

INTERNAL MOTIONS OF FAINT PN HALOS

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We have obtained long-slit echelle observations of faint halos for 10 PNe - NGC 2022, 2438, 6210, 6309, 6543, 6720, 6751, 6826, 6891, and 7662. Only NGC 2022 and 6720 have linesplits indicative of a hollow expanding-shell structure. The others have observed FWHM ranging from 13 to 47 km/s in the $[O\ III]\lambda 5007$ line, with an instrumental FWHM of 9-10 km/s. We have subtracted the instrumental and thermal widths and made geometric corrections to derive the expansion velocities.

Assuming no turbulence, we may derive upper limits of expansion velocities from the widths of velocity profiles. NGC 6309 and 6751 have the most quiescent halos, of which the expansion velocities are < 5 km/s. NGC 2438, 6210, 6543, 6826, and 6891 have kinematic FWHM's of 17-25 km/s in the halos. High S/N ratio was obtained in the data of NGC 6826 and 6891, and the variation of the velocity width is consistent with a nearly sonic expansion velocity (~ 10 km/s). In the case of NGC 2438, 6210, and 6543, we do not have enough S/N ratio and spatial information to derive more precisely their expansion patterns. Their expansion velocities are probably < 15 km/s. NGC 7662 has the broadest unresolved profile in the halo, 47 km/s, implying a supersonic expansion velocity of ≤ 24 km/s.

We detected a linesplit of 35 km/s in the halo of NGC 2022. It is probably a shell expanding at 20 km/s. NGC 6720 has larger linesplits in the $[N\ II]$ line than $H\alpha$ and $[O\ III]$. The linesplits in the $[N\ II]$ line are ~ 36 and 84 km/s in the halo and the inner shell, respectively. Such velocity structure does not support the hypothesis that NGC 6720 is a bipolar nebula projected along the poles.

The swept-up interstellar mass in the halo is about $0.01 n_0 M_{\odot}$, where n_0 is the ambient density in cm^{-3} . This amount of mass is too small to have significantly slowed down the expansion of the PN halos. The different expansion velocities in these 10 halos must be inherent. The lack of linesplit in the broad profiles can be explained by a large amount of turbulence and/or a filled envelope geometry, as opposed to a hollow shell. In the cases of NGC 6826, 6891, and 7662, it seems that the inner nebula tapers off gradually into the halo; their halos are probably filled.