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EXTINCTION DISTANCES TO THE PLANETARY NEBULAE NGC 6565 AND HE 2-436[1]

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RESUMEN

Se han derivado distancias por el método de extinción de las nebulosas planetarias NGC 6565 y He 2-436. Se presenta una breve discusión sobre el método de extinción y un análisis de los datos.

ABSTRACT

Extinction distances to the planetary nebulae NGC 6565 and He 2-436 have been derived. A brief discussion of the extinction method and data analysis have been carried out.

Key words: **EXTINCTION DISTANCE – PLANETARY NEBULAE**

I. INTRODUCTION

In the past few years the galactic subsystem of planetary nebulae (PN) has become more and more suitable to study the structure and chemical evolution of our Galaxy, together with H II regions, early- and late-type stars. For this purpose, an accurate analysis of the distribution of PN in our Galaxy has to be done, which involves a systematical and detailed study of these objects. This is possible only if accurate distances are available for a large number of PN, keeping in mind that the determination of accurate distances is still one of the problems where uncertainties are close to $\sim$ 40% or even higher. A more precise knowledge of the galactic distribution of PN would also help in testing stellar evolutionary models as well as in improving the estimates of the present PN birthrate.

Statistical methods are generally used for distance determination under the assumption that a few parameters of PN are constant for all of them. As an example, we cite the widely employed Shklovsky method (Shklovsky 1956), where it is assumed that all PN have the same ionized mass. Distances determined in this way have been published by Cahn and Kaler (1971) and Milne and Aller (1975), among others.

On the other hand, individual distance methods such as the "extinction" or "reddening-distance" method, usually produce better estimates. This particular method is based on the determination of a relation between the color excess and the distance of stars lying angularly close to the PN in the plane of the sky. If the color excess of the PN itself can be determined, then its distance will follow immediately.

So far, this method has been applied to a small number of objects (see e.g., Metik and Pronik 1963; Lutz 1973; Gathier 1983, 1985; Kaler and Lutz 1985; Maciel, Faúndez-Abans, and de Oliveira-Abans 1986; Gathier, Pottasch, and Pel 1986 (GPP henceforward), producing reliable individual distances. In this paper we present individual reddening distances to the planetary nebulae NGC 6565 and He 2-436 (see Table 1).

II. THE EXTINCTION METHOD

According to this method, the nebular distance can be obtained from a *foreground* extinction-distance relation in the direction of the PN (Pottasch 1980, 1983; Gathier and Pottasch 1983; Maciel 1985), knowing beforehand the planetary's color excess. The reddening of a PN can be determined in a number of ways (see e.g., Pottasch 1984, GPP), namely, from the radio/Hβ ratio, the Balmer decrement, the ultraviolet He II-line intensities and

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TABLE 1

COORDINATES OF THE TWO PLANETARY NEBULAE

	NGC 6565	He 2-436
PK	003−04 5	004−22 1
α(1950)	18 09 40.0	19 28 56.3
δ(1950)	+06 50 25	−34 17 40
ℓ_{II}	3.532	4.907
b_{II}	−4.617	−22.734

from the λ2200 A absorption. Nevertheless, PN are known to emit also infrared continuum radiation, frequently attributed to dust associated with the nebula itself. So, one would expect that some of the observed reddening were due to internal extinction, which should be subtracted before applying this method. Although it was concluded before that the internal reddening is usually small compared to the foreground one, this does not seem to be the case of NGC 6565, which was shown to have an internal $E(B-V) = 0.06$ against an adopted foreground $E(B-V) = 0.14 \pm 0.05$ (see GPP).

General extinction curves are usually employed (see e.g., Acker 1978; Pottasch 1980; Maciel 1983), which are obtained from the study of the distribution of the galactic absorbing matter (Fitzgerald 1968; Lucke 1978). It is tacitly assumed that this material is smoothly distributed along the line of sight, but one must be aware of its actual patchy nature, down to scales of one degree and even less. This causes some plateaux in the reddening-distance relation.

Alternatively, measurements of stars of known spectral types and luminosity class lying angularly close to the PN usually produce better estimates of the distances as has been shown by many authors (e.g., Metik and Pronik 1963; Lutz 1973; Maciel *et al.* 1986). An improvement to this particular approach has been done by GPP, who observed stars as close as 0.3° to the PN, classyfied them spectroscopically and calculated model atmospheres in order to obtain the intrinsic colors and M_V. The resulting distances were found to be uncertain from ~ 10% to ~ 40%.

