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New results for Galactic post-AGB objects. *(Research Note)*

Spectral types distribution and M-type central stars problem

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ABSTRACT

Context. The Toruń catalogue of Galactic post-AGB and related objects was created to facilitate the research on the unsolved problems of the late evolution of intermediate-mass stars such as the AGB - post-AGB transition and switch from spherical to non spherical symmetry during this phase, or the dual dust chemistry, but also to help in the identifiction of new post-AGB objects among AKARI sources.
Aims. The main reason for this upgrade of the catalogue was the necessity to open entries for *possible* post-AGB objects. As we have checked, most of them have double-peaked spectral energy distribution which is believed to be typical for post-AGB phase.
Methods. We have searched the literature available on the NASA Astrophysics Data System to find new or missed post-AGB objects and analysed available data provided by the Vizier for the new post-AGB objects with an open entry.
Results. We have updated *the Toruń catalogue of Galactic post-AGB and related objects*. The present version of the catalogue contains 346 *very likely*, 106 *possible* and 60 *unlikely* post-AGB objects. We have given on-line access to optical spectra for 130 *very likely* and *possible* objects. Altogether, the catalogue gives available optical and infrared photometry, optical and infrared spectra and spectral types, and links to finding charts and bibliography, for 452 *very likely* and *possible* post-AGB objects.

Key words. stars: AGB and post AGB stars — Stars: evolution — Catalogs

1. Introduction

Post-Asymptotic Giant Branch (post-AGB) stars are rapidly evolving stars of low- and intermediate initial mass ($\sim 0.8 - 8$ $M_\odot$), in the transition phase between AGB and planetary nebulae (PNe) (c.f. Kwok 1993; van Winckel 2003; Waelkens & Waters 2004). This phase is very short (of the order of 1000 yrs) but yet very important and still poorly understood. For example, the AGB - post-AGB transition and the origin of the observed changes in geometry, from spherical on the AGB to aspherical in post-AGB objects and PNe, remains an open issue. The dual dust-chemistry observed in PNe and some post-AGB objects is just starting to be studied as well.

To facilitate the research on the unsolved problems mentioned above, we have published *The Toruń catalogue of Galactic post-AGB and related objects* (Szczerba et al. 2007, hereafter Paper I). So far, the information on post-AGB objects was disseminated among the astronomical literature, and no systematic search of the properties of post-AGB objects was attempted. The published version of the catalogue contains 3 categories or sub-catalogues: *very likely*, *possible* and *disqualified* (now rephrased *unlikely*) post-AGB objects. The distinction between *very likely* and *possible* was based on the number of references in the Astrophysics Data System (ADS) in favor of the classification of the object as post-AGB. The limit applied in most cases was arbitrarily set to 5. Obviously, such a classification is bound to evolve with time, both because of the increasing number of papers and because of a personal evaluation of the criteria. Data

We have now checked that many of the sources labelled *possible* post-AGBs actually show the characteristic double-peaked spectral energy distribution (SED) seen in classical post-AGB sources (e.g. Kwok 1993), where the optical peak is attributed to the star and the infrared peak to the detached

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dusty envelope. Therefore, the natural approach was to provide on-line access to the data collected for *possible* post-AGB sources, as well (these data were not available on-line in the previous version of the catalogue). In addition, we have added data from the new release of the Guide Star Catalogue, version 2.3.2 to the old

In addition we have included optical spectroscopy and spectral type (if available) from Suárez et al. (2006) and Pereira & Miranda (2007), and added data from the new release of the Guide Star Catalogue, version 2.3.2.

In Sect.A we describe the updates of our catalogue and discuss briefly the problem of M-type central stars of post-AGB objects. Updated statistical properties of the post-AGB objects are shortly described in Sect.2. Concluding remarks are presented in Sect.3.

1.1. The M-type stars problem

In Paper I we had systematically disqualified from being post-AGB objects those sources that have central stars classified as M-type. Exceptions were two RV Tau stars (which as a group are considered post-AGB objects in our catalogue) classified as *possible* because of the confusion with their spectral types: EG Lyr with spectral type M5III as given by SIMBAD and GK Car with spectral type M0I as given by de Ruyter et al. (2006). As discussed by Szczerba et al. (2001), at least in the case of H-burning models, a low temperature of the central star (below about 4000 K or spectral type later than K) at the beginning of the post-AGB evolution would result in a too long evolution during the proto-planetary phase and a full dispersion of matter before ionization. More recent discussion of the relation between the mass of the H-rich envelope and the effective temperature can be found in Frankowski (2003). One can argue that the lowest mass objects may start their post-AGB evolution still being M-type stars. However, the lowest mass stars had the lowest mass loss rates at the end of AGB and therefore they should show the smallest infrared excess. In our sample of M-type post-AGB objects the infrared excess (as inferred from the height of the IR peak relative to the height of the optical peak) is significant and suggests a rather large mass loss rate at the end of their AGB evolution. The only case of small infrared excess is EG Lyr, which has single-peaked SED with maximum at near-IR wavelenghts.

