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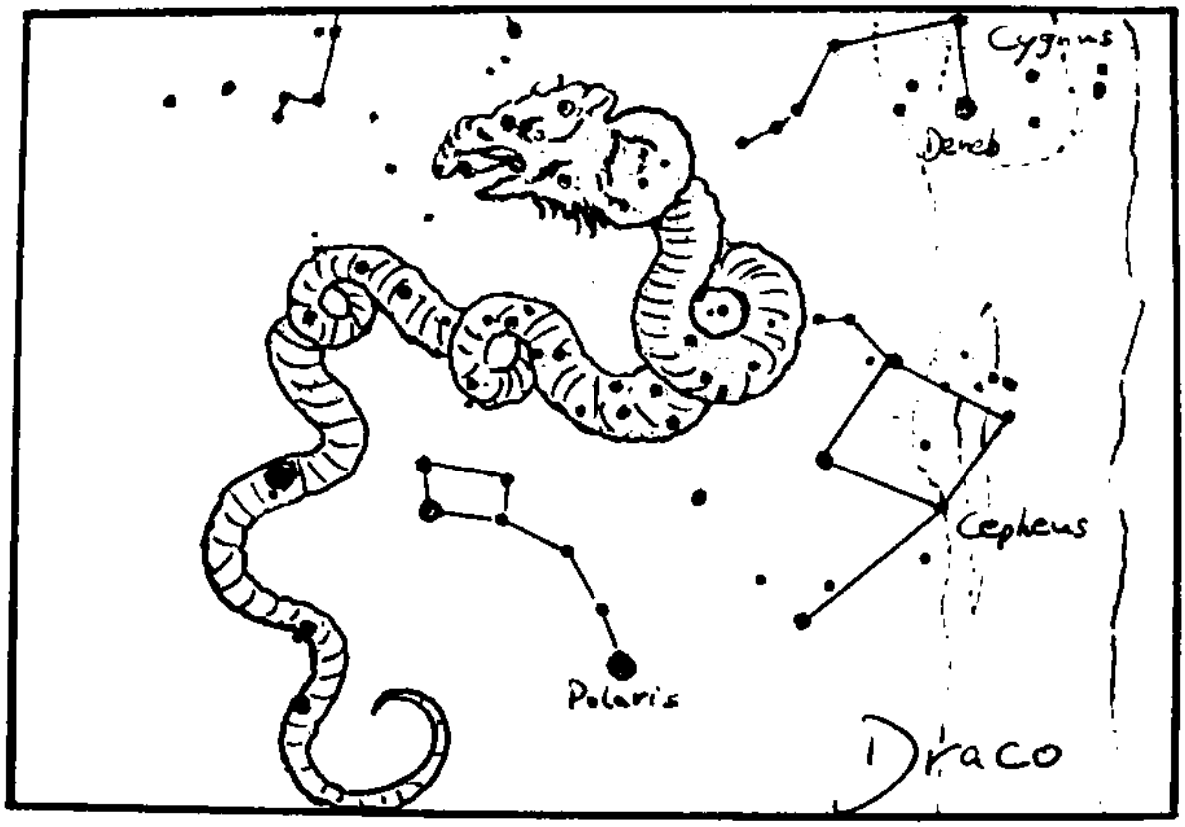
Astronomy Society



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Stardust

While, like Joni Mitchel, we may not no clouds at all, the penumbral eclipse of the Moon certainly happened behind the clouds and passed us by. Tracking down comet Pojmanski eluded me as well. About a week after our club meeting I got up just after 5 am with the full Moon about to set. I carefully scanned the sky around Delphinus, but no luck. All I can say is that its hard out there for a comet tracker. However , thanks to Charles Messier we can scope out his comet imitators and discover a marvelous variety of nebulae, clusters, and galaxies. And the last thing we need is an Oscar that needs dusting on in our book shelves.
It's time time to drool over the new Celestron SkyScout. We're talking loaded with features. Maybe Brian will bring one along to the meeting. The handy observers chairs seen at the last one certainly past the weight bearing test by the editor. And then there are the full colour images that go with articles in the *Starfinders* projected on the big screen, a feature only those members that come out for that night can enjoy. Last but not least the Hayden Planetarium volume visualization of Orion nebula had the audience spellbound. If you would like your own copy got to

http://vis.sdsc.edu/research/orion.html

For important club related dates please check out previous editions. A new date to promote would be the **Introduction to Stargazing** on May 19, 7-9pm at the Cowichan Community Center by the editor. Cost $14.

