

## HST Snapshot Images of Planetary Nebulae

Howard E. Bond<sup>1</sup>, Laura K. Fullton<sup>1</sup>, Karen G. Schaefer<sup>1</sup>, Robin Ciardullo<sup>2</sup> and Michael Sipior<sup>2</sup>

<sup>1</sup>Space Telescope Science Institute; <sup>2</sup>Pennsylvania State University

During Cycle 5 of the *HST* General Observer program we have been carrying out a “snapshot” survey of central stars of planetary nebulae. The snapshots are short exposures in the *V* (F555W) and *I* (F814W) filters, taken with the Wide Field Planetary Camera (WFPC2) during brief scheduling opportunities.

The primary aim of the survey is to find close, resolved main-sequence companions of the central stars, which through main-sequence fitting will provide excellent distance estimates for the nebulae. This will in turn allow us to calibrate other, indirect distance methods, and thus materially improve the distance scale for Galactic PNe.

**New Visual Binaries in Planetary Nebulae.** The visual binaries that we have observed to date with *HST* include those listed below. (A few of the wider pairs were already known from the ground, but most of them are new discoveries.) Photometry and distance determinations are underway.

PN	$\Delta V$ (mag)	Separation	PN	$\Delta V$ (mag)	Separation
NGC 650-1	0.9,2.2*	1''36	A 7	5.3:	0''91
NGC 1535	5.7	1''03	A 31	5.4:	0''26
NGC 6309	5.9	1''49	A 66	0.2	3''04
NGC 7008	0.5	0''44	A 74	1.4	3''78
IC 4637	1.9	2''42	K 1-22	0.3	0''35
Mz 2	-1.2	1''28	Sp 3	3.4	0''30

\*Companion is itself a 0''17 binary

**High-Resolution Images of Planetary Nebulae** As a byproduct, our deeper exposures provide spectacular high-resolution images of PNe, several of which were shown at the Symposium as high-quality pseudo-color prints. Due to space limitations, we are able to show only two of our most interesting images here. These black-and-white versions are not able to show all of the beautiful details seen in the color prints.

*Faint periodic shells.* Several PNe show numerous closely spaced arcs or shells, with spacings of order one arcsecond. A spectacular case is that of NGC 7027 (left-hand panel of Fig. 1). If the shells arise from episodic ejection from the AGB progenitor, the timescale is of order 500 yr, too short to correspond to ejections at individual thermal pulses, and too long to correspond to Mira-like envelope pulsation. Deguchi, at this Symposium, suggests instead that they arise from an instability that separates dust and gas in the outflow.

*The “Red Rectangle.”* This nebula (right-hand panel of Fig. 1) surrounds the post-AGB F-type supergiant HD 44179. The WFPC2 image shows that the central object is

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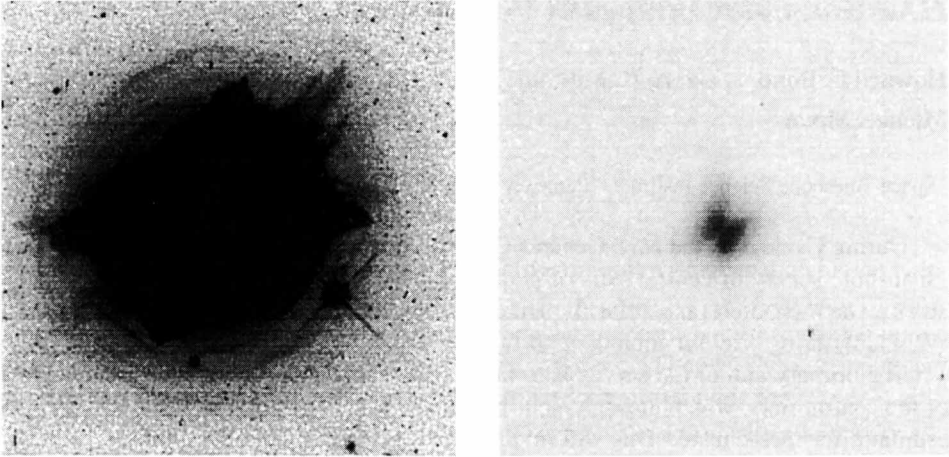


Figure 1: **(Left)** Snapshot *I*-band image of NGC 7027, stretched to show the very faint, periodic circular shells outside the bright, non-spherical main body of the nebula. **(Right)** An 0.18-sec WFC2 exposure of the Red Rectangle in broad-band *V* (F555W), showing the disk shadow that bisects the nebula and hides the central star.

bisected by a dark lane, probably the shadow of a thick disk surrounding the star. The star itself is not visible, but is seen only as light scattered from the surrounding dusty region. Linear features in the surrounding nebula may represent a precessing jet emanating from the central object.

Among other interesting new phenomena are: (a) “*Spicules.*” The outer halos of a few PNe, notably NGC 3918, show a myriad of very faint “spicules,” i.e., linear features pointing directly away from the central star; these may arise from dust scattering of light leaking out of the inner nebula through “pinholes.” (b) *Dust globules.* A number of PNe show, at *HST* resolution, huge numbers of resolved dust features. They are particularly spectacular in NGC 7027 (many dozens of individual blobs) and IC 4406 (which has an extensive network of filamentary dust). The Ring Nebula (NGC 6720) shows many tiny globules around its periphery, suggesting that they are distributed toroidally rather than spherically.