sahai@lb6.jpl.nasa.gov

YES

Bipolar Bubbles, Jets and Rings in Very Low Excitation Planetary Nebulae - First Results from an HST/WFPC2 Imaging Survey

Raghvendra Sahai (JPL/ Caltech), John Trauger (JPL/ Caltech)

Planetary nebulae (PNe) show a variety of structures not apparent in the circumstellar envelopes of the AGB stars from which they evolve. The physical phenomena which shape PNe are thought to occur early in their formation history, perhaps involving the hydrodynamic interaction of one or more fast winds with the slower AGB mass-outflow. However, since the youngest PNe, which retain the clearest signatures of these phenomena, are very compact (< 5"), ground-based observations provide very limited information. We are therefore conducting a WFPC2 Cycle 6 SNAPshot imaging survey of a set of 30 very PNe selected on the basis of their very low excitation (VLE) characteristics.

We find that all the 10 VLE imaged so far show "disturbed" morphologies, characterised by an intriguing variety of non-spherical shapes, such as multiple bubbles, jets, rings, and a large degree of point-symmetry. It appears very difficult to explain these morphologies within the framework of the revised interacting stellar winds model, in which the variety of PNe shapes result from the expansion of a wry fast outflow within aspherical AGB envelopes with varying polar-to-equatorial density contrast, ratios. The presence of a companion to the central star is at the heart of most current hypotheses which aim to explain the morphologies of PNe. However, some of the structures seen in our VLE are so complex that more than one companion may be necessary, supporting the idea that the presence of multiple sub-stellar companions (such as massive Jupiters and brown-dwarfs) is common in (1-few) solar mass stars. Our sample of VLE PNe is proving to be uniquely valuable in probing the earliest phases of PNe formation. Classification] of the morphological structures observed in this sample of very young PNe, and statistical comparisons with more evolved PNe populations, should set new constraints on theories of how planetary nebulae form and evolve.

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