III. OBSERVATIONS AND REDUCTION

The observations were performed with the 61-cm telescope of the University of Toronto at Las Campanas Observatory (Chile) in August, 1986. A bi-alkali EMI photomultiplier and Johnson's *BVRI* filters were employed, being only *V* and $(B-V)$ results relevant for this work. The program stars were selected from the University of Michigan Catalogue, (Houk and Cowley 1975) preference having been given to those of best quality, when possible. About 76% of the stars around He 2-436

TABLE 2

STARS NEAR THE DIRECTION OF NGC 6565

HD	ℓ	b	Type	Qual.	V	$B-V$	M_V	$E(B-V)$	d(pc)
165410	3.6	−3.4	B2II/III	2	11.92	0.61	−4.70	0.84	5874
165424	4.8	−2.7	B3/5II	2	10.44	0.40	−4.65	0.58	4294
165465	4.7	−2.8	B3II	3	11.35	0.63	−4.85	0.83	4940
165597	4.9	−2.9	B8Ib/II	A2	9.04	0.27	−4.52	0.34	3093
165657	3.5	−3.7	A5II/III	A2	10.39	0.44	−1,05	0.31	1220
165676	2.8	−4.1	A3/7(III)	A4	10.29	0.31	0.52	0.16	705
166366	2.6	−5.1	F3V	2	11.35	0.42	3.00	0.07	422
166396	2.7	−5.0	B8III	3	10.24	0.20	−0.85	0.31	1038
166397	2.0	−5.4	B7II/III	2	10.68	0.33	−2.52	0.46	2181
166422	2.7	−5.0	B8/9IV	3	10.30	0.13	−0.45	0.22	1006
166423	2.0	−5.4	A8/9III	3	9.68	0.55	0.30	0.29	483
166446	5.4	−3.6	B5II/III	1	9.53	0.14	−3.40	0.30	2442
166447	3.7	−4.5	K4III	1	7.45	1.56	−0.15	0.17	255
166529	5.1	−3.8	A0V	1	8.31	0.25	0.70	0.22	238
166530	4.2	−4.3	B5IV	2	9.87	0.20	−1.85	0.38	1249
166531	2.8	−5.1	K5III	3	8.34	1.59	−0.20	0.08	450
166548	2.4	−5.3	B9V	1	9.33	0.20	0.40	0.27	406
166570	4.1	−4.5	A9V	2	9.86	0.47	2.55	0.19	218

in the plane of the sky lie between 1° and 2°, and only 24% within 1° of the object.

Due to instrumental constraints, we considered the brightest ones as first priority, having thus selected stars within 2° of the nebula. In the case of NGC 6565, our previous observations were already done within 1.5° of the nebula, and in this work the range was extended to 2° just to include other bright ones. The stars have been measured at least twice at a precision level better than 3% each time. The magnitude and color transformation equations were solved with a multiple linear regression technique (see e.g., Harris, Fitzgerald, and Reed 1981), the best fits for $(B - V)$ for each night having been chosen independently. The photometric uncertainties are typically within 0.03 mag for the color index, while V and $(B - V)$ are uncertain within 0.02 mag and 0.04 mag, respectively.

The observational results for the stars located in the direction of NGC 6565 and He 2-436 are displayed in Tables 2 and 3, respectively. The different columns display: (1) the HD number, (2) and (3) the galactic coordinates, (4) the spectral type and luminosity class, (5) Houk and Cowley's catalog level of quality, (6) the observed V magnitude, (7) the observed color index, together with (8) the adopted absolute visual magnitude M_V, (9) the color excess $E(B - V)$, and (10) the derived distance.

IV. DATA ANALYSIS

a) *General Procedure*

The values of M_V and $(B - V)_0$ have been extracted from the works of Fitzgerald (1970); Allen (1973); Golay (1974); Acker (1976), and Schmidt-Kaler (1982), who provide spectral type-color index and color index-absolute magnitude calibrations.

