Astron. Astrophys. 337, 253–260 (1998)

ASTRONOMY AND ASTROPHYSICS

A sample of planetary nebulae observed by HIPPARCOS

A. Acker[1], **A. Fresneau**[1], **S.R. Pottasch**[2], **and G. Jasniewicz**[1,3]

[1] Observatoire de Strasbourg, CNRS UMR 7550, 11 rue de l'Université, F-67000 Strasbourg, France
[2] Kapteyn Astronomical Institute, Groningen University, Postbus 800, 9700 AV Groningen, The Netherlands
[3] GRAAL, CC72, Université de Montpellier II, Place Eugène Bataillon, F-34095 Montpellier Cedex 05, France

Received 17 July 1997 / Accepted 18 June 1998

Abstract. By using HIPPARCOS data (magnitudes, parallaxes, proper motions), (1) we determine new values of the apparent luminosity of the central stars of 19 planetary nebulae, (2) we discuss their distance and position on the T/L diagram. By comparison with the distances determined by individual or statistical methods, we see that most of these "ground" distances look overestimated when we trust the HIPPARCOS trigonometric parallaxes. It seems that for compact nebulae, the nebula itself could influence the parallax measurement. In particular, the very small HIPPARCOS distances to SwSt 1 and Hu 2-1 are unexpected and are not trustworthy. Peculiar motions are analyzed, in terms of astrophysical parameters of the binary system A 35, and in relation with asymmetric morphology.

Key words: planetary nebulae: general – stars: distances – stars: evolution

1. Introduction

Despite recent improvements of distance determinations (parallax and expansion methods, see Pottasch, 1997) of planetary nebulae (PN), many questions remain open. We showed in a preceding paper (Pottasch & Acker, 1998) that HIPPARCOS distances appear smaller than "gravity-distances". We will check whether such a conclusion is valid in the case of other methods. On the other hand, the theoretical ages of bright nuclei still appear different from the kinematic ages of the nebulæ. We try to bring some contribution to these points, through HIPPARCOS observations. We determine first more accurate values of the stellar apparent magnitudes (Sect. 2). Trigonometric parallaxes are compared to other distances scales, individual and statistical (Sect. 3). From the position of the nuclei in the T/L diagram and comparison with theoretical tracks, we can estimate the mass of the ionizing nuclei and their theoretical ages, compared with their kinematic ages (Sect. 4). The case of the binary central star of A 35 is discussed (Sect. 5).

Send offprint requests to: A. Acker

2. Magnitudes of the central stars

2.1. Selection of the objects

The PN were pre-selected from their appearance similar to a compact bright stellar object, or to a bright nucleus surrounded by a very faint nebula. Therefore, most of the observed PN may belong to two extreme evolutionary phases: either very young and compact PN, or very old and extended PN.

Table 1 lists the 19 PN from the programs 106 and 143 submitted and accepted by the Hipparcos project. For 7 objects (He 2–138, He 2–438, Hu 2–1, M 2–54, SaSt 2–12, SwSt 1, He 3–1333), the central star with the nebula appears like a very bright *nucleus* and the observed data concern both the star and the nebula. Large nebulæ of very faint surface brightness surround a bright central star for NGC 1360, A 35, A 36, PHL 932, LoTr5.

Table 1 lists the denominations: HIC number, galactic denomination following Acker et al. (1992), usual names of the nebula and of the central star (col. 1–4), astrometric data, with errors, for the epoch 1991.25: parallaxes π (col. 5), proper motions $\mu_\alpha \cdot \cos\delta$ and μ_δ (col. 6–7). Most of the objects – which are some of the brightest central stars known – are well studied.

Note that two objects from the programs are not listed here as they do not belong to the PN-class: HIC 114552 is a misclassified PN, and HIC 76881 corresponds to the B8/B9 giant star HD 139636 = CPD-56° 6854, nearby the faint PN He 2-133 (see Acker et al., 1992).

2.2. HIPPARCOS magnitudes of the nuclei

The HIPPARCOS H magnitudes were measured along a large spectral range (the FWHM of the H response curve extends from 400 to 620 nm), and through an aperture with a diameter of 30 arcsec. For the 19 PN identified by their usual names (col. 1), Table 2 presents the H magnitudes with their uncertainties (col. 4 and 5) and the different photometric quantities used for our determination of the magnitude V_H of the nuclei (col. 7).

In a first step, we estimate the total nebular contribution. We determine the total nebular flux by calculating the convolution of the H response curve and of the total nebular spectrum. The Hβ fluxes and the relative lines intensities are taken from the spectrophotometric survey done by Acker and Stenholm, and

Table 1. Sample of planetary nebulae observed by HIPPARCOS.

