

## A NEW SYNTHETIC DISTANCE SCALE FOR PLANETARY NEBULAE

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A new distance scale is provided for the Planetary Nebulae (PN). It combines thirteen lists, published between 1950 and 1976, for which the distances have been recalibrated with the aid of a large number of individual distances  $D_{ind}$ : 19 values were selected from among individual distances already published, and 62 new distances have been calculated from kinematic and absorption laws.

- Kinematic distances were calculated for 18 PN near the sun and comparable to population I stars by various converging criteria: high relative abundances,  $\langle N/H \rangle$ ,  $\langle O/H \rangle$ ; a large proportion of morphological "B" types; high mean excitation class and nuclei with spectra similar to those of population I stars.

- For PN whose reddening is known, distances were deduced from the interstellar absorption law: for 10 of them, the distance was calculated by comparison with the reddening of the stars located in a circle of  $1^\circ$  radius around each nebula. A less localized estimate was made for 34 PN by comparing their reddening with the mean reddening in the galactic disc, estimated by Lucke (1975, unpublished) from compiled observations for 2860 stars.

Comparison of the distances  $D_{ind}$  with the statistical scales, carefully applied to each PN according to its optical depth, permits deduction for each  $D_i$  - scale of a mean coefficient  $X_i = \langle D_i/D_{ind} \rangle$ , varying from  $0.84 \pm 0.05$  for the Kohoutek-scale (1961-62) to  $1.9 \pm 0.2$  for that of Cudworth (1974); this calibration corresponds to a scale intermediate between those of Shklovsky and O'Dell for optically thin PN, and to a mean absolute magnitude of  $-0.6$  for optically thick PN.

A new distance  $D = \sum X_i D_i / n$  was calculated for 330 PN.

With the aid of these values, in combination with radial velocities already known or calculated from personal observations, the kinematic and spatial parameters were calculated; they are very different for PN with dissimilar chemical, spectral and morphological characteristics and correspond to very different ages. (Paper will appear in Astronomy and Astrophysics.)

## DISCUSSION

Seaton: I would like to congratulate Mme. Acker on her work and on its presentation. I believe that some distances of optically thick nebulae are obtained using a method originally due to Minkowski, which assumes constant stellar luminosity. The nature of the assumption made must not be overlooked.

## THE PLANETARY NEBULA IN THE GALACTIC CLUSTER NGC 2818

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The planetary nebula PK 261+8°1 is of special interest due to its apparent physical association with the galactic cluster NGC 2818 (Tiff, Connally, and Webb 1972, *M.N.R.A.S.*, 158, 47). During 1975-76 we obtained spectrophotometric observations (both photographic and photoelectric) and interference filter photographs (H $\beta$ , [OIII], [NII], and [SII]) of this object at Cerro Tololo. The nebula has a rather smooth bilaterally symmetric "hourglass" structure in the H $\beta$  and [OIII] photographs, while several bright filaments appear in [NII] and [SII]. The spectrum of PK 261+8°1 is very rich in lines characteristic of both low ionization ([OI], [OII], [NI], [NII], [SII]) and high ionization (He II, [OIII], [NeV]) regions. Using the photo electric observations, we derive  $T_e = 14,500 \pm 1500^\circ\text{K}$  from the [OIII] lines and  $T_e = 11,000 \pm 1300^\circ\text{K}$  from the [OIII] lines and  $T_e = 11,000 \pm 1300^\circ\text{K}$  from the [NII] lines. The  $\lambda 6717/\lambda 6730$  [SII] ratio suggests that  $\text{Ne} \leq 800 \text{ cm}^{-3}$  in the regions where  $\text{S}^+$  exists. Additional information on the density and temperature structure of the nebula derived from the deep photographic spectra will also be presented. Due to the complicated ionization structure, an accurate abundance analysis of PK 261+8°1 is difficult. Consequently, we will present the quantitative results from a variety of abundance calculation techniques. We conclude that  $\text{He}/\text{H} = 0.14 \pm .01$ , N is substantially enriched relative to H and O ( $\text{N}/\text{H} \geq \text{O}/\text{H} = 4 \times 10^{-4}$ ), while the abundances of O, Ne, S, Ar, and Cl relative to H are similar to values typical of galactic planetary nebulae. Other characteristics of the nebula derived from its association with the cluster NGC 2818 and its spectral similarity to Henize 97 in the Large Magellanic Cloud will be discussed. This research was supported in part by a grant from the Research Corporation.