# Rochester Skies

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Rochester, Minnesota  Serving the community since 1996  43.9° N 92.5° W Elev 1319 ft

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# 2023: Time to Get Back to Awe

*"He who can no longer pause to wonder and stand rapt in awe is as good as dead; his eyes are closed*" – Albert Einstein's

The pandemic left our eyes closed longer than we would have wanted, limiting our opportunities to meet with each other and the public. However, in 2023 we will likely be gathering with each other increasingly more often. And since there are no clear criteria determining the end of a pandemic, we will move forward with club activities by more or less "dealing with it."

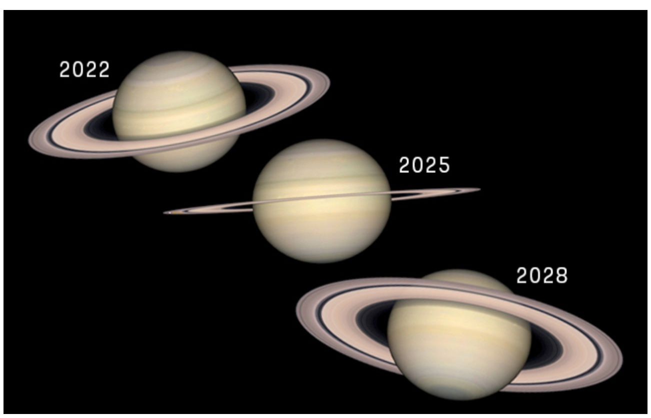
This means it is time to get back to the business of what we do – our meetings, outreach, and star parties. But it is much more than that. I would like to think what we really do is generate discussions, education, and visual experiences which in turn create "awe." Let us delve into that a little more. Surprisingly, awe is an existential human emotion that has been studied in only the past few decades. The reason for this may be researchers have had a challenging time fitting awe into their list of fundamental human self-preservation emotions. It makes more sense to understand how other emotions such as fear, joy, or anger had evolved in us to preserve our species.

Recently, scientists at Berkley have found that experiences of awe may bring with them a host of physiological,

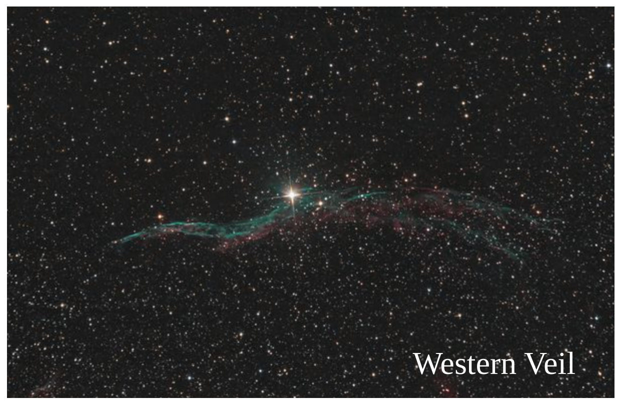
Image Credit: NASA

psychological, and pro-social effects. For example, feelings of awe can be accompanied by heart rate changes, "goosebumps," and the sense of chills. There is evidence that awe may even decrease markers of chronic inflammation, possibly lowering the risk of type 2 diabetes, clinical depression, heart disease and arthritis.

I recently read psychologist Dacher Keltner’s book, aptly titled “Awe,” in which he defines awe as “the feeling of being in the presence of something vast that transcends your understanding of the world.” He has been a pioneering researcher in the study of awe, and in one of his experiments, he exposed a group of students to look at a grove of towering Eucalyptus trees and a control group to look at an equally tall but plainly constructed building adjacent to the Eucalyptus grove from the same location on the ground. The first group answered a set of follow-up questions revealing themselves to be less narcissistic and less entitled than the control group – even after only two minutes! They were even better at picking up trash on the grounds after themselves! The short and simple awe experience felt by the first group by viewing the beautiful trees connected with them somehow to be suddenly more appreciative and humbler.