Now take off your lens caps and turn on the red light

Yours Uli

Vernacular Spring or A Fresh Look At Common Astronomy

The **vernal equinox** has come and gone and now we're in the vernal season, i.e. when things are new, young, and fresh, and the air smells like Spring. Since our Earth's axis has a 23.5^o tilt against the plane of the solar system (the **ecliptic**), the celestial equator has to intersect this plane at two points. These events indicate the two days when night and day are of equal duration (equal 'nox'). The **celestial equator** and its 24 hour division (right ascension) lets us readily mark these points, 0h for the spring equinox and halfway at 12h for the fall equinox. Moreover, these are the points where the celestial **meridian**, the great circle similar to Earth's longitude, intersects the equator. At right angles we can mark the seasonal extremes, 6h for the summer **solstice** (longest day) and 18h for the winter solstice (longest night).
If all you see is circles, i.e. you're longitudinal challenged, just grab hold of a globe and spin it instead. Night and day, the seasons, and even the cause of meteor showers will be revealed as you walk around the candle lit dinner table tilted globe in hand and tripping over the cat food dish.
But, no matter how complicated celestial mechanics might be, sticking to this observable pattern of solstices and equinoxes gives us a year with seasons and festivals always in the right place. Even Pope Gregory succumbed to this convincing arrangement and ordered ten days to be eliminated in 1582 just to keep the vernal equinox on March 21. But why was this necessary, given that Stonehenge and the pyramids had the equinox positions hardwired into them?

Let's start with a contemporary star trail image. Even a two hour exposure will lead us to the conclusion that the heavens 'turn' around the celestial pole. Even **Polaris**, the brightest star in the Little Dipper will move in an arc resulting, after 24 hours, in a circle, albeit a small one. Therefore, our polestar is after all not the hook in the celestial ceiling that supports the starry mobile. And don't we all know how hard it is to find a ceiling joist obscured by drywall?
Fortunately, Egypt comes to our aid. A passage in one of the pyramids points towards **Thuban**, the brightest star in Draco. 4500 years ago, Thuban was the Polaris of that epoch. And just as the pole position seems to move, the position of the equinox drifts through the **Zodiac**. Unlike the celestial equator, the ecliptic is divided into twelve 30^o segments, approximately fitting the constellations of the Zodiac that loop around this circle. During the time of the Babylonians, the equinox occurred in the first degree of **Aries** and horoscopes still preserve this fact. In the meantime, a few thousand years later, the equinox moved to the 21^o of **Pisces**. Moreover, in the year 2600 AD we will finally enter the age of **Aquarius**. That is why newspaper horoscopes seem a litt'l out of date. The constellation that coincides with the sun's position is currently 'once removed.' Geminis' should therefore consult the advice given to Taurus' or ask Rhonda. Who would have thought these complications would arise and that the heavenly pole joist was circular?
Finally, Physics gives us an experimental analogy and Newton the numerical answer to this mystical drift, called the **precession** of the equinox. Like the wobble we observe on a fast spinning top, the Earth's axis describes a circle in the sky that takes 25800 years to complete and repeat. Newton's answer rests in the conservation of momentum and is experienced by most of us who have been on a bicycle. Sideways bumps from rocks, or even pushes will not bring a coasting bike to fall just wobble. Did a passing star upset the original perfect spin and alignment of our solar system? A few people have taken on the forensic investigation of this *hit and run*. Check out the UVic library if you're interested in their analysis of this earth shaking event.

GoTo News

Terminator
Wed, 08 Mar 2006 - This view of Iapetus, one of Saturn's moons, shows its terminator running from pole to pole. This is the line that separates night from day on the moon, and right along this line, the shadows are very long. This allows planetary geologists to see a tremendous amount of detail and measure the height of mountains and the depths of craters. Cassini took this photograph on January 22, 2006, when it was 1.3 million kilometers (800,000 miles) from Iapetus.

Furthest Gamma Ray Burst Seen
Wed, 08 Mar 2006 - Just a few hundred millions years after the Big Bang, a massive star exhausted its fuel, collapsed as a black hole, and exploded as a gamma ray burst. The radiation from this catastrophic event has only now reached Earth, and astronomers are using it to peer back to the earliest moments of the Universe. The burst, named GRB 050904, was observed by NASA's Swift satellite on September 4, 2005. One unusual thing about this burst is that it lasted for 500 seconds - most are over in a fraction of that time.

Saturn's G Ring
Wed, 08 Mar 2006 - This Cassini photograph shows Saturn's faint G ring, with its sharp inner edge and more diffuse outer boundary. When Cassini arrived at Saturn nearly two years ago, it flew directly through this ring, using its main antenna as a shield; a wise move as it was struck several times by icy particles. This image was taken on January 19, 2006 when Cassini was 1.2 million km (700,000 miles) from Saturn.

Enceladus in Front of Saturn
Tue, 07 Mar 2006 - This beautiful natural colour image shows Enceladus hanging in front of Saturn and its rings. This view of Saturn shows the terminator; the line across the planet that separates day from night. Cassini took separate images with its red, green, and blue filters, and then controllers combined the images together on computer. Cassini took this photograph on January 17, 2006 when it was 200,000 kilometers (125,000 miles) from Enceladus.

