Star struck

The year 2009 marks the 400th anniversary of the time astronomical pioneer Galileo Galilei pointed his telescope towards the heavens to look at astronomical objects.

In doing so, this remarkable Italian man overhauled the way humans considered the solar system. He is particularly renowned for his work in observing the phases of Venus, which helped to show that the sun was in the centre of the solar system. In recognition of Galileo's pioneering work, the International Astronomical Union has officially sanctioned 2009 as the International Year of Astronomy. The United Nations Educational, Scientific and Cultural Organisation (UNESCO) has endorsed the year as a way of commemorating Galileo's achievements and what they represent for humanity.

by Chris Mesiku

The International Year of Astronomy will thrust the spotlight on the importance of space study to everyday life on Earth. Looking beyond our atmosphere provides clues to climatic processes and phenomena that take place on our planet. For example, the effect of wind on trees and loosely bound soil is similar to the effect solar wind has on comets. And knowledge of Saturn and Jupiter's storms and cyclones and Venus's greenhouse effect gives us an idea of what would happen to an Earth filled with too many greenhouse gases. As such, astronomers contribute in a unique way to the understanding of environmental processes on our amazing planet Earth. They also help to understand the possible future evolution of our planet.

Dying stars

The Department of Environment and Conservation's Perth Observatory is conducting a variety of research programs aimed at better understanding the mysteries of the universe. Much of this study focuses on the latter stages of stellar evolution—the evolution of stars through time. Included in this research is the continued search for supernovae (the final explosion of some stars) in far away galaxies, and the study of planetary nebulae (the emissions of gasses and other matter that can occur towards the end of a star's life).

