Planetary Nebulae in our Galaxy and Beyond
Proceedings IAU Symposium No. 234, 2006
M. J. Barlow & R. H. Méndez, eds.

doi:10.1017/S1743921306003322

Investigating the formation of planetary nebulae

L. Cerrigone[1]†, J. L. Hora[1] G. Umana[2] and C. Trigilio[2]

[1] Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA

[2] INAF, Osservatorio Astrofisico di Catania, Catania, Italy

Abstract. The formation of planetary nebulae is a poorly understood phase of stellar evolution. In particular it is still not clear what mechanism leads to the complicated morphologies observed in such sources. We have started a systematic study of objects in transition from post-AGB to planetary nebula, and in this poster we show some preliminary results.

Keywords. ISM: planetary nebulae, Stars: evolution

1. Introduction

Several models have been proposed to explain the formation of planetary nebulae (PN). All of them concern the residual, slowly expanding AGB envelope that is swept up by a fast shaping agent, whose origin has not been explained yet (wind?, jets?). There is evidence that such shaping starts well before the onset of ionization, as shown by proto-PN (pPN) imaging, but it is not clear in what way the ionization front can contribute to the shaping and in general alter the circumstellar environment: in fact it could disrupt dust and molecular shells. In this context, important information can be provided by observations of very young Planetary Nebulae, or pPN, where the physical processes associated with PN formation, such as dynamical shaping, are still occurring.

2. Our project

We have selected a sample of hot post-AGB/pPN stars on the basis of their far-IR and optical characteristics (Umana *et al.*, 2004): strong IRAS emitters and B[e] spectral type. Some of them also show photometric and spectroscopic variability. We observed our sample with the Very Large Array† in 2001 and then in 2005 with the VLA and the Australia Telescope Compact Array‡ to check if radio emission, arising from an ionized shell, is present. Out of the 36 selected sources, radio emission was found in 18 of them. Our first sample was observed in all cm bands at the VLA in 2003 and the brighter objects were also observed with the A array at 3.6 cm, detecting bipolar morphologies in our sources. For a better understanding of the shaping process, multi-wavelength observations, mapping the several emitting components coexisting in PN, can provide clues to the collimation process. We have therefore planned to observe our sample at Infrared wavelengths with the Spitzer Space Telescope.

† Present address: Harvard-Smithsonian Center for Astrophysics, 60 Garden St, Cambridge, MA, USA

† The VLA of the National Radio Astronomy Observatory (NRAO) is operated by Associated Universities, Inc. under a contract with the National Science Foundation

‡ Australia Telescope is funded by the Commonwealth of Australia for operation as a National Facility managed by CSIRO

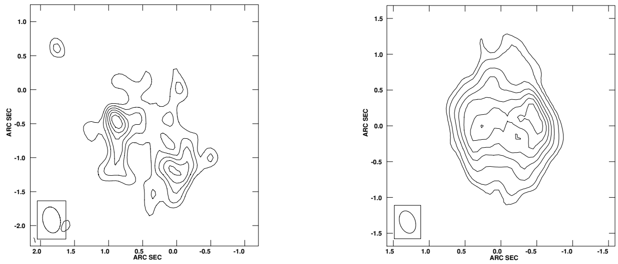

Figure 1. Examples of radio maps obtained for our sources. Left: IRAS 19590-1249 (levels: 0.02 mJy times −3, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; pointing: 20h01m49.8s, −12d41'17.0"). Right: IRAS 18442-1144 (levels: 0.03 mJy times −3, 3, 5, 10, 15, 20, 25, 30, 35, 40, 45; pointing: 18h47m04.0s, −11d41'12.0").

In this poster we present part of our results about the continuum spectra obtained so far. Observations were carried out in February and March 2003 with the VLA in D array at all *cm* bands. Unfortunately configuration problems during the observation led to fail almost the whole 20 cm run. It was possible to observe some of our sources again in July 2005 both at 3.6 and 20 cm.

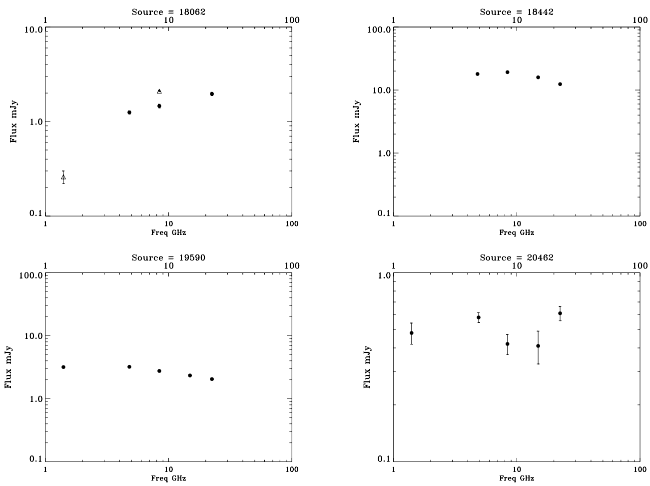

Figure 2. Radio spectra obtained for four of our sources: most of them are flat or nearly flat spectra. For source 18062 (upper left) solid circles are 2003 data, triangles are 2005 ones.

Our observations seem to confirm the calculations in Sharova, 2002, showing that young PN can be optically thin below 5 GHz, if their progenitor is not very massive ($\sim$0.5 $M_\odot$). IRAS 18062+2410 has increased its 8.4 GHz flux from 2001 to 2005 by $\sim$44%.

References

Aaquist, O. B. & Kwok, S. 1991, *ApJ* 378, 599
Sharova, O. I. 2002, *Astronom. and Astroph. Transactions* 21(4-6), 271
Garcia-Segura, G. 1997, *ApJL* 489, L189
Sahai, R. & Trauger, J. T. 1998, *AJ* 116(3), 1357
Soker, N. 2006, *PASP* 118, 260
Umana, G., Cerrigone, L., Trigilio, C. & Zappalà, R. A. 2004, *A&A* 428, 121