With the optical spectra and their spectral classification now available (Suárez et al. 2006), we can address the problem of M-type post-AGB objects in more depth. Among 102 post-AGB objects from Suárez et al. (2006) there are 11 objects with optical spectra classified as M-type. They are:

- IRAS 05089+0459 (M3 I; disq.)
- IRAS 07227−1320 (M1 I; disq.)
- IRAS 07430+1115 (M2 I; v.l. - information about spectral type from Suárez et al. 2006 was missing)
- IRAS 13010−6012 (M2 I; cand. - information about spectral type from Suárez et al. 2006 was missing)
- IRAS 15406−4946 (M4 II; disq.)
- IRAS 16279−4757 (M3 II; v.l. - information about spectral type from Suárez et al. 2006 was missing)
- IRAS 16476−1122 (M1 I; disq.)
- IRAS 17223−2659 (M5 III; disq.)
- IRAS 17253−2831 (M4 III; miss.)
- IRAS 18420−0512 (M1 I; disq.)
- IRAS 19225+3013 (M2 II; disq.),

where, in parenthesis we have shown spectral type from Suárez et al. (2006) and the object status in the previous version of the catalogue: disq. - *disqualified* (*unlikely*); cand. - *possible*; v.l. - *very likely*; miss. - *missed* source.

In this version of the catalogue, 2 objects (IRAS 07430+1115, and IRAS 16279−4757) are classified as *very likely*, while the remaining 9 as *possible* objects. IRAS 07430+1115 clearly shows the presence of the aromatic infrared bands (AIBs) at 3.3 and 3.4 μm and the star itself shows clear signature of C_2 and C_3 absorption bands (see Hrivnak et al. 2007 and references therein). We have checked that optical spectrum of Suárez et al. (2006) shows the same absorption bands of C_2 and C_3 (see their Fig. A1) as in the Hrivnak & Kwok (1999). It mean that the M-spectral type was mistakenly attributed to this C-rich source by Suárez et al. (2006). Another source where AIBs are observed, while the optical spectrum is classified as M-type by Suárez et al. (2006) is IRAS 16279−4757 (see Matsuura et al. 2004). It seems to be unlikely that an M-type source is able to excite AIB's, so it may be that a wrong counterpart was observed by Suárez et al. (2006).

The remaining 9 objects with M-type spectra obtained by Suárez et al. (2006) are classified as *possible*. They have double-peaked SED and low IRAS variability index. In fact, the IRAS variability index in all cases is below 15 percent, except for IRAS 17253−2831, where it reaches 45%, but the MSX variability flag is set to 0 for all MSX measurementsof this source. In addition, the MSX variability flags (for sources which were observed by MSX) are 0, except for band C (at 12.13 μm) for IRAS 07227−1320 where it is set to 1 (avariability of 3.8 σ has been reported). Therefore, taking into account their SEDs (which are typical for post-AGB objects) and non-variability in the infrared we may expect that these 9 objects are genuine post-AGB objects with M-type central stars. As we discussed in Sect A.2 in some cases (IRAS 15406−4946, IRAS 17223−2659, and IRAS 17253−2831) a wrong counterpart might been observed. However, in at least 4 sources (IRAS 05089+0459, IRAS 07227−1320, IRAS 16476−1122, and IRAS 19225+3013) this is probably not the case, since the striking match between optical spectroscopy and photometry suggest that the correct counterpart was observed. In these cases a large IR excess and M-type central source seems to be a good example of discrepancy between theory and observations. In one case (IRAS 13010−6012) the optical spectrum is below the photometric data (it may be understood, for example, by bad weather conditions during observations), and in one case (IRAS 18420−0512) the optical spectrum is above (probably a result of wrong callibrations). In both these cases the shape of optical sectrum follows that of photometry.

Concluding, we can state that in our sample we have at least 4 objects from Suárez et al. (2006), which are genuine post-AGB due to their double-peaked SEDs, and have M-type

central stars with optical spectra well matched to the collected photometry. In addition, at least one RV Tau star with M-type spectrum reported by de Ruyter et al. (2006) also deserve special attention as a possible post-AGB object with M-type central star. Now, when 2MASS counterparts are known, the new optical observations of these several objects may be necessary to fully confirm the existence of M-type post-AGB stars with large IR excess and to understand the origin of this class of objects.

2. Some statistical properties of post-AGB objects in our catalogue

The distribution of the *very likely* and *possible* post-AGB objects among the classes of objects introduced in Paper I is shown in Table 1. The classes of objects introduced in Paper I are: *IRASsel* - IRAS selected sources, *hglsg* - high Galactic latitude supergiants, *hglB* - high Galactic latitude B-type supergiants, *IRexc* - bright stars with infrared (IR) excess, *UU Her* - UU Her-type stars, *RV Tau* - RV Tau stars, *R CrB* - R CrB stars, *eHe* - extreme helium stars, *LTP* - Late Thermal Pulse objects, *21 micron* - 21 micron emission sources, *refneb* - reflection nebulosity, *?* - objects for which the classification is uncertain. Note that one object may belong to several classes.