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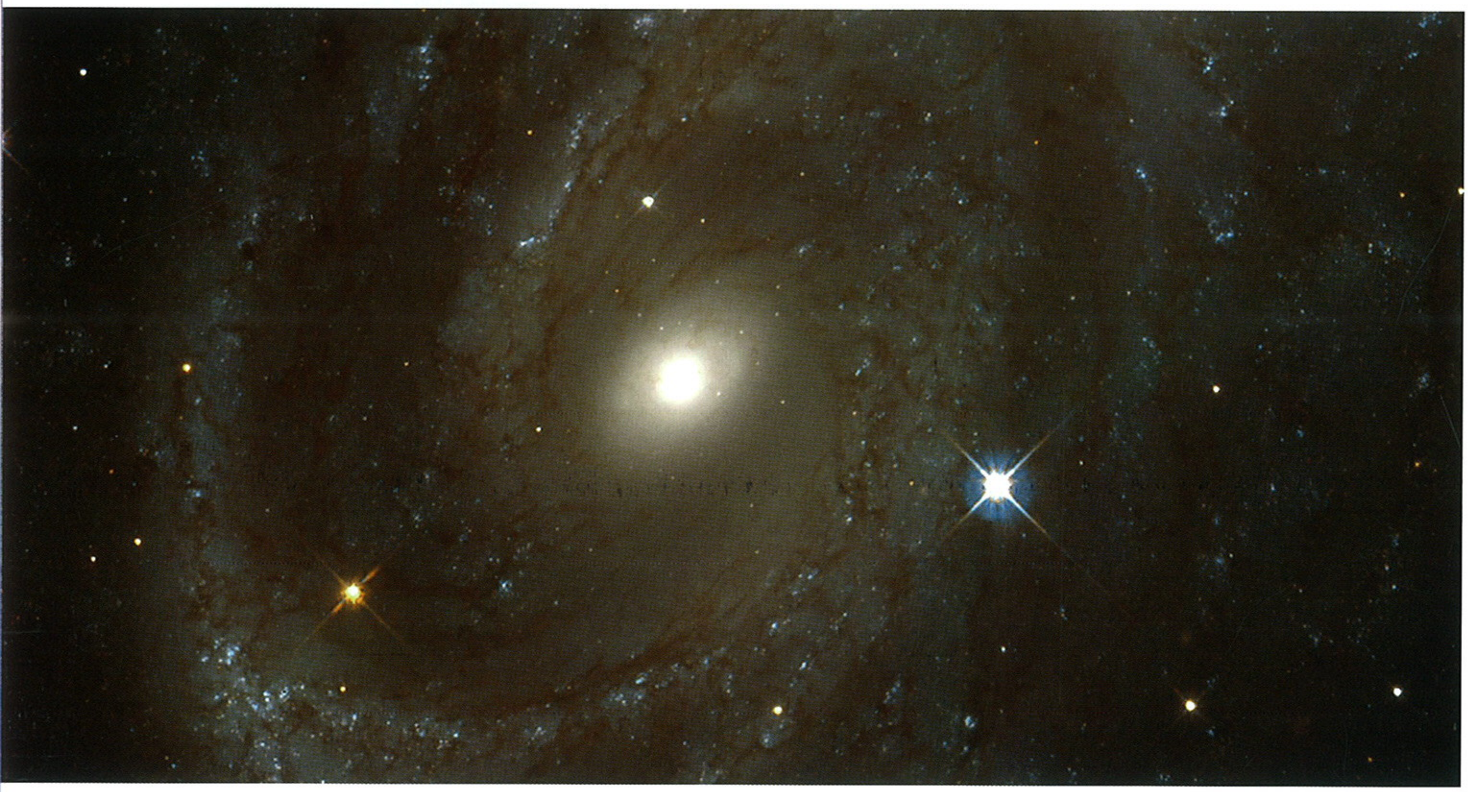
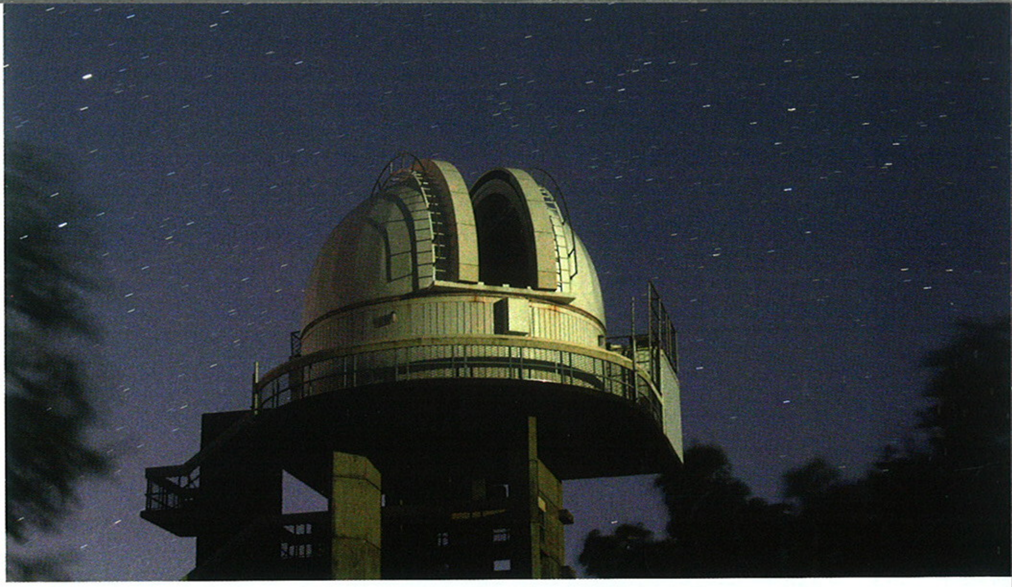
Main Australian summer sky, Milky Way, Orion and Southern Cross.
Photo – Dick Beilby/Lochman Transparencies
Inset Detail digital portrait of Galileo Galilei.

