Blowing Bubbles

Wolf-Rayet Stars and their Nebulae

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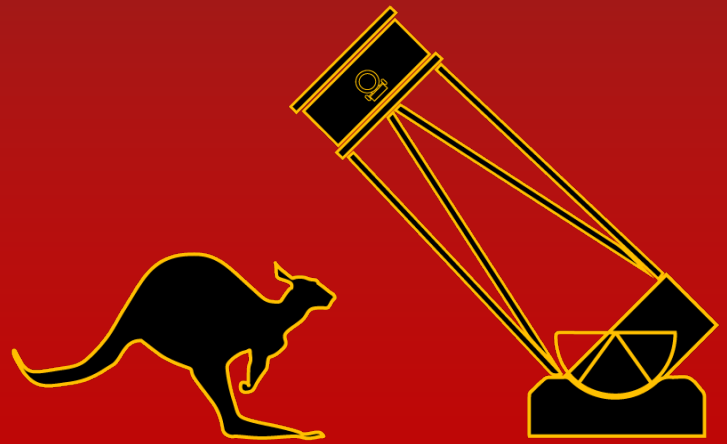

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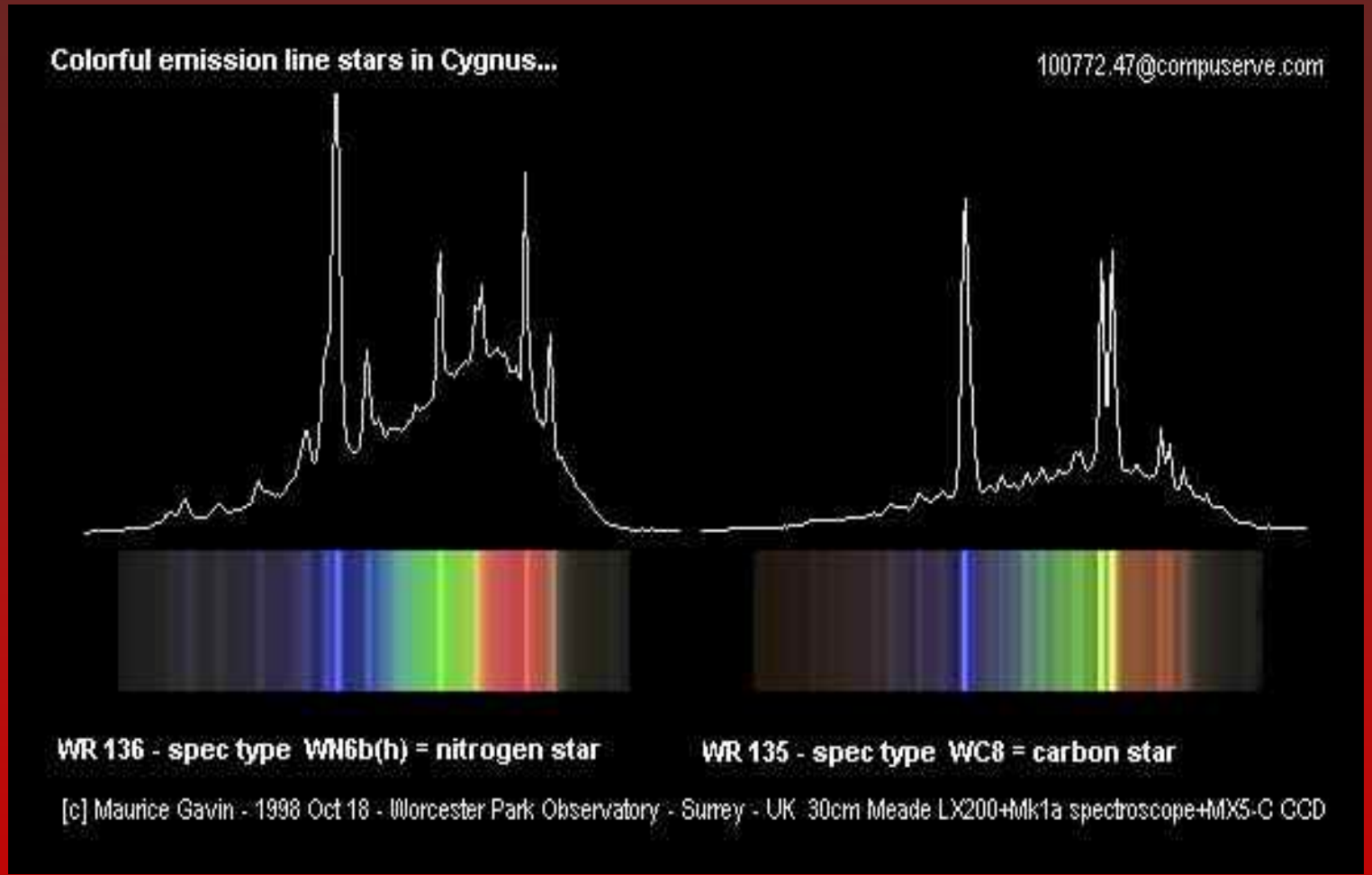
Discovery of Wolf-Rayet Stars