The question was then raised, whether the "standard" value of R = 3.2 (Pottasch *et al.* 1977) does characterize the interstellar extinction in the direction of the two planetaries. To check this, R has

TABLE 3

STARS NEAR THE DIRECTION OF HE 2-436

HD	ℓ	b	Type	Qual.	V	$B-V$	M_V	$E(B-V)$	d(pc)
182324	4.3	−21.5	K1III	2	8.81	1.24	0.30	0.18	379
182372	4.2	−21.6	A4V	1	7.49	0.28	1.80	0.18	103
182559	6.0	−21.1	A0/IV	1	8.13	0.18	0.85	0.20	208
182664	6.6	−21.1	G8III	2	13.16	1.26	0.65	0.33	1886
182890	3.7	−22.3	G6V	1	9.28	0.84	5.25	0.14	52
183092	6.2	−21.7	A9V	1	8.95	0.42	2.55	0.14	154
183153	3.8	−22.5	G8III	1	12.88	1.19	0.65	0.26	1873
183549	5.7	−22.4	F5V	1	8.40	0.70	3.40	0.26	67
183717	6.1	−22.4	GIIV/V	2	12.17	0.92	3.75	0.31	299
183783	3.6	−23.2	K3/4V	1	11.20	1.17	6.75	0.17	59
183802	6.3	−22.4	A2/3V	1	7.32	0.31	1.40	0.25	104
183878	4.8	−23.0	G2V	2	8.20	0.79	4.75	0.15	39
183963	6.4	−22.5	G8/K0III	1	8.50	1.17	0.60	0.20	276
183998	4.7	−23.1	K0III+F/G	3R	8.55	1.01	0.50	0.01	402
184124	3.5	−23.6	K2/3III	3	13.37	1.58	0.03	0.37	2595
184373	5.6	−23.3	F2/3V	1	11.64	0.59	2.95	0.23	380
184258	6.5	−22.8	K0III	1	8.03	1.15	0.50	0.15	252
184459	3.2	−24.1	F5V	1D	9.20	0.73	3.40	0.29	92
184514	4.7	−23.7	G1V	1	8.41	0.73	4.55	0.10	51
184597	6.8	−23.1	B4III	1	6.92	0.11	−3.30	0.30	693
184649	4.9	−23.9	A9V	1	9.60	0.48	2.55	0.20	188
184671	6.8	−23.2	B8IV	A1	9.41	0.21	−0.60	0.31	619
184797	5.2	−23.8	F6/8V+A/F	A1R	9.34	0.64	3.80	0.14	103
184816	5.2	−23.8	F6/7V	2	9.35	0.63	3.70	0.15	106
184817	4.7	−24.0	K1III	2D	9.23	1.19	0.30	0.13	499
184839	5.3	−23.8	F7V	1	9.48	0.54	3.80	0.04	129
184922	6.6	−23.5	K0III	2	6.73	1.04	0.50	0.04	166

been calculated for each program star according to Olson's (1965) relation:

$$R = 3.25 + 0.25\,(B - V)_0 + 0.05\;E(B - V), \qquad (1)$$

valid if $E(B - V) < 1.5$ and $(B{-}V)_0 < 1.4$; these conditions are not satisfied by only four stars. It turned out that R (NGC 6565) = 3.3 ± 0.1 and R (He 2-436) = 3.4 ± 0.1. These somewhat larger values imply a decrease in distances up to 6% if $E(B - V) \geq 0.5$ mag, and an increase in the slope of the straight-line fit to E vs. d of 6% also, a change that might be considered negligible. These results agree with the statement that the variations of R around the standard value in the galactic plane are small and less than 5% (Schultz and Wiemer 1975; Turner 1976, and GGP). Cester and Marci (1985) studied the effects of bandwidth on interstellar reddening and on the R-ratio. The point is that the color excess and R are functions of the filter's effective wavelength which, in turn, depends on the energy distribution of the star, as well as on the amount of interstellar matter (the parameter n in equation 1 of Cester and Marci 1975). This causes $E(B - V)$ and R to change with the color of the star. They derived a relation by means of which $E(B - V)$ may be calculated for any given spectral type once the color excess and the value of n for an A0 V star are known; likewise for R it is necessary to apply another relation. Our observational data for NGC 6565 included one such star, but it turned out that changes in distance due to the new value R (NGC 6565) = 3.4 ± 0.1 were of the order of 7% – a minor deviation again. We have decided, nonetheless, to