Antarctica is Melting Faster
Tue, 07 Mar 2006 - Researchers have completed the first comprehensive survey of Antarctic ice mass; not surprisingly, ice loss is on the rise - mostly from the West Antarctic ice shelf. From 2002 to 2005, the continent lost enough ice to raise global sea levels by about 1.2 mm (0.05 inches). The measurements were made by the GRACE satellite, which detects slight changes in the Earth's gravity field over time. This is the most accurate estimate of Antarctic ice loss ever made.

Scientists are Starting to Understand Solar Cycles
Mon, 06 Mar 2006 - Solar scientists think they're finally getting a handle on predicting the Sun's cycles. If everything goes as they predict, the next solar cycle will be 30-50% stronger, and be up to a year late. Astronomers have been tracking the two major flows of plasma that goven the Sun's cycles. One acts like a conveyor belt, pulling plasma from the poles to the equator, and the other gets stretched since the Sun rotates faster at the equator than at the poles. This causes the Sun's magnetic field to concentrate, creating the solar maximum.

Towering Cliffs at the Edge of Olympus Mons
Mon, 06 Mar 2006 - This photograph was taken by ESA's Mars Express spacecraft. It shows the eastern edge of the Olympus Mons volcano on Mars - the biggest mountain the Solar System. These huge cliffs tower above the relatively flat eastern plains around the mountain. The region has been covered repeatedly by lava flows, as recently as 200 million years ago.

Jupiter's Next Great Red Spot
Mon, 06 Mar 2006 - If you're an amateur astronomer with a reasonably good telescope, you might be able to see a new red spot on Jupiter. Its official name is Oval BA, and it's half the size the of the famous Great Red Spot. It first appeared in 2000 when three smaller storms collided and merged together. It started out white, then changed to brown, and now it's the same colour as the Great Red Spot. It's possible that huge storms like this dredge material from deep beneath Jupiter's cloud tops, and then ultraviolet light from the Sun changes it red.

Galactic Chimneys Rising Above NGC 2841
Mon, 06 Mar 2006 - This photograph of spiral galaxy NGC 2841 was taken by the Chandra X-Ray observatory. It shows gasses millions of degrees hot rising above the disk of stars and cooler gas. This superheated gas is created by giant stars and supernovae explosions which blow huge bubbles of gas above the disk like smoke rising from chimneys.

Shock Wave in Stephan's Quintet Galaxy
Sun, 05 Mar 2006 - This photograph, taken by the Spitzer space telescope and a ground-based telescope in Spain, shows the Stephan's Quintet galaxy cluster, with one of the largest shockwaves ever seen in the Universe. The green arc in the photograph is the point which two galaxies are colliding. There are actually 5 galaxies in this photograph, but two have been so beaten up, all that's left are their bright centers. The galaxies are located 300 million light-years away in the Pegasus constellation.

Magnetic Fields Confine a Dying Star's Jets
Fri, 03 Mar 2006 - Radio astronomers have uncovered a dying star with twin jets of material confined by a powerful magnetic field. The star is located about 8,500 light-years away from Earth in the constellation of Aquila, and it's in the process of forming a planetary nebula. Many stars like this produce elongated nebulae, where the star's outer envelope is pushed away and channeled into tight jets. The jets come out in a corkscrew shape, which means that the star is slowly rotating.

Hubble Portrait of the Pinwheel Galaxy
Thu, 02 Mar 2006 - This amazing photograph of galaxy M101 (also known as the Pinwheel Galaxy) was taken by the Hubble Space Telescope - it's the largest and most detailed photo ever taken of this galaxy. The photo is actually composed of 51 separate Hubble exposures, stitched together on computer. M101 is one of the most popular galaxies for astronomers, because it's seen perfectly face on. You can see the incredible spiraling arms containing dust, stars and large regions of star forming nebulae.

Swift Sees an Unusual Gamma Ray Burst
Tue, 28 Feb 2006 - NASA's Swift satellite is continuing to send back surprising information about gamma ray bursts. On February 18, 2006, it discovered something completely unique; a burst that originated 440 million light-years away and lasted about 30 minutes. This event is very similar to the more common bursts that have been seen in the past; however, it was about 25 times

closer, and lasted 100 times longer than a typical burst.

Mimas and Saturn
Mon, 27 Feb 2006 - This is a photograph of Saturn's icy moon Mimas, perched in front of the ringed planet. Mimas is only 397 kilometers (247 miles) across, so it's absolutely dwarfed by Saturn in the background. NASA's Cassini spacecraft took this photograph on January 20, when it was approximately 1.4 million kilometers (900,000 miles) from Mimas.

