	5.9	S		−	114
074⋆	Hen 3−1341	17 08 36.6	−17 26 30.0	5.02	+13.39	12.5	7.6	S	+	−	114
075	Hen 3−1342	17 08 55.0	−23 23 35.0	0.08	+9.92	12.7	8.5	S		−	114
076	AS 221	17 12 02.2	−32 34 24.9	352.98	+4.00	12.0	7.6	S		−	114
077⋆	H 2−5	17 15 19.0	−31 34 05.9	354.20	+4.02		5.5	S,D		−	114
078	Sa 3−43	17 17 55.9	−30 01 48.0	355.79	+4.45		7.9	S		−	54.4
079	Draco C−1	17 19 57.6	+57 50 04.9			17.0	11.4		+	+	77.5
080	Th 3−7	17 21 02.4	−29 22 59.4	356.70	+4.27	14.0	8.1	S		−	114
081	Th 3−17	17 27 31.9	−29 02 53.0	357.78	+3.27	14.0	8.2	S		−	54.4
082	Th 3−18	17 28 27.0	−28 38 34.0	358.23	+3.33	12.6	8.2	S		−	114
083	Hen 3−1410	17 29 06.0	−29 43 24.1	357.41	+2.61	12.8	8.5	S		−	114
084⋆	V2116 Oph	17 32 03.0	−24 44 44.3	1.94	+4.79	19.0	8.1	S		+	235
085	Th 3−29	17 32 28.0	−29 05 06.0	358.34	+2.35	17.0	7.0	S		−	35.1
086	Th 3−30	17 33 43.0	−28 07 18.0	359.30	+2.65	13.1	8.3	S		−	114
087	Th 3−31	17 34 26.5	−29 28 05.0	358.25	+1.78	13.6	7.6	S		−	114
088⋆	M 1−21	17 34 17.2	−19 09 21.9	6.96	+7.36	13.7	7.2	S		−	114
089⋆	Hen 2−251	17 35 22.3	−29 45 20.0	358.12	+1.46	15.4	7.3	D		−	114
090	Pt 1	17 38 49.8	−23 54 02.9	3.48	+3.94	15.0	8.6	S		−	114
091	K 6−6	17 39 18.3	−28 15 06.9	359.85	+1.54	16.5		S		−	114
092⋆	RT Ser	17 39 51.8	−11 56 44.7	13.89	+9.97	15.0	7.0	S	+	−	114
093⋆	AE Ara	17 41 04.9	−47 03 20.9	344.00	−8.66	12.5	6.4	S	+	−	77.5
094⋆	SS73 96	17 41 28.3	−36 47 51.9	352.85	−3.38	15.2	6.4	S		−	100
095	UU Ser	17 42 37.9	−15 24 29.9	11.23	+7.62	15.3	9.1	S		−	114
096⋆	V2110 Oph	17 43 33.3	−22 45 37.0	5.03	+3.62	19	7.9	D		−	114
097	V916 Sco	17 43 54.9	−36 03 24.9	353.73	−3.41		8.3	S		−	54.4
098	Hen 2−275	17 45 31.0	−38 39 47.9	351.67	−5.03	15.5	>9.3	S		−	114
099	V917 Sco	17 48 04.0	−36 08 17.9	354.10	−4.17	13.0	7.9	S		−	114
100⋆	H 1−36	17 49 48.1	−37 01 27.9	353.51	−4.92	12.0	7.5	D	+	+	114

Table 1. continued

No.	Cool-star spectrum	Radio [mJy]	*IRAS* F_{12}[Jy]	*IRAS* F_{25}[Jy]	References
051	K2(237)	<0.22(3.6 cm)			18(fc,class,spc) 291(parm)
052	Mira M5/M7(237, 14)	0.70(3.5 cm)	0.5	0.3	18(fc,class,spc) 198(spc,parm)
053	M5.5(237)	10(6 cm)			18(fc,class,spc) 198(spc,parm)
054	M3.5/M0(237, 14)	<1(2 cm)			18(fc,class) 182(spc,parm)
055	G5(237)	34(2 cm)	20.0	37.4	18(fc,spc) 1(class) 266(parm)
056	Mira,M6.5(237)		4.9	2.8	18(fc,class,spc)
057	M4.5(237)	<0.08(3.6 cm)	0.68	0.20	18(fc,class) 285(spc) 31(parm)
058	K2(237)	0.48(6 cm)	0.25	0.09	18(fc,class) 36(spc) 209(parm)
059	M6(237)				18(fc,class)
060	Mira M7/M8.5(237, 14)	<12(6 cm)	5.3	2.9	18(fc,class,spc) 198(spc,parm)
061	C4.5Jch(263)	<0.07(3.6 cm)			18(fc,spc,class) 263(parm)
062	mid M(174)				248(fc) 198(class,spc,parm) 245(parm)
063	M3,M6(237, 186)	<0.07(3.6 cm)			18(fc,class,spc)
064	Mira M6.5,M6(237, 186)	3.39(3.6 cm)	7.7	4.5	18(fc,class,spc) 131(parm)
065	M2/K4(256, 14)	<12(6 cm)			18(fc,class) 182(spc,parm)
066	M4.5,M7(237, 186)	0.21(3.6 cm)	0.20	0.05L	18(fc,class,spc) 198(spc,parm)
067	Mira(312);M4/M7(237, 14)	4.05(3.6 cm)	2.3	3.6	18(fc,class,spc)
068	M6(237)	<22(6 cm)	0.35	0.17	69(fc) 18(class) 182(spc) 77(parm)
069	Mira; C3(186)	4.56(3.6 cm)	4.0	1.2	18(fc,class,spc) 266(parm)
070	M3.5(237)	<0.07(3.6 cm)			18(fc,class,spc)
071	M5(237)	0.34(3.6 cm)	0.04L	0.18L	18(fc,class,spc) 192(parm)
072	M2(198)				173(fc) 198(spc,class,parm)
073	M6.5,M6(237, 186)	1.99(3.6 cm)	1.50	1.00	18(fc,class,spc) 198(spc,parm)
074	M4/M0(237, 14)	1.04(3.6 cm)			18(fc,class,spc) 183(parm)
075	M0(237)	<0.08(3.6 cm)			18(fc,class,spc)
076	M7.5(237)	0.16(3.6 cm)	3.32	3.46	18(fc,class,spc) 198(spc,parm)
077	M5.5(237)	<0.09(3.6 cm)	0.4	0.8L	18(fc,class,spc)
078	early M(18)	<0.57(6 cm)			18(fc,class) 180(spc,parm)
079	C1.2(137)	<0.10(3.6 cm)			18(fc,class) 2(spc) 225(parm)
080	M5(186)	0.36(6 cm)			18(fc,class,spc) 198(spc,parm)
081	M3(198)	<0.11(3.6 cm)			18(fc,class,spc) 198(spc,parm)
082	M3(186)	<0.14(3.6 cm)			18(fc,class,spc) 198(spc,parm)
083	M1.5,M3(237, 198)	0.57(6 cm)			18(fc,class,spc) 198(spc,parm)
084	M5/M6:(46, 14)	0.06:(6 cm)			59(spc,class) 46(fc,parm)
085	M3(198)	<0.26(6 cm)	6.02	5.62	4(fc,class) 198(spc,parm)
086	M1(198)	<0.11(3.6 cm)			18(fc,class,spc) 198(spc,parm)
087	M5(14)	<0.10(3.6 cm)	1.89	2.10	18(fc,class,spc) 198(spc,parm)
088	M6/M2(237, 14)	0.51(3.6 cm)	0.65	0.36:	18(fc,class,spc) 198(spc,parm)
089	late M(204)		7.33	7.46	248(fc) 48(spc) 198(class,parm)
090	M3(237)	<0.10(3.6 cm)			18(fc,class,spc) 226(parm)
091					153(fc) 167(spc) 198(class,parm)
092	M6(237)	1.19(3.6 cm)	0.12	0.05L	18(fc,class,spc) 286(parm)
093	M5.5/M2(237, 14)	<18(2 cm)	0.22	0.08L	18(fc,class) 182(spc) 200(parm)
094	M0/M2(186, 14)	1.59(3.6 cm)	0.43	0.35L	18(fc,class,spc)
095	M4(198)	<0.13(3.6 cm)			18(fc,class,spc) 198(spc,parm)
096	Mira M8(14)	<0.19(3.6 cm)	0.15	0.06L	18(fc,class,spc)
097	M(137)	<0.14(3.6 cm)			18(fc,class) 257(parm)
098	M3(198)				4(fc,class,spc) 198(spc,parm)
099	M7(14)	<0.12(3.6 cm)			18(fc,class,spc)
100	Mira(17);M4-5:(186)	65.3(3.6 cm)	17.9	30.4	18(fc,class,spc) 246(parm)

Table 1. continued

No.	Name	$\alpha(2000)$ h m s	$\delta(2000)$ ° ′ ″	$l^{\rm II}$ °	$b^{\rm II}$ °	V [mag]	K [mag]	IR	*IUE*	X	$\mathrm{IP}_{\max}$ [eV]
101⋆	RS Oph	17 50 13.2	−06 42 28.4	19.80	+10.37	11.5	6.5	S	+	+	114
102⋆	WRAY 16−312	17 50 16.5	−30 57 41.1	358.79	−1.91		7.8	D		+	108.8
103⋆	V4141 Sgr	17 50 24.0	−19 53 42.0	8.31	+3.73	16.4	7.9	D,S		−	54.4
104	ALS 2	17 50 51.1	−17 47 56.0	10.18	+4.70	14.2		S			114
105⋆	AS 245	17 51 00.8	−22 19 41.3	6.29	+2.38	11.0	7.2	S,D		−	114
106	Hen 2−294	17 51 38.2	−32 50 57.0	357.31	−3.12		8.4	S		−	114
107⋆	Bl 3−14	17 52 25.9	−29 46 00.0	0.05	−1.70	14.3	8.7	S		−	114
108	Bl 3−6	17 52 57.0	−31 19 18.0	358.77	−2.59	17.0		S		−	114
109	Bl L	17 53 13.0	−30 18 00.0	359.68	−2.12	16.0	7.8	S		−	114
110⋆	V745 Sco	17 55 22.2	−33 14 59.3	357.36	−4.00	17	8.4	S	+	−	262
111	MaC 1−9	17 55 52.6	−14 06 49.3	13.99	+5.51	15.2		S		−	54.4
112⋆	AS 255	17 57 08.7	−35 15 38.0	355.79	−5.32	12.5	8.4	S,D		−	114
113	V2416 Sgr	17 57 15.9	−21 41 35.4	7.57	+1.44	15.1	4.6	S	+	−	114
114⋆	H 2−34	17 58 28.0	−28 33 42.0	1.76	−2.23	18.0	>9.9			−	114
115⋆	SS73 117	18 02 22.9	−31 59 11.0	359.19	−4.66	12.5	7.7	S		−	114
116⋆	AS 269	18 03 23.8	−32 42 21.9	358.67	−5.20	13.9	8.7	D’		−	54.4
117	Ap 1−8	18 04 29.8	−28 21 28.0	2.59	−3.28	15.2	7.9	S		−	114
118⋆	SS73 122	18 04 41.1	−27 09 32.8	3.66	−2.73	12.0	6.6	D		−	114
119	AS 270	18 05 33.6	−20 20 44.6	9.64	+0.37	13.1	5.5	S		−	54.4
120⋆	H 2−38	18 06 01.0	−28 17 10.8	2.81	−3.54	13.8	6.7	D	+	+	114
121	SS73 129	18 07 05.7	−29 36 25.9	1.77	−4.39	12.5	8.0	S		−	114
122⋆	Hen 3−1591	18 07 31.9	−25 53 44.0	5.07	−2.68	12.5	9.0	S,D’		+	54.4
123	V615 Sgr	18 07 49.6	−36 10 09.0	356.05	−7.66	13.3	7.6	S		−	54.4
124⋆	Ve 2−57	18 08 24.0	−24 34 00.0	6.33	−2.20	12.5	7.4	S		−	35.1
125⋆	AS 276	18 09 09.6	−41 13 26.0	351.64	−10.24	12.0	8.1	S,D		−	114
126	Ap 1−9	18 10 28.9	−28 07 41.0	3.43	−4.33	12.5	8.8	S		−	54.4
127	AS 281	18 10 47.5	−27 56 24.0	3.63	−4.30	12.9	7.0	S		−	114
128⋆	V2506 Sgr	18 11 01.6	−28 32 39.9	3.12	−4.63	12.0	8.4	S		−	114
129	SS73 141	18 12 11.2	−33 10 41.0	359.13	−7.04	12.5	9.0	S		−	54.4
130	AS 289	18 12 22.0	−11 40 13.0	18.08	+3.20	12.1	5.0	S	+	−	114
131	Y CrA	18 14 24.1	−42 51 00.0	350.60	−11.84	14.4	6.6	S	+	−	114
132⋆	YY Her	18 14 34.3	+20 59 20.0	48.14	+17.24	12.8	8.0	S	+	−	109.3
133⋆	V2756 Sgr	18 14 34.5	−29 49 22.4	2.36	−5.92	11.5	7.8	S		−	114
134⋆	FG Ser	18 15 06.2	−00 18 57.6	28.5	+7.9	11.0	4.5	S	+	−	100
135	HD 319167	18 15 24.5	−30 31 57.2	1.81	−6.41	12.5	7.5	S		−	54.4
136	Hen 2−374	18 15 36.4	−21 34 40.0	9.75	−2.23	12.0	6.5	S		−	114
137	Hen 2−376	18 15 46.0	−27 53 48.0	4.19	−5.24	14.1		S	+		35.1
138⋆	V4074 Sgr	18 16 05.5	−30 51 11.3	1.59	−6.69	11.5	7.7		+	−	235
139⋆	V2905 Sgr	18 17 20.5	−28 09 51.0	4.11	−5.68	12.3	7.1	S		−	63.5
140	StHA 149	18 18 55.9	+27 26 12.0	54.81	+18.77	13.5					114
141	Hen 3−1674	18 20 19.2	−26 22 47.8	6.01	−5.43	12.5	7.7	S		−	114
142	AR Pav	18 20 27.8	−66 04 42.9	328.54	−21.60	10.0	7.2	S	+	−	97.1
143	V3929 Sgr	18 20 58.8	−26 48 32.0	5.70	−5.76	12	7.4	D		−	114
144	V3804 Sgr	18 21 28.5	−31 32 03.9	1.52	−8.02	12.0	7.3	S		−	114
145	V443 Her	18 22 08.4	+23 27 20.0	51.23	+16.59	11.5	5.4	S	+	−	97.1
146⋆	V3811 Sgr	18 23 28.9	−21 53 08.9	10.34	−3.98	14	8.5	S		−	54.4
147	V4018 Sgr	18 25 27.0	−28 35 57.5	4.55	−7.46	11.4	7.5	S	+	−	100
148⋆	V3890 Sgr	18 30 43.0	−24 00 59.0	9.21	−6.44	∼14	8.2	S	+		361
149	V2601 Sgr	18 37 58.9	−22 42 07.9	11.14	−7.34	15	8.0	S		−	54.4
150	K 3−9	18 40 24.1	−08 43 46.6	23.91	−1.54	18.0	5.6	D		−	114

