COLLIMATED OUTFLOWS IN PLANETARY NEBULAE

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ABSTRACT. The kinematics of the gas motions in several e-m E planetary nebulae (PNs) have been mapped with $\sim$ 1 - 2" resolution. All of the eE PNs (e.g., NGC 2392, 3242, 6543, 6826, 7009, and 7662) show evidence of highly focused linear flows at projected velocities of 20 - 170 km s^{-1}. The flows generally appear as linear, almost jet-like features in emission lines of low ionization. mE PNs show expanding protuberances along their polar axes.

We propose a hydrodynamic mechanism for focussing flows in PNs with prolate elliptical symmetry whose nuclei emit an isotropic wind. The wind streamlines are bent as they pass through a prolate shock near the star, and are focussed along the polar axes of the PN. Where the gas converges and, hence, cools relatively efficiently, knots or jets can form. The subsequent evolution of the system is expected to lead to a barrel-like PN with two bubbles of rapidly expanding gas from the ends of the barrels (as observed in mE PNs), and ultimately to a large bipolar PN of low surface brightness.

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