MORPHOLOGIES OF PLANETARY NEBULAE WITH CLOSE-BINARY NUCLEI

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ABSTRACT. We will present photographic and CCD images of planetary nebulae that are known, on the basis of photometric observations of the central stars, to possess close-binary nuclei. All of the orbital periods range from 2.7 to 16 hours, except for the 16-day binary nucleus of NGC 2346.

We attribute the ejection of a planetary nebula from a close-binary system to the interaction that occurs when the more-massive star expands and engulfs a main-sequence companion in a common envelope. The companion spirals in toward the core of the giant, until the envelope is spun and up and ejected.

Theoretical considerations suggest that the morphology of a planetary nebula ejected via a common-envelope interaction will depend on the evolutionary stage of the primary star at the onset of the interaction: (1) If the interaction occurs when the primary star is on its first ascent of the giant branch, or low on the AGB, the envelope is ejected preferentially in the orbital plane, creating a large density constrast between the equatorial and polar regions and leading to a "butterfly"-shaped PN (e.g., NGC 2346). (2) In the case of a primary star that attains a highly centrally condensed supergiant configuration well up on the AGB before encountering its companion, the ejected material is less concentrated toward the orbital plane, a more moderate density contrast is created, and the PN will have an elliptical morphology (e.g., Abell 41, Abell 63, K 1-2).

The initial morphologies created by common-envelope ejection can subsequently be modified by stellar winds and/or interaction with the interstellar medium. Abell 35 and possibly HFG1 and Abell 46 show evidence of the latter.

S. Torres-Peimbert (ed.), Planetary Nebulae, 461.