Table 1. continued

No.	Cool-star spectrum	Radio [mJy]	*IRAS* F_{12}[Jy]	*IRAS* F_{25}[Jy]	References
101	M0-M2(63, 24)	<0.33(3.6 cm)	0.30	0.16	18(fc,class,spc) 63, 37(parm)
102	Mira(313)	0.96(6 cm)	5.0	3.1	18(fc,spc) 1(class)
103	M6(204)	<0.17(6 cm)	1.88	0.65	18(fc) 180(spc,class) 198(spc,parm)
104	M2(198)				4(fc,class,spc) 198(spc,parm)
105	Mira(313);M6(14)	0.87(6 cm)	1.67	0.62	18(fc,class,spc) 198(spc,parm)
106	M3(198)	<0.11(3.6 cm)	2.19	2.89	18(fc,class,spc) 198(spc,parm)
107	M6(177)	<0.12(3.6 cm)			18(fc,class,spc) 177(parm)
108	M3(198)	<0.20(6 cm)	1.62	1.14	4(fc,class) 198(spc,parm)
109	M6.5(14)	<0.10(3.6 cm)			18(fc,class,spc)
110	M6,M7(24, 284)				284(fc) 317(spc,class) 24(parm)
111	M2(198)				173(fc) 198(spc,class,parm)
112	K3(186)	<0.10(3.6 cm)	1.31L	1.58L	18(fc,class) 182(spc,parm)
113	M6/M5(237, 14)	2.26(3.6 cm)	1.44	0.71	18(fc,class,spc) 198(spc,parm)
114	M5:(1)				185(fc) 4(spc,class)
115	M5/M6(186, 14)	0.25(3.6 cm)	0.33	0.09	18(fc,class,spc)
116	G5-K2(198)	<1(2 cm)	1.01	2.54	248(fc) 1(class) 198(spc)
117	M4/M0(198, 14)	<0.10(3.6 cm)	0.66	0.49	18(fc,class,spc) 198(spc,parm)
118	Mira(313);M7(186)	2.19(3.6 cm)	1.4	1.2	18(fc,class,spc) 198(spc,parm)
119	M5.5/M1(237, 14)	0.29(3.6 cm)	1.67	5.98L	18(fc,class,spc) 182(spc,parm)
120	Mira(313);M7(237)	4.50(3.6 cm)	3.2	2.0	18(fc,class) 246(spc,parm)
121	M0(237)	<0.14(3.6 cm)	0.74	1.42L	18(fc,class,spc) 198(spc,parm)
122	G(14)	0.41(3.6 cm)	1.0	0.6	18(fc,class,spc) 178(parm)
123	M5.5,M5(237, 186)	<0.11(3.6 cm)	0.87	0.54L	18(fc,class,spc) 198(spc,parm)
124	M(11)	<0.25(6 cm)			18(fc,spc) 1(class)
125	M4.5(237)	<0.14(3.6 cm)	0.31L	0.37L	18(fc,class,spc)
126	K5/K4(198, 14)	<0.16(3.6 cm)	1.13	0.70:	18(fc,class,spc) 131(parm)
127	M5(186)	0.24(3.6 cm)	0.79	0.54:	18(fc,class,spc) 198(spc,parm)
128	M5.5(237)	0.23(3.6 cm)	0.21	0.18L	18(fc,class,spc) 198(spc,parm)
129	M5(237)	<0.10(3.6 cm)			18(fc,class,spc)
130	M3.5(237)	1.84(3.6 cm)	0.55	0.45L	18(fc,class) 182(spc,parm)
131	M6/M5(237, 14)	0.31(3.6 cm)	0.25L	0.25L	18(fc,class) 182(spc,parm)
132	M4(237)	<0.11(3.6 cm)	0.10	0.04L	18(fc,class,spc) 228(parm)
133	M3(186)	0.17(3.6 cm)			18(fc,class,spc) 198(spc,parm)
134	M5.3,M5(141, 237)	0.43(6 cm)	1.00	0.35	18(fc,class,spc) 234(parm)
135	M3(198, 186)	0.31(3.6 cm)			18(fc,class,spc) 198(spc,parm)
136	M5.5(237)	0.39(3.6 cm)	1.28	0.71:	18(fc,class,spc) 198(spc,parm)
137	M2(198)				4(fc) 48, 198(spc,class) 198(parm)
138	M4(221)	<0.47(3.6 cm)	14.6	65.1	18(fc,class,spc) 221(parm)
139	late M,M0(10, 198)		0.07L	0.06L	198(class,parm) 245(spc)
140	M2(294)				67(spc,class)
141	M5(186)	0.28(3.6 cm)			18(fc,class,spc)
142	M5/M6(237, 14)	<14(6 cm)	0.14	0.05L	18(fc,class,spc) 258(parm)
143	Mira M1-2(186)	0.28(3.6 cm)	5.0	4.1	18(fc,class,spc) 252(parm)
144	M5/M6(186, 14)	0.46(3.6 cm)	0.52	0.26	18(fc) 245(spc) 137(class) 180(parm)
145	M5.5(237)	0.23(3.6 cm)	0.40	0.13	18(fc,class,spc) 61(parm)
146	M3.5(237)	<0.07(3.6 cm)	5.40	2.20	18(fc,class,spc)
147	M4(14)	<0.11(3.6 cm)	0.44	0.27L	18(fc,class) 18, 182(spc) 224(parm)
148	M5,M8(95, 316)				69(fc) 316(spc) 1(class) 24(parm)
149	M5(198)	<0.12(3.6 cm)	0.50	0.50L	18(fc,class,spc) 198(spc,parm)
150	Mira(115, 198);M3(198)	8.63(3.6 cm)	8.09	4.08	248(fc) 198(spc,class) 115, 198(parm)

Table 1. continued

No.	Name	α(2000) h m s	δ(2000) ° ′ ″	$l^{\rm II}$ °	$b^{\rm II}$ °	V [mag]	K [mag]	IR	*IUE*	X	$\rm IP_{max}$ [eV]
151	AS 316	18 42 33.0	−21 17 48.0	12.89	−7.67	12.0	7.8	S		−	114
152	DQ Ser	18 44 40.0	+05 03 29.9	36.67	+3.81	14.6					54.4
153	MWC 960	18 47 55.9	−20 05 49.9	14.53	−8.27	12.0	7.8	S	+	−	114
154	AS 323	18 48 35.7	−06 41 08.9	26.66	−2.41	15.5	7.9	S		−	114
155	AS 327	18 53 16.9	−24 22 54.0	11.14	−11.23	11.8	8.5	S		−	114
156*	FN Sgr	18 53 52.9	−18 59 42.0	16.15	−9.06	12.7	7.9	S	+	−	114
157	Pe 2−16	18 54 10.0	−04 38 53.9	29.10	−2.72	16.0	8.1	S		−	114
158	CM Aql	19 03 35.2	−03 03 15.0	31.59	−4.09	13.6	7.7	S		−	54.4
159	V919 Sgr	19 03 46.0	−16 59 53.9	19.01	−10.32	12.2	7.3	S		−	54.4
160*	V1413 Aql	19 03 51.6	+16 28 31.7	48.97	+4.77	14.0	7.5	S	+	−	114
161	NSV 11776	19 09 55.8	−02 47 40.3	32.55	−5.39	13.6					114
162*	Ap 3−1	19 10 36.1	+02 49 32.0	37.64	−2.97	15.4	8.6	S		+?	114
163	MaC 1−17	19 12 57.3	−05 21 20.0	30.59	−7.22	15.6		S		−	63.5
164	V352 Aql	19 13 33.6	+02 18 14.0	37.51	−3.86	16.2	>9.6	S		−	114
165	ALS 1	19 16 16.2	−08 17 45.9	28.30	−9.27	14.8		S			114
166*	BF Cyg	19 23 53.4	+29 40 25.1	62.93	+6.70	12.3	6.3	S	+	−	97.1
167*	CH Cyg	19 24 33.0	+50 14 29.1	81.86	+15.58	7.1	−0.7	S	+	+	77.5
168	StHA 164	19 28 40.9	−06 03 42.0	31.73	−11.03	13.6					114
169*	HM Sge	19 41 57.1	+16 44 39.9	53.57	−3.15	17	4.3	D	+	+	205.1
170*	Hen 3−1761	19 42 25.3	−68 07 35.3	327.67	−29.76	10.4	5.6	S	+	−	100
171*	QW Sge	19 45 49.6	+18 36 50.0	55.64	−3.02	12.8	7.1	S	+	−	114
172*	CI Cyg	19 50 11.8	+35 41 03.2	70.90	+4.74	11.0	4.5	S	+	−	109.3
173	StHA 169	19 51 28.9	+46 23 06.0	80.38	+9.85	>13.5					54.4
174*	V1016 Cyg	19 57 04.9	+39 49 33.9	75.17	+5.68	11.2	5.3	D	+	+	141.3
175	RR Tel	20 04 18.5	−55 43 33.1	342.16	−32.24	10.8	4.2	D	+	+	141.3
176*	PU Vul	20 21 12.0	+21 34 41.9	62.58	−8.52	11.6	6.2	S	+	+	235
177*	LT Del	20 35 57.3	+20 11 34.0	63.40	−12.15	13.1	9.4	S	+	−	77.5
178	StHA 180	20 39 21.0	−05 16 59.9	40.89	−26.36	13.5					114
179	Hen 2−468	20 41 18.9	+34 44 52.0	75.94	−4.44	14.2	8.0	S		−	114
180*	ER Del	20 42 46.4	+08 40 56.4	54.46	−20.00	10			+	−	47.9
181*	V1329 Cyg	20 51 01.1	+35 34 51.2	77.80	−5.56	13.3	6.9	S	+	−	141.3
182	CD−43 14304	21 00 06.3	−42 38 49.9	358.65	−41.10	10.8	7.6	S	+	+	114
183*	V407 Cyg	21 02 13.0	+45 46 30.0	86.99	−0.49	14	3.3	D	+	−	54.4
184*	StHA 190	21 41 44.8	+02 43 54.4	58.41	−35.43	10.5	7.8	D’	+	−	47.9
185*	AG Peg	21 51 01.9	+12 37 29.4	69.28	−30.89	9.0	3.9	S	+	+	100
186*	LL Cas	23 09 20.1	+54 44 53.0	108.47	−5.23	15	7.6	S			54.4:
187*	Z And	23 33 39.5	+48 49 05.4	109.98	−12.09	10.8	5.0	S	+	+	114
188*	R Aqr	23 43 49.4	−15 17 04.2	66.52	−70.33	9.1	−0.9	D	+	+	97.1