HIC	PNG	Name	central star	$\pi \times 10^{-3}$ arcsec	$\mu_\alpha \cdot \cos\delta \times 10^{-3}$ arcsec·yr^{-1}	$\mu_\delta \times 10^{-3}$ arcsec·yr^{-1}
1041	120.0+9.8	NGC 40	HD 826	-4.40±4.78	-8.29±4.66	4.36±4.63
3678	118.8-74.7	NGC 246	BD -12° 134	1.59±3.54	-23.31±3.59	-2.53±2.20
4666	125.9-47.0	PK 125-471	PHL 932	9.12± 2.79	36.13±2.99	7.09±2.00
16566	220.3-53.9	NGC 1360	CPD -26° 389	2.86±2.12	1.32±1.41	26.15±1.76
19395	165.5-15.2	NGC 1514	BD +30° 623	5.40±1.70	-8.14±1.54	3.63±1.24
34541	215.6+03.6	NGC 2346	HD 293373	-2.20±2.71	-3.56±2.60	0.57±2.16
36369	197.8+17.3	NGC 2392	BD +21° 1609	0.87±4.35	-1.63±3.89	1.95±2.52
47691	279.6-03.1	He 2-36	CPD -56° 2466	-2.39±10.07	-6.81±10.17	7.22±10.17
62905	303.6+40.0	A 35	BD -22° 3467	7.48±1.55	-60.93±1.55	-15.10±1.22
63087	339.9+88.4	LoTr 5	HD 112313	0.83±1.17	-24.54±1.08	0.05±0.88
66732	318.4+41.4	A 36	FB 138	4.12±2.47	17.78±3.30	5.47±2.18
78034	320.1-09.6	He 2-138	HD 141969	0.62±3.40	-3.94±2.29	-6.85±2.84
83421	334.8-07.4	SaSt 2-12	CPD -53° 8315	7.64±2.81	-3.40±2.89	-8.60±2.14
83916	332.9-09.9	He 3-1333	CPD -56° 8032	-35.10±30.07	-60.54±29.09	-21.74±22.37
89535	001.5-06.7	SwSt 1	HD 167362	8.93±6.04	-27.68±7.81	-17.76±4.62
92400	51.4+9.6	Hu 2-1	-	12.76±8.02	5.44±6.92	-13.79±7.18
96295	064.7+05.0	He 2-438	BD +30° 3639	-1.63±2.37	-4.16±1.52	-10.19±1.73
99527	060.3-07.3	He 1-5	FG Sge	4.60±2.78	0.09±2.91	-8.49±2.46
112887	104.8-6.7	M2-54	LSIII+51 42	0.42±3.55	-2.15± 2.67	-3.81 ±2.36

Table 2. Determination of the magnitude of the central stars of the planetary nebulae (* see the text). Original H$_\beta$ fluxes taken from (a) Pottasch and Acker, 1998 and (b) Acker et al., 1991

Name	Diam(")	$F(tot/30'')$	H	±	H^*	V_H	V_{lit}	$B-V$	$H-V$
NGC 40	36	18	10.664	0.005 v	11.38	11.33	11.35	0.14	0.05
NGC 246	224	0.7	11.66	0.01	11.70	*11.84	11.96	-0.36	-0.135
PHL 932	270	0.01 a	12.03	0.01	12.03	12.14	12.14	-0.31	-0.11
NGC 1360	370	0.4	11.178	0.003	11.20	11.35	11.35	-0.39	-0.15
NGC 1514	160	0.7	9.5695	0.003	9.58	9.47	9.42	0.51	0.11
NGC 2346	55	10	11.0324	0.0073 v	11.55	11.48	11.47	0.31	0.07
NGC 2392	34	70	9.458	0.0034 v	10.51	10.57	10.53	-0.15	-0.06
He 2-36	10	2	11.237	0.006	11.34	11.25	11.3	0.38	0.09
A 35	770	0.01	9.797	0.005 v	9.80	9.64	9.63	0.90	0.16
LoTr 5	525	0.01	9.0413	0.0030	9.04	8.89	8.88	0.8	0.15
A 36	195	0.1	11.465	0.008	11.47	11.57	11.53	-0.25	-0.095
He 2-138	7	10	10.524	0.005 v	10.82	10.85	10.9	-0.12	-0.035
SaSt 2-12	5	2.5 b	11.47	0.01	11.64	11.51	11.54	0.62	0.13
He 3-1333	1.5	3 b	11.407	0.016 v	11.60	*11.47	11.15	0.63	0.13
SwSt 1	1.3	17 b	10.866	0.008	11.74	11.73	11.76	0.01	0.01
Hu 2-1	1.8	15	11.438	0.006 v	13.32	13.31	13.31	0.01	0.01
He 2-438	5	40	9.482	0.004 v	9.97	*9.92	11.8	0.01	0.05
He 1-5	36	0.3	9.34	0.012 v	9.34	9.18	9.2	1.70	0.16
M2-54	4	0.3	12.304	0.01	12.34	12.31	12.08	0.10	0.035

reported in Acker et al. (1992), excepting some cases indicated in Table 2. The nebular continuum was taken from Tylenda et al. (1991). The uncertainty in the estimation increases with the value of the relative contribution of the nebula.

Then, we apply a factor depending on the ratio of the surface of the nebula and the surface of the 30 arcsec HIPPARCOS aperture. The angular diameter given in col. 2 is taken from Acker et al 1992, from Cahn et al. 1992, and from Kaler (1983) for some large PN. The scaling of the nebular fluxes to the HIPPARCOS aperture produces errors depending (1) on the inhomogeneity of the nebular density, (2) from neglecting external structures and haloes. This *geometrical* effect is already taken into account in the calibration of the Hβ fluxes (see the discussion in Acker et al., 1991). The resulting total nebular contribution is given in $10^{-11}\ mW/m^2$ (col. 3).

The second step leads to the determination of the stellar H^* magnitude (col. 6), after correction from the nebular contribution.

Finally, we use the values $B-V$ (col.9) extracted from Acker et al. (1992), and with the relations given in Perrymann (1997) between $B-V$, $V-I$ and $V-H$, we determine $V-H$ (col.10) in order to estimate the magnitude V_H for the central stars (col. 7). Given the uncertainties on the various corrections, we cannot define V_H better than ± 0.03 mag.

2.3. *Comparison of the HIPPARCOS magnitudes with values from the literature*

We compare the V_H magnitude with the V_{lit} magnitude (col. 8) deduced from the continuum (Tylenda et al, 1991). A good correlation is observed. However, significant differences appear for 3 objects (identified by *): NGC 246; He 3-1333 and He 2-438, which are also detected as *variables* by HIPPARCOS (9 stars are noted *v* in col. 5 on Table 2). For all these objects, we can propose an explanation, in terms of binary systems, or unstable stars (pulsating or WR).