- Discovered by the French astronomers Charles Wolf and George Rayet in 1867

- They found several stars in Cygnus that displayed prominent emission lines

Wolf-Rayet Spectra



What are Wolf-Rayet Stars?

- The most widely held theory states that these objects represent the advanced stages of stellar evolution in high mass stars.
- Stars in excess of 40 solar masses will develop into WR stars
- Stars between 40 and 50 solar masses start their development towards becoming a WR during the red supergiant phase
- Stars larger than 50 solar masses enter the WR state from the luminous blue variable phase.

What are Wolf-Rayet Stars?

- As the large-mass star ages, the outer layers of the star are shed by a strong solar wind
- This wind can make the star lose up to 1 Earth mass every year
- Some WR nebulae can have up to 20 solar masses of material in them
- The solar wind from a WR star can reach speeds of up to 2,000 km/sec *(7,000,000 km/hour)*

What are Wolf-Rayet Stars?

- This ejected material creates a shell of nebula around the exposed core of the star
- The shell surrounding the WR star can reach diameters of up to 30 light years
- The exposed core can reach temperatures of up to 50,000°K
- This extreme temperature gives the star it's unusual spectrum

Types of Wolf-Rayet stars

- **WR stars are split into two major types:**
  1. Wolf Nitrogen (WN) with Nitrogen-rich spectra
  2. Wolf Carbon (WC), with Carbon-rich spectra

- **WN are cooler in temperature and Hydrogen is still seen in the spectra. These are early-stage WR stars**

- **WC stars show no Hydrogen lines and have much higher temperatures. These are late-stage WR stars**

Some Wolf-Rayet nebula

Star	Name	R.A.	Dec	Spec	Size	Distance
HD 50896	S 308	$6^h\ 54^m\ 13^s$	-23° 55’ 52”	WN5	40’	1.5kpc
HD 56925	NGC 2359 Thor’s Helmet	$7^h\ 18^m\ 31^s$	-13° 13’ 03”	WN4	4.5’	5.0kpc
HD 89358	NGC 3199 Southern Crescent	$10^h\ 17^m\ 02^s$	-57° 54’ 47”	WN5	16’ x 20’	3.3kpc
HD 92809	MR 26	$10^h\ 41^m\ 38^s$	-58° 46’ 20”	WC6	15’ x 35’	2.5kpc
HD 96548	RCW 58	$11^h\ 06^m\ 17^s$	-65° 30’ 35”	WN8	7’ x 9’	3.0kpc

HD 50896 / S 308

HD 50896 / S 308

- HD50896 is a 6.7 magnitude star in Canis Major also know as *EZ CMa*
- It is located 15’ north of the 4th magnitude star *Omicron CMa*
- The nebulosity associated with the star has been estimated to be equivalent to 40 solar masses
- The nebula is a wind-blown bubble with an approximate age of 70,000 years

HD 50896 / S 308

- This is a faint object and is visible in 16” scopes and larger
- It has a very low surface brightness just visible above the sky background
- It appears as an indistinct arc of haze 15’ east of the WR star
- Beware of a 4th magnitude star 15’ south
- 20” and larger scopes show a full ring of nebula surrounding the star, about 30’ in diameter

Thor's Helmet – NGC 2359

Thor's Helmet – NGC 2359

- Thor's Helmet is also known as NGC 2359 and is associated to the WR star HD 56925

- Discovered by William Herschel in 1785 it was given the common name by his son, John