Images relating to these news clips can be seen at the next meeting or by looking them up at www.universetoday.com.

Andromeda's Origin is Similar to That of the Milky Way

For the last decade, astronomers have thought that the Andromeda galaxy, our nearest galactic neighbor, was rather different from the Milky Way. But a group of researchers have determined that the two galaxies are probably quite similar in the way they evolved, at least over their first several billion years.
In an upcoming issue of the Astrophysical Journal, Scott Chapman of the California Institute of Technology, Rodrigo Ibata of the Observatoire de Strasbourg, and their colleagues report that their detailed studies of the motions and metals of nearly 10,000 stars in Andromeda show that the galaxy's stellar halo is “metal-poor.” In astronomical parlance, this means that the stars lying in the outer bounds of the galaxy are pretty much lacking in all the elements heavier than hydrogen.
This is surprising, says Chapman, because one of the key differences thought to exist between Andromeda and the Milky Way was that the former's stellar halo was metal-rich and the latter's was metal-poor. If both galaxies are metal-poor, then they must have had very similar evolutions.
“Probably, both galaxies got started within a half billion years of the Big Bang, and over the next three to four billion years, both were building up in the same way by protogalactic fragments containing smaller groups of stars falling into the two dark-matter haloes,” Chapman explains.
While no one yet knows what dark matter is made of, its existence is well established because of the mass that must exist in galaxies for their stars to orbit the galactic centers the way they do. Current theories of galactic evolution, in fact, assume that dark-matter wells acted as a sort of “seed” for today's galaxies, with the dark matter pulling in smaller groups of stars as they passed nearby. What's more, galaxies like Andromeda and the Milky Way have each probably gobbled up about 200 smaller galaxies and protogalactic fragments over the last 12 billion years.
Chapman and his colleagues arrived at the conclusion about the metal-poor Andromeda halo by obtaining careful measurements of the speed at which individual stars are coming directly toward or moving directly away from Earth. This measure is called the radial velocity, and can be determined very accurately with the spectrographs of major instruments such as the 10-meter Keck-II telescope, which was used in the study.
Of the approximately 10,000 Andromeda stars for which the researchers have obtained radial velocities, about 1,000 turned out to be stars in the giant stellar halo that extends outward by more than 500,000 light-years. These stars, because of their lack of metals, are thought to have formed quite early, at a time when the massive dark-matter halo had captured its first protogalactic fragments.
The stars that dominate closer to the center of the galaxy, by contrast, are those that formed and merged later, and contain heavier elements due to stellar evolution processes.
In addition to being metal-poor, the stars of the halo follow random orbits and are not in rotation. By contrast, the stars of Andromeda's visible disk are rotating at speeds upwards of 200 kilometers per second.
According to Ibata, the study could lead to new insights on the nature of dark matter. “This is the first time we've been able to obtain a panoramic view of the motions of stars in the halo of a galaxy,” says Ibata. “These stars allow us to weigh the dark matter, and determine how it decreases with distance.”

Backwards

Polar lights are fascinating to look at on Earth. On other planets, they can also be spectacular. Scientists from the Max Planck Institute for Solar System Research in Katlenberg, Lindau, Germany, have now observed Saturn's polar region using the particle spectrometer MIMI, on the Cassini Space Probe. They discovered electrons not only being accelerated toward the planet, but also away from it (Nature, February 9, 2006).
We can see polar lights on Earth when electrons above the atmosphere are accelerated downwards. They light up when they hit the upper atmosphere. Some years ago, researchers discovered that electrons inside the polar region can also be accelerated away from the Earth - that is, “backwards”. These anti-planetary electrons do not cause the sky to light up, and scientists have been puzzled about how they originate.
Until now it has also been unclear whether anti-planetary electrons only occur on Earth. An international team led by Joachim Saur at the University of Cologne have now found electrons on Saturn that are accelerated “backwards” - that is, in an anti-planetary direction. These particles were measured using “Magnetospheric Imaging Instruments” (MIMI) on NASA's Cassini Space Probe. One of these instruments' sensors, the “Low Energy Magnetospheric Measurement System” (LEMMS), was developed and built by scientists at the Max Planck Institute for Solar System Research.
The rotation of the space probe helped the researchers to determine the direction, number, and strength of the electron rays. They compared these results with recordings of the polar region and a global model of Saturn's magnetic field. It turned out that the region of polar light matched up very well with the lowest point of the magnetic field lines in which electron rays were measured.
Because the electron ray is strongly focussed (with an angle of beam spread less than 10 degrees), the scientists were able to determine where its source lies: somewhere above the polar region, but inside a distance of maximum five radii of Saturn. Because the electron rays measured on the Earth, Jupiter, and Saturn are so similar, it appears that there must be some fundamental process underlying the creation of polar lights.