Table 1. continued

No.	Cool-star spectrum	Radio [mJy]	*IRAS* F_{12}[Jy]	*IRAS* F_{25}[Jy]	References
151	M4(237)	0.28(3.6 cm)			18(fc,class) 182, 198(spc,parm)
152	M3-5(49)				49(fc,spc,class)
153	K7/M0(237, 14)	<0.22(3.6 cm)			18(fc,class,spc) 225(parm)
154	M3(198)	<0.3(6 cm)			248(fc) 4(class) 198(spc,parm)
155	M4,M2(186, 267)	0.21(3.6 cm)			18(fc,class) 198, 182(spc,parm)
156	M3,M4(237, 186)	0.14(3.6 cm)	0.16	0.06L	18(fc,class,spc) 201(parm)
157	M5(14)	0.14(3.6 cm)			18(fc,class,spc) 198(spc,parm)
158	M4/K3(98, 14)	0.30(3.6 cm)			18(fc,class,spc)
159	M4.5/M1(237, 14)	<0.08(3.6 cm)			18(fc,class,spc) 113(parm)
160	M4/M5(1, 14)	0.66(3.6 cm)	1.68	0.69	18(fc,class,spc) 220(parm)
161	M7(237)				48(spc,class)
162	M5,M7(237, 90)	<0.07(3.6 cm)			18(fc,class)
163	M1(198)				173(fc) 198(class) 245(spc,parm)
164	M3,M2(198, 70)	<0.2(6 cm)	0.46	1.01	69(fc) 198(class) 70(spc,parm)
165	M3(198)				4(fc,spc) 198(class,parm)
166	M5(141, 237)	0.66(3.6 cm)	0.23	0.11	18(fc,class) 208(spc) 290(parm)
167	M6.5,M7(141, 237)	1.6(6 cm)	535	179	18(fc) 36(spc) 137(class) 213(parm)
168	mid M(67)				67(spc,class)
169	Mira,M7(237)	99.6(3.6 cm)	106	75.5	18(fc,class,spc) 240(parm)
170	M5.5/M3(237, 14)	<12(6 cm)	0.37	0.09	18(fc,class,spc) 183, 42(parm)
171	M5/M6(237, 14)	0.20(3.6 cm)	0.14	0.05L	18(fc,class,spc) 222(parm)
172	M5.5(237)	2.47(3.6 cm)	0.85	0.15	18(fc,class) 146(spc,parm)
173	M(67)				67(spc,class)
174	Mira(313);M7(237)	61.1(3.6 cm)	42.4	32.8	18(fc,class) 36(spc) 260(parm)
175	Mira(313);M6/M5(237, 14)	26.6(3.5 cm)	19.8	15.8	18(fc,class) 55, 296(spc) 121(parm)
176	M6,M6.5(237, 33)	0.50(3.6 cm)	0.39	0.25L	18(fc) 137(class) 23(spc) 47(parm)
177	G6(223)	<0.05(3.6 cm)	0.03L	0.07	18(fc,class,spc) 223(parm)
178	mid M(67)				67(spc,class)
179	late M(18)	<0.04(3.6 cm)			18(fc,class) 239(spc)
180	S5.5/2.5(6)	<0.45(3.6)			1(class) 119(parm)
181	M6,M6-7(237, 30)	1.81(3.6 cm)	0.88	0.74	18(fc,class) 36(spc) 261(parm)
182	K7/K3(237, 14)	<0.15(3.6 cm)			18(fc,class) 182(spc) 265(parm)
183	Mira;M6(155)	<0.06(3.6 cm)	27.24	15.14	18(fc,class) 155(spc,parm)
184	G5(237)		1.84	1.65	67(spc,class) 266(parm)
185	M3,M4(141, 237, 107)	8.15(6 cm)	1.6	0.60	18(fc,class,spc) 145(parm)
186	M(255)				248(fc) 159(spc,class)
187	M4.5(237)	1.74(3.6 cm)	0.67	0.26	18(fc,class) 36(spc) 207(parm)
188	Mira;M7,M8(139, 237)	12.3(6 cm)	1690	530	18(fc,class) 139(spc) 43(parm)

Table 2. Suspected symbiotic stars

No.	Name	α(2000) h m s	δ(2000) ° ′ ″	l^{II} °	b^{II} °	V [mag]	K [mag]	IR	*IUE*	X	IP_{max} [eV]
s01⋆	RAW 1691	01 18 36.1	−72 42 24.0			15.3	12			–	13.6
s02⋆	[BE74] 583	05 26 54.0	−71 06 00.0			16.1					13.6
s03⋆	StHA 55	05 46 42.0	+06 43 48.0	199.34	−11.12	13.5					13.6
s04⋆	CD−28 3719	07 01 09.4	−29 06 25.9	240.19	−10.89	10.6	5.0				13.6
s05⋆	GH Gem	07 04 04.9	+12 02 12.0	203.57	+8.23	14.6	>9.7			–	
s06⋆	ZZ CMi	07 24 13.9	+08 53 51.7	208.64	+11.30	9.9	2.8	S			35.1
s07⋆	NQ Gem	07 31 54.5	+24 30 12.5	194.63	+19.35	7.9	3.0		+	–	54.4
s08⋆	WRAY 16−51	09 33 29.4	−46 34 49.0	271.35	+3.80		4.4				13.6
s09⋆	Hen 3−653	11 25 32.5	−59 56 31.9	292.36	+1.16	12.5	5.4	S		–	29.6
s10⋆	NSV 05572	12 21 52.5	−13 53 09.9	292.10	+48.36	15					13.6
s11⋆	CD−27 8661	12 24 34.3	−28 19 09.0	295.78	+34.18	10.5	4.1				13.6
s12⋆	AE Cir	14 44 52.0	−69 23 35.9	312.67	−8.69	14.1					54.4
s13⋆	V748 Cen	14 59 37.0	−33 25 23.9	331.51	+22.24	12.6	8.1			–	13.6
s14⋆	V345 Nor	16 06 44.3	−52 02 30.1	330.51	+0.05	11.4				–	13.6
s15⋆	V934 Her	17 06 34.5	+23 58 18.5	45.15	+32.99	7.8	3.3		+	+	77.5
s16⋆	Hen 3−1383	17 20 31.5	−33 09 55.7	353.53	+2.20	12.5				–	24.6
s17⋆	V503 Her	17 36 46.0	+23 18 18.0	47.00	+26.23	13.8				–	
s18⋆	WSTB 19W032	17 39 02.8	−28 56 35.0	359.24	+1.22	17.2					35.1
s19⋆	WRAY 16−294	17 39 13.9	−25 38 06.0	2.06	+2.94	15.5		S			35.1
s20⋆	AS 241	17 44 58.0	−38 18 12.9	351.92	−4.76	12.0	7.8	S		–	24.6
s21⋆	DT Ser	18 01 52.0	−01 26 06.0	25.92	+10.34	15.4					54.4
s22⋆	V618 Sgr	18 07 57.0	−36 29 35.9	355.77	−7.83	15.2					13.6
s23⋆	AS 280	18 09 52.9	−33 19 41.9	358.77	−6.69	13.2	>9.4	S			54.4
s24⋆	AS 288	18 12 48.0	−28 20 00.9	3.49	−4.87		8.4	D?			54.4
s25⋆	Hen 2−379	18 16 17.4	−27 04 32.9	4.97	−4.96	12.5	9.3				35.1
s26⋆	V335 Vul	19 23 14.2	+24 27 40.2	58.22	+4.40	11.8					13.6
s27⋆	V850 Aql	19 23 34.6	+00 38 03.0	37.18	−6.85		5.0	S			13.6
s28⋆	Hen 2−442	19 39 39.0	+26 30 42.0	61.80	+2.13	14	5.3				100
s29⋆	*IRAS* 19558+3333	19 57 48.4	+33 41 15.9	69.98	+2.38			D?			
s30⋆	V627 Cas	22 57 41.2	+58 49 14.9	108.66	−0.86	12.9	3.3	D			13.6

4. Classification notes and comments on particular objects

Symbiotic stars

004=SMC3 V magnitude during outburst.
005=SMC N60 IR-type S –[137, 236], D –[18].
008=AX Per Incorrect coordinates given by [18, 137].
009=V471 Per This star appears in previous symbiotic catalogs [18, 137] as V741 Per. The correct name is V471 Per as given in the *General Catalog of Variable Stars* [147].
010=o Ceti Cool component is Mira [313] of type M2-7 III [132], UV spectrum shows emission lines with ionization potentials up to 54.4 eV [133] and in the optical spectrum there are emission lines of H I and He I [320]. Preliminary orbit with orbital period of 400 yrs was reported in [28], but recent high precision interferometric observations show that the apparent binary separation is much larger than predicted, and imply orbital period much longer then 400 yrs [133].

011=BD Cam Cool component is S giant of type S5.3 [135]; UV spectra shows emission lines with ionization potential up to 77.5 eV [8]. 24.76-day periodicity estimated from *BVRI* photometry; pulsational origin has been suggested [5].

016=UV Aur Although there has been some controversy over the interpretation of the 395-day period sometimes attributed to orbital motion (e.g. [36]), we believe that it is due to pulsation (see [87] for discussion). The object is thus classified as a C-rich symbiotic Mira with little dust (S-type). The broad-band polarimetric data show a periodicity of ∼ 14 yrs which may be due to orbital motion [148].

Table 2. continued

No.	Cool-star spectrum	Radio [mJy]	*IRAS* F_{12}[Jy]	*IRAS* F_{25}[Jy]	References
s01	C(311)				191(fc) 311(spc) 1(class)
s02	G-K(218)				38(fc) 218(class)
s03	C(67)				67(spc) 1(class)
s04			0.53	0.25L	124(class)
s05	F2:(190)				190(fc) 137(class)
s06	M6,M5(108, 295)		6.60	2.65	300(fc) 108(spc) 1(class)
s07	C6.2(134)		3.28	0.84	84(spc) 58(class) 120(parm)
s08	S?,M?(174)		2.33	0.69	1(class)
s09	late M,M6,M(11, 276, 245)		0.90	0.28L	18(fc,class) 245(spc)
s10	late M,M9(68, 151)				68(fc,spc) 1(class)
s11			1.14	0.41L	124(class)
s12					214(fc) 149(spc,class)
s13	M3,M4(271, 301)				302, 271(spc) 137(class) 301(parm)
s14	M3-5(165)				69(fc) 1(class) 165(spc,parm)
s15	M3(82)	<0.8(20 cm)	2.8	0.74	82(fc,spc,class) 298(parm)
s16	Mep?(256)	2.54(6 cm)			1(class)
s17	M2p(40)				190(fc) 40(spc) 137(class)
s18	K0-M3(52)	21(6 cm)	3.42	12.57	152(fc) 52(spc) 1(class)
s19	K5(198)				198(spc,class,parm)
s20	M1(198)	<0.21(6 cm)	0.67L	0.28L	18(fc,spc,class)
s21	G?,G2-K0(49, 50)				49(fc,spc) 1(class)
s22					150(spc,class)
s23					248(fc) 198(class,spc)
s24		26.4(6 cm)	1.24	1.10	248(fc) 1(class)
s25	K2,G-K(168, 293)	9.0(6 cm)	0.69L	1.67:	248(fc) 22(spc) 1(class)
s26	Mira?,C(57, 229)		1.79	0.62	57(fc) 229(spc,class)
s27	Mira?,late(39, 3)	4(2 cm)	5.96	2.66	248(fc) 1(class)
s28		6.0(6 cm)			248(fc) 1(class) 25(spc,parm)
s29	OH/IR (277)	0.44 (3.6 cm)	42.9	46.0	277(class,parm)
s30	Mira M2,M4(158, 128)	<9(2 cm)	189.4	170.4	100(fc) 158(spc,class) 154(parm)

017=V1261 Ori Cool component is S giant of type S4.1 [127]; UV spectrum shows emission lines with ionization potential up to 77.5 eV [7].