– BINARIES: the nucleus of **NGC 246** is known as being a visual binary. The O star has a G8-K0 companion with a magnitude of 14.3, the separation of the two stars being 3.8 arcsec. The HIPPARCOS magnitude V_H = 11.84 corresponds to the total magnitude of the system. We calculate a value of 11.96 for the magnitude of the O star, in perfect agreement with the literature magnitude.
  Other nuclei are known spectroscopic binaries, a situation which could explain the variability detected by HIPPARCOS: case of NGC 2346 (central star V 651 Mon), and of A35 (see Sect. 5). A35 and LoTr 5 are very old extended PN, whose central stars are binaries or more complicated systems. The primary is (for these two objects) a cool giant; the IUE satellite has revealed an extremely hot companion, very faint for A35, and with a magnitude of 14.9 for LoTr 5 (Kaler and Feibelman, 1985).
– PULSATING STAR: The central star of He 1-5 is the pulsating star FG Sge. The magnitude V is variable, increasing from 8.9 in 1970 to 9.3 in early 1992, and fading by about 4 mag. in August 1992 over a period of 40 days, due probably to an ejection of obscuring matter; then the luminosity increases in 1993, and fluctuates around V = 12 (see Iijima, 1996). Over the 3 years of observations by HIPPARCOS, the mean value of the ground-magnitude is in agreement with the value V_H = 9.18.
– [WC] STARS: The nuclei of **He 3-1333** and **He 2-438** are late [WC]-stars, with strong mass loss. Their photometry over 3 years is provided in Fig. 1, and shows new results.
  The light curve of the [WC11] nucleus of **He 3-1333** shows long-term, possibly periodic, variations, with strong (about 0.5 mag) dips lasting several days, possibly related to dust formation episode (comparable to the variation found for the Pop. I star WR 121, by Marchenko et al, 1997). Variations were already reported by Pollaco et al. (1992) from ground-based observations. The star appears variable on time-scales ranging from hours to months, with an amplitude nearly ΔV =1, with associated colour variations. During the period outside the strong variations, the V-magnitude is stabilized around 11.15.
  BD+30° 3639 (V1966 Cyg) is the variable [WC9] nucleus of **He 2-438**, with inhomegeneous and variable mass loss (Acker et al , 1997). As shown in Fig. 1, the luminosity increases over the 3 years by about 0.1 mag. Such a long-term variation is compatible with the variability already detected, and with the different values of V found in the literature. The mean magnitude V_H=9.92 corresponds to (i) the V-continuum of the star plus (ii) the bright stellar emission lines (CIII and CIV lines around 565-580 nm) which represent about 0.7 mag. The magnitudes given in the literature are fainter, and show a large spread, going from 10.9 in Perek and Kohoutek (1967) and 9.95 in Pottasch (1983), (both magnitudes are not corrected for the nebular continuum nor for the stellar emission lines) to 12.5 in Tylenda et al. (1991), (the magnitude corresponds to the V-continuum of the star, corrected for the nebular continuum and for the stellar emission lines).

The behaviour of these late-[WC] stars need further photometric observations. Note that two other emission-line stars appear as variables: the [WC8] nucleus of NGC 40 with variables CIII/CIV emission lines, and the *wels* nucleus of Hu 2-1 (*wels* means *weak emission lines star*, classified by Tylenda et al., 1994), considered by Miranda (1995) as a possible mass exchanging binary.

3. Distances

3.1. *HIPPARCOS distances*

Distances to planetary nebulae are very difficult to obtain with HIPPARCOS due to their large distances (the nearest PN are located at about 100 pc). Table 3 (col.2) gives the distances deduced from the HIPPARCOS results; we give the mean value, and between brackets the minimal and maximal values derived from the parallaxes uncertainty. Good parallaxes have been measured for 4 objects with the usual first order approximation $\frac{\sigma_\pi}{\pi}$ valid to within about 40%: A 35 ($\frac{\sigma_\pi}{\pi}$ = 0.2), NGC 1514 and PHL 932 ($\frac{\sigma_\pi}{\pi}$ = 0.3), SaSt 2-12 ($\frac{\sigma_\pi}{\pi}$ = 0.4). Furthermore, for most of these objects, the large proper motion supports the large parallax. Positive values are given for A 36, He 1-5 and Hu 2-1 ($\frac{\sigma_\pi}{\pi}$ = 0.6), NGC 1360 and SwSt 1 ($\frac{\sigma_\pi}{\pi}$ = 0.7). There is some indication of a positive measurement for LoTr 5 ($\frac{\sigma_\pi}{\pi}$ = 1.4), NGC 246 ($\frac{\sigma_\pi}{\pi}$ = 2.), NGC 2392 and He 2–138 ($\frac{\sigma_\pi}{\pi}$ = 5.), and M 2–54 ($\frac{\sigma_\pi}{\pi}$ = 8.).

Brown et al. (1997) discuss **systematic errors** in the HIPPARCOS catalogue, and about the interpretation of the measured parallaxes in terms of distances and luminosities of stars. Following their analysis, the absolute magnitudes computed from HIPPARCOS distances are unbiased for small relative errors, but are on the average 0.6 mag too faint for a 200% relative error. Therefore we increase the values of D_H by a factor of 1.32 for the PN with $\frac{\sigma_\pi}{\pi} \geq 2$, which is the case for NGC 2392 ($\frac{1}{\pi}$=1.15) and He 2–138 ($\frac{1}{\pi}$=1.6) (marqued * in Table 3).

A set of 5 PN shows a **negative trig. parallax** (see Table 1). In addition, very uncertain values of the proper motion components are shown for some of them. Therefore we don't use the HIPPARCOS astrometric data for NGC 2346, for He 2-36 (binary systems) and for the two late [WC] stars. For the central star of PN He 3-1333 (π=-35±30 mas), the large proper motion may indicate that the distance is not too large, but no precise value can be derived from the present measurements.

