Evolution of the Cat's Eye Nebula Revealed Through Morpho-Kinematic and Hydrodynamic Modeling

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The planetary nebula known as the Cat’s Eye Nebula (NGC 6543) has a complex, point-symmetric morphology that is unexplained by the current theory of planetary nebula formation, the Interacting Stellar Winds Model. To reveal the three dimensional (3D) structure of the Cat's Eye Nebula, I created the first 3D morpho-kinematic model of this nebula using a NII image from the Hubble Space Telescope and five different position-velocity diagrams. I also created the first 3D hydrodynamic model of the Cat's Eye Nebula to offer a physically justified, plausible picture of the nebula's evolutionary history. Initial conditions in the hydrodynamic simulation are constrained by kinematical data, spectral data, and the morpho-kinematic model. My results show that the rings and inner shell of the Cat’s Eye Nebula are consistent with a formation by two separate precessing wind events, while the bipolar lobes can be explained by standard interacting stellar winds. The inner shell is highly unusual in that it likely represents a “born again” wind event. These features are strong evidence of a close binary star system at the center of the Cat's Eye Nebula, which drives its unusual structure.

Awards Won:

First Award of $5,000

China Association for Science and Technology (CAST): Award of $1,200

Patent and Trademark Office Society: Second Award of $500