Block Starlight to See Planets

“Some people say that I study darkness, not optics,” jokes Grover Swartzlander. But it's a kind of darkness that will allow astronomers to see the light. Swartzlander, an associate professor in The University of Arizona College of Optical Sciences, is developing devices that block out dazzling starlight, allowing astronomers to study planets in nearby solar systems.

The devices also may prove valuable to optical microscopy and be used to protect camera and imaging systems from glare. The core of this technology is an “optical vortex mask” - a thin, tiny, transparent glass chip that is etched with a series of steps in a pattern similar to a spiral staircase.

When light hits the mask dead on, it slows down more in the thicker layers than in thinner ones. Eventually, the light is split and phase shifted so some waves are 180 degrees out of phase with others. The light spins through the mask like wind in a hurricane. When it reaches the “eye” of this optical twister, light waves that are 180 degrees out of phase cancel one another, leaving a totally dark central core.

Swartzlander says this is like light following the threads of a bolt. The pitch of the optical “bolt” - the distance between two adjacent threads - is critical. “We're creating something special where the pitch should correspond to a change in the phase of one wavelength of light,” he explained. “What we want is a mask that essentially cuts this plane, or sheet, of incoming light and curls it up into a continuous helical beam.”

“What we've found recently is knock-your-socks-off amazing from a theoretical point of view,” he added. “Mathematically, it's beautiful.”

Optical vortices are not a new idea, Swartzlander noted. But it wasn't until the mid 1990s that scientists were able to study the physics behind it. That's when advances in computer-generated holograms and high-precision lithography made such research possible.

Swartzlander and his graduate students, Gregory Foo and David Palacios, garnered media attention recently when “Optics Letters” published their article on how optical vortex masks might be used on powerful telescopes. The masks could be used to block starlight and allow astronomers to directly detect light from a 10-billion-times-dimmer planet orbiting the star. This could be done with an “optical vortex coronagraph.” In a traditional coronagraph, an opaque disk is used to block a star's light. But astronomers who are searching for faint planets near bright stars can't use the traditional coronagraph because glare from starlight diffracts around the disk obscuring light reflected from the planet. “Any small amount of diffracted light from the star is still going to overwhelm the signal from the planet,” Swartzlander explained. “But if the spiral of the vortex mask coincides exactly with the center of the star, the mask creates a black hole where there is no scattered light, and you'd see any planet off to the side.”

The UA team, which also included Eric Christensen from UA's Lunar and Planetary Lab, demonstrated a prototype optical vortex coronagraph on Steward Observatory's 60-inch Mount Lemmon telescope two years ago. They couldn't search for planets outside our solar system because the 60-inch telescope isn't equipped with adaptive optics that corrects for atmospheric turbulence.

Instead, the team took pictures of Saturn and its rings to demonstrate how easily such a mask could be used with a telescope's existing camera system. A photo from the test is online at Swartzlander's website, http://www.u.arizona.edu/~grovers.

Optical vortex coronagraphs could be valuable to future space telescopes, such as NASA's Terrestrial Planet Finder (TPF) and the European Space Agency's Darwin mission, Swartzlander noted. The TPF mission will use space-based telescopes to measure the size, temperature, and placement of planets as small as the Earth in the habitable areas of distant solar systems.

“We're applying for grants to make a better mask - to really ramp this thing up to get better quality optics, Swartzlander said. ”We can demonstrate this now in the lab for laser beams, but we need a really good-quality mask to get closer to what's needed for a telescope.“ The big challenge is developing a way to etch the mask to get ”a big fat zero of light“ at its core, he said.

Swartzlander and his graduate students are doing numerical simulations to determine the proper pitch for helical masks at the desired optical wavelengths. Swartzlander has filed a patent for a mask that covers more than one wavelength, or color of light.

The U.S. Army Research Office and State of Arizona Proposition 301 funds support this research. The Army Research Office funds basic optical sciences research, although Swartzlander's work also has practical defense applications. Optical vortex masks also could be used in microscopy to enhance the contrast between biological tissues.

Book Review: Parallel Worlds

Nearly all cosmologists agree that our universe isn't static. It's apparently expanding at an accelerating rate. A long time from now, living beings, even ones adapted to a low density environment, will eventually be unable to process information, or anything else, and thus couldn't live. This we deduce from many years research with telescopes, antennas and very fast computers. Step by step with the observations are the mathematical reasonings. The uncertainty principle, quantum mechanics, relativity, string theory all try to correlate the forces, fields and particles that constitute our existence. But, once entering into the realm of mathematics, the equations can lead to places that aren't observable. Here, the fifth dimension is more than a musical group. String theory may need up to 11 dimensions for its resolution, but where are these dimensions located? Not much farther past this issue is the thought of many universes. Maybe the other dimensions are in other universes. In consequence, should our universe be no longer habitable, then perhaps we need just pop into another one and continue on.