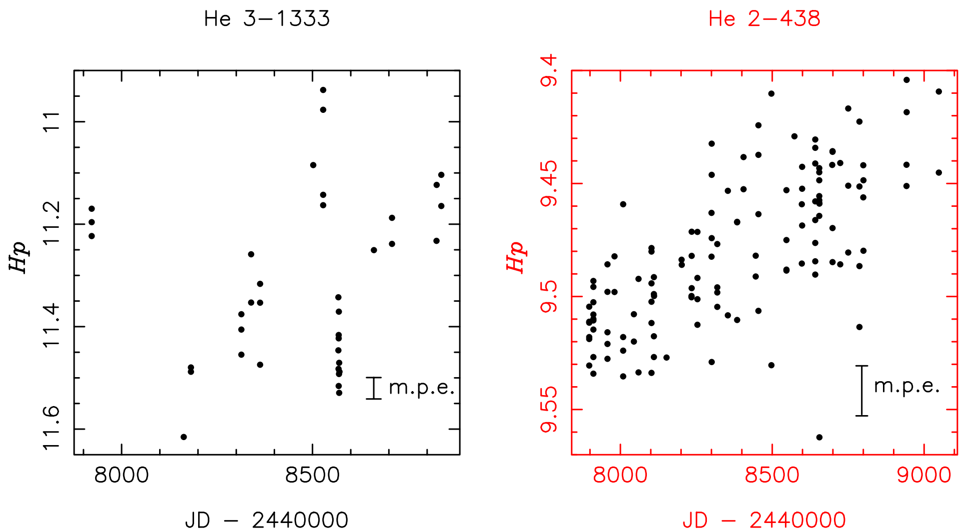

Fig. 1. 3-years photometry of 2 variable nuclei of planetary nebulae: He 3-1333 and He 2-438. The error bar is equal to 2·m.p.e.

Table 3. Hipparcos distances D_H compared to other distances (a= Rao (1987), SB = spectroscopic binaries, G = spectroscopic and atmospheric models, ext = extinction, exp = expansion, kin = kinematic. CKS92 = Cahn et al., 1992; Z95 = Zhang, 1995; VZ = van de Steene and Zijlstra, 1994/1995). PN are ordered by decreasing accuracy of Hipparcos distances (for the objects identified by *, see 3.1). The small PN (diam $\leq$ 5 arcsec) are listed separately. The mean ratio $\mathbf{D}_H/\mathbf{D}_{other}$, weighted according to the errors on D_H, is shown for each distance scale. The value D of the adopted distance is given in col. 11 (see Sect. 3.3).

Name	D_H(kpc)	SB	G	ext	exp	kin	CKS92	Z95	VZ	D (kpc)
A 35	0.134(0.11-0.17)	0.2					0.22	0.74		0.134
PHL932	0.110(0.08-0.16)		0.52				0.82	3.33	2.34	0.110
NGC 1514	0.185(0.14-0.3)	0.4		0.74			0.75	1.01	0.83	0.185
SaSt 2-12	0.131 (0.10-0.21)									0.131
A 36	0.243(0.15-0.6)		0.6				0.38	1.02		0.24
NCC 1360	0.35 (0.2-1.3)		0.42				0.35	0.92	0.71	0.35
NGC 246	0.63 (0.2-?)	0.48	0.42		0.59		0.47	0.99		0.6
NGC 2392	*1.5 (0.2-?)		2.0	0.7	>1.4	1.9	1.25	1.44	1.29	1.5
He 2-138	*2.1 (0.25-?)		2.6				3.55	3.61	3.43	2.1
	$\mathbf{D}_H/\mathbf{D}_{other}$ =	**0.72**±0.3	**0.62**±0.4				**0.59**±0.4	**0.29**±0.3	**0.36**±0.35	
Small PN										
Hu 2-1	0.078 (0.05-0.2)						2.50	4.52	4.54	(1.5)
SwSt 1	0.112(0.07-0.34)			1.0			1.37	3.79	4.7	(1.2)
M 2-54	2.4 (0.3-?)						9.28	13.8		(5.)
He 3- 1333										(1.5) a
	$\mathbf{D}_H/\mathbf{D}_{other}$ =						0.10±0.1	0.05±0.07	0.02±0.01	
He 1-5	0.22(0.13-0.55)		2.0				3.48	6.71		(1.8)
LoTr 5	1.2 (0.5-?)	0.42					6.29:			(0.5)
NGC 2346		0.69	2.0	0.88			1.36	2.07	1.76	(0.8)
He 2-36		0.78				(2.40)	3.10	2.91		(1.1)
NGC 40							1.24	1.21	1.12	(0.5)
He2-438			1.6	0.6	1.5	0.8	1.6	1.85	1.84	(0.9)

For the very small PN, there is an additional problem not encountered in other Hipparcos measurements: the presence of a nebula surrounding the central star. If the nebula is not symmetric and if it is as bright as the central star at the same time, spurious measurements may be made. It may be possible to take this effect into account since the nebula brightness is accurately known at a sub-arcsecond resolution in the Hipparcos passband. Then, the individual HIPPARCOS scans could be better interpreted. This has not been done in the present paper because we do not have the necessary photometric images. The same problem may occur for SwSt 1 and Hu 2-1, because these candidates are the smallest nebulae with the highest surface brightness (H and H^* differ from 1-2 magnitude, see Table 2). For He 3–1333, the very large negative parallax leads to suspect that that the nebular itself is influencing the parallax measurement.

The error associated with the parallax of these objects is much higher than expected for stars of this magnitude, indicating that the problems that we just quoted, may play an important role. We just want to recommend further investigations.

3.2. Comparison with other distances

Comparison with distances from the literature allows to test the reliability of the methods used. A recent discussion about distances is given in Pottasch (1996, 1997) and Terzian (1997).

Individual distances are based on (1) the *spectroscopic* parallax for classical MK-type spectra, for the central star itself in a few cases, or for the cool companion if the nucleus is a spectroscopic binary; (2) the analysis of absorption lines in the spectrum compared to model atmosphere in terms of the surface gravity (Mendez et al., 1988, 1992; Pottasch, 1996; Maciel and Cazetta, 1997); (3) the interstellar extinction (see Pottasch 1983, 1996); (4) the tangential versus radial expansion velocities (Hajian et al., 1993, 1995; Kawamura and Masson, 1996); (5) the *kinematic* distances from interstellar lines intensities (Maciel, 1995, 1997).