Table 1. How the *very likely* and *possible* post-AGB objects are distributed among various classes.

Class	*very likely*	*possible*
IRASsel	131	87
hglsg	63	5
hglB	9	
hotpAGB	22	2
IRexc	34	
UU Her	13	1
RV Tau	101	4
R CrB	36	
eHe	16	
LTP	2	
21 micron	12	
refneb	5	
?		10

There are 264 objects classified as post-AGB in the SIMBAD catalogue[1]. Of these 189 are among our *very likely* post-AGB objects, 48 are *possible*, 3 have been *unlikely*, IRAS 05298−6957 is an LMC object, and we are still keeping 23 objects on the "waiting list" of OH-selected sources as possible non-variable OH/IR stars which are not considered in this edition of the catalogue.

There are 49 objects classified as post-AGB candidates in the SIMBAD catalogue. Of these 37 are among our *possible*, 2 have been classified as *unlikely*, and 10 are among the *very likely* group.

There are 97 stars classified as RV Tau in the SIMBAD database. Of these 79 are in our list of *very likely* post-AGB objects, 2 are among *possible*, 11 are *unlikely* and 5 are not considered in the catalogue since they are LMC sources. On the other hand, we included in the catalogue 22 RV Tauri stars which are not classified as RV Tau in the SIMBAD database. They are mostly from the work of de Ruyter et al. (2006). The statistics of helium-rich stars (*R CrB*, *eHe* or *LTP*) remains the same as in Paper I.

On the other hand, our catalog still contains 18 *very likely* sources and 12 *possible* (not classified as *RV Tau*, *R CrB*, *eHe* or *LTP* objects) which are not considered as post-AGB objects or post-AGB candidates in the SIMBAD database.

Fig. 1 shows four panels with the distribution of spectral types for the *very likely* and *possible* post-AGB objects in our catalogue (left panels) and only *very likely* sources (right panels). The top panels correspond to post-AGB objects located relatively close to the Galactic plane, while the bottom ones correspond to high Galactic latitudes ($|b| > 15°$). These diagrams were prepared taking into account the spectral types derived by Suárez et al. (2006) or Pereira & Miranda (2007) and from SIMBAD in other objects. The only exceptions are the two *very likely* post-AGB objects (IRAS 07430+1115, and IRAS 16279−4757) which spectra were classified as M-type by Suárez et al. (2006), but for which we prefer the spectral type given by SIMBAD (see Sect. 1.1 for details).

As previously (Szczerba et al. 2007) a gap around 10000 K (spectral type A) is clearly seen. The existence of such gap can be inferred from theoretical models (e.g., Blöcker 1995) and is related to the evolutionary rates during the post-AGB phase of stellar evolution. The problem of post-AGB objects with spectral type M was discussed briefly in Sect.1.1. We note, however, that by taking into account the spectral classification by Suárez et al. (2006), the problem discussed in Paper I, of difference in the distribution of spectral types for sources lying higher and closer to the Galactic plane had disappeared. Now, there are more F-type stars than G-type ones for different classes of post-AGB objects. However, the distributions of spectral types shown in these plots still cannot be considered as representative of the true distribution, because they do not result from a systematic survey.

3. Summary

By searching the available literature we were able to find new *very likely* as well as *possible* post-AGB objects in our Galaxy and include them in our catalogue. The present version contains 346 *very likely*, 106 *possible*, and 60 *unlikely* post-AGB objects. We made significant changes in comparison to the previous version of the catalogue: We opened data entries for *possible* post-AGB objects, we added 130 optical spectra from Suárez et al. (2006) and Pereira & Miranda (2007), and introduced new photometry data from GSCversion 2.3.2). The catalogue can be used to look for correlations between various properties of post-AGB objects and to search for evolutionary connections between different classes of post-AGB stars and

[1] The new release of SIMBAD database is available from the end of 2006. SIMBAD 4 gives more identifiers, measurements and classifications than its previous version, which was used in the first release of the Toruń catalogue. This version of our catalogue makes use of SIMBAD 4 .

