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VISUAL BINARIES IN PLANETARY NEBULAE*

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Close companions to the central stars have been observed in several planetary nebulae. Proper motions for some of these are consistent with physical association.

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It has long been known from the large common proper motion and common radial velocity that the central star of NGC 246 is a visual binary (see e.g. Minkowski 1965). The spectroscopic parallax of the late-type companion has given this nebula one of the best-determined distances of any planetary. In the course of a new proper-motion study of planetary nebulae, close companions have been observed for a few other central stars. Hopefully at least some of these will prove to be physical pairs, since most of them are much closer than other apparent pairs in the same fields. All of these could have been observed earlier but they do not seem to have been mentioned in the literature.

The observations reported here were made on yellow plates (103A-G + OG 4) with the Lick 36-inch (91 cm) refractor (scale = $11''.72$ mm^{-1}). Table I gives the observed properties of these new pairs with NGC 246 included for comparison. The first column lists the NGC or Abell (1966) designations of the nebulae. The magnitudes of the primary and secondary components appear in the second column and were estimated from my plates. They are uncertain by about $\pm 0^m.5$. The only exception is NGC 246, for which the photoelectric (V) values by Baum (1960) are given. The primary has been defined as the brighter star, and except for NGC 246 and NGC 6853 it is unknown which star is the true central star. The third and fourth columns give the separations (in arc seconds) and position angles (in degrees). The fifth column gives the separations in astronomical units, assuming these to be physical pairs, calculated using the distances from O'Dell (1962) or Abell (1966). The final two columns give the measured centennial proper motions in α and δ with their associated mean errors for both components. These motions were each measured on two plate pairs with a ten-year epoch difference and are relative to 15–20 reference stars of $m_{pv} \approx 15$–16. Whenever possible, the plates were measured on the Lick Automatic Measuring Engine (AME). Proper motions are not available for NGC 650-1 and A 30 since the first epoch plates were taken in 1972.

The individual objects are discussed briefly below.

NGC 650-1. The northern component appears slightly fainter on a red plate (103A-E + RG 1) taken with the 120-inch (305 cm) reflector and thus may be the true central star.

A 24. The plates were measured on the AME but the images are very weak so the proper motions are uncertain.

A 30. If the distance is correct, the separation in a.u. is much larger than that of the other pairs and this may argue against physical association.

A 33. The plates were measured by hand since the images are too close for the AME. The proper motions are inconclusive.

NGC 6853 (M27). The plates were measured on the AME and the motions appear to be common.

These stars are faint, but it is hoped that further observations will decide which of these are physical pairs and perhaps yield accurate distances for those which are. In addition, observations of physical companions could put constraints on the evolutionary state of the systems.

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TABLE I

OBSERVED PROPERTIES

Nebula	m_{pv}	ρ''	θ	$\rho_{a.u.}$	μ_α (″ 100 yrs^{-1})	μ_δ
NGC 246	11.9	3.8	129°	1640	−2.6 ± 0.3	0.1 ± 0.5
	14.3				−3.2 ± 0.3	0.3 ± 0.2
NGC 650-1	17.5	1.4	190°	865		
	17.7					
A 24	17.3	3.4	164°	1190	−0.4 ± 0.5	0.4 ± 0.8
	17.8				−1.1 ± 1.5	1.3 ± 0.5
A 30	14.5	5.3	142°	6850		
	17.0					
A 33	15.7	1.8	212°	1130	−0.9 ± 0.3	1.6 ± 0.4
	17.0				−1.7 ± 0.3	1.2 ± 0.2
NGC 6853	14.0	6.5	214°	1690	+1.6 ± 0.2	0.9 ± 0.3
(M27)	17.0				+2.2 ± 0.4	0.7 ± 0.3

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