Statistical distances are based on average values of the ionized mass or on relations adopted or calculated for some physical parameters (the nebular mass for the Shklovsky-distances, recalibrated by Cahn et al, 1992; radio-continuum brightness temperature versus radius relation by Van de Steene and Zijlstra, 1994, 1995; mass versus radius relation by Zhang, 1995). For He 3–1333, we give the distance adopted by Rao (1987) who used a mean relation between the linear radius and the dust temperature.

Table 3 is separated in 3 parts: the first part indicates the 9 PN with fairly large diameters; then the 4 PN with a diameter smaller than 5 arcsec are listed; finally we show variable and binary stars, 4 of them presenting a negative trig. parallax.

For the different distance methods, we calculate the ratio $\frac{D_H}{D_{other}}$; each ratio is weighted according to the errors on HIPPARCOS distances: for $\frac{\sigma_\pi}{\pi} \leq 0.4$, we attribute a weight of 3 (the 4 first objects in Table 3); for $0.5 \leq \frac{\sigma_\pi}{\pi} \leq 0.7$, a weight of 2 is given, and a weight of 1 for all other PN with positive parallax measurements.

It appears that all distance scales are overestimated. For our sample, the individual distances which are in closest accordance with HIPPARCOS trigonometric parallaxes are the spectroscopic estimates for binary systems. Concerning the statistical scales, the nearest values to D_H are those derived in the scale of Cahn et al., 1992, using the ratio R/r, where r is the angular radius and R the linear radius determined from the ionized mass and an optical thickness factor. The angular radius is very uncertain and can differ by a factor 2 or 3 from one observer to the other. Especially in the case of very small PN, a *stellar* appearance leads to an underestimation of r. But for the small nebulae, the uncertainty in the HIPPARCOS measurements, as discussed previously, may play a role, leading to unreliable distances, largely too small compared to all statistical distance scales (see Table 3).

3.3. Adopted distances

The adopted distances (shown in Table 3, col. 12) are those deduced from HIPPARCOS parallaxes for the large PN. For the others, the distance (between brackets) is the mean value of all available distances (excepting He 2-36 kinematic distance), weighted by the ratios calculated for each distance scale (Table 3). For LoTr5 with very uncertain parallax, we select a value of the distance inside the HIPPARCOS distance-range, in agreement with the best literature value (based on spectroscopic classification). We give the adopted distances with a number of significant decimals corresponding to the uncertainty.

4. Position on the HR diagram

The *luminosity* of the stars is calculated by using the relation given by Maciel and Cazetta (1994):

$$\log(L^*/L_\odot) = -0.4V_H + 2.726 \log T * +2 \log D(pc) + 1.28E(B-V) - 11.08$$

For the sdO nucleus of LoTr5, we adopt a value of 14.9 for the magnitude. We give the value of the luminosity for the 13 hot nuclei (Table 4, col. 5) with an estimation of the uncertainty, due essentially to the errors on the distance.

The *temperatures* T* of the central stars are taken from different sources. We use the temperatures determined by the Zanstra-method (Gleizes et al., 1989), or/and the the energy-balance method (Preite-Martinez et al., 1991). For the G-K nuclei, we adopt the value T = 5300±200 K given by Thevenin and Jasniewicz (1997) for A 35, and log T = 3.7 by van Genderen et al. (1995) for FG Sge after 1980. For LoTr 5, Jasniewicz et al. (1994 a,b) give the temperature both of the sdO star (150 000 K) and of the G star (5 030 K).

Kinematic ages are derived from the diameter and the expansion velocity, taken from Acker et al., 1992 completed with velocities determined by Hajian et al. (1995), by Masson (1989) for He 2-438, by Miranda (1995) for Hu 2-1. The expansion velocities show a large spread. As found by Weinberger (1989) and Gurzadyan and Terzian (1991), the distribution of the velocities shows a maximum near 15 km·s^{-1}; PN at high galactic latitude and distance z show faster expansion (30-40 km·s^{-1}). For PHL 932, SaSt 2-12 and He 2-36, we adopt the usual value of 15 km·s^{-1} for the expansion velocity.

Theoretical ages are deduced from the T/L diagram (Fig. 2). Note that, for BD+30° 3639, an exhaustive study done by Siebenmorgen et al. (1994) leads to the theoretical age of 900 years after the end of the AGB mass-loss.

Table 4 presents the 7 hot nuclei with a distance given by Hipparcos, 4 nuclei of small PN, the 2 [late-WC] nuclei, 6 cool stars belonging mostly to binary systems.

The following data are given:

- col 1: name of the PN;
- col 2: spectral type of the central stars;
- col 3: $E(B-V)$, taken from Tylenda et al, 1992;
- col 4: logT^*;
- col 5: luminosity;
- col 6: expansion velocity in km·s^{-1};
- col 7: diameter (pc) of the nebula, deduced from the angular diameter;
- col 8: kinematic age (in 10^3 yrs), and, in bracket, the theoretical age.

Table 4. Physical parameters of the central stars of planetary nebulae ordered by decreasing temperatures. The mark S designs small PN (diam.≤ 5 arcsec). The mark * is given for PN with negative parallaxes. The last 6 lines refer to the cool companions of the true central stars and the pulsating nucleus of He1-5, and are not plotted on Fig. 2.