We can experience awe in a moment of sudden clarity, as in an “aha” moment when we suddenly understand an astronomical concept. We can be surprised into awe when a tight row of Starlink satellites appear and race across the sky, or when an Iridium satellite abruptly pulses its bright beacon above. But our greatest moments of awe are produced by the night sky gems we see with our lenses and mirrors. It is that list of “awe” deep sky objects such as the dust lanes of the Andromeda Galaxy, Saturn, the Western Veil, or any globular cluster which create those eye-piece jaw-dropping moments. The same awe comes of course in vistas, such as when we sweep our eyes from horizon to horizon to appreciate the glow of the Milky Way, or suddenly realize we are seeing the Zodiacal Light.



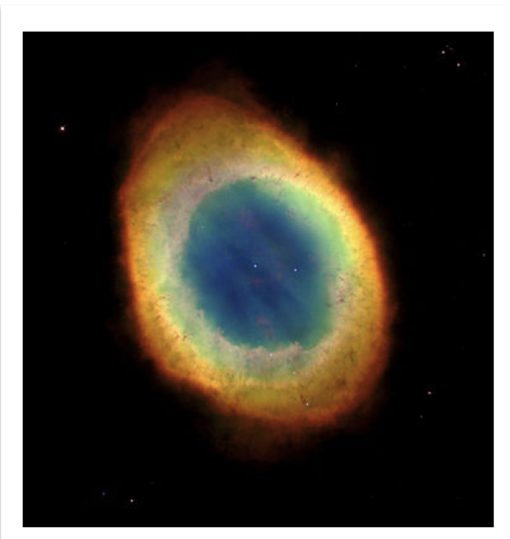

So, let us hope for an AWE-some year ahead and I hope to see you all soon! Remember as Mr. Keltner pointed out, never underestimate the power of goosebumps.

Randy Hemann
President
Rochester Astronomy Club

# Planetary Nebula – The Future of Our Sun

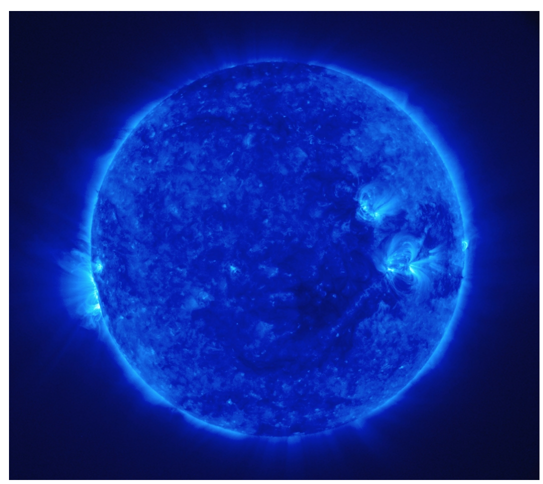
By John Attewell, Ph.D.

Many of our Rochester Astronomy Club members volunteer to act as docents for our monthly public observing events. During those events each docent picks a sky object to target with their telescope and offers explanations of that object to viewers. For the past few events, I tracked one of my favorite objects; the Ring Nebula (M57). It is easily observable from May through October and visible just before astronomical twilight. It's high enough in the sky at my latitude that atmospheric distortion is at a minimum. Those are the technical reasons; but it also makes a thoughtful impression because M57 foretells the fate of our sun.



***M57**, The Ring Nebula (NGC 6720). Hubble Space Telescope*

It was at the last observing session that other docents disagreed about the specifics of this nebula. We all estimated that the nebulous part of M57 to be about 20,000 years old (which is not very old by astronomical standards). We also agreed that it is about 2,000 light years from earth. But we disagreed about its width. I thought it was about two light years in diameter but others thought that M57 could not possibly be that large because the nebular material surely could not expand that far in such a relatively short time. The view through my telescope at 100X showed the nebula to be about 1/20 of a degree across. Using a phone app, I did a little trigonometry based on these estimates. That calculation came to 1.7 light years wide. But what are the true values? The next day I decided to find the answers.

