THE DISTANCES OF PN AND THE GALACTIC ROTATION CURVE

S.E. Schneider, Y. Terzian
Cornell University, Ithaca, N.Y., USA

A. Purgathofer
Institut fur Astronomie der Universitat Wien, Austria

M. Perinotto
Astrophysical Observatory of Arcetri, Largo E. Fermi 5,
Firenze, Italy

The problem of determining the distance scale for planetary nebulae (PN) is approached through the kinematics of this subpopulation in the galaxy. To this end, we have compiled a catalogue of all known radial velocities for 457 galactic PN with standardized error statistics. External (calibration?) errors of the same magnitude as internal spectral line deviations are noted.

A subsample of 62 PN lying in the galactic longitude ranges 20^{o} to 50^{o} and 310^{o} to 340^{o} and having distances determined by Acker was chosen for examination since radial velocities vary rapidly with distance in these directions. We find that Acker's distances must be increased by a factor 1.5 (± 0.1) $R_{\odot}/9$ kpc for velocities and distances to correspond with the known rotation curve interior to the solar circle. This technique is relatively more sensitive to the distant PN, but locally we similarly find that distances must be increased to give the PN a scale height commensurate with their velocity dispersion.

The scatter of kinematical distances from the rescaled distances is small - less than that attributable to the expected velocity dispersion alone in most cases. Since most of these distances were based upon Schlovskii's method, this small deviation lends support to such distance determinations when properly scaled.

Conversely, we are able to estimate the galactic rotation exterior to the sun. We find that the rotation curve steadily rises out to 6 kpc (and possibly 11 kpc) beyond the solar circle, in agreement with previous determinations.

OSTERBROCK: Does the check on distances which you propose rely on the assumption that PN have circular (or nearly circular) orbits in the Galaxy, like the interstellar gas from which the rotation curve which you use was derived? Is there observational evidence to justify such an assumption?

SCHNEIDER: While the velocities of individual, old disk stars may be peculiar, on the average they take part in the general Galactic rotation. For example, in the solar vicinity, the asymmetric drift of the mean PN rotation is observed to be only about 15 km s^{-1}. The close agreement of our predicted velocities with the observed velocities suggests that this asymmetric drift does not increase much beyond this value, to within 4 kpc of the Galactic centre.

ALLER: Plots of PN radial velocities against longitude display a marked departure from a double sine wave, as Minkowski showed long ago. There are many orbits of high eccentricity. I do not understand how Galactic rotation theory can be applied fruitfully to such a mixture of orbits.

SCHNEIDER: It is true that plots of PN velocities along a given direction, regardless of distance, show a large scatter. Towards the Galactic centre, the scatter is intrinsic to the PN orbits - they have a large radial velocity dispersion. However, none of the PN we use is as close as 3 kpc to the Galactic centre, and the scatter of points about the predicted velocity/distance curves is small. This result, and preliminary computer simulations of the evolution of orbits in the presence of a ring of molecular clouds, indicate that the apparent velocity dispersions should be and are sufficiently small to obtain meaningful results.

ACKER: In 1976 and 1980, I studied the relationships between chemical, spatial and kinematic parameters of PN. Using a sample of 330 PN with known radial velocities, I found the usually accepted values for the rotation parameters. However, the velocity dispersion is high because the majority of PN belong to an old disk population. I believe that it is very difficult to calibrate a distance scale using kinematic criteria alone.