ASTRONOMY & ASTROPHYSICS
SUPPLEMENT SERIES

Astron. Astrophys. Suppl. Ser. **125,** 445-451 (1997)

Search for envelopes of some stellar planetary nebulae, symbiotic stars and further emission-line objects⋆

L. Kohoutek

Hamburger Sternwarte, Gojenbergsweg 112, D-21029 Hamburg, Germany

Received January 6; accepted January 25, 1997

Abstract. At 17 emission-line objects, mainly PN, the seeing disc has been compared with that of some surrounding stars (CCD frames taken through B, V, R, [OIII] 5007 Å and Hα filters). Nebulosities were found at: CPD − 53°8315 (0.″5 in x-direction, 0.″4 in y-direction), H 2 − 2 (0.″3, 1.″4) and CPD − 56°8032 (1.″3, 1.″3). Further small nebulosities are possible at MWC 560, MWC 574, LS IV − 12°111 and HR Del, but they should be considered as rather uncertain. Besides, the known outer nebula at CPD − 53°8315 (2 condensations, 11.″6 separation, PA = 146°) was observed, and the author discovered a circular halo of 50″ around Hb 6 - both outer nebulosities visible in the light of Hα.

Key words: planetary nebulae: general; stars: symbiotic; stars: novae; stars: horizontal branch

1. Introduction

There are many emission-line objects classified as planetary nebulae (PN) which are of stellar appearance. Assuming that this classification is correct, such objects have to be either young PN with very small nebulae, or old PN with large nebulae, which are very faint and so far invisible. It would be very important from the evolutionary point of view to differentiate between these two possibilities.

Besides, there are 43 emission-line objects which appear simultaneously in the catalogues of planetary nebulae as well as in the catalogues of symbiotic stars (SS; see Allen 1984). The variability and the presence of a red component do not seem to be sufficient criteria for distinguishing both cases. In spite of the fact that the origin and the early evolution of PN is little known, the knowledge of the existence of nebulae can help to classify such objects better than in the past.

This is the first series of objects the choice of which (Table 1) was made mainly with regard to the above circumstances.

2. Observations

The observations were made with the telescope 0.9 m Dutch + CCD in April/May 1995 at La Silla, Chile (European Southern Observatory). We used the following systems or interference filters:

System/ filter	ESO No.	Peak wavelength	Band-width
		nm	nm
B	419	438.4	101.9
V	420	529.3	116.9
R	421	599.4	163.8
[OIII]	688	500.5	5.7
Hα *)	387	654.6	8.1

*) + [NII] em.-lines at 6548 and very little at 6584 Å.

We made both long integrated frames in order to find faint outer envelopes (haloes), and short integrations with the aim of comparing $FWHM$ in x and y directions of the object with those of surrounding stars in order to find small envelopes. The list of observed objects is given in Table 1. We observed 17 objects, mainly proto-PN and stellar PN (11 objects), but also some symbiotic stars, emission-line stars and old novae. The small planetary nebulae Hb 6 and IC 4997 were observed for comparison. The remark "paper" in this table means that a separate paper is being planned on the respective object.

For the programme objects we give in Table 2 the list of individual frames (altogether 119) with the respective $FWHM$ in both directions as well as $FWHM$ of stars in the vicinity (n is the number of stars used, total $n = 737$). The mean value of $FWHM$ for stars is 1.″62 and 1.″58 in the x and y direction, respectively. These values represent mainly the seeing images together with the instrumental

Send offprint requests to: L. Kohoutek

⋆ Based on observations collected at the European Southern Observatory at La Silla, Chile.