018=LMC1 *IUE* spectra described in [236].

020=Sanduleak's star In the optical spectrum, there is an emission feature at 6825 Å [215]; moreover, there are emission lines with an ionization potential up to 108.8 eV [215, 13] including lines of H I and He I [236]. The *IUE* spectra are described in [236].

023=BX Mon *IRAS* data from [142].

024=V694 Mon Object in permanent outburst [176]; contains M3-5 giant [243, 11]; optical spectrum shows emission lines of H I and He I with highly blueshifted ($\sim 2000-7000\,\mathrm{km\,s^{-1}}$) shell absorption [11, 243, 188] and emission lines of singly-ionised metals [243] over an A-B type continuum [243]. VK magnitudes are appropriate for the outburst.

026=RX Pup Highly variable radio emission [114]. Nebula resolved at optical and radio wavelengths with a possible jet-like feature in the [N II] line ([53] and references therein).

027=Hen 3−160 *IRAS* data from [142].

028=AS 201 A spherical nebula detected in H_α and [N II] lines ([53] and references therein).

029=KM Vel Cool component is Mira [313, 75] of M spectral type [274]; optical spectrum shows emission lines with ionization potential up to 41.0 eV [21] and emission lines of H I and He I [275]. Finding chart in [248] is incorrect and no other has been published.

032=SS73 29 *IUE* observations reported in [225]. *IRAS* data from [142].

033=SY Mus The system inclination, $i = 101\overset{\circ}{.}1 \pm 2\overset{\circ}{.}5$, and the position angle of the line-of-nodes, $\Omega = 58\overset{\circ}{.}6 \pm 1\overset{\circ}{.}7$,

Table 3. Orbital photometric ephemerides for symbiotic and suspected symbiotic stars

No.	Star	Ephemeris	Eclipse	Ref.
003	EG And	Min(UV) = JD 2445380 + 481×E	Yes	[308]
008	AX Per	Min($m_{\rm vis}/m_{\rm pg}$) = JD 2436667 + 680.8×E	Yes	[205]
017	V1261 Ori	Min(Vyb) = JD 2445494 + 642×E	Yes	[126, 123]
023	BX Mon	Min($m_{\rm pg}$) JD 2449530 + 1401×E	Yes	[71]
024	V694 Mon	Min($m_{\rm pg}/B$) = JD 2437455 + 1930×E	No	[65]
033	SY Mus	Min($m_{\rm vis}$) = JD 2450176 + 625×E	Yes	[72]
045	RW Hya	Min(UV) = JD 2445072 + 370.2×E	Yes	[144]
050	V417 Cen	Min($m_{\rm pg}$) = JD 2427655 + 245.7×E	?	[304]
057	T CrB	Min(UBV) = JD 2435687.6 + 227.67×E	No	[166]
058	AG Dra	Max(U) = JD 2443886 + 554×E	No	[189]
071	CL Sco	Min($m_{\rm pg}$) = JD 2427020 + 624.7×E	No	[137]
092	RT Ser	Max(B) = JD 2446600 + 4500×E	No	[286]
093	AE Ara	Min($m_{\rm vis}$) = JD 2448571 + 830×E	?	[200]
132	YY Her	Min(V) = JD 2448945 + 590×E	No	[228]
133	V2756 Sgr	Min($m_{\rm pg}$) = JD 2437485 + 243×E	Yes?	[103]
134	FG Ser	Min(B) = JD 2448492 + 650×E	Yes	[230]
142	AR Pav	Min($m_{\rm vis}/m_{\rm pg}$) = JD 2411265.6 + 604.46×E	Yes	[289]
145	V443 Her	Min(U) = JD 2443660 + 594×E	No	[157]
149	V2601 Sgr	Min($m_{\rm pg}$) = JD 2429850 + 850×E	Yes?	[102]
156	FN Sgr	Min($m_{\rm vis}$) = JD 2441750 + 567.2×E	Yes	[201]
160	V1413 Aql	Min(B) = JD 2446650 + 434.1×E	Yes	[220]
166	BF Cyg	Min(V) = JD 2415058 + 756.8×E	Yes	[208]
167	CH Cyg	Min(U) = JD 2446275 + 5700×E	Yes	[212]
172	CI Cyg	Min($m_{\rm pg}/B$) = JD 2442687.1 + 855.6×E	Yes	[194]
176	PU Vul	Min($m_{\rm vis}$) = JD 2444550 + 4900×E	Yes	[241]
177	LT Del	Min(U) = JD 2445910 + 478.5×E	No	[26]
181	V1329 Cyg	Min(V) = JD 2444890.0 + 956.5×E	Yes	[261]
185	AG Peg	Max(V) = JD 2442710.1 + 816.5×E	No	[79]
187	Z And	Min($m_{\rm vis}$) = JD 2442666 + 758.8×E	No	[80]
s13	V748 Cen	Min(V) = JD 2441917 + 566.5×E	Yes	[302]

has been derived from spectropolarimetric studies of the Raman-scattered O VI emission lines [91, 89].

034=BI Cru A bipolar nebula resolved in the optical ([53] and references therein) with the bipolar lobes and associated outflows perpendicular to the position angle of intrinsic scattering polarization [88].

036=TX CVn Low ionization potential ($\rm IP_{max} = 13.6$ eV), but this is a confirmed symbiotic star ([138]: combination spectrum of late B + early M, emission lines of H I and singly-ionised metals). Classification is also based on its light curve showing eruptions as in other symbiotics (with $\Delta m_{\rm pg}$ up to $\sim 3^m$). Since the 1970's, the star is in permanent outburst with P-Cyg type spectrum.

038=Hen 3−828 *IRAS* data from [142].

041=St 2−22 The SIMBAD database uses different name for this object: PN Sa 3−22.

043=V840 Cen *IRAS* data from [94]. Finding chart available in [184] where object is marked as star A [70].

046=Hen 3−916 Finding chart in [18] is wrong, object is 2 mm ($\sim 20''$) E of marked star [90].

047=V704 Cen Cool component might be Mira [313].

048=V852 Cen Cool component is Mira [313, 75]; optical spectrum shows emission lines with ionization potential up to 100 eV and emission lines of H I and He I [244, 60, 198, 171]. Bipolar nebula resolved in the optical (Southern Crab) ([53] and references therein).

050=V417 Cen An irregular nebula resolved at optical wavelengths ([53] and references therein).

055=HD 330036 This is a yellow symbiotic star; cool component is F5 giant or subgiant [169]. In UV, there are emission lines with ionization potential up to 77.5 eV [169] and in the optical spectrum there are emission lines with ionization potential up to 54.4 eV [198, 169]. IR-type D' –[1].

056=Hen 2−139 Only H I emission lines in spectrum according to [18], but other emission lines (like [O III]) are reported in [21].

058=AG Dra A secondary periodicity of $\sim 355^{\rm d}$ has been detected in the optical light curve and interpreted in terms of non-radial pulsation of the cool giant [81]. An orbital inclination, $i \sim 120°$, has been derived from spectropolarimetric observations [268].

060=V347 Nor An elliptical nebula resolved at optical wavelengths ([53] and references therein).

065=Hen 3−1213 *IUE* observations reported in [183].

066=Hen 2−173 *IRAS* data from [142].

Table 4. Orbital elements for symbiotic and suspected symbiotic binaries

No.	Star	P [days]	$K_{\rm g}$ [km s^{-1}]	$q \equiv M_{\rm g}/M_{\rm h}$	γ_0 [km s^{-1}]	e	T_0 [JD]	$a_g$sin$i$ [$R_\odot$]	$f(M)$ [$M_\odot$]	Ref.
003	EG And	482.6	7.3		−95	0	2450804(3)	70	0.020	[78]
008	AX Per	680.8	7.5	2.5	−116.5	0	2445511.8	100	0.030	[205]
011	BD Cam	596.21	8.5		−22.3	0.09	2442794(1)	99.7	0.037	[86]
017	V1261 Ori	642	7.5	3.0	79.7	0.07	2446778(3)	95	0.028	[125]
023	BX Mon	1401	4.3	6.7	29.1	0.49	2449530	104	0.0076	[71]
		1259	4.6		29.1	0.44	2449680	103	0.0092	[78]
033	SY Mus	624.5	7.4		12.9	0	2449082(3)	91	0.026	[270]
036	TX CVn	199	5.7		2.3	0.16	2445195.25(1)	22	0.004	[143]
045	RW Hya	370.2	8.8		12.4	0	2445071.6	65	0.026	[144]
		370.4	8.8		12.9	0	2449512		0.026	[259]
051	BD−21 3873	281.6	10.6		203.9	0	2449087.3(3)	59	0.035	[291]
057	T CrB	227.57	23.9	0.6	−27.8	0	2447918.6	107	0.322	[78, 31]
058	AG Dra	554	5.1		−148.3	0	2446366.4	56	0.008	[209]
101	RS Oph	455.7	16.7		−40.2	0	2450154.1(3)	150	0.221	[78]
134	FG Ser	650	8.3	2.8	71.2	0	2448491	107	0.039	[234]
142	AR Pav	604.5	9.6	2.7	−68.4	0	2448139	115	0.055	[258]
145	V443 Her	594	3.2		−49.2	0	2446007.7	39	0.002	[61]
167	CH Cyg	5700	4.9		−57.7	0.47	2445086	478	0.045	[212]
		756.0	2.6		−60.6	0	2446643.7	39	0.0014	[101]
		5292	4.8			0.06	2445592(1)	500	0.060	[101]
172	CI Cyg	855.3	6.7	3	18.4	0	2445241.8	114	0.027	[146]
		853.8	6.7		15.0	0.11	2450426.4	112	0.026	[78]
182	CD−43 14304	1448	4.4		27.6	0	2445929(3)	126	0.013	[265]
		1442	4.6		27.5	0.22	2445560(1)	128	0.014	[265]
185	AG Peg	816.5	5.3	4	−15.9	0	2431667.5	84	0.012	[145]
		818.2	5.4		−15.9	0.11	2446812	87	0.0135	[78]
187	Z And	758.8	6.8		−1.8	0	2445703.0	102	0.025	[207]
s11	CD−27 8661	763.3	10.5		−5.5	0	2449280.5(3)	158	0.092	[306]

(1) T_0 – time of the passage through periastron.
(2) Assumed from photometric ephemeris (eclipse).
(3) Time of maximum velocity.

067=Hen 2−176 Classified as D-type in [18] based on its very red IR colours. However the IR colours are also consistent with an M4 − M7 giant and a very high interstellar reddening, $E_{B-V} \sim 2 \div 3$. Such a high reddening is also indicated by permitted and forbidden emission line ratios [198]. Moreover both the location in the He I 6678/5876, 7065/5876 diagram [250] and in the [O III] 5007/H$_\beta$, [O III] 4363/H$_\gamma$ diagram [181] is consistent with S-type system.

068=KX TrA The finding chart in [18] is wrong: the object is really 3 mm ($\sim$ 25″) W of marked star, although tabulated coordinates are correct [90]. The orbital period, $P = 1347 \pm 29$ days, the system inclination, $i = 135° \pm 38°$, and the position angle of the line-of-nodes, $\Omega = 58° \pm 15°$, has been derived from spectropolarimetric studies of the Raman-scattered O VI emission lines [91].

071=CL Sco *IRAS* data from [92].

073=V455 Sco An elliptical nebula possibly resolved in [O III] ([53] and references therein). The orbital period, $P = 1419 \pm 39$ days, the system inclination, $i = 93°\!.6 \pm 2°\!.3$, and the position angle of the line-of-nodes, $\Omega = 170°\!.1 \pm 1°\!.0$, has been derived from spectropolarimetric studies of the Raman-scattered O VI emission lines [91].