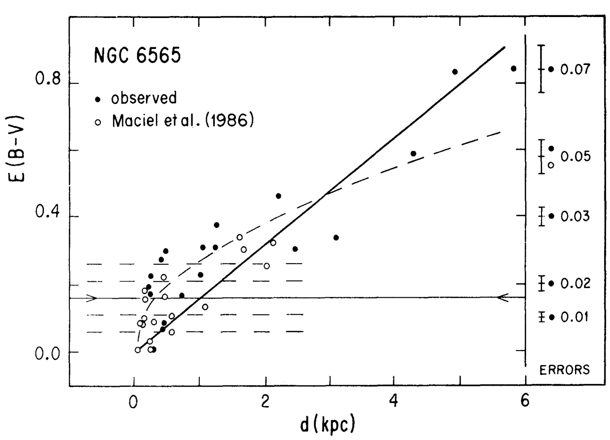

Fig. 1. $E(B{-}V)$ vs. d diagram for stars around NGC 6565. The symbols are: open circles represent the data by Maciel *et al.* (1986) and filled circles the present observational data. Two possible fits are displayed: in solid lines a straight-line fit and in broken lines a square-root one. On the right, the errors at the various color excess levels are displayed for each source. For the present data $\sigma_E \cong 0.08\,E(B - V)$. The arrows indicate E_{NP}.

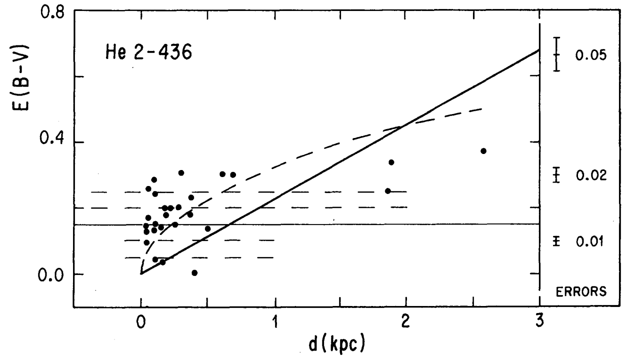

Fig. 2. $E(B{-}V)$ vs. d diagram for stars around He 2-436. On the right, the errors at the various color excess values are displayed. The arrows are located at E_{NP}.

apply these individual extinction values in order to better estimate the planetaries' distances.

Scatter diagrams of color excess vs. distance have been constructed, and the distances have been afterwards estimated by means of the different E vs. d relations found. We have also followed Kaler and Lutz's (1985) procedure, adopting two ranges of color excess, ± ΔE, around the mean nebular color excess and averaging the distances of the observed stars that fall within the so-defined intervals. In this approach the derived nebular distance is not heavily affected by the dust distribution well away from that position as in the case of fitting E vs. d relations to all stars. See Figures 1 and 2 for NGC 6565 and He 2-436, respectively.

Following GPP's argument that it is better to derive the distances from diagrams of $E(B - V)$ vs. $(V - M_V)_0$ because the errors are symmetrical in this kind of representation, we present these diagrams for NGC 6565 and He 2-436 in Figures 3 and 4, respectively. In the next section a detailed discussion on the influence of the several parameters involved is presented.

b) *Errors Involved*

A number of factors hinders the full exploitation of the reddening-distance method. From our observational point of view, a rather small number of stars per planetary was observed, and the choice of stars within 2° of the PN makes the influence of the patchiness of the Interstellar Medium (ISM) important. The error due to the selection of stars would be much smaller if one just chose a certain small region around it and then made spectroscopic measurements of every potential candidate star inside it. In this way, the determination of their spectral types would be almost free of uncertainties, thus reducing the scatter in the E vs. d diagrams, in agreement with Pottasch (1988).