Name	Spec	$E(B-V)$	$logT^{*}$	$logL^{*}/L_{\odot}$	V_{exp}	$Dia\,(pc)$	$t_{exp}\,(t_{theor})$
LoTr 5	sdO(+G)	0.05	5.18	2.5:	27	1.2	23(10)
NGC 1360	O(H)	0.05	5.08	3.4±.6	28	0.63	11(10)
NGC 246	DOZ	0.02	5.08	3.6:	39	0.7	9(5)
A 36	O(H)	0.2	4.97	2.9±.5	36	0.23	3(10)
NGC 2392	Of	0.17	4.67	4.0:	52	0.25	2.5(1)
PHL 932	O(H)	0.2	4.57	0.85±.2	(15)	0.144	3(?)
He 2-138	O(H)	0.08	4.40	3.3:	11	0.07	3(?)
M2-54 S	B	0.38	4.30	3.6:	9	0.05	3 (3)
Hu 2-1 S	wels?	0.3	4.60	2.9:	15	0.17	6 (?)
SwSt 1 S	wels?	0.5	4.50	3.3	13	0.03	1(?)
He 3-1333*S	[WC 11]	0.6	4.23	3.0:	16	(0.01)	0.4(?)
He 2-438*	[WC 9]	0.24	4.50	3.5:	22	(0.02)	0.5(3)
NGC 40*	[WC 8]	0.3	4.50	2.5:	29	(0.1)	1.5(?)
NGC 1514	AOIII(+sdO)	0.45	4.00	1.15±.2	25	0.143	2.8
SaSt 2-12	F?	0.4	3.90	-0.3±.1	(15)	0.002	0.1?
A 35	G8IV(+sdO)	0.5	3.70	0.05±.1	4	0.50	60
He 1-5	K2Ib	0.2	3.70	2.1	34	0.4	6
NGC 2346*	A2VI(+sdO?)				10	0.16	9
He 2-36*	A2III(+sdO?)				(15)	0.03	0.8

The following *comments* could be given:

– NGC 246, NGC 1360, NGC 2392 show high temperatures and luminosities, which should imply fairly massive nuclei ($0.6-0.7M_{\odot}$), and relatively short *theoretical* ages. We see that the *kinematic* ages, calculated with a constant expansion velocity assumption, appear longer for these bright nuclei, surrounded by large nebulae. This should imply that the expansion is faster in the first years, after the onset of the fast wind.
– SwSt 1 and Hu 2-1, as discussed, have very small nebulae. The case of PHL 932 was already discussed in Pottasch and Acker (1998): following Mendez et al. (1988), this star surrounded by a large nebula is not a post-AGB star and its mass must be much lower than the mass of any post-AGB star.
– The luminosity of the cool stars agrees with the previous spectral classification, excepting SaSt 2-12. This star shows a too low luminosity for a main sequence star with a temperature of about 8 000 K, and could be a metal deficient subdwarf, companion of the ionizing nucleus.

5. Peculiar motions. The case of A 35

5.1. Orbital parameters of A 35

The binary central star of A 35 is composed of a bright G-star, BD-22°3467, which is the HIPPARCOS target HIC 62905, and of a hot star which ionizes the nebula, detected in IUE spectra by Grewing and Bianchi (1989). Thévenin and Jasniewicz (1997) have estimated for BD-22°3467 a surface gravity $\log g$=3.7±0.5 and an effective temperature $T_{\rm eff} = 5300 \pm 200$ K, which are typical of a G8IV spectral type. They deduced a distance of 200 ± 100pc for Abell 35. The HIPPARCOS distance of 134 ± 30pc confirms their spectroscopic analysis: it implies for the G-star an absolute magnitude of $M_V = 4.0 \pm 0.5$ in agreement with a luminosity IV and, according to the Popper's (1980) empirical radius-luminosity relation a radius of $1.8 \pm 0.5\ R_{\odot}$ in agreement with $\log g$=3.7.

The origin of the Abell 35 system is discussed in Thévenin and Jasniewicz (1997). The high equatorial rotational velocity of BD-22°3467, about 55 ± 5 km s^{-1}, can be explained by two scenarios: spin-up during a common envelope interaction (Bond 1993) or during a wind-accretion phase (Jeffries and Stevens 1996). Both scenarios could explain the observed contamination of the companion by the s-process-overabundant envelope of the former AGB star (Thévenin and Jasniewicz, 1997). But in the first case, the actual binary should be a *close* binary whilst in the second case the binary could be a wide one.

The value of the goodness-of-fit of the astrometric solution to the accepted data (column H30) is 3.14 for BD-22°3467, indicating a bad fit to the data. However the star was not detected as binary by HIPPARCOS (column H59 is blank). If we assume that the standard deviation σ_a (about 2×10^{-3} arcsec) of astrometric measurements with regard to the best fit is entirely due to orbital motion, we can estimate an upper value of $3\sigma_a$=6×10^{-3} arcsec for the angular distance corresponding to the semi-major axis a. In assuming a total mass of $1.5 M_{\odot}$ for the binary system (0.9 $M_{\odot}$ for the G8IV star and $0.6 M_{\odot}$ for the white dwarf), we derive from the Kepler's third law an upper value of 0.6 year for the orbital period. Interferometric observations are planned in order to detect the companion which is about 4 magnitudes fainter than the bright G8IV star.