- The nebula lies at a distance of 15,000 ly

Thor's Helmet – NGC 2359

Thor's Helmet – NGC 2359

- The entire nebula complex is 30 ly across and has 20 solar masses of material in its shell
- The WR star is also embedded in a cloud of neutral hydrogen
- The output of energy from the star is making the cloud fluoresce

Thor's Helmet – NGC 2359

Thor's Helmet – NGC 2359

- This nebula can be glimpsed with a 5” telescope
- It is located 7º southeast of *Alpha Monoceros*
- The WR star is 12th magnitude and will be a challenge for a 5” telescope
- Best viewed with an OIII or UHC filter
- The WR star is offset from the centre of the bubble and the western edge of the bubble is well defined against the background sky

Thor's Helmet – NGC 2359

- **The nebula appears in 2 parts:**
  1. the bubble around the star (dome of the helmet)
  2. the arcs around the bubble (the horns)
- **This is visible in a 12” telescope**
- **Through a 20” the nebula comes alive**
- **It nearly doubles in size as the background faint nebula becomes visible**
- **The horn to the north is fainter and can be traced for about 1.5’**
- **The southern arm is much brighter and is about 5’ long**

NGC 3199 / HD 89358

- Discovered by John Herschel from the Cape of Good Hope using an 18” scope
- The star is 10.6 magnitude and approximately 10,800ly away
- The nebula contains almost 40 solar masses of material and is expanding at 20$^{km/sec}$
- At an absolute magnitude of -6.7 it is one of the brightest stars in the galaxy

NGC 3199 / HD 89358

NGC 3199 / HD 89358

- The nebula can be seen in a 5” scope as a faint arc of haze
- The WR star itself is easily visible and appears where you would expect it to be at the focus of the arc
- The nebula is 7’ north south and 2.5’ east west at the widest point
- The nebula responds to the UHC filter which I prefer on this object as it doesn’t diminish the starry background
- In the 20” the faint outer regions of the arc become visible extending the visual size to an almost half circle 10’ across and 3.5’ thick

NGC 3199 / HD 89358

HD 92809

- HD 92809 is a 9.1 magnitude WR star just 1° north of the star *Eta Carinae*
- The star is 9.1 magnitude and is 8,200 ly distant
- The WR bubble is 30ly across and is expanding at 30$^{km/sec}$
- By tracing the expansion backward, the estimated age of the nebula is 360,000 years old
- This WR star is among the rarer Carbon type
- The total mass of the nebula may exceed 40 solar masses making it also one of the largest WR nebulae known