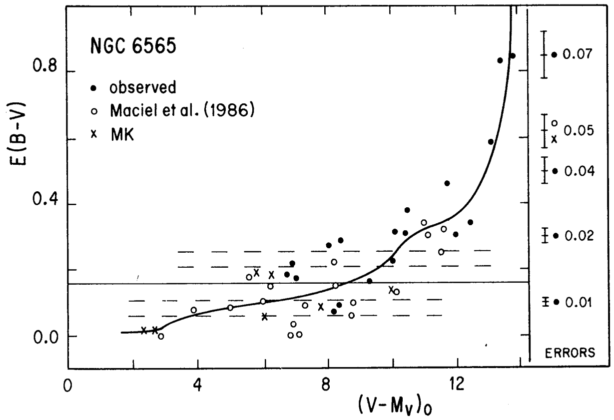

Fig. 3. Diagram of E$(B - V)$ vs. $(V - M_V)_0$, the true distance modulus, for the stars around NGC 6565. The continuous curve has been fitted visually. On the right, the various error bars are displayed for each source. The nebular color excess is indicated by the arrows.

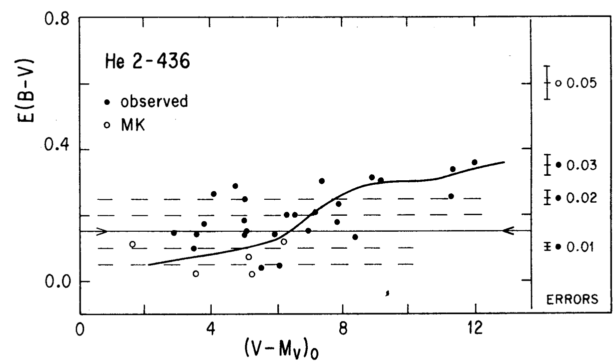

Fig. 4. The same as Figure 3 for He 2-436.

Interpolating on the M_V and $(B - V)_0$ calibrating diagrams led to errors of 0.1 mag in M_V when reading off values from the individual curves for a given luminosity class, and of even 1 mag when the luminosity class itself is uncertain; and of (*i*) 0.5 mag in $(B - V)_0$ if luminosity class is IV and $M_V \geq 3$, (*ii*) 0.05 mag if $M_V < 3$, and (*iii*) 0.05 mag in the remaining cases. The color excess was computed with an error never exceeding 0.2 mag.

Careful analysis of the uncertainties revealed that even though the term of the linear regression that was more uncertain was the air-mass dependent one, it turned out that $\sigma_E \cong \sigma\ (b - v) \cong 8\%$. In the case of NGC 6565, the largest E$(B - V) = 0.85$, implying that σ_E (max) = 0.07 mag; in the case of He 2-436, we have 0.67 and 0.05 mag, respectively. Each program star's distance is hence strongly affected by the error in its E$(B - V)$, the other parameters giving just a minor contribution.

A rapid inspection of the various values of E_{NP} for each PN available in the literature (whenever there is any) reveals that it is not uncommon to find values that may differ within 30% of each other, therefore making judicious choices necessary.

Due to instrumental constraints, there is a tendency of observing stars selected from a magnitude-limited sample, their color excesses being generally small. The slope of the resulting E vs. d relation tends to be less steep, causing an overestimate of the distance of the PN.

The idea of fitting a least-square straight line to this diagram is a good first approximation in the majority of the cases, but the inclusion of some plateaux would be perhaps more realistic (e.g., GPP). This is reasonable when the presence of a plateau is clearly defined regardless the errors involved, and when E_{NP} does not coincide with one of them. We have also tried other possible fits, but discuss only the square-root one.

Once the least-square fit (E = b.d) was done on the E vs. d diagram being σ_E the error in the planetary color excess, the error in the NP distance (σ_d) was computed as follows:

$$\sigma_d^2 = \frac{1}{b^2}\left[\sigma_E^2 + d_{NP}^2\,\sigma_b^2\right] \quad . \tag{2}$$

Similarly, for the square-root fit:

$$\sigma_d^2 = \frac{4d_{NP}}{b^2}\left[\sigma_E^2 + d_{NP}\,\sigma_b^2\right] \quad . \tag{3}$$

And for the E$(B - V)$ vs. $(V - M_V)_0$ diagrams, as given by GPP:

$$\sigma_{(V-M_V)_0}^2 = \frac{\sigma_E^2}{\gamma^2} + \sigma_{RD}^2 \quad , \tag{4}$$

where γ is the slope of the reddening-distance modulus relation at the level of E_{NP} and σ_{RD} is the error in this relation. In order to estimate σ_{RD} one must take into account the observed scatter in the diagram at the level of E_{NP}. The so-derived distances are in Table 4. The method of Kaler and Lutz (1985) has the advantage of allowing one to calculate the mean error of a single point, so that one has a better estimate of the uncertainty in the planetary distance. ΔE must be well chosen so that a large range is not spanned to avoid introducing errors due either to a non-uniform distribution of stars around the E_{NP}, or to a non-linearity of extinction changes within the band. We have