074=Hen 3−1341 *IUE* observations reported in [183]. Spectral signatures of collimated bipolar jets have been found during the 1999 outburst [299].

077=H 2−5 IR-type D –[198],S –[18, 137].

084=V2116 Oph Orbital period of 303.8 days is derived from the spin changes of the X-ray pulsar companion [247, 56].

088=M 1−21 VK magnitudes – close and fainter companion also measured. The orbital period, $P = 892 \pm 40$ days, the system inclination, $i = 96° \pm 5°$, and the position angle of the line-of-nodes, $\Omega = 73°\!.1 \pm 3°$, has been derived from spectropolarimetric studies of the Raman-scattered O VI emission lines [91].

089=Hen 2−251 K-band spectrum is practically identical with that of the symbiotic Mira, RX Pup, as observed during the dust obscuration event, with strong dust continuum and weak CO 2.3-μm band [204, 196].

092=RT Ser *IRAS* data from [142].

Table 5. Pulsations ephemerides for Miras in symbiotic and suspected symbiotic stars

No.	Star	T_0 [JD]	P [days]	Ref.
010	o Ceti	Max(V) = 2444839	331.96	[147]
016	UV Aur	Max($m_{\rm pg}$) = 2441062	395.42	[147]
026	RX Pup	Min(J) = 2440214	578	[202]
029	KM Vel	?	370	[75]
030	V366 Car	?	433	[75]
034	BI Cru	?	280	[314]
048	V852 Cen	?	400	[312]
049	V835 Cen	?	450	[75]
060	V347 Nor	?	370 − 380	[313]
100	H 1−36	?	450 − 500	[312]
169	HM Sge	Max(J) = 2446856	527	[322]
174	V1016 Cyg	Min(K) = 2444852	478	[219]
		Max(K) = 2445038	478	[219]
175	RR Tel	Max(J/K) = 2442999	387	[76]
183	V407 Cyg	Max(B) = 2429710	745	[155]
188	R Aqr	Max(V) = 2442398	386.96	[147]
s27	V850 Aql	Max(V) = 2425888	320	[147]
s30	V627 Cas	?	466	[158]

Table 6. Hipparcos parallaxes for symbiotic stars [249]

No.	Star	π [mas]
003	EG And	1.48 ± 0.97
010	o Ceti	7.79 ± 1.07
011	BD Cam	6.27 ± 0.63
017	V1261 Ori	1.32 ± 0.99
057	T CrB	−1.61 ± 0.63
058	AG Dra	−1.72 ± 0.98
142	AR Pav	3.37 ± 2.47
167	CH Cyg	3.73 ± 0.85
172	CI Cyg	−0.36 ± 1.58
185	AG Peg	−0.30 ± 1.17
187	Z And	2.34 ± 2.91
188	R Aqr	5.07 ± 3.15

093=AE Ara *IRAS* data from [142].
094=SS73 96 *IRAS* data from [142]. An axisymmetrical nebula resolved at radio wavelengths ([53] and references therein).
096=V2110 Oph *IRAS* data from [142].
100=H 1−36 In [186] there is an estimate of cool component spectral type M4-5 III based on TiO 7100 Å band depth. However the spectrum of H 1−36 shown on their Fig. A1 does not show any absorption features or red continuum. A complex nebula resolved at optical and radio wavelengths ([53] and references therein). The only symbiotic star known to support an OH maser [116].
101=RS Oph Bipolar nebula detected in radio range ([53] and references therein).

Table 7. Flickering and outburst characteristics of symbiotic and suspected symbiotic stars. SyN – symbiotic nova, SyRN – symbiotic recurrent nova, Z And – Z And type outburst

No.	Star	Flick.	Ref.	Out.	Type of Out.	Ref.
002	SMC2			+		[215]
004	SMC3			+		[215]
008	AX Per			+	Z And	[205]
010	o Ceti	+	[309]			
012	S32			+?		[129]
013	LMC S154			+?		[252]
024	V694 Mon	+	[62]	+		[176]
026	RX Pup			+	SyRN?	[202]
035	RT Cru	+	[48]	+		[48]
036	TX CVn			+	Z And	[175]
043	V840 Cen			+		[163]
050	V417 Cen			+?		[304]
057	T CrB	+	[140]	+	SyRN	[310]
058	AG Dra			+	Z And	[209, 85]
068	KX Tra			+		[162]
074	Hen 3−1341			+		[299]
084	V2116 Oph	+	[118]			
092	RT Ser			+	SyN	[235]
093	AE Ara			+	Z And?	[200]
096	V2110 Oph			+?		[12]
097	V916 Sco			+?		[257]
099	V917 Sco			+		[45]
101	RS Oph	+	[62]	+	SyRN	[137]
107	Bl 3−14			+		[177]
110	V745 Sco			+	SyRN	[284]
128	V2506 Sgr			+		[69]
132	YY Her			+	Z And	[228]
134	FG Ser			+	Z And	[232]
138	V4074 Sgr			+		[99]
139	V2905 Sgr			+?		[104]
142	AR Pav			+	Z And	[297]
143	V3929 Sgr			+?		[252]
148	V3890 Sgr			+	SyRN	[95]
156	FN Sgr			+	Z And	[200]
158	CM Aql			+	Z And	[136]
160	V1413 Aql			+	Z And	[220, 73]
164	V352 Aql			+		[105]
166	BF Cyg			+	Z And	[290]
167	CH Cyg	+	[62]	+		[210]
169	HM Sge			+	SyN	[235]
172	CI Cyg			+	Z And	[146]
174	V1016 Cyg			+	SyN	[235]
175	RR Tel			+	SyN	[235]
176	PU Vul			+	SyN	[156, 235]
177	LT Del			+		[27]
181	V1329 Cyg			+	SyN	[235]
183	V407 Cyg			+		[227]
185	AG Peg			+	SyN	[145, 235]
187	Z And	+	[292]	+	Z And	[207]
188	R Aqr			+		[206]
s13	V748 Cen			+		[221]
s14	V345 Nor			+		[69]
s15	V934 Her			+		[298]

Table 8. Different names for symbiotic and suspected symbiotic stars

001=SMC 1=NAME SMC1=[MH95] 183

002=SMC 2=NAME SMC2

003=EG And=HD 4174=BD+39 167=SAO 36618=GCRV 403=HIC 3494=GEN# +1.00004174= AG+40 66=GC 880=DO 8473=GPM1 20=SKY# 1157=AGKR 609=IRC +40014=JP11 413= PPM 43262=HIP 3494=*IRAS* 00415+4024

004=SMC 3=NAME SMC3=RX J0048.4−7332

005=SMC N60=LHA 115−N 60=LIN 323=HV 1707(???)

007=SMC N73=LHA 115−N 73=LIN 445 a

008=AX Per=MWC 411=HV 5488=CSI+54−01331=GCRV 896=JP11 5465=*IRAS* 01331+5359

009=V471 Per=PN M 1−2=PK 133−08 1=PN VV 8=LS V +52 1=PN G133.1−08.6=PN ARO 116=CSI+52−01555=PN VV' 11=*IRAS* 01555+5239

010=o Cet=MIRA=HD 14386=RAFGL 318=SKY# 3428=GC 2796=omi Cet=ADS 1778 AP= IRC +00030=YZ 93 562=MWC 35=BD−03 353=GEN# +1.00014386J= CCDM J02194−0258AP=PLX 477=GCRV 1301=JP11 625=CSI−03 353 1=DO 430= HIC 10826=SAO 129825=68 Cet=HR 681=UBV 21604=LTT 1179=TD1 1361= PPM 184482=JOY 1AP=*IRAS* 02168−0312

011=BD Cam=HD 22649=BD+62 597=HR 1105=SAO 12874=GC 4383=IRC +60125=FK4 129= UBV 3468=CSS 79=[HFE83] 244=GEN# +1.00022649=AG+63 277=N30 751= GCRV 2027=RAFGL 506=PPM 14446=HIP 17296=SKY# 5606=UBV M 9615=PLX 758= JP11 803=CSV 328=HIC 17296=S1* 60=*IRAS* 03377+6303

012=S32=StHA 32

013=LMC S154=LHA 120−S 154

014=LMC S147=LHA 120−S 147=[BE74] 484

015=LMC N19=LHA 120−N 19=[BE74] 191=LMC B0503−6803=MC4(0503−680)= PMN J0503−6757

016=UV Aur=HD 34842=BD+32 957=ADS 3934 A=IRC +30110=SAO 57941=HV 3322=Case 9= GEN# +1.0003482A=CGCS 911=IDS 05153+3224 A=AG+32 505=JP11 1034=UBV M 10852= AN 58.1911=LEE 179=RAFGL 735=PPM 70251=HIC 25050=GCRV 3199= DO 11210=CSI+32 957 1=Fuen C 29=CCDM J05218+3231A=C* 318=*IRAS* 05185+3227

017=V1261 Ori=HD 35155=BD−08 1099=RAFGL 736=SAO 132035=GCRV 56103=YZ 98 1455= HIC 25092=GEN# +1.00035155=GC 6602=HERZ 11764=CSS 133=HIP 25092=SKY# 8520= IRC −10086=PPM 187990=S1* 98=*IRAS* 05199−0842

019=LMC N67=CH−95=LHA 120−N 67=[HC88] 95

021=LMC S63=LHA 120−S 63=HV 12671

022=SMP LMC 94=LHA 120−S 170=LM 2−44

023=BX Mon=AS 150=HV 10446=MHA 61−12=JP11 5448=SS73 4

024=V694 Mon=MWC 560=SS73 5=LS 391=CSI−07−07234=GSC 05396−01135= MHA 61−14=*IRAS* 07233−0737

025=WRAY 15−157=*IRAS* 08045−2823

026=RX Pup=HD 69190=WRAY 16−17=HV 3372=CPD−41 2287=Hen 3−138=AN 88.1914=SS73 8= JP11 1653=PK 258−03 1=CD−41 3911=*IRAS* 08124−4133

027=Hen 3−160=SS73 9=WRAY 15−208

028=AS 201=MHA 382−43=Hen 3−172=SCM 38=PK 249+06 1=PDS 32=PN SaSt 1−1= PN G249.0+06.9=*IRAS* 08296−2735

029=KM Vel=Hen 2−34=WRAY 16−56=PK 274+02 1=ESO 212−13=PN G274.1+02.5= SS73 14=*IRAS* 09394−4909

030=V366 Car=Hen 2−38=PK 280−02 1=PN SaSt 1−3=ESO 167−11=WRAY 16−62= *IRAS* 09530−5704

031=Hen 3−461=PK 283+06 2=*IRAS* 10370−5108

033=SY Mus=HD 100336=SS73 32=HV 3376=WRAY 15−824=TD1 15706=Hen 3−667= AN 118.1914=CPD−65 11298=CSI−65−11298=SPH 127=*IRAS* 11299−6508

034=BI Cru=Hen 3−782=SVS 1855=*IRAS* 12206−6221

035=RT Cru=HV 1245=AN 131.1906

036=TX CVn=BD+37 2318=UBV M 2779=PPM 76696=JP11 5415=CDS 866=FB 110= Case A-F 788=AG+37 1208=SAO 63173=GEN# +0.03702318=*IRAS* 12423+3702

037=Hen 2−87=SS73 36=PK 302−00 1=WRAY 16−119=ESO 95−16=*IRAS* 12423−6244

038=Hen 3−828=SS73 37=WRAY 15−1022

039=SS73 38=CD−64 665=CGCS 3295=DJM 390=*IRAS* 12483−6443

041=St 2−22=PN Sa 3−22=PK 305+03 1

042=CD−36 8436=NSV 06160=Hen 3−886=JP11 311=PK 308+25 6=*IRAS* 13131−3644

043=V840 Cen=LILLER'S OBJECT

044=Hen 3−905=SS73 40=WRAY 15−1108

045=RW Hya=HD 117970=MWC 412=CPD−24 5101=YZ 115 9978=SAO 181760=CD−24 10977= GCRV 8034=HV 3237=PPM 261808=GEN# +1.00117970=JP11 2404=AN 51.1910= FAUST 3820=*IRAS* 13315−2507