This book on parallel worlds by Michio Kaku's is a serious, science based review of alternate universes and their relevance to us. Using very little scientific jargon, Kaku takes the reader along the standard trail from Greek philosophers up to today's cosmologists. Along the way, he includes notice of the works of Newton, Halley, Darwin, Einstein, Gamow and other luminaries. These references, however, don't obscure the main thrust which is to enable understanding of our universe. Kaku explains why the night is black, how the uncertainty principle links to consciousness, and where quantum theory can lead to infinite realities. His main focus though is on the potential of string theory. He effectively argues that we need a theory of everything to deal with the expanding universe and, today, string theory is the best candidate. Kaku expects that one of the treats available with this theory is the ability to explore black holes and determine if they are a potential escape route to other universes.

As can probably be deduced from the previous paragraph, this book covers a lot of high-end physics in a very short time. But, as Kaku wanted, it can be read and grasped without any previous introduction to physics or cosmology. Given that the reader is expected to concur with the idea of future civilisations fabricating their own universe, there still remains a lot that remains a matter of faith. I compare this to the challenge of teaching a blind person about colour. Kaku easily passes this challenge. The book does draw on much at the forefront of today's research in physics, but the reader isn't left hanging.

As can be expected in a relatively small book that tackles a large topic, its pace is fast. By assuming no prior knowledge, Kaku needs to and does cover a lot before he gets to the life stages of universes. Universes and a unifying theory aren't his sole objective as he considers today's research into gravity waves and some attempts to discover the Higgs boson. He even contemplates research and engineering far into the future. For example, he sees the possibility for warp drive in the sense of a network of paths connecting people on disparate, distant planets. But the book's focus is on a grand unifying theory and how its discovery could shape humanity's future.

By using simple descriptions, Kaku shows off the works of today's physicists so that anyone can understand and appreciate their work. He maintains a nice balance between detail and corollary. This, together with a copious glossary and a large 'notes' section, makes this book easily accessible to anyone. As can be expected, sometimes the topics drift especially to the philosophical side of things. However, given that the concept of the book is on alternate universes, this is fair game. Hence, whether to appreciate the complexity of our existence, have an exhilarating companion reader for Star Trek episodes, or simply to get hyped up on physics, this book works.

Our own world has more than enough challenges to keep us busy for eons. There may, however, come a time when we the Earth is a safe abode for us all. Then would be a good time to consider how we might survive the end of our universe. Michio Kaku in his book *Parallel Worlds* takes a step in this direction. Certainly we have many obstacles to overcome, but we are also showing the ability with which to overcome them.

Review by Mark Mortimer

NASA'S RELEASE: 06-088

CASSINI DISCOVERS POTENTIAL LIQUID WATER ON ENCELADUS

NASA's Cassini spacecraft may have found evidence of liquid water reservoirs that erupt in Yellowstone-like geysers on Saturn's moon Enceladus. The rare occurrence of liquid water so near the surface raises many new questions about the mysterious moon.

"We realize that this is a radical conclusion - that we may have evidence for liquid water within a body so small and so cold," said Carolyn Porco, Cassini imaging team leader at the Space Science Institute, Boulder, Colo. "However, if we are right, we have significantly broadened the diversity of solar system environments where we might possibly have conditions suitable for living organisms."

High-resolution Cassini images show icy jets and towering plumes ejecting large quantities of particles at high speed. Scientists examined several models to explain the process. They ruled out the idea the particles are produced or blown off the moon's surface by vapor created when warm water ice converts to a gas. Instead, scientists have found evidence for a much more exciting possibility. The jets might be erupting from near-surface pockets of liquid water above 0 degrees Celsius (32 degrees Fahrenheit), like cold versions of the Old Faithful geyser in Yellowstone.

"We previously knew of at most three places where active volcanism exists: Jupiter's moon Io, Earth, and possibly Neptune's moon Triton. Cassini changed all that, making Enceladus the latest member of this very exclusive club, and one of the most exciting places in the solar system," said John Spencer, Cassini scientist, Southwest Research Institute, Boulder.

"Other moons in the solar system have liquid-water oceans covered by kilometers of icy crust," said Andrew Ingersoll, imaging team member and atmospheric scientist at the California Institute of Technology, Pasadena, Calif. "What's different here is that pockets of liquid water may be no more than tens of meters below the surface." "As Cassini approached Saturn, we discovered the Saturnian system is filled with oxygen atoms. At the time we had no idea where the oxygen was coming from," said Candy Hansen, Cassini scientist at NASA's Jet Propulsion Laboratory (JPL) in Pasadena. "Now we know Enceladus is spewing out water molecules, which break down into oxygen and hydrogen."