TABLE 4

DISTANCES DERIVED FROM E VS. $(V-M_V)_0$ DIAGRAMS

PN	$(V-M_V)_0$	γ	σ_{RD} (kpc)	d (kpc)	σ_d (kpc)
NGC 6565	8.5	0.06	0.13	0.50	0.22
He 2-436	6.2	0.05	0.07	0.17	0.09

chosen $\Delta E_1 = 0.05$ and $\Delta E_2 = 0.10$ mag for both nebulae, and have so derived a distance of (0.32 ± 0.17) kpc for NGC 6565, and (0.24 ± 0.15) kpc for He 2-436.

V. DISCUSSION

a) *NGC 6565*

The color excess of this planetary has been determined in a number of ways, e.g., from the radio flux/Hβ ratio, the Balmer decrement, the *UV* He II line intensity ratios, λ2200 A absorption feature, and the [O II] ratio λ2470/($\lambda\lambda$7320+7330). The results are in the range 0.17 – 0.26 (Milne and Aller 1975; Kaler, Aller, and Czyzak 1976; Kaler 1978; Kohoutek and Martin 1981; Torres-Peimbert and Peña 1981; Feibelman 1982, and GPP). These last authors also compute the internal reddening based on the amount of IR emission from dust grains associated with the nebula. The internal reddening of NGC 6565 is thus not negligible being of 0.06 mag. We have averaged the several excess values and thus employed the final "clean"value of 0.16 ± 0.06 mag for the foreground extinction of NGC 6565. We were able to observe just 19 program stars, so we have decided to add the data from Maciel *et al.* (1986) (errors of 0.05 mag). These data points are plotted in Figure 1 together with two possible fits. Taking into consideration all the errors involved, there is agreement between the different authors and ourselves.

As the linear regression turned out to fail in representing the results at small distances, up to 2 kpc, the region of interest due to the value of the planetary's color excess and the data seem to suggest another possibility; a square-root curve was then considered to possibly represent the observed tendency. The different parameters for both fits are in Table 5 which is self-explanatory. Their χ^2_ν values show that neither of the fits is very good, the square-root one being slightly better; the large χ^2_ν value indicates, moreover, sources of errors other than counting statistics. Comparing our data to an early work of ours on the same object (Maciel *et al.* 1986, Figure 1) and to GPP, our points lie systematically above theirs, meaning that our measurements are

TABLE 5

PARAMETERS OF THE TWO FITS FOR NGC 6565

	E = bd	E = bd$^{1/2}$
Number of points	38	38
b	1.58×10^{-4}	8.55×10^{-3}
σ_b	0.11×10^{-4}	0.08×10^{-3}
Linear corr. coeff.	0.89	...
σ diagram	0.12	0.10
d_{NP}(kpc)	1.0	0.35
$\sigma_{d_{NP}}$(kpc)	0.3	0.22

redder. The star HD 166470 was observed on both runs, with a difference of 0.11 mag in color excess. This could be due to poor sky conditions during the present run and slightly different filter and detector characteristics, not well corrected for in the calibration process. We note, however, that even lowering the new values by 0.1 mag a fit different from a straight line is still a possibility.

We choose a square-root fit, although we could have chosen any other one as well; in fact, we also tried a logarithmic curve of the form E = b log (d); even though it could not represent the data beyond 1 kpc. In any case, the planetary's distance turned out to be the same. The fits provide distances which exclude one another (see Table 5). Having drawn a E vs. $(V-M_V)_0$ diagram to compare our results with GPP's directly and even combining our data with theirs and with the MK Spectral Classification (Kennedy and Buscombe 1974; Buscombe 1977, 1980, 1981) with an estimated error of 0.1 mag for the stars under consideration, the distance to the PN did not change significantly (see Table 4). The fact that the square-root result is similar to that obtained following Kaler and Lutz (1985) is explained by the increased weight given to the stars of color excess closer to E_{NP}, which coincidentaly lie close to us.

