ONE OF THE HEAVEN’S MOST SPECTACULAR DEATHS: PLANETARY NEBULAE

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If you haven’t seen the stunning images of planetary nebulae or PNe from Hubble you should take a few minutes out of your day and find them on the NASA.gov website to enjoy their lovely, various structures. In contrast to their name, they actually are not related directly to planets. William Hershel back in the 1780s discovered these objects and gave PNe the name because their shapes resembled that of a planet through a telescope. The name has stuck ever since. Now we have discovered that they are not planets at all but rather they are hot, ionized gas shells that were emitted from red giant stars.

As one might expect, there are different types of stellar “deaths”, with planetary nebulae being one of them. PNe play a great role in the formation of some of the heavy elements we have in the universe known as metals. Average to low mass stars much like our sun undergo a process called nuclear fusion that burns their helium and hydrogen and they eventually expand into a red giant. After they have fused all their hydrogen, the red giants start to fuse helium and become unstable. The loosely bound layers of gas are then ejected into space forming a planetary nebula. By this time the star has fused its hydrogen and helium into elements such as carbon, nitrogen, and oxygen. These elements then mix in the interstellar medium creating what we know as metals.

One might assume that PNe structure would be spherical in nature since stars themselves are spherical, but pictures taken from Hubble proved this theory to be incorrect. As you browse through these images you will see the various mysterious shapes of PNe. It is still unknown exactly why the shapes are so complex. Naturally there are some theories on why planetary nebulae are not spherical which include interaction between the white dwarf/companion star and magnetic field guidance.

One of the most complex nebulae known is the Cat's Eye (Figure 1). It was the first PNe showing emission lines in its spectrum leading to the conclusion that the Cat's Eye consisted of only hot gases. Spectra are a result of the fact that all heated objects give off light and when they are dispersed in a prism we see the colors broken up into a series of lines. Emission lines are a result of hot gas emitting light, in contrast absorption lines resulting from cold gas absorbing light from a light source. Absorption
lines look like a continuous “rainbow” with some black lines blocking some colors, whereas emission lines show only the colored lines. Let’s get back to Cat’s Eye. The biggest mystery of the Cat's Eye is its complicated shape. We see swirls, knots, and overlapping patterns, suggesting that there is a binary star system present (two stars orbiting each other), with a companion star swirling around the white dwarf at the center of the nebula creating these mysterious patterns.

Another interesting planetary nebula to note is Fleming 1 (Figure 2). Once again we do not see a spherical shape but rather an intricate structure of knotted and curved jets. It was recently discovered that the shape is indeed created by a companion star. To explain how it got its shape we must look into the past. The binary star system we see now is a close orbiting system but this wasn't always this case. When the companion star reached the Red Giant phase of its life time, the white dwarf accreted (“ate”) the material from its high mass companion. Jets were created that pushed away the materiel from the stars. The stars eventually became closer together after the companion lost all its gas and enveloped the stars forcing them together. The jets, done with their job, can now quit, resulting in the shape we see today.

Unlike other nebulae that have been studied, "This is the first time we've seen these jets fresh out of the oven," (Howell, 2012). This is an important find because it is the beginning of really finding out why PNe have odd shapes. If more systems like Fleming 1 can be found we can confirm the theory of companion stars being at least part responsible for the structures of planetary nebulae.
Works Cited