046=Hen 3−916=SS73−42=WRAY 15−1123

047=V704 Cen=Hen 2−101=PK 311+03 1=PN G311.1+03.4=WRAY 16−141=ESO 133−7= *IRAS* 13515−5812

048=V852 Cen=Hen 2−104=PK 315+09 1=ESO 221−31=PN G315.4+09.4=SS73 43= NAME SOUTHERN CRAB=WRAY 16−147=SCM 78=*IRAS* 14085−5112

049=V835 Cen=Hen 2−106=WRAY 16−148=PK 312−02 1=ESO 97−14=SCM 79=NSV 06587= *IRAS* 14103−6311

050=V417 Cen=HV 6516=*IRAS* 14122−6139

052=Hen 2−127=SS73 45=PK 325+04 2=ESO 224−2=SCM 94=WRAY 16−180= *IRAS* 15210−5139

053=Hen 3−1092=Hen 2−134=SS73 46=PK 319−09 1=WRAY 16−186=LS 3391=ESO 99−10= JP11 5230=CSI−66−15425

054=Hen 3−1103=SS73 47=WRAY 15−1359

055=HD 330036=BD−48 10371=PN Cn 1−1=PK 330+04 1=CD−48 10371=HIP 77662= ESO 225−1=HIC 77662=WRAY 15−1364=PN G330.7+04.1=*IRAS* 15476−4836

056=Hen 2−139=PK 326−01 1=WRAY 16−193=ESO 178−2=*IRAS* 15508−5520

057=T CrB=HD 143454=MWC 413=GC 21491=IDS 15553+2612 AB=DO 15377=PPM 104498= GEN# +1.00143454J=BD+26 2765=GCRV 9203=SAO 84129=NOVA CrB 1866= CCDM J15595+2555AB=AG+26 1536=HR 5958=SBC 558=NOVA CrB 1946=HIC 78322= HIP 78322=*IRAS* 15574+2603

058=AG Dra=AG+66 715=CDS 889=SAO 16931=HIC 78512=1ES 1601+66.9= BPS BS 16087−0012=BD+67 922=GCRV 9231=UBV 13635=GEN# +0.06700922= 2E 1601.3+6656=2RE J1601+664=HIP 78512=JP11 236=SVS 1155=PPM 19692= 2E 3573=2RE J160133+664805=*IRAS* 16013+6656

059=WRAY 16−202=PN Sa 3−33=PK 332+01 1

060=V347 Nor=Hen 2−147=WRAY 16−208=PK 327−04 1=ESO 178−13=PN G327.9−04.3= *IRAS* 16099−5651

061=UKS Ce−1=UKS−Ce1=UKS Ce1=UKS 1612−22.0

062=QS Nor=Hen 2−156=SS73 53=WRAY 15−1461=PK 338+05 2=SCM 111=ESO 331−2= CSV 2635

063=WRAY 15−1470=Hen 3−1187=SS73 55

064=Hen 2−171=SS73 59=WRAY 16−226=PK 346+08 1=PN G346.0+08.5=ESO 390−7= *IRAS* 16307−3459

065=Hen 3−1213=SS73 60=WRAY 15−1511

066=Hen 2−173=SS73 61=WRAY 15−1518=PK 342+05 1=ESO 331−7

067=Hen 2−176=PK 339+00 1=WRAY 16−230=ESO 277−5=*IRAS* 16379−4507

068=KX TrA=Hen 3−1242=PN Cn 1−2=Hen 2−177=PK 326−10 1=WRAY 16−233= ESO 101−10=JP11 5232=PN StWr 1−1=JP11 5233=*IRAS* 16401−6231

069=AS 210=MHA 276−52=Hen 3−1265=SS73 66=JP11 5249=WRAY 16−237=PK 355+11 1= *IRAS* 16482−2555

070=HK Sco=HV 4493=AS 212=MHA 71−6=Hen 3−1280=SS73 68=WRAY 15−1563

071=CL Sco=HV 4035=AS 213=MHA 71−5=Hen 3−1286=SS73 69=WRAY 15−1564= CD−30 13603

072=PN MaC 1−3=PK 339−03 1

073=V455 Sco=HV 7869=AS 217=MHA 71−15=Hen 3−1334=SS73 74=PN H 2−2= PK 351+03 1=ESO 392−3=WRAY 16−252=Haro 3−2=PN VV' 162=*IRAS* 17040−3401

074=Hen 3−1341=NSV 08226=SS73 75

075=Hen 3−1342=SS73 77

076=AS 221=MHA 276−12=Hen 3−1348=SS73 79=PN H 2−4=PK 352+03 1=WRAY 15−1637= PN VV' 166=Haro 3−4=ESO 392−4=*IRAS* 17087−3230

077=PN H 2−5=PK 354+04 2=PN VV' 172=ESO 454−3=WRAY 15−1655=Haro 3−5= *IRAS* 17121−3131

078=PN Sa 3−43=PK 355+04 1

079=Draco C−1=Irwin Dra 22025=Stetson 3203=McClure C1=[ALS82] C1

080=PN Th 3−7=PK 356+04 3=PN ARO 249=ESO 454−12

081=PN Th 3−17=PK 357+03 3=WRAY 17−81=ESO 454−30=PN Sa 3−54

082=PN Th 3−18=PK 358+03 5=ESO 454−32=WRAY 17−83=Hen 2−228

083=Hen 3−1410=PN Th 3−20=PK 357+02 3=PN ARO 251=NSV 08805=WRAY 15−1714= ESO 454−37

084=V2116 Oph=GX 1+04=PK 001+04 1=4U 1728−24=1M 1728−247=H 1728−247= PN MaC 1−5=2S 1728−247=GX 2+05=2U 1728−24=3U 1728−24=3A 1728−247= 1H 1728−247

085=PN Th 3−29=WRAY 17−89=PN Sa 3−61=PK 358+02 3=ESO 455−15= *IRAS* 17299−2905

086=PN Th 3−30=PK 359+02 1=ESO 455−18=WRAY 17−90=Hen 2−243=PN Sa 3−63

087=PN Th 3−31=PK 358+01 2=ESO 455−19=Hen 2−245=WRAY 17−91= *IRAS* 17312−2926

088=PN M 1−21=SS73 90=Hen 2−247=PK 006+07 1=PN VV' 216=PN VV 103= ESO 588−7=*IRAS* 17313−1909

089=Hen 2−251=PK 358+01 3=PN H 1−25=PN VV' 218=Haro 2−25=WRAY 16−289= SS73 92=SCM 151=ESO 455−22=PN Bl A=*IRAS* 17321−2943

090=PN Pt 1=PK 003+03 3=EQ 1735−2352=ESO 520−12

091=PN K 6−6=WR 99=LuSt 1=PN G359.8+01.5=Terz V 2955

092=RT Ser=MWC 265=SS73 94=CSI−11−17371=NOVA Ser 1909=NOVA Ser 1917= GCRV 10203=AN 7.1917

093=AE Ara=HV 5491=MWC 591=Hen 3−1451=SS73 95=WRAY 15−1754=PN PC 18= PK 344−08 1=GSC 08347−01978=ESO 279−5

095=UU Ser=AS 237=SS73 98=AN 720.1936=HV 8771=CSV 2420

096=V2110 Oph=AS 239=MHA 79−52=Hen 3−1465=JP11 5250

097=V916 Sco=SSM 1=EQ 1740−360

098=Hen 2−275=WRAY 16−304=PK 351−05 1=ESO 334−8

099=V917 Sco=Hen 3−1481=SS73 103

100=PN H 1−36=PK 353−04 1=Hen 2−289=PN Sa 2−249=PN G353.5−04.9= ESO 393−31=PN VV' 259=Haro 2−36=*IRAS* 17463−3700

101=RS Oph=HD 162214=MWC 414=BD−06 4661=NOVA Oph 1898=AN 20.1901= PPM 201101=GCRV 10316=HV 164=SS73 106=JP11 2898=NOVA Oph 1933= *IRAS* 17474−0641

102=WRAY 16−312=PN Sa 3−80=PK 358−01 2

103=V4141 Sgr=PN Th 4−4=PK 008+03 2=ESO 589−10=PN ARO 260=*IRAS* 17477−1948

104=ALS 2=[ALS88] 2=SS 324=EQ 174755.9−174710=PK 010+04 7

105=AS 245=MHA 359−110=Hen 3−1501=SS73 107=PN H 2−28=PK 006+02 2= ESO 589−13=PN VV' 268=PN ARO 261=Haro 3−28=*IRAS* 17479−2218

106=Hen 2−294=PK 357−03 1=ESO 394−1=WRAY 16−318=*IRAS* 17483−3250

107=PN Bl 3−14=PK 000−01 4=ESO 455−55

108=PN Bl 3−6=PK 358−02 2=PN Sa 3−85=ESO 456−4=*IRAS* 17496−3120

109=PN Bl L=PK 359−02 1=PN Sa 3−86=ESO 456−6

110=V745 Sco=NOVA Sco 1937

111=PN MaC 1−9=PK 013+05 2

112=AS 255=MHA 363−45=Hen 3−1525=SS73 111=*IRAS* 17537−3513

113=V2416 Sgr=PN M 3−18=SS73 112=PK 007+01 2=ESO 589−24=PN VV' 295= Hen 2−312=Ve 2−61=*IRAS* 17542−2142

114=PN H 2−34=PN Sa 3−105=PK 001−02 1=ESO 456−28=PN VV' 304=Haro 3−34

116=AS 269=PN H 1−49=SS73 119=PK 358−05 2=Hen 2−331=MHA 304−52=ESO 394−23= WRAY 16−356=Haro 2−49=PN VV' 323=SCM 178=*IRAS* 18001−3242

117=PN Ap 1−8=SS73 121=PK 002−03 1=ESO 456−47=*IRAS* 18013−2821

118=SS73 122=PN KFL 6=*IRAS* 18015−2709

119=AS 270=Hen 3−1581=SS73 126=*IRAS* 18026−2025

120=PN H 2−38=SS73 128=PK 002−03 4=Hen 2−343=WRAY 17−108=ESO 456−51= PN VV' 342=Haro 3−38=*IRAS* 18028−2817

121=SS73 129=PK 001−04 3=T 17=PN KFL 8=*IRAS* 18038−2932

122=Hen 3−1591=SS73 132=T 53=NSV 10219=*IRAS* 18044−2558

123=V615 Sgr=Hen 2−349=PK 356−07 1=SS73 131=ESO 394−29=WRAY 15−1840= HV 7199=*IRAS* 18044−3610

124=Ve 2−57=SS 134=NSV 10241

125=AS 276=Hen 3−1595=SS73 135=MHA 363−7=*IRAS* 18058−4108

126=PN Ap 1−9=SS73 137=PK 003−04 2=Hen 2−356=WRAY 16−377=ESO 456−63= SCM 186=*IRAS* 18073−2753

127=AS 281=MHA 208−83=SS73 138=PN Ap 1−10=PK 003−04 1=WRAY 16−378= ESO 456−65=Hen 2−357=*IRAS* 18076−2757

128=V2506 Sgr=AS 282=MHA 304−113=Hen 2−358=SS73 139=PN Ap 1−11= PK 003−04 6=WRAY 16−379=ESO 456−66

129=SS73 141=PK 359−07 2=WRAY 16−384

130=AS 289=Hen 3−1627=SS73 143=F1−11=*IRAS* 18095−1140

131=Y CrA=HD 166813=Hen 3−1632=CSI−42−18107=SS73 144=HV 169= PK 350−11 1=AN 25.1901=*IRAS* 18110−4252

132=YY Her=AS 297=CSI+20−18124=GSC 01579−00381=AN 6.1919=JP11 5444= MHA 352−34

133=V2756 Sgr=AS 293=MHA 304−122=Hen 2−370=SS73 145=PK 002−05 1=ESO 456−79= WRAY 16−392

134=FG Ser=AS 296=D 143−2=SS73 148=SON 10363=JP11 5251=*IRAS* 18125−0019

135=HD 319167=PN CnMy 17=Hen 2−373=SS73 146=PK 001−06 1=WRAY 16−395= SCM 195=ESO 456−81

136=Hen 2−374=SS73 147=PK 009−02 1=ESO 590−10=*IRAS* 18126−2135

137=Hen 2−376=AS 294=NSV 10435=PK 004−05 2=MHA 304−123=WRAY 16−396= PN Sa 3−126=ESO 457−1

138=V4074 Sgr=AS 295B=Hen 3−1641=HIC 89526=HIP 89526

139=V2905 Sgr=AS 299=SS73 151=GEN# +6.20010299=MHA 208−92

141=Hen 3−1674=SS73 153=T 21=WRAY 15−1864=PN KFL 17

142=AR Pav=MWC 600=CPD−66 3307=GCRV 10756=HIC 89886=HV 7860=PPM 363277= HIP 89886=SBC 668=GSC 09080−00788=*IRAS* 18157−6609