Table 1. List of objects

Object	Present status	RA 1950.0 h m s	DEC o ′	Remarks
MWC 560	ES	07 23 28	-07 37.6	neb:
MWC 574	PPN	07 45 45	-14 00.2	neb:
PN 1230-275	PN	12 30 36	-27 32.0	
Cn 1-1	PN,SS	15 50 25	-48 42.8	
Cn 1-2	PN,SS	16 40 00	-62 31.4	paper
AS 210	SS	16 48 16	-25 55.4	
CPD -53 8315	PPN	16 59 00	-53 51.5	neb paper
H 2-2	PN,SS	17 04 04	-34 01.3	neb paper
CPD -56 8032	PN	17 04 36	-56 52.0	neb paper
RT Ser	N	17 37 04	-11 55.1	
PC 18	PN,SS	17 37 20	-47 01.8	
AS 239	N	17 40 31	-22 44.3	paper
Hb 6	PN	17 52 07	-21 44.2	neb paper ST
V 348 Sgr	PN	18 37 20	-22 57.4	paper
LS IV -12 111	PN,ES	19 59 03	-12 49.6	neb:
IC 4997	PN	20 17 51	+16 34.4	neb ST
HR Del (N Del 67)	N	20 40 04	+18 58.8	neb:

paper - a separate paper is planned
neb - presence of the nebula
ST - standard nebula

ES emission star
N nova
PN planetary nebula
PPN proto-planetary nebula
SS symbiotic star.

images combined with the focus inaccuracy and the guiding error. The last error is probably negligible because of nearly identical $FWHM$ values in both directions. The integration time was $0.3 - 720$ s, but for longer than about 180 s the autoguider was used. The studied objects were sometimes overexposed (10 frames) on the long integrated frames.

3. Results

The recognition of the nebula was defined in case the $FWHM$ value of the object exceeded that of the stars by 1 sigma = 0.″06 in at least one direction. This happened with CPD−53°8315, H 2−2 and CPD−56°8032 beside the standard nebulae Hb 6 and IC 4997. The following further objects have larger $FWHM$ values compared with those of the stars in the vicinity, being close to 0.″06: MWC 560, MWC 574, LS IV − 12°111 and HR Del. The existence of small nebulae at these objects is therefore possible.

For the calculation of the nebular diameter the simple relation

$$FWHM^2(\text{nebula}) = FWHM^2(\text{object}) - FWHM^2(\text{stars})$$

was used. The results are given in Table 3 for reliable and possible nebulae. We summarized the diameters in x and y direction, respectively, together with the mean errors, for which N - number of frames (see Table 2) - was used.

4. Discussion of individual objects

4.1. CPD − 53°8315 (PK 334 − 07.1)

This object (He 3 − 1312) was classified as possible proto-PN in Supplement 1 (Kohoutek 1978) to CGPN (Perek & Kohoutek 1967) and included among PN in Supplement 4 to CGPN (Kohoutek 1993). It appears in SECGPN (Acker et al. 1992) as SaSt 2 − 12, PN G 334.8 − 07.4. There it is of stellar diameter, but recently Schwarz et al. (1992) found two condensations visible through Hα + [NII] filter (and not visible through [OIII] 5007 Å filter) having a separation of about 12 arcsec and lying symmetrical to the centre (to the star). We confirm this observation (Fig. 1) and present the picture of this nebula showing the central object and two condensations. May be the condensations (Table 3) are part of a faint outer envelope. The higher brightness in the vicinity of the star may also be an instrumental reflection. The nature of this "faint nebulosity" near the star cannot be recognized according to our frames.

Besides, CPD − 53°8315 belongs to objects where the image is larger than those of stars, which fact we interpret with the presence of a nebulosity. This inner nebula of about 0.5×0.4 arcsec is very small, but reliable as we hope; its diameter is nearly the same in Hα (4 frames) and in [OIII] 5007 Å (2 frames).