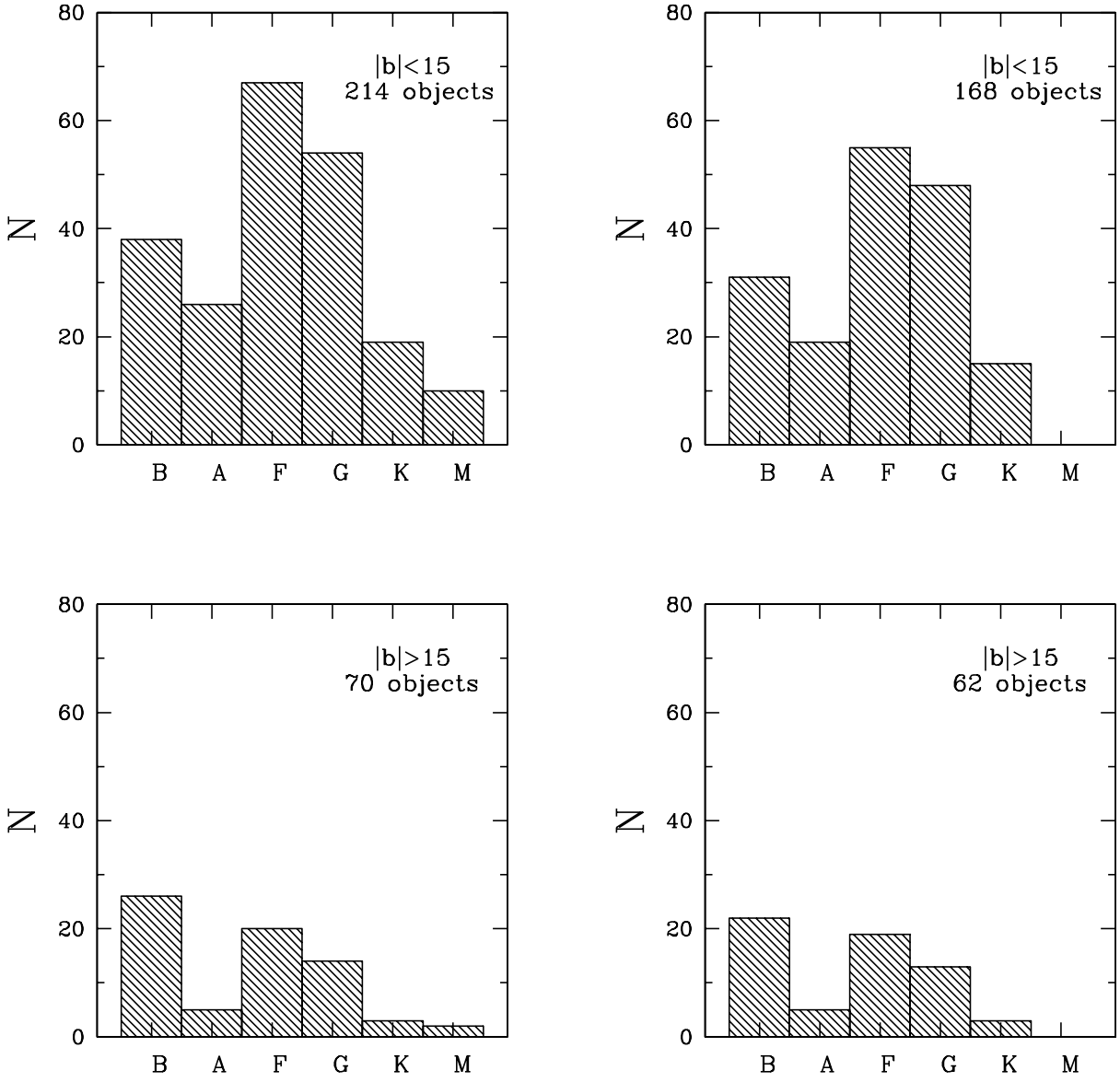

Fig. 1. Distribution of spectral types for *very likely* and *possible* post-AGB objects (left panels) and solely *very likely* objects (right panels). ***PERHAPS INDICATE THIS IN THE FIGURES AS WELL***Top panels post-AGB objects lying close to he Galactic plane, bottom panels for post-AGB objects at the high Galactic latitudes. Spectral types were taken preferably from Suárez et al. (2006) and Pereira & Miranda (2007). See text for details.

their progenitors or progenies. The catalogue is also meant to facilitate the search for new post-AGB objects in the AKARI survey which will become available soon and should provide a large number of candidates. The next planned significant upgrade of the catalogue will be the inclusion of the still missing part of the hidden evolution between AGB and post-AGB.

We briefly discussed the problem of M-type post-AGB stars. In our sample we have at least 4 objects from Suárez et al. (2006), which are genuine post-AGB as shown by their double-peaked SEDs, and have M-type central stars with optical spectra well matched to the collected photometry. In addition, at least one RV Tau star with M-type spectrum reported by de Ruyter et al. (2006) also deserve attention as a candidate post-AGB object with M-type central star.