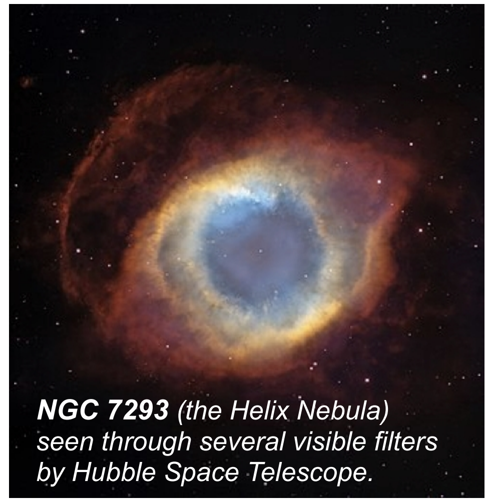


*STEREO's image of the Sun. Image credit: NASA*

I found a great variation among references concerning the dimensional aspects of planetaries such as distance, diameter, apparent magnitude, temperature of the central star and velocity of the escaping nebular material. I soon began to realize that the differences were due to the type of instrument used for these measurements. Professional earth-based telescopes tended to have wide variation in their values. Orbiting telescopes like Hubble generally had smaller variation. For consistency I will cite those found on Wikipedia as they are mostly based on space-based telescopes. wide variation in their values. Orbiting telescopes like Hubble generally had smaller variation. For consistency I will cite those found on Wikipedia as they are mostly based on space-based telescopes.

The “arguable answers” to my questions are: The distance to M57 is 2567±115 light years, it is relatively young at 16,000 years old and it’s diameter is 1.3 ± 0.8 light years[1]. Astrophysicists have further determined that the nebular material is traveling at least 20 km/second; which is almost 45,000 miles/hour! That speed matches perfectly with the width, age, and distance estimates. So, these values are not wild speculation.

Planetary nebula form from stars like our sun. But, even with billions of Sun-like stars in our galaxy, only some 3,000 planetary nebulas have been discovered. Why don’t we see more? They are truly remarkable objects in many other ways. An understanding of the history and life cycle of these wonderful objects is a fascinating story.

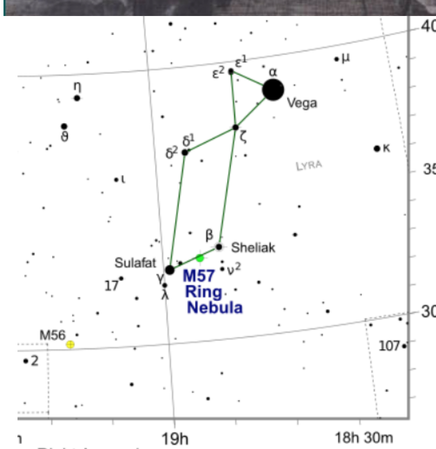


***NGC 7293*** *(the Helix Nebula) seen through several visible filters by Hubble Space Telescope.*

Antoine Darquier de Pellepoix

## Observational History

M57 was one of the first planetary nebula to be discovered. It was first seen in January 1779 by the French comet hunter Charles Messier when he began tracking Comet Bode (C/1779 A1)[2]. Messier labeled all objects that were not star clusters as “nebulae.” The word “nebula” comes from the Latin word for “cloud” or “fog.” Another French astronomer, Antoine Darquier de Pellepoix, was also observing Comet Bode when he co-discovered M57.[3] Darquier reported that M57 was "as large as Jupiter and resembles a planet which is fading." This description most likely led William Herschel to later

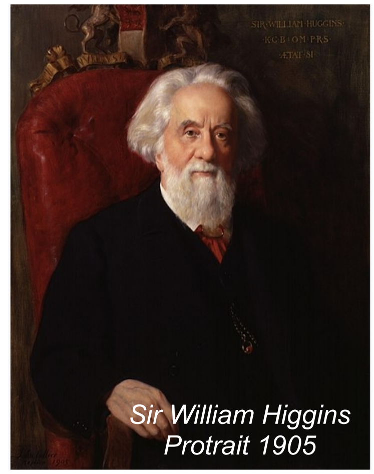



1 Almost all sources agree that M57 is at least one light year across.

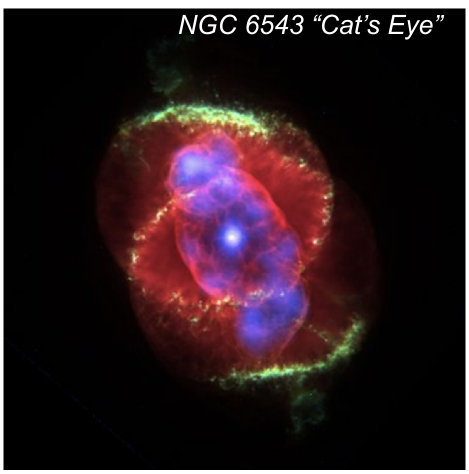
2 This comet was independently discovered by Messier and Johann Ehlert Bode, a German astronomer. Bode has been given priority for the discovery so it is labeled with his name.