Table 2. Observed images

Object	Frame		exp. [sec]	FWHM stars X	FWHM stars Y	n	FWHM object X	FWHM object Y
				"	"		"	"
MWC 560	546	Ha	30	2.30	1.63	4	2.48	1.74
	547	Ha	30	2.03	1.55	5	2.06	1.60
	548_s	Ha	600	1.75	2.08	6	overexp.	
	541	V	15	2.07	1.63	9	2.15	1.60
	544	V	15	2.13	1.71	8	2.21	1.73
	540	B	10	2.07	1.74	8	2.01	1.71
	543	B	10	2.20	1.92	8	2.30	1.97
	542	R	7	2.01	1.57	8	2.02	1.64
	545	R	7	1.70	1.45	7	1.77	1.52
MWC 574	730	Ha	30	2.12	1.63	5	2.27	1.77
	731	Ha	240	1.88	1.58	7	1.89	1.61
	732_s	Ha	600	1.65	1.65	6	overexp.	
PN 1230-275	096	Ha	720	1.13	1.12	6	1.12	1.08
	094	[OIII]	60	1.38	2.01	4	1.40	1.92
	095	[OIII]	600	1.32	1.73	5	1.28	1.68
Cn 1-1	836	Ha	20	1.91	1.22	6	1.96	1.28
	837	Ha	60	1.60	1.39	6	1.66	1.41
	838_s	Ha	600	1.64	1.37	6	overexp.	
	839	[OIII]	60	1.95	1.52	5	1.97	1.53
	840	[OIII]	480	1.58	1.64	6	overexp.	
Cn 1-2	126	Ha	30	2.19	1.56	6	2.19	1.57
	127	Ha	360	2.17	1.52	5	overexp.	
	124_s	[OIII]	30	2.17	2.42	6	2.15	2.48
	125	[OIII]	720	3.42	2.71	6	3.40	2.72
AS 210	627	Ha	30	1.76	1.31	6	1.81	1.27
	628_s	Ha	600	1.34	1.39	6	overexp.	
	444	[OIII]	60	1.84	1.69	6	1.92	1.68
	445	[OIII]	720	1.92	1.76	8	1.95	1.76
	441	V	10	1.65	1.59	6	1.65	1.55
	442	B	15	2.06	2.00	6	2.14	2.00
	443	R	7	1.61	1.67	6	1.61	1.64
CPD-53 8315	633	Ha	20	1.35	1.39	5	1.45	1.46
	635_s	Ha	30	1.31	1.35	4	1.40	1.43
	636	Ha	600	1.60	1.63	8	overexp.	
	637	Ha	90	1.60	1.56	4	1.67	1.57
	638	Ha	60	1.61	1.52	5	1.68	1.54
	446	[OIII]	60	1.89	1.64	3	1.95	1.73
	639_s	[OIII]	90	1.80	1.84	4	1.85	1.86
H 2-2	128	Ha	30	2.05	1.25	6	2.09	1.24
	129	Ha	30	1.98	1.26	6	2.01	1.23
	130_s	Ha	360	2.05	1.37	6	overexp.	
	131	[OIII]	60	1.40	1.78	6	1.40	2.13
	132	[OIII]	720	1.59	2.14	6	1.67	2.63
CPD-56 8032	640	Ha	30	1.54	1.53	8	2.07	2.10
	641	Ha	60	1.60	1.67	8	2.02	2.14
	642	Ha	5	1.43	1.50	8	1.92	1.97
	644	Ha	600	2.18	1.90	8	2.49	2.33
	645	Ha	240	1.60	1.61	8	2.03	2.07
	448	[OIII]	60	1.83	1.70	6	2.37	2.20
	449	[OIII]	60	1.95	1.85	7	2.36	2.27
	450	[OIII]	720	1.82	1.75	7	2.29	2.18
	265	V	20	1.33	1.40	7	1.85	1.81
	267	V	10	1.12	1.40	7	1.67	1.88
	268	V	10	1.29	1.53	6	1.80	1.98
	269	V	10	1.31	1.65	6	1.80	2.06
	270	V	10	1.34	1.45	6	1.86	1.88
	271	V	10	1.18	1.38	6	1.71	1.85
	272	V	10	1.21	1.34	7	1.71	1.78
	273	V	2	1.13	1.47	6	1.68	1.90