Left Perth Observatory astronomer Ralph Martin uses the visitor telescope.
Photo – Chris Mesiku/DEC

Below The galaxy in which Ralph Martin discovered the Supernova SN2008cn.
Photo – Jeffrey Newman/UC Berkeley and NASA

These studies have resulted in Perth Observatory astronomer Ralph Martin recently reporting a new supernova known as 'SN2008cn', which was located in the galaxy called 'NGC 4603'. Studying supernovae in far away galaxies can help to determine the expansion of the universe and, consequently, its age. To do this astronomers need three things—the distance and speed of galaxies and their direction of motion relative to Earth. To determine the distance, scientists need to find the type of supernova known as 'Ia'. Type Ia supernovae have similar characteristics so their measured brightness is more or less the same. The accurate knowledge of brightness directly leads to a measure of distance. So if the brightness of the supernova is precisely measured then its distance can be found. Usually when you look at stars in the sky, a fainter star does not mean it's further than a bright star. However, the great thing about some supernovae (type Ia) is that the fainter they are, the further they are and vice versa.





Right The Lowell Automated Telescope at the Perth Observatory.

Below right The Scorpius region in the Milky Way.
Photos – Richard Tonello

Once astromomers have calculated the distance of galaxies, they still need to determine the speed and direction of their travel to help work out the speed of expansion of the universe and its age. To determine this, they calculate a phenomenon called 'redshift', which is the measure of the shift in the wavelength of light coming from galaxies. When they know the direction, speed and the distance accurately by finding supernovae and calculating redshift, they are able to more accurately calculate a phenomenon called the Hubble constant. The Hubble constant expresses the rate at which the universe is expanding. It also gives the estimated age of the universe, which is currently 13.7 billion years old. So, by discovering a supernova, astronomers can measure the distance to faraway galaxies and thus independently verify the accuracy of the current estimates of distance and possibly the Hubble constant and the age of our universe.

The galaxy in which Ralph's supernova was detected is located 108 million light years away from Earth. If you look into the night sky during summer, the galaxy is located roughly north of the Southern Cross. The Perth Observatory's Lowell Automated Telescope automatically searches for supernovae. Sometimes it may detect one a month but sometimes it may go a few months without a positive identification.

New planets

The observatory also devotes four months of telescope time every year to searching for planets beyond our solar system using a technique known as 'gravitational microlensing'—using the gravity of a star as a giant natural telescope lens.

Using this method, Perth Observatory astronomers Andrew Williams and Ralph helped discover the smallest and coldest known planet outside our solar system. The planet is known as 'OGLE-2005-BLG-390-Lb' and is extremely cold—minus 220°C. It is five times bigger than Earth and lies about 20,000 light years away. The discovery was made as part of an international collaboration in the Probing Lensing Anomalies NETwork (PLANET). PLANET in turn worked with other international collaborative bodies Optical Gravitational Lensing Experiment (OGLE) and Microlensing Observations in Astrophysics (MOA), hence the name of the planet. Published in *Nature* magazine, this discovery and others since have shown that planets around other stars are a common occurrence.

Planetary nebulae

The planetary nebula phase is a key stage of stellar evolution that occurs before a star's death. While stars greater than eight solar masses skip the planetary nebula phase, stars between 1.4 to about five times the size of our sun go through it. During the planetary nebula phase, stars dramatically reduce in mass by losing their outer layers into space as gas and dust. During the past two years, planetary nebulae have increasingly become an important research component at the Perth Observatory.

Planetary nebulae hold the key to determining how low-mass stars lose their mass and over what time periods. It is estimated that 15 per cent of the total interstellar dust and gas in the galaxy is due to planetary nebulae. This is roughly about five solar masses of material a year (that's material weighing about five times more than the sun). These gases and dusts provide the building blocks of new stars and are responsible for a considerable amount of the chemicals in the Milky Way galaxy. Understanding them lets astronomers