Scientists still have many questions. Why is Enceladus so active? Are other sites on Enceladus active? Might this activity have been continuous enough over the moon's history for life to have had a chance to take hold in the moon's interior? In the spring of 2008, scientists will get another chance to look at Enceladus when Cassini flies within 350 kilometers (approximately 220 miles), but much work remains after the spacecraft's four-year prime mission is over. "There's no question, along with the moon Titan, Enceladus should be a very high priority for us. Saturn has given us two exciting worlds to explore," said Jonathan Lunine, Cassini interdisciplinary scientist, University of Arizona, Tucson, Ariz.

Mission scientists report these and other Enceladus findings in this week's issue of Science. The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency.

NASA RELEASE: 06-090

SPACECRAFT HELPS RESEARCHERS SEE THE SUN'S FAR SIDE

NASA researchers using the Solar and Heliospheric Observatory (SOHO) spacecraft have developed a method of seeing through the sun to the star's far side. The sun's far side faces away from the Earth, so it is not directly observable by traditional techniques.

"This new method allows more reliable advance warning of magnetic storms brewing on the far side that could rotate with the sun and threaten the Earth," said NASA-supported scientist Phil Scherrer of Stanford University, Stanford, Calif.

Magnetic storms resulting from violent solar activity disrupt satellites, radio communications, power grids and other technological systems on Earth. Advance warning can help planners prepare for operational disruptions. The sun rotates once every 27

days, as seen from Earth, and this means the evolution of active regions on the far side of the sun previously has not been detectable.
Many of these storms originate in groups of sunspots, or active regions - areas with high concentration of magnetic fields. Active regions situated on the near side of the sun, the one facing the Earth, can be observed directly. However, traditional methods provided no information about active regions developing on the other side of the sun. Knowing whether there are large active regions on the opposite side of the sun may greatly improve forecast of potential magnetic storms.
The new observation method uses SOHO's Michelson Doppler Imager (MDI) instrument to trace sound waves reverberating through the sun to build a picture of the far side. The sun is filled with many kinds of sound waves caused by the convective (boiling) motion of gas in its surface layers. The far side imaging method compares the sound waves that emanate from each small region on the far side with what was expected to arrive at that small region from waves that originated on the front side. An active region reveals itself because its strong magnetic fields speed up the sound waves. The difference becomes evident when sound waves originating from the front side and from the back side get out of step with one another.
“The original far-side imaging method only allowed us to see the central regions, about one-quarter to one-third of its total area,” Scherrer said. “The new method allows us to see the entire far side, including the poles.” Scherrer started an effort to use the new method to create full far-side images from archived MDI data collected since 1996. The project was completed in December 2005.
Douglas Biesecker of the National Oceanic and Atmospheric Administration's Space Environment Center, Boulder, Colo., said, “With the new far side photo album going back to 1996, we can discover identifying characteristics of active regions. This will improve our ability to distinguish real active regions.”

The Part-Time Pulsar

Astronomers using the 76-m Lovell radio telescope at the University of Manchester's Jodrell Bank Observatory have discovered a very strange pulsar that helps explain how pulsars act as 'cosmic clocks' and confirms theories put forward 37 years ago to explain the way in which pulsars emit their regular beams of radio waves - considered to be one of the hardest problems in astrophysics.
Their research, now published in Science Express, reveals a pulsar that is only 'on' for part of the time. The strange pulsar is spinning about its own axis and slows down 50% faster when it is 'on' compared to when it is 'off'.
Pulsars are dense, highly magnetized neutron stars that are born in a violent explosion marking the death of massive stars. They act like cosmic lighthouses as they project a rotating beam of radio waves across the galaxy. Dr Michael Kramer explains, “Pulsars are a physicist's dream come true. They are made of the most extreme matter that we know of in the Universe, and their highly stable rotation makes them super-precise cosmic clocks - but, embarrassingly, we do not know how these clocks work. This discovery goes a long way towards solving this problem.“
The current understanding of a pulsar. The central neutron star is highly magnetised and emits a radio beam along its magnetic axis, which is inclined to the rotation axis. The strong magnetic