Table 2. continued

Object	Frame		exp. [sec]	FWHM stars X	FWHM stars Y	n	FWHM object X	FWHM object Y
				"	"		"	"
	276	B	15	1.50	1.71	6	2.01	2.18
	277	B	10	1.37	1.50	7	1.94	2.02
	278	B	10	1.44	1.62	7	1.97	2.12
RT Ser	139	Ha	60	1.14	1.18	6	1.15	1.18
	140_s	Ha	600	1.21	1.21	6	overexp.	
	141	[OIII]	600	1.17	1.60	7	1.14	1.60
PC 18	669	Ha	30	1.97	1.42	6	1.97	1.40
	670	Ha	20	1.50	1.64	6	1.56	1.67
	671_s	Ha	720	1.48	1.62	6	overexp.	
	451	[OIII]	60	1.69	1.57	8	1.69	1.57
	453_s	[OIII]	720	1.70	1.59	8	1.73	1.62
	452	V	10	1.49	1.63	8	1.50	1.62
AS 239	048	Ha	60	1.71	1.42	7	1.74	1.44
	137	Ha	720	1.26	1.30	7	1.23	1.29
	138	Ha	720	1.19	1.25	7	1.16	1.24
	136	[OIII]	720	1.38	1.88	7	1.29	1.81
Hb 6	865	Ha	10	1.32	1.05	10	4.53	4.74
	866	Ha	10	1.50	1.06	10	4.58	4.78
	867	Ha	360	2.13	1.66	9	4.68	4.84
	868	Ha	720	2.10	1.53	9	4.72	4.84
	869	Ha	240	2.12	1.54	11	4.75	4.85
	870	Ha	60	1.84	1.43	10	4.64	4.78
	871	[OIII]	10	1.62	1.08	6	4.30	4.36
	872	[OIII]	10	1.60	1.10	8	4.20	4.25
	863	B	20	1.42	1.53	10	4.09	4.35
	864	B	4	1.25	1.35	7	3.95	4.42
V 348 Sgr	050	Ha	300	1.95	2.02	6	1.95	2.02
	051_s	Ha	600	1.45	1.55	6	1.42	1.57
	052_s	[OIII]	600	1.67	2.19	6	1.66	2.22
	053	[OIII]	600	1.71	2.22	6	1.70	2.23
	054	[OIII]	600	1.76	2.25	6	1.76	2.30
LS IV-12 111	055	Ha	30	1.60	1.80	5	1.60	1.82
	057_s	Ha	120	1.81	1.82	6	1.85	1.85
	058	Ha	120	1.54	1.69	6	1.56	1.72
	060	[OIII]	120	2.00	2.59	3	2.07	2.55
	061	[OIII]	120	1.93	2.50	3	1.93	2.47
	699	V	10	1.26	1.36	4	1.28	1.39
	702	V	10	1.46	1.51	4	1.55	1.54
	700	B	15	1.52	1.54	4	1.66	1.63
	703	B	15	1.32	1.29	4	1.39	1.37
	701	R	7	1.40	1.30	4	1.47	1.38
	704	R	7	1.25	1.49	4	1.31	1.52
IC 4997	310	V	2	1.18	1.29	6	1.58	1.58
	311	V	0.3	1.14	1.22	5	1.49	1.58
	313	V	1	1.30	1.30	5	1.74	1.58
	314	V	1	1.16	1.22	5	1.59	1.54
	315	B	1	1.15	1.40	5	1.56	1.62
	316	B	1	1.26	1.36	5	1.63	1.57
	317	B	1	1.19	1.23	5	1.47	1.51
HR Del	150	Ha	50	1.58	1.52	5	1.60	1.49
	151	Ha	50	1.33	1.44	7	1.31	1.42
	897	Ha	50	1.53	1.30	5	1.63	1.35
	898	Ha	50	1.60	1.40	5	1.77	1.48
	899	Ha	50	1.73	1.45	5	1.85	1.54
	147	[OIII]	30	1.74	2.11	5	1.81	2.28
	148	[OIII]	50	1.97	2.13	5	1.96	2.25
	149	[OIII]	50	1.87	2.15	7	1.93	2.30
	894	[OIII]	40	1.65	1.60	5	1.91	1.63
	895	[OIII]	40	1.70	1.47	5	1.67	1.44
	896	[OIII]	50	1.81	1.50	5	1.75	1.48