Star gazing this summer

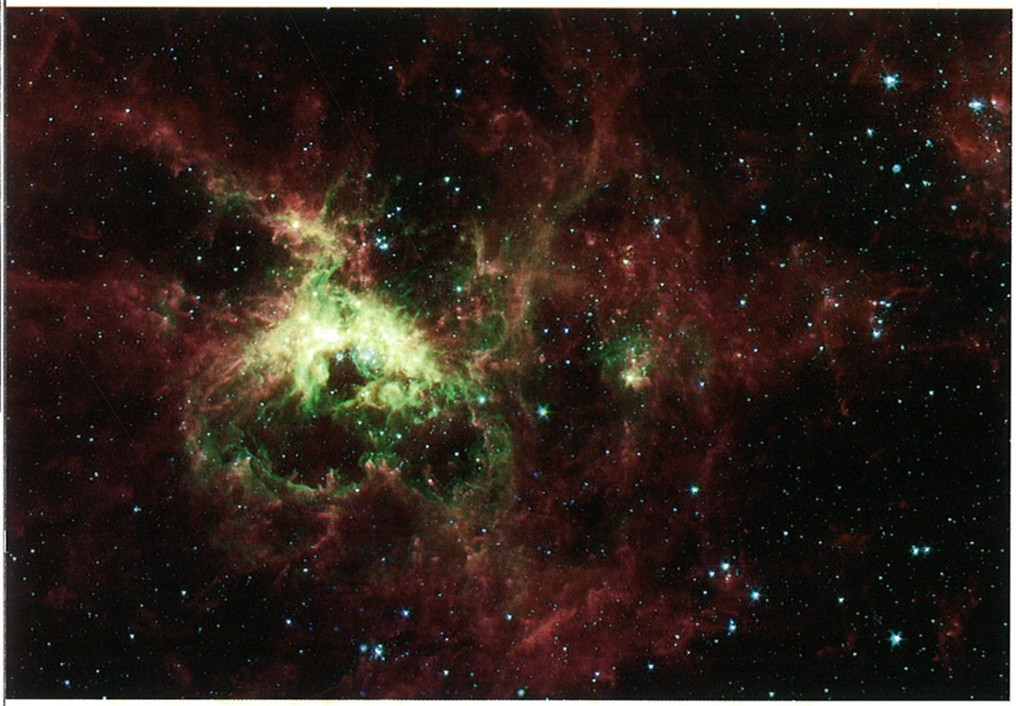
Look for the nebula NGC 5189 (New General Catalogue 5189) this summer in the constellation of Musca the fly. It is a curious spiral nebula near other interesting features like the star cluster known as the 'Jewel Box' in the Southern Cross. The constellation of Musca can be found at the tip of the long end of the Southern Cross. The point is marked by the Southern Cross's brightest star, Acrux, which is the twelfth brightest star in the sky.

The constellation of Orion has within it an easily recognisable star-forming region called the 'Orion Nebula' located some 1,350 light years away. The constellation is recognised by finding the 'Saucepan'. During the summer, the Seven Sisters (Pleiades) is also visible not far from Orion. The Seven Sisters is about 440 light years away from Earth.

There are also a number of globular clusters to observe including the beautiful 47 Tucanae in Tucana (the Toucan constellation). The Globular Cluster is a visible globe-shaped cluster of about a million stars approximately 14,700 light years away.

There are also interesting galaxies to look at, such as the Andromeda Galaxy. At 2.5 million light years away, it's one of the furthest things we can see. The Large and Small Megellanic Clouds have very interesting objects visible through small 100-millimetre telescopes. In the Large Megellanic Cloud is the Tarantula Nebula, so named because it looks like a spider. Its web-like appearance is a great sight through medium to large consumer telescopes.

For other fascinating facts about the night sky, contact the Perth Observatory.



Background above Western Australian night sky.
Photo – Dick Beilby/Lochman Transparencies

Left Tarantula Nebula.
Photo – NASA

understand where chemicals in the Milky Way galaxy come from and how they evolve. The knowledge of chemical evolution in the galaxy may help scientists understand chemical evolution of Earth.