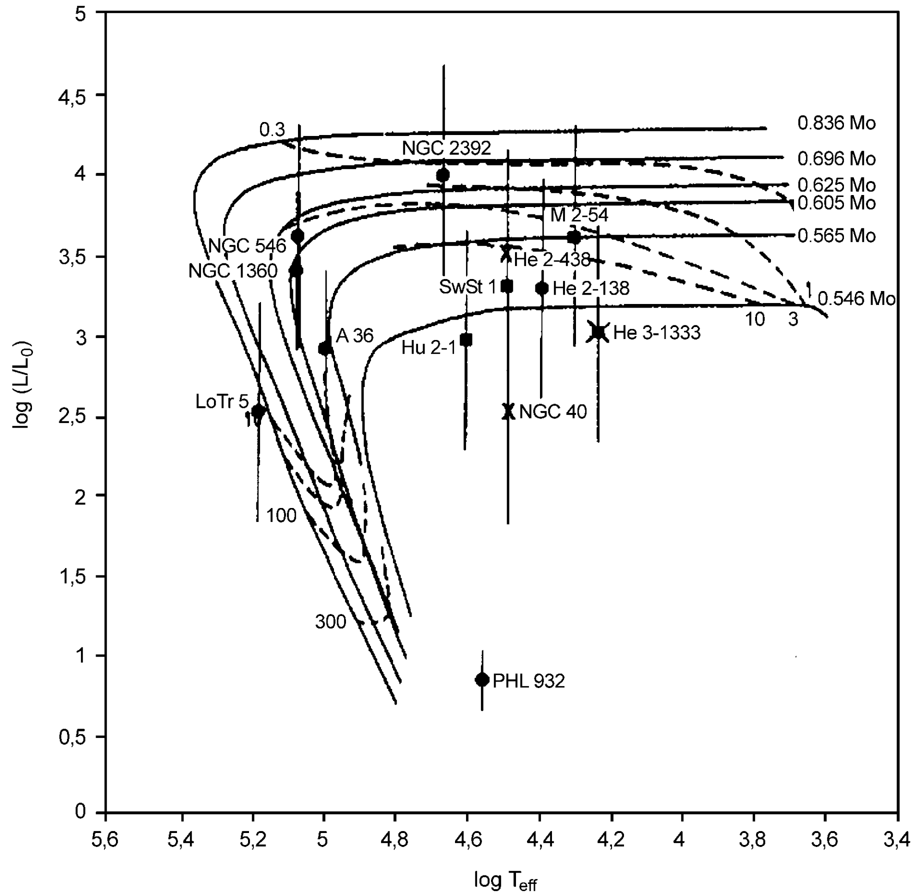

Fig. 2. HR diagram of the central stars of PN (data from Table 4). The theoretical curves are taken from Blocker (1995). The lines of constant age are shown and marked in units of 10^3 years. Small nebulae are identified by filled squares. Negative parallaxes are identified by crosses.

5.2. Asymmetric morphology

In the case of A35, Jacoby (1981) and Hollis et al. (1996) have emphasized the existence of two kinds of features in the nebula: a bow shock, best seen predominantly in [OIII], and two prominent parallel nebular (pipes) features seen at 6cm continuum and in Hα, [O II], and [N II]. These authors suggest that these features are the consequence of an interaction, respectively between the nebula and the central binary star, and between the nebular material and the interstellar medium.

From the HIPPARCOS proper motions, we deduce a transverse velocity v_T=40$\pm$10km$\cdot$s^{-1} and a proper motion position angle of 256$\pm$1°, in agreement with the the results of Hollis et al. (1996): the 249.5° position angle of the symmetry axis of the bow shock and the 253$\pm$2° position angle of the pipes (see Fig. 3).

As already noted by Marchenko et al. (1997) for WR stars, the tangential velocity vectors tend to point towards enhanced emission around stars with strong winds, assisted by Roche-lobe overflow in some binaries. A brightening of the surrounding shell in the direction of the stellar motion is clearly apparent for the [WC] star of NGC 40.

For He 2-36 (with a binary nucleus), the bipolar structure shaped by a very strong wind seems to be oriented by the star's motion in the north-western direction and ended by a bright knot. The bipolar structure of NGC 2346 (binary nucleus) appears less confined; the western side of the upper lobe appears slightly deformed by the stellar motion effect. Hu 2-1 is a bipolar PN with a slowly expanding toroid and two wide bipolar lobes; the map of the [NII]/Hα line intensity ratio shows a ring-like zone concentric with the toroid and expanding at higher velocity (Miranda, 1995). The shell appears compressed by the motion of the star, as shown in Fig. 3.

6. Conclusions

We have presented the HIPPARCOS space-borne measurements for a sample of 19 planetary nebulae.

An important conclusion concerns the distance scale. All the previously known distances of each target in this small sample look overestimated when we trust the HIPPARCOS trigonometric parallaxes.

For very compact nebulae, the HIPPARCOS parallax measurement could be biased by the motion of the nebula; in particular, the very small distances given by HIPPARCOS for Sw St 1 and Hu 2-1 are not trustworthy.

The position on the HR-diagram is not significantly different from previous studies, excepting PHL 932 and SaSt 2-12.

Additional analysis of the proper motion constrains the orbital parameters of the binary nucleus of A 35, which seems to be a wide system.

Asymmetric morphology of some PN is related to the transverse velocity direction.

