VLA OBSERVATIONS OF PLANETARY NEBULAE AT THE GALACTIC CENTRE

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The Very Large Array (VLA) in Socorro, New Mexico, has been used to measure the 6 cm continuum flux densities and the angular sizes of 42 planetary nebulae (PN) in the direction of the galactic centre (GC). These were all optically confirmed PN for which the radial velocities (and positions on the sky) make it very likely that they are close to the GC. With a detection limit of about 1 mJy, 34 PN were detected. Their flux densities range from 2 to 100 mJy. Initially we used a configuration of the VLA with an instrumental resolution of 1". About 80% of the detected PN could be clearly resolved with this resolution. The unresolved PN were observed again with a configuration of the VLA that has a resolution of 0".4. For all but one of the 34 detected PN we could determine reliable angular sizes. The inferred total ionized masses range from < 0.01 to $\sim 0.5\ M_{\odot}$, assuming a distance to the GC of 9 kpc. The results argue strongly against the use of the Shklovsky method for distance determinations. Previous measurements of PN at the GC showed that their luminosities were substantially higher than those for nearby PN (Pottasch, 1980). The luminosity distribution of the PN in our sample is broader towards lower luminosities (up to the detection limit of the observations), but the luminosities are still high compared with nearby PN. We interpret this as a selection effect: by studying only optically confirmed PN, the intrinsically brightest PN are selected.

S.R. Pottasch, 1980, Astron. Astrophys. 89, 336.

TERZIAN: If I understand correctly, you have assumed that all the PN that you observed have a distance of 9 kpc. Since all these PN are observed optically, did you check the "extinction" distances of each one? It is perhaps surprising that, given the high extinction towards the Galactic centre, you can see all of them out to 9 kpc!

GATHIER: We did, indeed, assume a distance of 9 kpc for the whole sample. We have not yet tried to determine individual extinctions; this will be difficult, as the Hβ fluxes of most of these objects are not accurately determined.

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SCHNEIDER: The radial velocity dispersion of PN both in our Galaxy and in M 31 appears to be greater than 70 km s^{-1} out to at least 3 kpc from their centres, so I would question your distance scale.

GATHIER: From the distribution of PN as a function of Galactic longitude, we estimate that 80% of the objects in our sample are close to the Galactic centre. Allowing for the fact that most of our objects have high radial velocities, in excess of 150 km s^{-1}, we estimate that at least 90% are close to the Galactic centre.

BIRTHRATE OF PN

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Recent observations of planetary nebulae have called into question the Shklovsky method of measuring distances. For those planetaries for which independent distance and electron density determinations are available, it is found that the ionized mass and the radius are linearly correlated (Maciel and Pottasch, 1980) and also that the ionized masses increase with decreasing electron density (Pottasch, 1981). These relations imply that the nebulae are optically thick in Ly continuum radiation and the distances based on the Shklovsky method are overestimates. Using an empirically determined mass-radius relationship Maciel and Pottasch have obtained new distances for the nebulae in the catalogue of Milne and Aller (1975). We have used the more complete catalogue of Cahn and Kaler (1971) to obtain distances corrected for possible variations in the ionized mass and have compiled a new list of local planetaries. We obtain a surface density of 15 ± 3 kpc^{-2} and a planar number density of 44 ± 4 kpc^{-3}.

Using the galactic centre PN density derived by Isaacman (1981) and the local density determined here, a radial scale factor of 2.16 kpc is obtained which leads to a total number of 28 000 in the Galaxy. The lifetime of planetary nebulae has been calculated keeping in mind that initially they are optically thick. Assuming that the ionizing photon luminosity remains constant it is found that the lifetime is more or less independent of the ionizing luminosity and the shell mass. The derived lifetime yields a birthrate of $(2.4 \pm 0.2) \times 10^{-3}$ kpc^{-3} y^{-1} for planetaries in the solar neighbourhood. Theoretical estimates of the birthrate based on the Initial Mass Functions due to Lequeux (1979) and Miller and Scalo (1979) are consistent with the observational birthrate.

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