3 It was determined that Darquier found M57 two weeks later than Messier so Messier gets credit for the discovery.

classify objects like M57 as “planetary nebulae.” He felt, however, that planetary nebulae were classify objects like M57 as “planetary nebulae.” He felt, however, that planetary nebulae were probably clouds of stars that were too far away to be individually resolved with his telescopes.


Sir William Higgins Protrait 1905

In August of 1864 Sir William Huggins, an English astronomer, was the first to collect a light spectrum of the planetary nebula called the “Cat’s Eye” (NGC 6543). The spectrum was not continuous like the sun but had just a few strong lines.[4] One emission line called “Hα” or “Hydrogen Alpha” that is at 656.3 nm corresponded with hydrogen. Huggins also found two green lines[5] at 495.9 nm and 500.7 nm that were even stronger than hydrogen but they did not correspond to any known elements at that time. Therefore he thought these lines corresponded to some yet-undiscovered element that he called, “Nebulium.” In 1927 Ira Sprague Bowen discovered that these lines were not due to an unknown element but to doubly ionized oxygen.


NGC 6543 “Cat’s Eye”

In 1910, Henry Norris Russell was visiting Edward Pickering and Williamina Stevens Fleming at the Harvard Observatory. Russell studied very dim stars that also had stellar parallax.[6] At the time, it seemed that all these stars were of spectral class “M.”[7] Russell asked Pickering for some routine spectra of other dim stars that were not on his observation list and Pickering suggested 40 Eridani B. After viewing Ms. Fleming’s spectra of 40 Eridani B he was stunned to find it was not of spectral class M but of spectral class “A.” It was well known that spectral class A stars are white and therefore very hot. But this star is only 16 light years distant so why would such a hot star be so dim?

40 Eridani B is a companion of the very bright and large 40 Eridani A. Unfortunately, these two stars had such a long orbital period (7,300 years) their mass could not be determined by observational techniques of the day. But, in 1915, Walter Sydney Adams, working at Mount Wilson Observatory, discovered that Sirius B was also a small dim star

4 There are other emission lines in the ultraviolet but they are not visible under our atmosphere. They can only be seen by high altitude detectors.

5 These wavelengths correspond to “green-turquoise-cyan” spectral colors. Some authors refer to them as “green” while others prefer “blue” and yet others “blue-green.”

6 In those days stellar parallax was about the only method for determining a star’s distance. With the telescopes that were available in 1910, only stars that were relatively close to earth had such a property that could be measured. In 1912 Henrietta Swan Leavitt published a paper that established Cepheid variables as another form of distance measurement.

7 In 1915 “M” stars were named “red dwarves” and found to be quite cool in temperature.

of spectral class A. Like 40 Eridani B, Sirius B was a companion of a much larger partner, Sirius A. But, unlike the Eridani system, the orbital period of the Sirius system is only 50 years which allowed for their masses to be determined. Astronomers were further shocked to find that tiny Sirius B had an enormous density; over one million times of our sun!

In 1922 these small, hot, and very dense stars were named “white dwarfs.” They were truly mysterious and unique objects that, at the time, had no explanation. Happily for us, one hundred years later, we know their story.

***Planetary Nebula – The Future of Our Sun, written by John Attewell, PhD, will continue in the next issue #32 of Rochester Skies.***

## UPCOMING EVENTS

**FEB 24 Fri** — **Public Presentation & Sky Observing 2023-02/24 @ Oxbow Park**
Feb 24 @ 7:00 pm – 8:30 pm

**MAR 31 Fri** — **Public Presentation & Sky Observing 2023-03/31 @ Oxbow Park**
Mar 31 @ 8:30 pm – 10:00 pm

For more information go to http://www.rochesterastronomy.org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**Rochester Astronomy Club**
**P.O. Box 513**
**Rochester, MN 55903-0513**