143=V3929 Sgr=Hen 2−390=SS73 154=CSV 4026=PK 005−05 2=ESO 522−19= PN ARO 274=PN StWr 2−3=SCM 202=HV 9397=P 4629=*IRAS* 18178−2649

144=V3804 Sgr=AS 302=MHA 304−33=Hen 3−1676=SS73 155=*IRAS* 18182−3133

145=V443 Her=MWC 603=GCRV 68111=CSI+23−18201=JP11 5216=FB 171= *IRAS* 18200+2325

146=V3811 Sgr=Hen 2−396=ESO 590−19=PK 010−03 1=SS73 160=*IRAS* 18206−2157

147=V4018 Sgr=CD−28 14567=AS 304=Hen 3−1691=SS73 162=PN KFL 20= GSC 06869−00806=*IRAS* 18221−2837

148=V3890 Sgr=NOVA Sgr 1962=SS 390

149=V2601 Sgr=AS 313=MHA 208−51=SS73 171=*IRAS* 18349−2244

150=PN K 3−9=PN Sa 3−142=PK 023−01 1=*IRAS* 18376−0846

151=AS 316=MHA 208−58=Hen 2−417=SS73 172=PK 012−07 1=ESO 591−14

152=DQ Ser=CSV 4342

153=MWC 960=MHA 204−22=Hen 3−1726=SS73 174

154=AS 323=PN K 4−7=PK 026−02 2=MHA 369−39=PN ARO 292

155=AS 327=MHA 208−67=Hen 3−1730=SS73 176=PK 011−11 1=JP11 5253=WRAY 16−421

156=FN Sgr=AS 329=SS73 177=CSI−19−18509=NOVA Sgr 1925=GCRV 11342=JP11 5475

157=PN Pe 2−16=PK 029−02 1=PN Th 1−F=PN ARO 296=PN VV' 464

159=V919 Sgr=AS 337=MHA 227−6=SS73 178=AN 237.1932

160=V1413 Aql=AS 338=MHA 305−6=Hen 3−1737=PN K 4−12=PK 048+04 1=SS 428= *IRAS* 19015+1625

162=PN Ap 3−1=PK 037−02 1=SCM 231=PN ARO 145

163=PN MaC 1−17=PK 030−07 1

164=V352 Aql=PN K 3−25=PK 037−03 3=PN ARO 306=AN 279.1931=*IRAS* 19111+0212

165=ALS 1=[ALS88] 1=EQ 191333.1−082308=PK 028−09 3

166=BF Cyg=MWC 315=LS II +29 5=JP11 5433=CSI+29−19219 2=GCRV 11847= AN 112.1914

167=CH Cyg=HD 182917=SAO 31632=BD+49 2999=GCRV 11865=JP11 3103=RAFGL 2383= HIC 95413=GEN# +1.00182917=AG+50 1370=DO 37228=YZ 50 6001=HIP 95413= SKY# 36122=GC 26820=CDS 1064=IRC +50294=AN 24.1924=PPM 37375= *IRAS* 19232+5008

169=HM Sge=PK 053−03 2=2E 1939.7+1637=SVS 2183=2E 4280=*IRAS* 19396+1637

170=Hen 3−1761=NSV 12264=*IRAS* 19373−6814

171=QW Sge=AS 360=MHA 80−5=Hen 3−1771=JP11 5254=NSV 12383

172=CI Cyg=MWC 415=HV 3625=CSI+35−19484=JP11 5434=HIP 97594=GCRV 12195= AN 10.1922=HIC 97594=*IRAS* 19483+3533

173=StHA 169=NSV 12466

174=V1016 Cyg=AS 373=CSI+39−19553=JP11 5437=2E 1955.3+3941=PK 075+05 1= JP11 5438=2E 4302=GCRV 70112=MHA 328−116=*IRAS* 19553+3941

175=RR Tel=Hen 3−1811=SKY# 37701=AN 166.1908=2E 4313=CSI−55−20003= GCRV 6924 E=HV 3181=2E 2000.3−5552=*IRAS* 20003−5552

176=PU Vul=NOVA Vul 1979=KUWANO-HONDA=*IRAS* 20189+2124

177=LT Del=Hen 2−467=PK 063−12 1=PN ARO 353=StHA 179

179=Hen 2−468=PK 075−04 1=PN ARO 355

180=ER Del=BD+08 4506=AG+08 2842=SVS 654

181=V1329 Cyg=HBV 475=PK 077−05 1=UBV M 46710=VES 248=*IRAS* 20492+3518

182=CD−43 14304=Hen 3−1924

183=V407 Cyg=AS 453=MHA 289−90=AN 148.1940=NOVA Cyg 1936

184=StHA 190=RJHA 120=*IRAS* 21392+0230

185=AG Peg=HD 207757=MWC 379=AGKR 19529=JP11 3412=TD1 28516=SKY# 41636= HIC 107848=GEN# +1.00207757=BD+11 4673=SAO 107436=DO 7622=HIP 107848= AG+12 2570=PLX 5279=GCRV 13724=YZ 12 8693=SBC 879=PPM 140717= *IRAS* 21486+1223

186=LL Cas=PN K 4−46=PK 108−05 1=AN 207.1940=PN ARO 379

187=Z And=HD 221650=MWC 416=PLX 5697=SAO 53146=2E 2331.6+4834=GEN# +1.00221650= BD+48 4093=GCRV 14773=HV 193=PPM 64386=2E 4735=AG+48 2087=JP11 3636= AN 41.1901=HIC 116287=HIP 116287=*IRAS* 23312+4832

188=R Aqr=HD 222800=SAO 165849=HR 8992=GCRV 14862=MWC 400=SKY# 44830= GC 32948=YZ 105 8733=PPM 242022=HIP 117054=GEN# +1.00222800=IRC −20642= BD−16 6352=RAFGL 3136=HIC 117054=*IRAS* 23412−1533

s01=RAW 1691=[MA93] 1858=LIN 521

s04=CD−28 3719=CSS 294=Hen 3−21=Hen 4−18=S1* 200=*IRAS* 06591−2902

s05=GH Gem=CSV 950=AN 241.1943

s06=ZZ CMi=BD+09 1633=IRC +10162=AN 306.1934=GCRV 4915=HIP 35915=HIC 35915= *IRAS* 07214+0859

s07=NQ Gem=HD 59643=BD+24 1686=SAO 79474=N30 1687=DO 13087=YZ 24 2992= GEN# +1.00059643=AG+24 848=YZ 0 823=PPM 97628=CGCS 1737=SKY# 13794= UBV M 13339=GCRV 5014=UBV 7255=LEE 197=HIC 36623=HIP 36623= C* 779=*IRAS* 07288+2436

s08=WRAY 16−51=PK 271+03 1=*IRAS* 09316−4621

s09=Hen 3−653=SS73 30=PK 323−08 1=WRAY 15−807=*IRAS* 11232−5940

s10=NSV 05572=Ross 234=G 241−60=GD 407=LTT 16957

s11=CD−27 8661=CSS 792=Hen 3−785=Hen 4−121=S1* 443=*IRAS* 12219−2802

s12=AE Cir=HV 5112

s13=V748 Cen=CD−32 10517=CSV 2229=SON 5003=[OM87] 145632.12−331309.6

s14=V345 Nor=HV 8827=NSV 07429=CSV 2543

s15=V934 Her=HD 154791=BD+24 3121=3A 1703+241=SKY# 30847=AG+24 1704= YZ 24 5850=1E 1704.4+2402=2A 1704+241=2E 1704.4+2402=AT 1700+239= AGKR 15254=PPM 105555=1H 1706+241=2E 3831=HIP 83714=SAO 84844=DO 15788= 4U 1700+24=HIC 83714=1ES 1704+24.0=*IRAS* 17044+2402

s16=Hen 3−1383=SS73 82=WRAY 15−1680

s18=WSTB 19W032=PK 359+01 3=ESO 455−139=SCM 152=PN G359.2+01.2= *IRAS* 17358−2854

s19=WRAY 16−294=PK 002+02 1

s20=AS 241=PN H 2−19=WRAY 16−302=PK 351−04 1=MHA 363−30=PN Sa 3−70=ESO 334−7= PN VV' 238=Haro 3−19=*IRAS* 17415−3816

s22=V618 Sgr=HV 7203=AN 313.1933

s23=AS 280=SS73 136=PK 358−06 1=Hen 2−354=WRAY 16−375=MHA 304−17=ESO 394−32

s24=AS 288=PN H 2−43=PK 003−04 9=ESO 456−75=PN G003.4−04.8=MHA 304−119= WRAY 16−388=PN VV' 367=Hen 2−366=Haro 3−43=*IRAS* 18095−2820

s25=Hen 2−379=SS73 150=PN M 1−44=PK 004−04 2=PN VV 165=WRAY 16−399=SCM 198= ESO 522−11=PN G004.9−04.9=PN VV' 380=*IRAS* 18131−2705

s26=V335 Vul=AS 356=MHA 215−33=Case 452=LD 120=GSC 02128−00676= C* 2728=CGCS 4253=*IRAS* 19211+2421

s27=V850 Aql=PN K 4−26=PK 037−06 2=CSV 4646=PN ARO 320=*IRAS* 19210+0032

s28=Hen 2−442=PN M 4−16=PK 061+02 1=PN G061.8+02.1=PN ARO 157

s30=V627 Cas=AS 501=RAFGL 2999=MHA 73−59=HBC 316=*IRAS* 22556+5833

102=WRAY 16−312 *IRAS* and *JHKL* colours confirm earlier suggestions [312, 313] that cool component of this system is a Mira [1]. In the optical spectrum presented in [18] there are emission lines with ionization potential up to 108.8 eV and moreover lines of H I and He I are present [1]. *IRAS* data from [142].

103=V4141 Sgr Classified as S-type in [18, 233], but in the near-IR/*IRAS* colour diagrams (e.g. [141, 313]) it falls in the region occupied by symbiotic Miras [198]. K-band spectrum shows strong CO 2.3-μm band consistent with an M6 giant [204]. Spectral type of cool component also estimated in [174, 18] to be mid or late M.

105=AS 245 Classified as S-type in [14, 198] but in the near-IR/*IRAS* colour diagrams (e.g. [141, 313]) it falls in the region occupied by symbiotic Miras [313].

107=Bl 3−14 The finding chart in [18] is good, but the coordinates are reported to disagree with the measured position: $\alpha = 17^{h}52^{m}06^{s}.4, \delta = -29°45'49''$ (1950) [90] (if this is right, our coordinates should also be corrected).

110=V745 Sco VK magnitudes during decline from outburst [284].

112=AS 255 IR-type S –[18, 16], D –[137, 172].

114=H2−34 Spectral type M5 is estimated by comparing "by eye" the depths of TiO λ 6180 and λ 7100 Å in the spectrum in Fig. 2 in [198] with those of spectral standards.

115=SS73 117 *IRAS* data from [142].

116=AS 269 This is a yellow symbiotic star, cool component is G-K giant [198, 3]. In the optical spectrum there are emission lines with ionization potential up to 54.4 eV [130].

118=SS73 122 IR-type D –[142], others note only possible S type ([18, 137]).

120=H 2−38 There was a report of a pulsational period of 433 days for this star in [221], but this is a mistake and the reported number is the pulsation period of another symbiotic star: V366 Car (Hen 2−38). The spectral type of the cool component is estimated in [14] to be M8.5.

122=Hen 3−1591 IR-type D –[18, 233], S –[137, 20].

124=Ve 2−57 Cool component is M star [11]. In the optical spectrum there are emission lines with ionization potential up to 35.1 eV or probably up to 54.4 eV [11].

125=AS 276 IR-type S –[18, 16], D –[137]. There is also a D' classification in [172], but it doesn't look reliable.

128=V2506 Sgr *IRAS* data from [93].

132=YY Her *IRAS* data from [142].

133=V2756 Sgr Finding chart in [248] is incorrect ([293]).

134=FG Ser K magnitude during outburst. Coordinates taken from [96] – SIMBAD coordinates are not correct.