As a result, we suggest a value of the distance between 320 pc and 1000 pc for NGC 6565. Table 6 displays a summary of various previous distance determinations that, except for Maciel *et al.* (1986), GPP, and this work, are based on statistical methods and yield distances that are very large although similar to each other. The application of a general extinction law (Pottasch 1983), in contrast, leads to a distance value which is similar to those given by individual methods. Our fit is the first one to give so low a value because we have attempted a different fit. We are aware, nonetheless, of the various errors involved that certainly contribute to the rather large uncertainties associated to our parameter determinations.

TABLE 6

DISTANCES TO NGC 6565

Reference[a]	Method	d (pc)
CK71	Shklovsky (Hβ)	2490
CK71	Shklovsky (red)	2560
MA75	Shklovsky (ratio)	4567
MA75	Effective Absorption	2860
Ac78	Synthetic	3000
MP80, Ma84	Mass-Radius Relation	3468
Da82	Mass-Radius Relation	3540
Po83	General Extinction	1300
Ma86	Individual Extinction	1540
Ga86	Reddening Distance	1000
This work	Individual Extinction	320 - 1000

a. References: Ac78 Acker 1978, CK71 Cahn and Kaler 1971, Da82 Daub 1982, Ga86 Gathier *et al.* 1986. Ma84 Maciel 1984, Ma86 Maciel *et al.* 1986, MA75 Milne and Aller 1975, MP80 Maciel and Pottasch 1980, and Po83 Pottasch 1983.

We have also derived the height from the galactic plane: $z = -26$ to -89 pc, which places this nebula within the interstellar absorbing layer, in accordance with the estimates from other methods.

b) *He 2-436*

There were enough data points within 700 pc, and data from the MK Catalogue improved the coverage of this interval (Figure 2). Here, the necessity of the alternative fit is not as evident as in the case of NGC 6565, even though it can still be the best fit (see Table 7 for the different fit parameters), but then again, neither one represents the data well. We have assigned an error of 0.05 mag to this planetary's color excess, $E(B-V) = 0.15$ (Milne and Aller 1975); the inferred distances are compatible with each other. In this case, the distance obtained following Kaler and Lutz (1985) agrees well with them.

A smooth relation has been fitted visually to the E vs. $(V - M_V)_0$ diagram where MK data are also plotted (Figure 4), the so-derived distance agrees very well with the one from the square-root fit and has a slightly lower error (see Table 4). Observing stars with distance modulus > 9 would help in better determining the tendency of the interstellar extinction, so that the slope of this relation could be calculated more reliably and the error in the distance estimated more precisely. If we adopt a distance interval of 210-660 pc, this corresponds to $z = -81$ to -255 pc, which would place this nebula almost inside the absorbing layer, closer to the galactic plane than any other previous estimate (e.g., $z > 1$ kpc from the statistical methods – see Table 8 for a summary of all of them). This result is in contradiction to its galactic latitude. In fact, this object may actually be located outside the galactic plane, a situation to which the extinction method is insensitive, and consequently, not applicable.

TABLE 7

PARAMETERS OF THE TWO FITS FOR HE 2-436

	$E = bd$	$E = bd^{1/2}$
Number of points	28	28
b	2.29×10^{-4}	9.97×10^{-3}
σ_b	0.37×10^{-4}	0.19×10^{-3}
Linear corr. coeff.	0.63	...
σ diagram	0.16	0.11
d_{NP}(kpc)	0.66	0.23
$\sigma_{d_{NP}}$(kpc)	0.24	0.15

TABLE 8

DISTANCES TO HE 2-436

Reference[a]	Method	d (pc)
MA75	Shklovsky (radio)	> 5011
MA75	Effective Absorption	390
Ma84	Mass-Radius Relation	4476
This work	Individual Extinction	210 – 660

a. References: MA75 Milne and Aller 1975, Ma84 Maciel 1984.

c) *Final Remarks*

The method described here is a powerful way of obtaining planetary nebulae's distances. It is important, nonetheless, to infer the internal absorption of the PN before applying this method, as well as to have very well determined photometric data and spectral type of the stars in their surroundings. In the near future, we intend to obtain spectra of the closest stars (on the sky) to a couple of selected PN in order to check if it reduces the scatter in the E vs. d relations (Pottasch 1988), as well as to extend the individual distance determination to other nebulae, presenting them in the form of a catalogue.

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