HD 92809

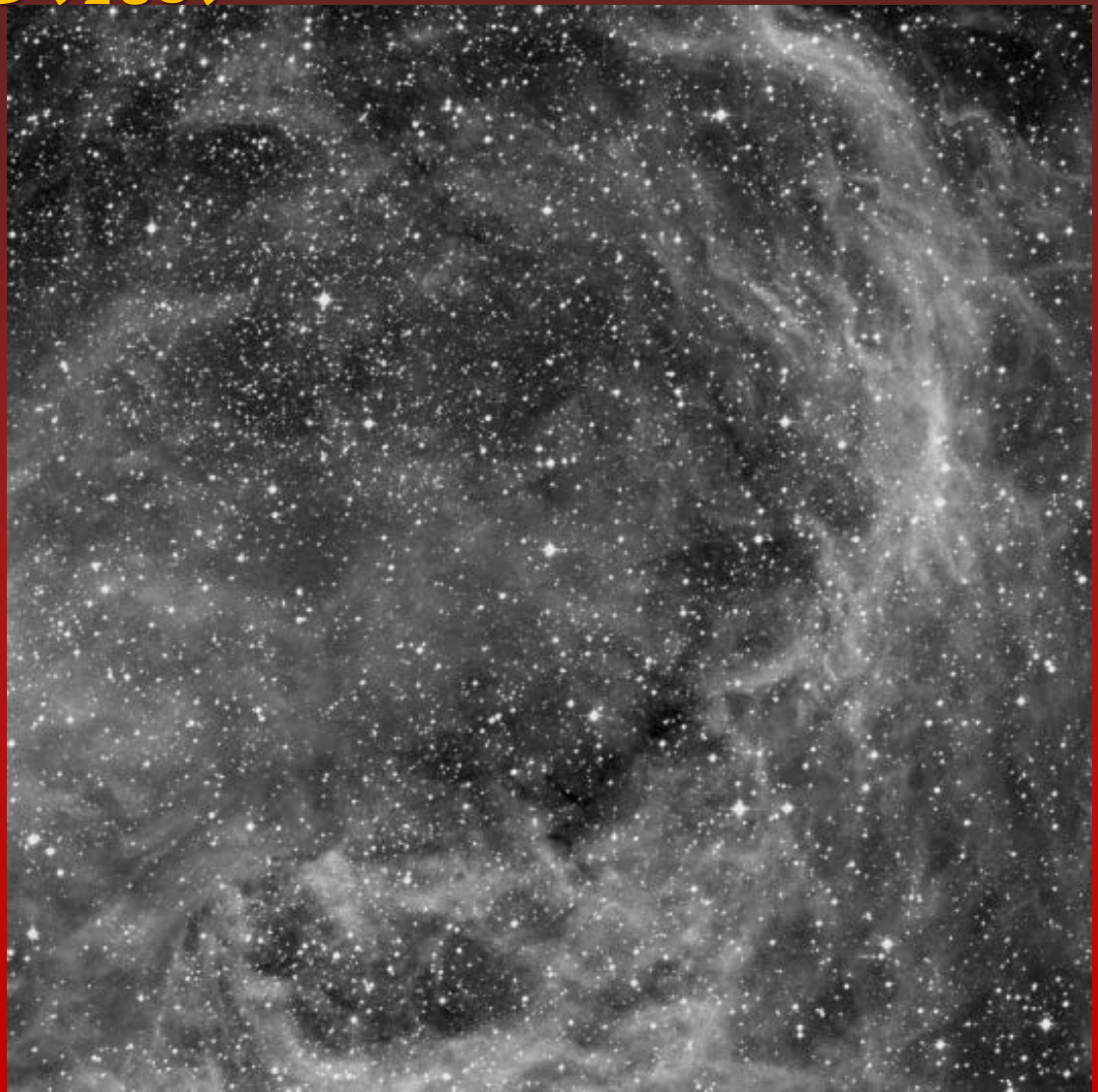
HD 92809

- This is a difficult nebula to observe due to its proximity to the bright nebula *Eta Carinae*

- The WR bubble has a surface brightness just above the brightness of the nebula in the region which makes this a challenge

- Centre the WR star in the eyepiece and you should notice a faint shallow arc of nebula about 15’ east

HD 92809



HD 92809

- The nebula is LARGE at 30’ long almost north south with and average of about 1’ thick
- The shape of the bubble is not regular and appears to have a kink about halfway along
- The WR star is again offset from the focus of the nebula
- The brightest section of the bubble should be visible in a 12” scope with some trying
- Again, using the UHC filter is recommended

RCW 58 / HD 96548

- RCW58 is located 2.5° southeast of *Theta Carina*
- It was discovered by A.W. Rodgers, C.T. Campbell, and J.B. Whiteoak hence the prefix “RCW”
- The bubble is small at 5 solar masses and the expansion is not uniform hence the shape
- The ejection speed range from 30-60$^{km/sec}$
- The diameter of the bubble is 20 x 26 ly
- The star has a magnitude of 7.7

RCW 58 / HD 96548

RCW 58 / HD 96548

- This is the most challenging of the WR bubbles I have selected
- You will need a 16” or larger scope to observe it
- Use a wide-angle eyepiece and a filter to assist you in locating the nebula
- It appears as an oval haze surrounding the star
- The size of the nebula is 7’ x 9’ so remember to look for a large object
- Even through Hector the object was seen as little more than a faint haze just above the sky background and glimpsed ONLY with averted vision

More WR Stars & WR Nebulae?

- These are not the only WR stars visible in the sky
- The WR phase of a star's life is very short, and the number of 40 solar mass and larger stars is small
- There are about 150 WR stars in the Milky Way galaxy
- Every single one of these stars will end their lives in supernova explosions

More WR Stars & WR Nebulae?

- WR stars are visible in the LMC and SMC and even some of their associated nebulae are visible
- *Gamma Velorum* and NGC 6888 are also WR stars and are interesting objects to observe
- One of the most luminous stars in our galaxy *Zeta Scorpii* at an absolute magnitude of -8.7 makes it 2,500,000 times as bright as the Sun

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