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Online Material

Appendix A: Development of the catalogue

A.1. Updates

The present version of the catalogue has opened entries for *possible* post-AGB objects (the entries for *unlikely* objects remain closed). Photometric and spectroscopic data are available now for 452 sources (346 *very likely* and 106 *possible* post-AGB objects). To allow an efficient search among the different parts of the catalogue we have included the possibility of querying the database by searching all sub-catalogues for a given object name. This may be done directly from the home page of the catalogue or by means of the "Search" button inside each of the sub-catalogues. Because the SIMBAD post-AGB database now includes many of names which were marked by "*" in the previous version of the catalogue (meaning that this counterpart was found by us), in this version we have removed all "*" even if given name is still not in the SIMBAD database.

The spectroscopic atlas of post-AGB stars and planetary nebulae presented by Suárez et al. (2006) contains low-resolution optical spectroscopy, finding charts and improved astrometric coordinates of a sample of 253 IRAS sources. The objects are divided in several groups, among which there are 102 sources classified as post-AGB stars, 21 as "transition sources", and 36 as planetary nebulae. 120 of them[2] (77 as *very likely*, 38 as *possible* and 5 as *unlikely* post-AGB objects) together with their spectra (if available) were included in the present version of the Toruń catalogue. The spectral types determined by Suárez et al. (2006) are also added, followed by "S:" and they appear independently of the spectral type from SIMBAD, in the column marked "Spectral type other".

In addition, a spectroscopic survey of 16 post-AGB candidates performed by Pereira & Miranda (2007) provided low resolution optical spectra for 11 objects which were or are included into our catalogue (10 as *very likely* or *possible* post-AGB objects and 1 as *unlikely*). We did not include objects classified by Pereira & Miranda (2007) as non-post-AGB, except for IRAS 18044−1303 which was *possible* in the previous version of the catalogue. These optical spectra and their spectral types are also included independently of the SIMBAD spectral type and are followed by "PM:" in the column marked "Spectral type other".

The release of The Guide Star Catalog (GSC), Version 2.3.2 (STScI & OATo 2007) allowed us to add photometry at Bj (blue), V (green), F (red), and N (0.8 μm) photographic bands to the catalogue. The limits on brightness which existed in the previous version of GSC were removed and hence data for more objects are available. However, we left the GSC2.2 photometry in our catalogue for comparison.

New objects were added to each of the 3 categories in our catalogue, some sources were removed and some others were moved between sub-catalogues. Changes are described in detail in Sect.A.2and in the log file in our catalogue. In summary, the present version of subcatalogue concerning *very likely* post-AGBs contains 346 sources (20 more than the previous version - see Paper I). The number of *very likely* post-AGBs increased due to:

- re-classification of 15 sources from *possible* to *very likely* due to the increased number of references [3] in ADS (as end of February 2008) to five or more;
- adding 6 sources, which were missing in the previous version of the catalogue, from Suárez et al. (2006) (3 sources), Sahai et al. (2007) (2 sources), Pereira & Miranda (2007) (1 source);
- re-classifying 1 *possible* post-AGB object (IRAS 14072−5446) as *very likely*;

However, 2 *very likely* objects (IRAS 17433−1750 and IRAS 21537+6435) were moved to the *possible* post-AGBs.

The present number of *possible* post-AGBs is 106 (1 less than in the previous version of the catalogue). This is the result of removing 18 objects, due to:

- the re-classification of 15 sources as being now *very likely* post-AGBs due to the increased number of references in ADS (see above);
- moving 1 object (IRAS 14072−5446) to *very likely* post-AGBs;
- moving 1 object (IRAS 18044−1303) to *unlikely* post-AGBs;
- removing IRAS 17516−2526 from the catalogue.

On the other hand, 17 sources have been added to the *possibles*:

- 2 which were removed from *very likely*;
- 7 which were missing in our catalogue, but still have not enough bibliographic entries in ADS to be included as *very likely* (1 from Nakashima & Deguchi 2005, 2 from Suárez et al. 2006, 2 from Pereira & Miranda 2007 and 2 from Sahai et al. 2007);
- 7 objects (IRAS 05089+0459, IRAS 07227−1320, IRAS 15406−4946, IRAS 16476−1122, IRAS 17223−2659, IRAS 18420−0512, and IRAS 19225+1950) with M-type central stars (as classified by Suárez et al. 2006) have been moved from *unlikely* to *possible*; and
  1 missing M-type object (IRAS 17253−2831 - also from Suárez et al. 2006) has been added to *possible*. All these sources have double-peaked spectral energy ditribution typical for post-AGB phase, so their M-type spectra are confusing since so cold stars are rather not expected for post-AGB stars. They are discussed in details in (Sects. A.2 and 1.1).

Finally, 60 objects are classified as *unlikely* post-AGBs (4 less than in the previous version of the catalogue). Seven objects with M-type stars were intentionally moved to *possible* and IRAS 15154−5258 has been removed from the catalogue since it is classified as [WR] planetary nebula. However,

[2] We have excluded 2 objects considered post-AGB stars and 2 considered as transition source because they are in fact PNe. They are: IRAS 17300−3509, IRAS 17579−3121, IRAS 17347−3139, and IRAS 17466−3031 (see Acker et al. 1992). However, we have included as *very likely* post-AGB the object IRAS 17381−1616, which was classified as a PN, but is a post-AGB object of spectral type B1Ibe.