138=V4074 Sgr *IUE* observations reported in [187].

139=V2905 Sgr *IRAS* data from [92]. Spectral type of cool component also estimated in [245] to be K/M.

146=V3811 Sgr Mis-identified in [248] and in [19] (see [20]).

148=V3890 Sgr Cool component is M4-8 giant ([95, 316, 283]). In the optical spectrum there are emission lines with an ionization potential up to 361 eV [316]. This object was earlier classified as recurrent nova with M type companion [283, 95]. The spectrum is also presented in [317].

156=FN Sgr *IRAS* data from [92].

160=V1413 Aql Spectral type M4 estimated from the TiO λ 7100 band depth as observed during mid-eclipse [197].

162=Ap 3−1 Short description of optical spectrum is given in [18]. The object was identified with the 2U 1907+2 X ray source [44] but so far there is no *ROSAT* detection, so this identification might not be correct.

166=BF Cyg *IRAS* data from [142].

167=CH Cyg Complex nebula with jet-like features resolved at optical and radio wavelengths ([53] and references therein). Both the light curves and the radial velocity curves show multiple periodicities: a $\sim 100^{d}$ photometric period has been attributed to radial pulsation of the giant [211], while the nature of the secondary period of $\sim 756^{d}$ also present in the radial velocity curve, is not clear [231]. There is controversy about whether the system is triple or binary [77], and whether the symbiotic pair is the inner binary [288] or the white dwarf is on the longer orbit [193, 74].

169=HM Sge Mean K magnitude during outburst. A complex nebula with possible jet-like features resolved at optical and radio wavelengths ([53] and references therein, [253]). The nebula is aligned with the binary orientation deduced from spectropolarimetry of the Raman scattered O VI lines [264].

170=Hen 3−1761 *IRAS* data from [142]. *IUE* observations reported in [183].

171=QW Sge *IRAS* data from [142] although [222] report no *IRAS* detection.

172=CI Cyg Coordinates from VLA observations [203].

174=V1016 Cyg A complex nebula with possible jet-like features resolved at optical and radio wavelengths ([29, 53] and references therein).

176=PU Vul V mag during the decline from outburst (XI 1994) [156]. In [321] $\sim 211^{d}$ periodicity has been reported.

177=LT Del *IRAS* data from [92]. Spectral type of cool component also estimated in [168] to be G5.

180=ER Del Cool component is S star of type S5.5/2.5 [6]. In the UV, there are emission lines with an ionization potential up to 47.9 eV and a strong UV continuum indicates the presence of a hot companion [119]; in the optical spectrum there are emission lines of H I [119].

181=V1329 Cyg The system inclination, $i = 86° \pm 2°$, and the position angle of the orbital plane, 11°, has been derived from spectropolarimetric studies. An extended nebulosity detected in the [O III] λ5007 line is aligned with the orbital plane [261].

182=CD−43 14304 The system inclination, $i = 58° \pm 6°$, and the position angle of the line-of-nodes, $\Omega = 103° \pm 7°$, has been derived from spectropolarimetric studies of the Raman-scattered O VI emission lines [91].

183=V407 Cyg *IRAS* data from [94]. IR-type S –[117], D –[227] and also there is D' estimate in [112]. In [227] there is an estimate of the orbital period of 43 yrs.

184=StHA 190 In [266] there is a suggestion, based on the *IRAS* ratio of F_{12}/F_{25}, that the cool component in this system is a Mira variable. Comparison of *IRAS* fluxes with diagnostic diagrams in [142] shows that this object is among or close to D' systems, and the $VJHKL$ colours are consistent with a G-K giant, so there is no reason to think that a Mira variable is present in this binary. The authors of [266] argue that $F_{12}/F_{25} > 1.0$ suggests the presence of a Mira but it may be merely the signature of dust around the system.

185=AG Peg VK magnitudes during outburst. A complex nebula with possible bipolar structure detected at optical and radio wavelengths ([53] and references therein).

186=LL Cas The presence of the [Fe VII] 4892 Å line reported in [159] is not reliable because of the absence of the strongest [Fe VII] 6087 Å iron line at that time. In [159], there is a report of a possible pulsational period for the cool component of this system (286.6 days). This is a plausible explanation, as the spectrum taken at maximum light shows a more pronounced late-type continuum than the spectrum taken at minimum (see [159]), indicating that the cool component is responsible for this variability. IR colours: $J = 8.90$, $H = 8.03$, $K = 7.55$ [9]) with assumed modest amount of interstellar reddening ($A_K = 0.2$) give $J_0 = 8.44$, $H_0 = 7.67$, $K_0 = 7.35$ which corresponds to the colours of a normal giant in an S-type symbiotic star, although this might still be a Mira without an IR excess (like the Mira in R Aqr, which is another S-type symbiotic star).

187=Z And Spectral type of cool component also estimated in [107] to be ∼M5.2. An inclination of $i = 47 \pm 12°$ and an orbit orientation, $\Omega = 72 \pm 6°$, derived from spectropolarimetry [269]. There is a report on 28-minute coherent oscillations observed in Z And [292]. We have included Z And in Table 7 as system with flickering, although these oscillations are different from rapid light variations observed for other symbiotics.

188=R Aqr The binary has been spatially resolved and a preliminary orbit (with a period of ∼ 44 yrs) derived in [106, 66]. The system is embedded in a complex bipolar nebula with jets ([53] and references therein).

Suspected symbiotic stars

s01=RAW 1691 Carbon star [311] + H_α profile as for interacting binary star [303].

s02=[BE74] 583 Suspected in [218].

s03=StHA 55 Carbon star [67] + with strong H I emission [67] (too strong for single carbon star).

s04=CD−28 3719 A symbiotic nature of this star has been suggested based on its broad H_α profiles ([124]) and blue colors ([305]).

s05=GH Gem Suspected in [190, 137].

s06=ZZ CMi This object was classified as symbiotic in [108, 41]. We disagree with this classification because: *i)* colours are bluer at minimum [324], the opposite to what is observed for symbiotics; the light curve looks more like a pulsational curve and not like a symbiotic light curve; *ii)* the spectrum presented in [108] does not look like a symbiotic spectrum (e.g. $H_\gamma > H_\beta$) and is noisy ([Ne III] line may not be present (so $IP_{max} = 35.1$ eV). However, this object contains a late-type star (though we do not know if the star is giant) and it displays an emission-line spectrum; also, the H_α profile shown in [41]) looks like a symbiotic star (for comparison see [303]). We therefore include this object as suspected symbiotic.

s07=NQ Gem Suspected in [120]. Highly variable UV continuum with strong C IV] emission and Si III]/C III] ratio similar to symbiotic stars. He II 1640 Å emission line has been detected in 1979 by *IUE*.

s08=WRAY 16−51 Probable presence of late-type star and emission-type spectrum (H I emission lines) [174].

s09=Hen 3−653 Suspected in [18, 245]: late-type star and emission-type spectrum (H I and He I emission lines).

s10=NSV 05572 Late-type giant and emission type-spectrum (H I emission lines).

s11=CD−27 8661 A symbiotic nature of this star has been suggested based on its broad H_α profiles ([124]) and blue colors ([305]).

s12=AE Cir Suspected in [149]. Periods of 3900 and 100 days are mentioned in [149] (based on visual photometric observations).

s13=V748 Cen Suspected in [137]: M type giant [301, 271] and emission-line spectrum (H I, Fe II, [Fe II], [S II]) [302] and UV excess.

s14=V345 Nor Suspected in [164]: M star [165] and emission-line spectrum (H I, Fe II) [165]. Listed as N Nor 1985/2 in [69].

s15=V934 Her Suspected in [82]: M bright giant and UV emission lines with ionization potential up to 77.5 eV but no emission lines in optical spectrum and no short-wavelength continuum was found (the $1200 - 2800$ Å integrated flux $< 1.5\,10^{-14}$ erg s^{-1} cm^{-2} Å^{-1} at Earth) which excludes the presence of a hot white dwarf companion (although a neutron star is still possible).

s16=Hen 3−1383 Possible M type star [256] and emission-type spectrum (H I, He I) [11]. Nebula resolved at radio wavelengths ([53] and references therein).

s17=V503 Her Suspected in [137]: M star [40] and blue excess in the optical spectra suggesting presence of hot companion.

s18=WSTB 19W032 Late type giant [52] and emission-line spectrum: lines of H I, He I and others with ionization potential up to 35.1 eV. But this emission-line spectrum might not be physically connected with the giant [52].

s19=WRAY 16−294 Suspected in [198]: red continuum typical of reddened K giant and emission-line spectrum (H I, He I and others with ionization potential up to

35.1 eV). WRAY 16−294 appears as WRAY 16−296 in [198].

s20=AS 241 Suspected in [18]: M star [198] and emission-line spectrum (H I, He I) [198]. M6 spectral type of cool component and D' IR type from [172] are not reliable, as M6 does not agree with IR colours (JHK) and authors do not follow original definition of D'.

s21=DT Ser Considered as symbiotic in [49, 50]: emission spectrum of H I, He I and other lines with ionization potential up to 54.4 eV plus G? [49] or G2-K0 III-I [50] cool component. But there is a report of a G star 5″ from this object, so the cool component may not be connected physically with the source of the emission-line spectrum.

s22=V618 Sgr Presence of late-type component (TiO bands in optical spectrum [150]) and emission-line spectrum (H I, Fe II [150]).

s23=AS 280 Suspected in [198]: this object resembles a symbiotic star in outburst.

s24=AS 288 This object shows optical emission-line spectrum (H I, He I and others with ionization potential up to 54.4 eV) but no late-type component has been seen so far, however K magnitude and *IRAS* fluxes compared to diagnostic diagrams in [142] place this object among symbiotics (of IR type D), emission-line fluxes ([O III]4363, 5007 Å, H_β, H_γ) compared to diagnostic diagrams in [181] place this object also among symbiotics (among IR type S but close to D-type objects).

s25=Hen 2−379 Cool component is G-K giant [168, 293] and there is emission-line spectrum: H I, He I and other lines with ionization potential up to 35.1 eV. But K giant might not be physically associated with nebula, which is source of the emission [170]. Finding chart in [248] is unclear as reported in [293].

s26=V335 Vul Suspected in [229]: presence of carbon giant and optical emission-line spectrum (H I) displaying hot continuum in blue. We agree with this classification although this object might be a single pulsating star: *(i)* the carbon star might pulsate with period of 342 days [57] and then emission lines behave as for a Mira variable – they disappear near minimum light and show up again at maximum (see spectra in [229]); *(ii)* H_α is very narrow: 2 Å (90 km s^{-1}) and for a symbiotic star we would expect a width of about $300-500$ km s^{-1}; *(iii)* the Balmer decrement is different than that observed for symbiotic stars (it resembles that of Mira variable), although the authors of [229] claim that the Balmer decrement resembles that of a symbiotic star.

s27=V850 Aql Probable presence of Mira [39, 147] or late-type star [3] in the centre of planetary nebula PK 037−6 2 (see note in [147]) with emission-line spectrum (H I lines). In [3] and [39] there are notes that in [19] this object is classified as symbiotic, but this is not true and in [19] there are only IR colours for V850 Aql.

s28=Hen 2−442 Suspected in [323]: TiO bands probably present, suggesting cool component [25, 323] and optical emission-line spectrum: H I, He I and other lines with ionization potential up to 100 eV. Hen 2−442 consists of two PN like objects: Hen 2−442A and Hen 2−442B [25] and values in catalogue are for the whole system. Symbiotic nature was suggested for Hen 2−442 A.

s29=IRAS 19558+3333 Suspected in [277]: OH/IR star, based on *IRAS* colours, but without an OH maser, so a probable, extreme D-type system. Radio continuum emission implies a hot, ionising companion. Correct coordinates given here for precise radio emission (incorrect coordinates given by [277]).

s30=V627 Cas Suspected in [158]. Spectral type of cool component also estimated in [154] to be M2-4.

5. Comments on other objects not included in the catalogue

V1017 Sgr In some publications, regarded as symbiotic, probably after inclusion in Kenyon's catalogue ([137]), but this is not a symbiotic star. This object is a cataclysmic variable with orbital period of 5.7 days ([282]).

CI Cam The optical counterpart of XTE J0421+560. Reported as symbiotic in [147], possibly after suggestion in [34]. It is, however, a high-mass X-ray binary with a Be star donor [51, 32].

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