Table 3. Nebular diameters

Object		Nebula (inner) X	m.e.	Y	m.e.	N	Nebula (outer)
		"	"	"	"		
A) Reliable nebulae:							
CPD-53 8315	Hα *)	0.49	±.02	0.35	±.06	4	2 condens. 11".6 (PA 146°)
	[OIII]	0.46	.02	0.38	.11	2	
H 2-2	Hα	0.34	.04	-0.22	.06	2	
	[OIII]	0.30	.20	1.36	.18	2	PA 172°
CPD-56 8032		1.29	.02	1.29	.02	19	
Hb 6	Hα *)	4.26	.03	4.59	.02	6	circular halo 50"
	[OIII]	3.94	.05	4.17	.06	2	
	B	3.79	.04	4.14	.07	2	
IC 4997		1.03	±.04	0.89	±.03	7	
B) Possible nebulae:							
MWC 560		0.40	±.15	0.25	±.13	8	
MWC 574		0.47	.35	0.48	.22	2	
LS IV-12 111		0.36	.05	0.21	.10	11	
HR Del		0.28	±.15	0.27	±.14	11	

*) see text (Sect. 4).

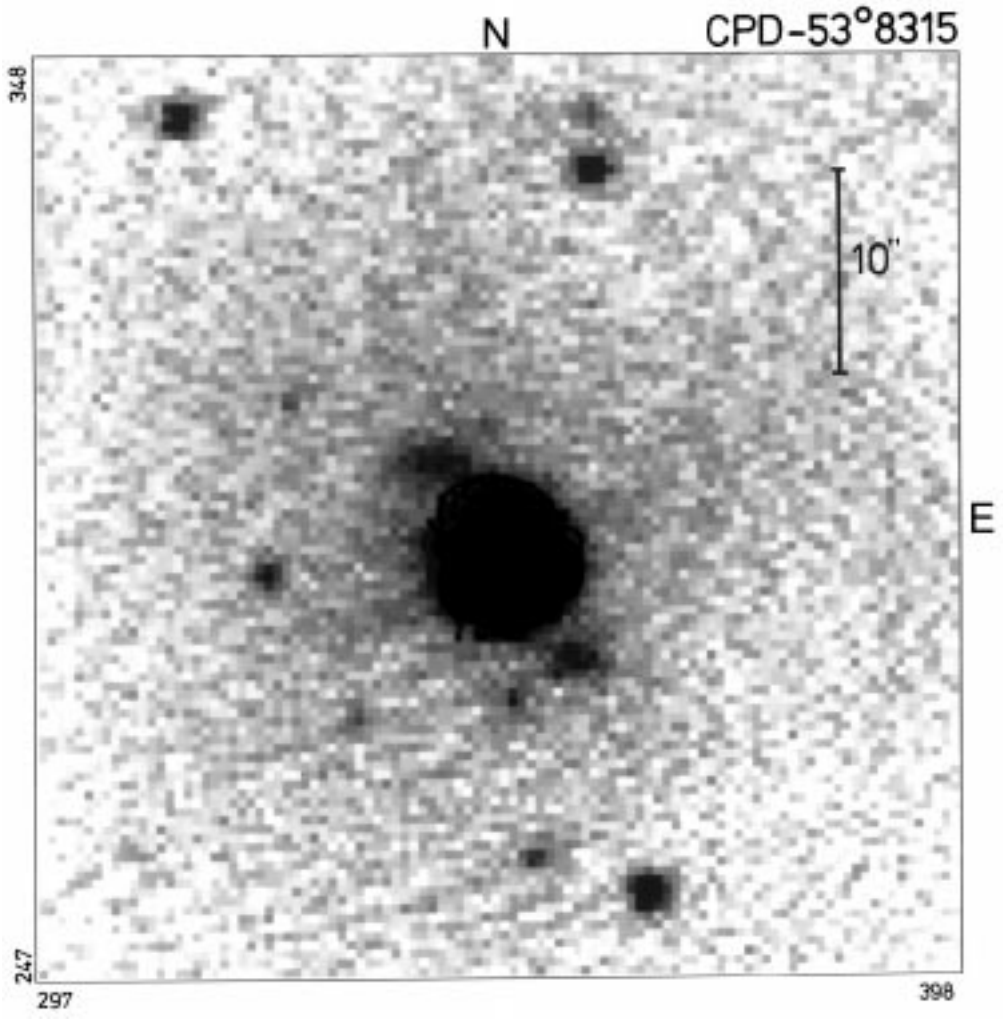

Fig. 1. CPD – 53°8315 in the light of Hα with two condensations 11.″6 (PA 146°) apart; exp. 30 s