The life cycle of any star can be accurately predicted by one of the most important tools in astronomy called the 'Hertzsprung-Russell diagram' (H-R diagram). The parameters needed for placing a star on the H-R diagram are the star's total energy output and its surface temperature.

Using the H-R diagram, it has been well noted that planetary nebulae candidates spend between 200 million to 10 billion years burning hydrogen in a stable nuclear fusion reaction. The length of time spent burning hydrogen is mass dependant with large stars spending less time burning hydrogen. At the completion of hydrogen fusion, a rapid burning of helium causes the star to go through inflation and deflation stages known as 'giant branch' and 'asymptotic giant branch'. During the final inflation (the asymptotic giant branch), the pressure from the energy produced deep inside the star is so strong and the surface gravity so weak that the star enters the planetary nebula phase by blasting its outer layers into space. Some of the ejected elements remain as gas but others eventually condense into dust and ice grains of mostly water ice and carbon dioxide ice. The fine dusts and gases stay in the vicinity of the star for about 10,000 to 50,000 years.

The central star in a planetary nebula can reach temperatures of about 200,000°C. At these temperatures, the central star outputs high energy, ultraviolet light that excites the dust and gas. This is similar to neon signs that glow when given electrical energy and, like neon signs, the fine space dusts glow with colours dependant on the types of gases within them.

White dwarf stars

Stars going through the planetary nebula phase become white dwarf stars as they expel their outer layer gases. A white dwarf star is a low-mass star going through a long drawn-out death, whereby its central core takes billions of years to diminish into a dark object while the surrounding gas and dust spread out and become thinner and less ionised. They could be likened to a torch that is left on for hours on end, its light slowly dimming as the batteries run out. However, not all white dwarfs are made equal; some may still undergo a supernova explosion by stripping mass from a star in mutual orbit with it.

Above New white dwarf star.
Photo – NASA

Right Horse Head Nebula in Orion 2008.
Photo – Vic Levis

Below Centre of the Milky Way Galaxy in Sagittarius.
Photo – Richard Tonello

There are two types of supernovae. Type Ia supernovae happen when a white dwarf in a binary system (a binary system involves two stars orbiting around each other) reaps out material from its companion until it becomes larger than its maximum limit of 1.44 solar masses. This causes the star to collapse under its weight. The better known, but rare, supernovae are Type II supernovae. Type II supernovae occur when a star larger than eight solar masses (eight times the weight of the sun) explodes by the process of an initial implosion within the star that sets up an energetic shock wave that rips the star apart.

The sky's the limit

Australia, and particularly Western Australia, is well positioned for a future in astronomy. The Perth Observatory is currently constructing an enclosure for a new one-metre telescope called the 'A. Montgomery Ward Telescope' from Lowell Observatory in the United States. The telescope is expected to be functioning in 2009.

Since the introduction of the International Astronomical Union's definition of a planet in 2006, there has been controversy regarding what constitutes a planet. Among the research topics to be tackled with the new telescope will be the detection, photometry (measure of brightness), and astrometry (measurement of positions) of Kuiper Belt Objects at the distance of Pluto and greater—an area of significant international focus. Also, by 2012, WA could host the largest array of radio telescopes in the world. The Square Kilometre Array (SKA) is an international astronomical undertaking that will either be based in WA or South Africa. Hosting the SKA would mean a bright future for radio and optical astronomy within WA. Which country will host the SKA will be announced in 2012. By then, the observatory's new one-metre telescope will be fully operational and will possibly complement the training of local university students in optical astronomy in the areas of photometry, imaging and spectroscopy.

Chris Mesiku works at Perth Observatory assisting research and conducting outreach activities.

You can visit the Perth Observatory during the public tour season from October 2008 to May 2009. Ring the Perth Observatory on (08) 9293 8255 or visit www.perthobservatory.wa.gov.au.

For information relating to the International Year of Astronomy visit www.astronomy2009.org.

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