The Asymmetric X-ray Morphologies of Planetary Nebulae

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Abstract

Planetary nebulae, the ejected outer envelopes of expired stars with initial masses in the range $\sim$1-8 $M_{\odot}$, have long been known to exhibit large departures from spherical symmetry in optical images. With the recent discovery by Chandra of extended X-ray emission from a handful of planetaries, we can investigate for the first time how such asymmetries manifest themselves at high energy. In particular, Chandra images have revealed that the X-ray emitting regions of the young planetary nebulae BD $+30°3639$ and NGC 7027 are much more asymmetric than the optical nebulosities. The rather low X-ray emission temperatures of both objects ($T_x \sim 3 \times 10^6$ K) support the notion that heat conduction effects, and hence magnetic fields, determine their X-ray emission morphologies. The observed asymmetries also could be generated by a combination of clumpy extinction and collimated outflows, however. To evaluate these possibilities, we are conducting a quantitative study of the optical, IR, and X-ray morphologies of these objects.

CATEGORY: NORMAL STARS AND WHITE DWARFS