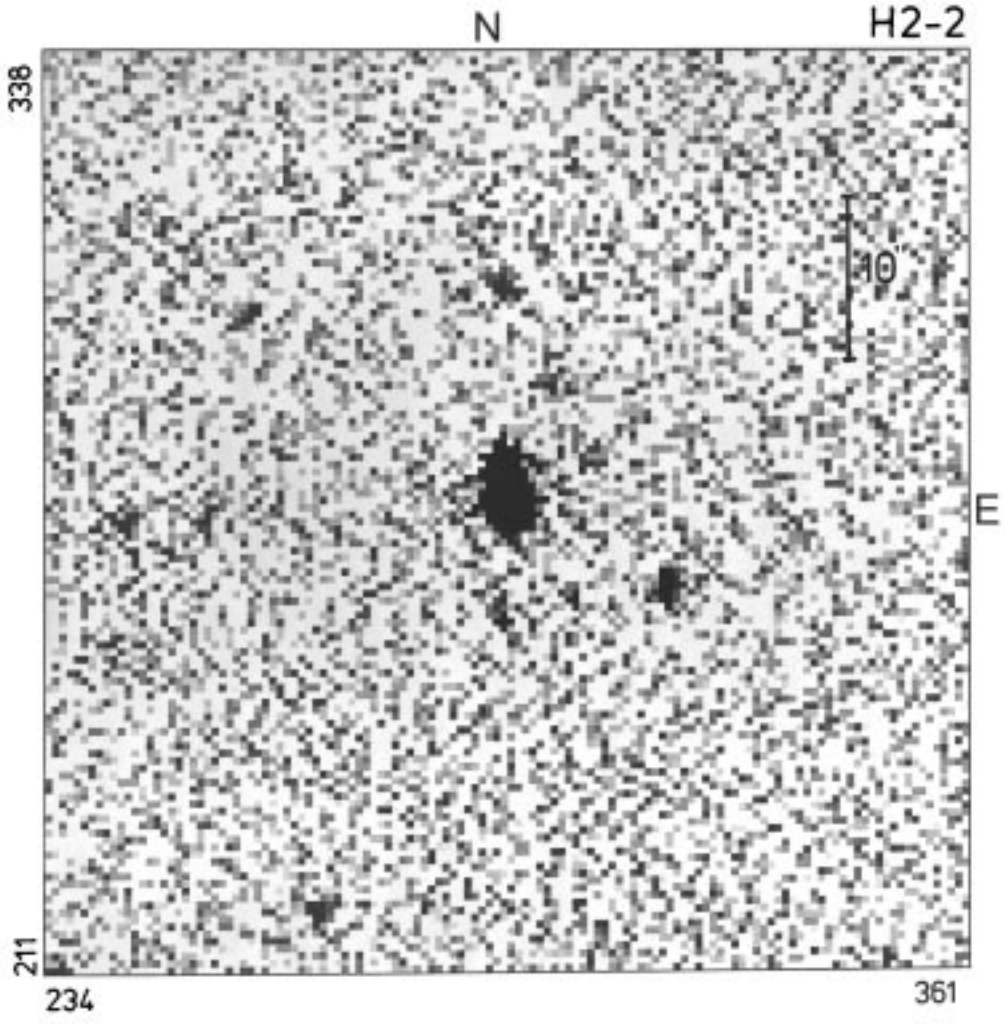

Fig. 2. H 2 − 2 in the light of [OIII] 5007 Å elongated in PA 172°; exp. 60 s

4.2. H 2 − 2 *(PK* 351 + 03.1*)*

Rejected from SECGPN as symbiotic star. Our frames show H 2 − 2 stellar in Hα, but elongated in y direction in [OIII] 5007 Å (1.4 arcsec, PA about 172°), which may be caused by condensations or loops (Fig. 2).

