A 3D Photoionization Model of the Extreme Planetary Nebula NGC 6302

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We present a 3D photoionization model of the PN NGC 6302, one of the most complex objects of its kind. Our Mocassin model is composed of an extremely dense circumstellar disk and a large pair of diffuse bipolar lobes, a combination necessary to reproduce the observed spectrum. The masses of these components gives a total nebular mass of 4.7Mo. Discrepancies between our model fit and the observations are attributed to complex density inhomogeneities in the nebula. The potential to resolve such discrepancies with more complex models is confirmed by a range of models introducing small-scale structures. Compared to solar abundances He is enhanced by 50%, C is slightly subsolar, O is solar, and N is enhanced by a factor of 6. These imply a significant 3rd dredge-up coupled with hot-bottom burning CN-cycle conversion of dredged-up C to N.
The central star is partly obscured by the edge-on circumstellar disk and its properties are not well constrained. Emission from a number of high-ionization `coronal' lines provides constraints on the form of the high-energy ionizing flux. Using a solar abundance stellar atmosphere we are unable to fit all of the observed line fluxes, but a substantially better fit was obtained using a 220,000K H-deficient stellar atmosphere with L*=14,300 Lo. The H-deficient nature of the central star suggests it has undergone a late thermal pulse, and fits to evolutionary tracks imply a central star mass of 0.73-0.82Mo. Timescales for these tracks suggest the object left the top of the AGB ~2100 years ago, in agreement with studies of the recent mass-loss event that formed the bipolar lobes. Based on the modelled nebular and central star masses we estimate the initial mass of the central star to be 5.5Mo, in agreement with that derived from evolutionary tracks.
(Abstract truncated)

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