

Rapid evolution and nebula formation

Garrelt Mellema

Stockholm Observatory

The formation of a Planetary Nebula is determined by the star which lives and evolves in the middle of it. The star produces both the winds and the photons which determine the shape and appearance of the nebula. Here I study how the shape of the PN depends on the stellar properties.

I simulate the formation of a PN using a two-dimensional radiation-hydrodynamics code, applying the Interacting Stellar Winds model. See e.g. Mellema (1995). I choose the AGB wind to be highly concentrated towards the equatorial plane, which normally results in a bipolar PNe. The AGB mass loss rate is $5 \cdot 10^{-5} M_{\odot} \text{ yr}^{-1}$ at the equator and 5 times lower at the poles. The central star follows the evolutionary track for either a $0.605 M_{\odot}$ (case A) or a $0.836 M_{\odot}$ (case B) post-AGB star. See Blöcker (1995).

The two simulations give very different results. In case A the ionization front shapes an elliptical attached halo similar to the ones described by Mellema (1995). Inside of that the fast wind shapes a nebula, which has an irregular elliptical shape. In case B the ionization front does not produce any shell and the fast wind shapes a nebula with a bipolar morphology.

The physical reason behind this difference is the speed with which the central star evolves. In case B the increase in the number of UV photons is so fast that the ionization is almost instant and this leaves the original density structure of the AGB wind intact. In case A the ionization front progresses slowly through the AGB wind, modifying its density distribution so that an elliptical nebula will form.

This mechanism creates a bias against bipolar PNe forming around lower mass stars which is consistent with the the observational evidence that bipolar morphology correlates quite well with high mass stars (see e.g. Corradi & Schwarz 1995).

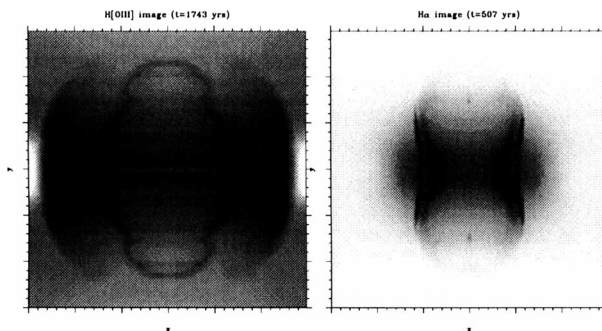


Figure 1: [OIII] image from case A (left) and $H\alpha$ image from case B (right)

REFERENCES

- Blöcker, T., 1995, *A&A* 299, 755
 Corradi, R.L.M., Schwarz H.E. 1995, *A&A* 293, 871
 Mellema, G., 1995, *MNRAS* 277, 173