4.3. CPD − 56°8032 *(PK* 332 − 9.1*)*

Included among PN in Supplement 5 to CGPN (Kohoutek 1996). It appears in SECGPN as He 3 − 1333, PN G 332.9 − 09.9, stellar appearance. Small optical nebulosity of 1.3×1.2 arcsec, PA 10°, was found (Kohoutek 1995) as well as its being nearly identical with the speckle infrared observations of dust emission features at 3.28 μm (Roche et al. 1986). This optical nebulosity was now confirmed using all existing frames.

4.4. Hb 6 (PK 7 + 01.1*)*

In SECGPN under 007.2+01.8; optical diameter 5 arcsec from Cahn & Kaler (1971). The variability of this object (= AS Sgr) is probably of instrumental origin (Arhipova 1973), the central star is unknown. Hb 6 has been chosen as a standard nebula in order to compare our measured dimension with that given in the literature. The derived nebular diameter (see Table 3) is somewhat smaller than that used by Cahn & Kaler. Besides, the diameter measured in the light of [OIII] 5007 Å and in B-system is smaller than that in Hα, which can be explained by the stratification effect. A large nearly circular halo (Table 3) of about 50 arcsec has been found in Hα.

4.5. IC 4997 (PK 58 − 10.1*)*

In SECGPN under 058.3−10.9; optical diameter 1.6 arcsec from Cahn & Kaler (1971). The measured nebular diameter (Table 3) of this standard object is again somewhat smaller than that given in the literature.

4.6. Possible nebulae

On the frames the objects MWC 560, MWC 574, LS IV − 12°111 and HR Del are somewhat larger than the surrounding stars, but their nebulae, if any, are extremely small (and the errors large), so that they should be concidered as uncertain. The most promising of them is LS IV − 12°111 with the smallest mean errors. As to HR Del the nebulosity in [OIII] 5007 Å was already reported (see e.g. Kohoutek 1981). For the year 1995 the nebulosity was expected to be larger than that we observed, so that we think that our small values are either due to the low brightness of the nebula relative to the very bright star in the centre, or that we see only the brightest part of the nebula.

5. General discussion and conclusions

About half of the objects listed in Table 1 show neither small nebulosities (their images are comparable with those of stars), nor large envelopes. Around three objects small nebulosities and around the standard nebula Hb 6 a halo were discovered. Besides, at four further emission-line objects the presence of very small nebulae is possible, but questionable.

The above method with the relation given in Sect. 3 requires nebulosities with Gauss profiles. This is of course not valid for large nebulae, but it may be accepted for very small nebulosities (in the range of 1 arcsec or below). Perhaps this is the reason why the somewhat larger standard nebulae Hb 6 and IC 4997, with a ringlike structure, appear smaller when using the Gauss approximation.

References

Acker A., Marcout J., Ochsenbein F., Stenholm B., Tylenda R., Schohn C., 1992, The Strasbourg-ESO Catalogue of Galactic Planetary Nebulae, European Southern Observatory (SECGPN)

Allen D.A., 1984, Proc. ASA 5 (3), 369

Arhipova V.P., 1973, Perem. Zvezdy 19, 273

Cahn J.H., Kaler J.B., 1971, ApJS 189, 319

Kohoutek L., 1978, IAU Symp. No. 76. In Terzian Y. (ed.), p. 47 (Suppl. 1 to CGPN)

Kohoutek L., 1981, MNRAS 196, 87P

Kohoutek L., 1993, IAU Symp. No. 155. In Weinberger R., Acker A. (eds.) - poster; Astron. Nachr. 315 (1994), 63 (Suppl. 4 to CGPN)

Kohoutek L., 1995, Hydrogen-Deficient Stars, Colloquium in Bamberg, Germany, August/Sept. 1995 - poster = Proceedings. In Jeffery C.S., Heber U. (eds.), ASP Conf. Ser. 96, 219 (1996)

Kohoutek L., 1996, IAU Symp. No. 180 - poster (submitted to Astron. Nachr.) (Suppl. 5 to CGPN)

Perek L., Kohoutek L., 1967, Catalogue of Galactic Planetary Nebulae, Academia Praha (CGPN)

Roche P.F., Allen D.A., Baily J.A., 1986, MNRAS 220, 7P

Schwarz H.E., Corradi R.L.M., Melnick J., 1992, A&AS 96, 23