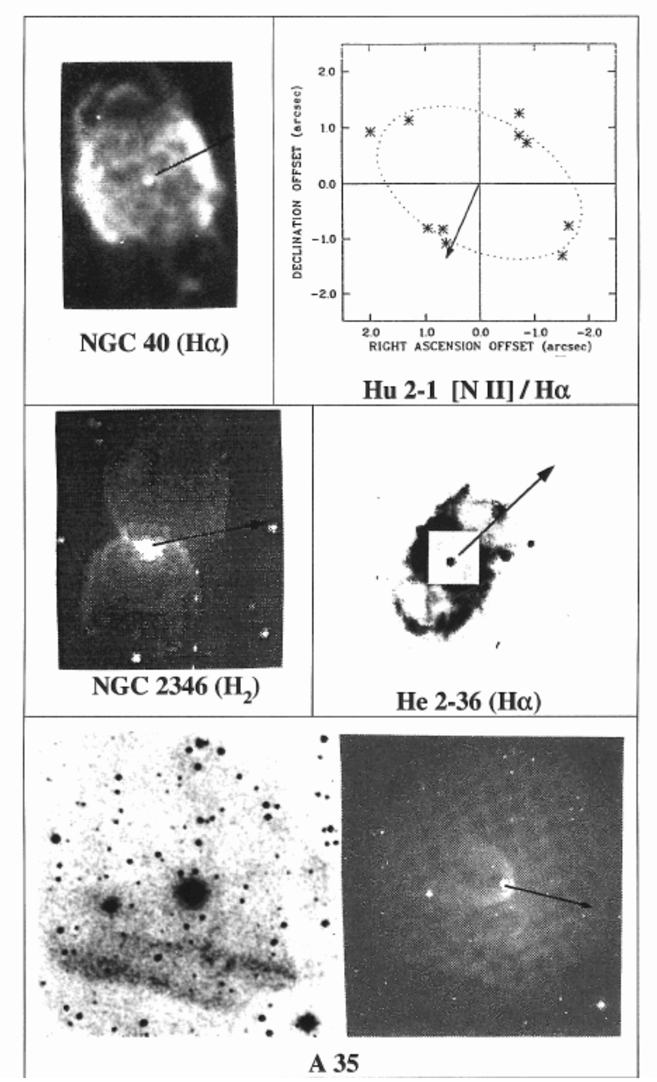

Fig. 3. Transverse velocity direction (arbitrary scale) and asymmetric morphology of some PN. The maps are taken from Balick (1987) for NGC 40, from Miranda ([NII]/H_α map,1995) for Hu 2–1, from Kastner et al. (1966) for NGC 2346, from Schwarz et al. (1992) for He 2–36; from Jacoby (1982) – right and from Acker et al. (1992) – left for A 35. North is up, east is left on all maps.

References

Acker A., Grosdidier Y., Durand S., 1997, A&A

Acker A., Stenholm B., Tylenda R., Raytchev B., 1991, A&AS 90; 89

Acker A., Ochsenbein F., Stenholm B., et al., 1992, Strasbourg-ESO Catalogue of Galactic Planetary Nebulae, European Southern Observatory

Balick B., 11987, AJ 94, 671

Blocker T., 1995, A&A 299, 755

Bond H.E., 1993, In: Barstow M.A. (ed) White Dwarfs: Advances in Observation and Theory. Kluwer, Dordrecht, p.85

Brown A.G.A., Arenou F., van Leeuwen F., Lindegren L., Luri X., 1997, ESA SP-402, page 63

Cahn J.H., Kaler J.B., Stanghellini L., 1992, A&AS 94, 399

Gleizes F., Acker A., Stenholm B., 1989, A&A 222, 237

Grewing M., Bianchi L., 1989, In: Torrès-Peimbert S. (ed)Proc. IAU Symp. 131, Planetary Nebulae, Kluwer, Dordrecht, p.314

Gurzadyan G. A., Terzian Y., 1991, A.J. 101, 1752

Hajian A.R., Terzian Y., Bignell C., 1993, Asron. J. 106, 1965

Hajian A.R., Terzian Y., Bignell C., 1995, Asron. J. 109, 2600

Handler G., 1996, IAU Inform. Bull. Var. Stars, 4283, 1-3

Hollis J.M., Van Buren D., Vogel S.N., Feibelman W.A., Jacoby G.H., Pedelty J.A., 1996, ApJ 456, 644

Iijima T., 1996, MNRAS 283, 141

Jacoby G.H., 1981, ApJ 244, 903

Jacoby G.H., 1982, Sky and Telescope 63, 1133

Jasniewicz G., Lapierre G., Monier R., 1994a A&A 287, 591

Jasniewicz G., Acker A., Mauron et al. 1994b, A&A 286, 211

Jeffries R.D., Stevens I.R., 1996, MNRAS 279, 180

Kaler J. B., 1983, Ap. J. 271, 188

Kaler J.B., Feibelman W. A., 1985, Astrophys. J. 297, 724

Kastner J.H., Weintraub D.A., Gatley I., Merrill K.M., Probst R.G., 1996, ApJ 462, 777

Kawamura J. and Masson C., 1996, Astrophys. J. 461, 282

Kwok S., Aaquist O.B., 1993, PASP 105, 694

Maciel W.J., Cazetta J.O., 1994, Astr. Sp.Sci. 222, 147

Maciel W.J., 1995, Astr. Sp. Sci. 229, 203

Maciel W.J., Cazetta J.O., 1997, Astronomia 132, Universidade de Sao Paulo, Instituto Astronomico e Geofisico

Marchenko S.V.,Moffat A.F.J., Seggewiss W., van der Hucht K., et al., 1997, A&A in press

Masson C.R., 1989, Astrophys. J. 346, 243

Mendez R.H., Kudritzki R.P., Herrero A., Husfeld D., Groth H.G., 1988, A&A 190, 113

Mendez R.H., Kudritzki R.P., Herrero A., 1992, A&A 260, 329

Miranda L.F., 1995 A&A 304, 531

Perek L., Kohoutek L., 1967, Catalogue of galactic planetary nebulae

Perrymann 1997, vol. 1 of **The Hipparcos and Tycho catalogues**, Sect. 1.3 page 57, ESA Publication SP-1200

Pollaco D.L, Kilkenny D., Marang F., van Wyk F., Roberts G., 1992,MNRAS 256, 669

Popper D.M., 1980, ARAA 18, 115

Pottasch S. R., 1983, IAU Symp. 103, 391

Pottasch S. R., 1996, A&A 307, 561

Pottasch S. R., 1997, IAU Sympos. 180, ed. Habing and Lamers, Kluwer, 483

Pottasch S. R., Acker A., 1998, A&A, 329, L5

Preite-Martinez A., Acker A., Koppen J., Stenholm B., 1991, Astron. Astrophys. Suppl. Ser. 88, 121

Rao N.K., 1987, QJRAS 28, 261

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

Siebenmorgen R., Zijlstra A., Krugel E., 1994, MNRAS 271, 449

Terzian Y., 1997, IAU Sympos. 180, ed. Habing and Lamers, Kluwer, 29

Thevenin, Jasniewicz G., 1997, A&A, in press

Tylenda R., Acker A., Stenholm B., Gleizes F., 1991, A&A Suppl. Ser. 89, 77

Tylenda R., Stasinska G., Acker A., Stenholm B., 1994, A&A Suppl. Ser. 106, 559

Van de Steene G.C. and Zijlstra A., 1994, A&AS 108, 485

Van de Steene G.C. and Zijlstra A., 1995, A&A 293, 541

Van Genderen A.M., Gautschy A., 1995, A&A 294, 453

Weinberger R., 1989, A&A Suppl. Ser. 78, 301

Zhang C.Y., 1995, Astrophys. J. 98, 659