[3] We did not count our Paper I as a reference. Therefore objects with 5 references in ADS, including our paper, are still counted as *possible* post-AGB objects. They can be recognized by the phrase "but only 5(-1) bibliographic entries in the ADS".

4 objects have been added as *unlikely*: 1 object moved from *possible* (IRAS 18044−1303); HD 319896 is not a counterpart of the *possible* object IRAS 17277−3506; and 2 objects from SIMBAD which were missing in the previous version of the catalogue (see Sect. A.2 for details).

There is still one group of objects considered as post-AGB in the literature which is intentionally not included in our catalogue. These are non-variable OH/IR stars (Habing et al. 1987), or, speaking more generally, objects in transition from AGB to post-AGB. We plan to cover this topic in the next edition of the catalogue.

A.2. Notes on individual objects

For brevity, below we label " *very likely* post-AGB object " by "*vl*", " *possible* post-AGB object " by "*p*", and " *unlikely* post-AGB object " by "*u*".

IRAS 01259+6823 - *vl* : This source was missing in the previous version of the catalogue. Its post-AGB nature was discussed in particular by Kelly & Hrivnak (2005) and Suárez et al. (2006).

IRAS 05089+0459 - *p* : This object (its spectral type is M3I) was *disqualified* (*unlikely*) in the previous version of the catalogue. However, it has a double-peaked energy distribution, so it has been upgraded to *possible*. Inside the IRAS error ellipse there is only one 2MASS source (05113615+0503262).

IRAS 07018−0513 - *p* : This source has been incorrectly attributed by Oudmaijer et al. (1992) to HD 53300 = SAO 134141. This wrong identification is followed by SIMBAD. The correct counterpart of IRAS 07018−0513 seems to be MSX G219.1270+00.4428 source, which lies in the error ellipse of the IRAS source and is located only about 9″ from the IRAS position almost along the major error ellipse axis. The MSX fluxes of about 0.5 Jy in band A at 8.28 μm (at other MSX bands only limits are available) may be compared with the IRAS flux at 12 μm of 0.75 Jy. There is no other MSX sources around and, therefore, we believe that the MSX source is the proper counterpart of IRAS 07018−0513. The only optical counterpart may be found in the USNO-A2.0 Catalogue (Monet et al. 1998). Therefore, for this specific case, the object USNO-A2.0 0825-03845665 and its photometry at *B* and *R* bands has been introduced in the GSC2.2 entry of the catalogue.

IRAS 07227−1320 - *p* : The object (its spectral type is M1I) was was *disqualified* (*unlikely*) in the previous version of the catalogue. However, it has a double-peaked energy distribution, so it has been upgraded to *possible*. Inside the IRAS error ellipse there is only one MSX (G228.6982+01.1764) and one 2MASS (07250306-1326199) source.

IRAS 08281−4850 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It is an A-type post-AGB star with s-process enrichment (Reyniers et al. 2007).

IRAS 10174−5704 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It is a RV Tau object from the list of 20 newly characterized stars by de Ruyter et al. (2006).

IRAS 10178−5958 - *vl* : This source was missed in the previous version of the catalogue. It is a bipolar proto-planetary nebula (e.g. Sahai et al. 2007; Parthasarathy et al. 2001) and was introduced as transition object in Suárez et al. (2006).

IRAS 11381−6401 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. Its spectral energy distribution has a double-peaked shape characteristic for post-AGB objects.

IRAS 11531−6111 - *p* : This object was missed in the previous version of the catalogue. It has a double-peaked SED and was classified as transition object in Suárez et al. (2006). It is a *possible* object in our catalogue due to the small number of references in ADS.

IRAS 12302−6317 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It was introduced as a post-AGB object in Suárez et al. (2006).

IRAS 12419−5414 - *vl* : This source was missed in the previous version of the catalogue. It is a well known reflection nebula (Sahai et al. 2007).

IRAS 13010−6012 - *p* : Information about the spectral type (M2I - Suárez et al. 2006) of this source was missing in the previous version of the catalogue. The object has a double-peaked SED so it is still classified as *possible* post-AGB object. Inside the IRAS error ellipse there is only one 2MASS (13040549-6028456) and one MSX (G304.4917+02.3547) source.

IRAS 13557−6442 - *vl* : This source was missed in the previous version of the catalogue. It is a bipolar proto-planetary nebula (Sahai et al. 2007).

IRAS 14072−5446 - *vl* : In the previous version of the catalogue this source was mistakenly considered as a possible OB star and treated, therefore, as a *possible*. It is a hot post-AGB star (Parthasarathy et al. 2000).

IRAS 14325−6428 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It is an A-type post-AGB stars with s-process enrichment (Reyniers et al. 2007).

IRAS 15154−5258. This object is a well known [WR] PN (PN G324.0+03.5) and there is no doubt about its nature (e.g. Manchado et al. 1989b; Acker et al. 1992; Acker & Neiner 2003; Kerber et al. 2003). Thus it has been removed from the *unlikely* list.

IRAS 15310−6149 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It has a double-peaked SED and was classified as post-AGB star in Suárez et al. (2006).

IRAS 15406−4946 - *p* : This object (its spectral type is M4II) was *disqualified* (*unlikely* in the previous version of the catalogue. However, it has a double-peaked energy distribution, so it has been upgraded to *possible*. The only MSX source (G329.1514+03.9200) inside the IRAS error ellipse is located about 18″ from the nominal IRAS position. The corresponding 2MASS source is 15442051-4956241 and its optical counterpart in GSC 2.3.2 catalogue is S8U4108432. This GSC source has (somewhat strange) photometry, which does not match spectrum of Suárez et al. (2006) (see SED of this source in or catalogue). However, we have checked that another GSC 2.3.2 object (S8U4074386), which is located only

about 4″ from the 2MASS source towards NE has photometry matching very well the optical spectrum. Therefore, we expect that in this case a wrong counterpart was observed.

IRAS 15544−5332 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It is a "water fountain source" (e.g. Imai et al. 2007).

IRAS 16283−4424 - *p* : This object was missed in the previous version of the catalogue. It has a double-peaked SED and was classified as post-AGB object in Suárez et al. (2006). It is a *possible* object in our catalogue due to a small number of references in ADS.

IRAS 16476−1122 - *p* : This object (its spectral type is M1I) was *disqualified* (*unlikely*) in the previous version of the catalogue. However, it has a double-peaked energy distribution, so it has been upgraded to *possible*. Inside the IRAS error elipse there is only one 2MASS source (16502429-1127577).

IRAS 17223−2659 - *p* : This object (its spectral type is M5III) was *disqualified* (*unlikely*) in the previous version of the catalogue. However, it has a double-peaked energy distribution, so it has been upgraded to *possible*. The surce is located in the crowded region. In the IRAS error ellipse there are at least four 2MASS sources, but only one MSX object (G359.1995+04.7774) which is located about 3 ″ from the nominal IRAS position. There are two 2MASS sources in the vicinity of the MSX source (3.6 and 5.5″ from the MSX position). For the presentation in the catalogue we have chosen 2MASS object (17252662-2702013) which is located at distance of 5.5″ from the MSX position. We have checked, however, that selecting the closer 2MASS source, which is weaker, do not change much the picture: the slope of the optical spectrum does not fit to the slope of the photometry. It may suggest that a wrong counterpart was observed by Suárez et al. (2006).

IRAS 17253−2831 - *p* : This source was missed in the previous version of the catalogue. Suárez et al. (2006) classified it as post-AGB object and its spectral type is M4II. The object has double-peaked SED and is classified as *possible*. The source is located in the crowded region, with three 2MASS sources inside the IRAS error elipse, but only one MSX source (G358.3116+03.3617). We have selected the closest 2MASS counterpart (17283296-2833258). The optical spectrum seems to have wrong slope, what might suggest that a wrong counterpart was observed.

IRAS 17291−2402 - *vl* : This source was missed in the previous version of the catalogue. The effective temperature is 6000 K (Reddy & Parthasarathy 1996), but the source is sometimes classified as planetary nebua PN G002.5+05.1 citep[e.g.,][]ker03. It is a transition object in Suárez et al. (2006).

IRAS 17310−3432 - *vl* : This source was a *possible* post-AGB in the previous version of the catalogue due to the small number of references in ADS. It has a double-peaked SED and was classified as post-AGB object in Suárez et al. (2006).

IRAS 17326−3324 - *unlikely* post-AGB object. This source was missed in the previous version of the catalogue, and is classified as post-AGB object by SIMBAD. However, this is a massive supergiant in a cluster (Massey et al. 2001) and thus we treat it as *unlikely* object in our catalogue.

IRAS 17392−3020 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It was considered as a post-AGB object by Suárez et al. (2006).

IRAS 17433−1750 - *p* : García-Hernández et al. (2007) classified it as O-rich AGB star and its optical spectrum is classified as M2I (Hu et al. 1993). However, its SED has a double-peaked shape and we have decided to keep the source as a *possible* post-AGB object.

IRAS 17440−3310 - *p* : This object was missed in the previous version of the catalogue. It has a double-peaked SED and was considered as a young proto-planetary nebula by Sahai et al. (2007). It is a *possible* object in our catalogue due to the small number of references in ADS.

IRAS 17488−1741 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It has a double-peaked SED and was classified as post-AGB star in Suárez et al. (2006).

IRAS 17516−2526. This is the same object as the *very likely* post-AGB object IRAS 17516−2525, so it was removed from our catalogue. The name "IRAS 17516−2526" was included in Manchado et al. (1989a).

IRAS 17542−0603 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It was introduced as post-AGB object in Kelly & Hrivnak (2005) and Suárez et al. (2006).

IRAS 17576−2653 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. Its SED has a double-peaked shape and it is a post-AGB object in Suárez et al. (2006).

IRAS 18044−1303 - *u* : The object has been moved from *possible* to *unlikely* since it is a Young Stellar Object and not a post-AGB star according to Pereira & Miranda (2007).

IRAS 18096−3230 - *p* : Suárez et al. (2006) observed the object at a position that corresponds to GSC2.2 source S301310298380, while the correct counterpart of IRAS 18096−3230 is located inside the IRAS error ellipse and corresponds to the 2MASS source 18125855−3230038 (9.7″ from the nominal IRAS position). It has an optical counterpart in the NOMAD Catalog (Zacharias et al. 2004) NOMAD1 0574-0991490 and, exceptionally, its photometry at *B* has been introduced in the GSC2.2 entry of our catalogue.

IRAS 18321−1401 - *p* : This source was missed in the previous version of the catalogue. Its spectrum shows characteristic features of a post-AGB object (Pereira & Miranda 2007), but due to a small number of references we classified it as a *possible*.

IRAS 18420−0512 - *p* : This source was classified as *disqualified* (*unlikely*) post-AGB in the previous version of the catalogue due to its spectral type M1I given by SIMBAD. Now, having optical spectrum from Suárez et al. (2006) we can see that the optical spectrum, while still classified as M1I, is located above the collected photometry (see SED of this object in our catalogue). This may be, however, effect of the wrong spectrum calibration since the shape of the optical spectrum match very well shape of the collected photometry. There is good coincidence between IRAS, MSX and 2MASS positions. The other closest source which might have been observed is lo-

cated 11″ away and is fainter in optical than the selected GSC source S9NC057178. The source has double-peaked SED and has elongated shape on the HST images by Sahai et al. (2007).

IRAS 18489−0629 - *p* : This source was missed in the previous version of the catalogue. Similarly to IRAS 18321−1401, this object was observed by Pereira & Miranda (2007). The small number of references allowed us to classify it only as *possible* post-AGB.

IRAS 18539+0549 - *vl* : This object was missed in the previous version of the catalogue. Characteristic features and the absence of nebular emission lines, allowed Pereira & Miranda (2007) to classify it as post-AGB star with spectral type G5I.

IRAS 19225+3013 - *p* : The object (its spectral type is M2II) was *disqualified* (*unlikely*) in the previous version of the catalogue. However, it has a double-peaked energy distribution, so it has been upgraded to *possible* post-AGB. The 2MASS and optical counterpart of this source is located inside the IRAS error ellipse at about 10″ from the IRAS nominal position. There is no other 2MASS sources inside the IRAS error ellipse.

IRAS 19292+1806 - *p* : This source was missed in the previous version of the catalogue. It is a bipolar proto-planetary nebula (Sahai et al. 2007), but due to the small number of references is classified as a *possible* post-AGB in our catalogue.

IRAS 19312+1950 - *p* : This source was missed in the previous version of the catalogue. The nature of this object is uncertain (e.g., Nakashima & Deguchi 2005) and thus it was added to our *possible* list.

IRAS 19422+1438 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. Suárez et al. (2006) and Pereira & Miranda (2007) considered it as a post-AGB object.

IRAS 20559+6416 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It was introduced as post-AGB object in Kelly & Hrivnak (2005) and Suárez et al. (2006).

IRAS 21537+6435 - *p* : The object was considered as a *very likely* post-AGB object in the previous version of the catalogue. However, up to now only Volk & Kwok (1989) listed it as proto-planetary nebula. Other publications say nothing about the nature of this object. Hence the status of IRAS 21537+6435 is uncertain.

IRAS 21546+4721 - *vl* : This source was a *possible* in the previous version of the catalogue due to the small number of references in ADS. It has a double-peaked SED and was classified as transition source by Suárez et al. (2006).

HD 319896 - *u* : HD 319896 is classified as T Tau-type star by SIMBAD and IRAS 17277−3506 was attributed to HD 319896 by Pottasch & Parthasarathy (1988). However, the IRAS nominal position is 31.3″ away in the SW direction, while its ellipse error has its major axis only 17 arcsec and position angle of +95° so this association seems to be unlikely. Gledhill (2005) assumed that counterpart of IRAS 17277−3506 is 2MASS source 17310400−3508413. However, his observations did not give the final conclusion as far as the nature of this object is concerned, so we keep it still as a *possible* post-AGB source, in spite of the fact that the number of references is larger than 5.

HD 326971 - *u* : This source was missed in the previous version of the catalogue. It has only 2 references in ADS but there is no evidence for this object being post-AGB star. Thus it is in our *unlikely* list.

List of Objects