field eventually leads to the extraction of particles from the surface, filling the surrounding, so-called magnetosphere with plasma. The size of the magnetosphere is given by the distance where plasma co-rotation reaches the speed of light, the so-called light-cylinder. The plasma creating the radio emission eventually leaves the light cylinder as a pulsar wind, which provides a torque onto the pulsar, contributing about 50% to its observed slow-down in rotation.
The research team, led by Dr Kramer, found a pulsar that is only periodically active. It appears as a normal pulsar for about a week and then ”switches off“ for about one month before emitting pulses again. The pulsar, called PSR B1931+24, is unique in this behaviour and affords astronomers an opportunity to compare its quiet and active phases. As it is quiet the majority of the time, it is difficult to detect, suggesting that there may be many other similar objects that have, so far, escaped detection.
Prof Andrew Lyne points out that, ”After the discovery of pulsars, theoreticians proposed that strong electric fields rip particles out of the neutron star surface into a surrounding magnetised cloud of plasma called the magnetosphere - but, for nearly 40 years, there had been no way to test whether our basic understanding was correct.“
The University of Manchester astronomers were delighted when they found that this pulsar slows down more rapidly when the pulsar is on than when it is off. Dr Christine Jordan points out the importance of this discovery, ”We can clearly see that something hits the brakes when the pulsar is on.“
This breaking mechanism must be related to the radio emission and the processes creating it and the additional slow-down can be explained by a wind of particles leaving the pulsar's magnetosphere and carrying away rotational energy. ”Such a braking effect of the pulsar wind was expected but now, finally, we have observational evidence for it“ adds Dr Duncan Lorimer.
The amount of braking can be related to the number of charges leaving the pulsar magnetosphere. Dr Kramer explains their surprise when it was found that the resulting number was within 2% of the theoretical predictions. ”We were really shocked when we saw these numbers on our screens. Given the pulsar's complexity, we never really expected the magnetospheric theory to work so well.“
Prof Lyne summarized the result: ”It is amazing that, after almost 40 years, we have not only found a new, unusual, pulsar phenomenon but also a very unexpected way to confirm some fundamental theories about the nature of pulsars.“

A River of Stars Streaming Across the Sky

Astronomers have discovered a narrow stream of stars extending at least 45 degrees across the northern sky. The stream is about 76,000 light-years distant from Earth and forms a giant arc over the disk of the Milky Way galaxy.

In the March issue of the Astrophysical Journal Letters, Carl Grillmair, an associate research scientist at the California Institute of Technology's Spitzer Science Center, and Roberta Johnson, a graduate student at California State University Long Beach, report on the discovery.

"We were blown away by just how long this thing is," says Grillmair. "As one end of the stream clears the horizon this evening, the other will already be halfway up the sky."

The stream begins just south of the bowl of the Big Dipper and continues in an almost straight line to a point about 12 degrees east of the bright star Arcturus in the constellation Bootes. The stream emanates from a cluster of about 50,000 stars known as NGC 5466.

The newly discovered stream extends both ahead and behind NGC 5466 in its orbit around the galaxy. This is due to a process called tidal stripping, which results when the force of the Milky Way's gravity is markedly different from one side of the cluster to the other. This tends to stretch the cluster, which is normally almost spherical, along a line pointing towards the galactic center. At some point, particularly when its orbit takes it close to the galactic center, the cluster can no longer hang onto its most outlying stars, and these stars drift off into orbits of their own. The lost stars that find themselves between the cluster and the galactic center begin to move slowly ahead of the cluster in its orbit, while the stars that drift outwards, away from the galactic center, fall slowly behind.

Ocean tides are caused by exactly the same phenomenon, though in this case it's the difference in the moon's gravity from one side of Earth to the other that stretches the oceans. If the gravity at the surface of Earth were very much weaker, then the oceans would be pulled from the planet, just like the stars in NGC 5466's stream.

Despite its size, the stream has never previously been seen because it is so completely overwhelmed by the vast sea of foreground stars that make up the disk of the Milky Way. Grillmair and Johnson found the stream by examining the colors and brightnesses of more than nine million stars in the Sloan Digital Sky Survey public database.

"It turns out that, because they were all born at the same time and are situated at roughly the same distance, the stars in globular clusters have a fairly unique signature when you look at how their colors and brightnesses are distributed," says Grillmair.

A River of Stars Streaming Across the Sky

"The new stream may be even longer than we know, as we are limited at the southern end by the extent of the currently available data," he adds. "Larger surveys in the future should be able to extend the known length of the stream substantially, possibly even right around the whole sky."

The stars that make up the stream are much too faint to be seen by the unaided human eye. Owing to the vast distances involved, they are about three million times fainter than even the faintest stars that we can see on a clear night.

Grillmair says that such discoveries are important for our understanding of what makes up the Milky Way galaxy. Like earthbound rivers, such tidal streams can tell us which way is "down," how steep is the slope, and where the mountains and valleys are located.

By measuring the positions and velocities of the stars in these streams, astronomers hope to determine how much Dark Matter the Milky Way contains, and whether the dark matter is distributed smoothly, or in enormous orbiting chunks.

April Almanac

The Planets:

Mercury	very low in E in morning twilight, lost by mid month.
Venus	low in ESE in morning twilight.
Mars	in W after dark, sets NW near 1:30 am
Jupiter	rises in ESE after dark, in SSW at dawn.
Saturn	high in SW after dark, sets in WNW near 3:30 am.

April 1	Moon occults Pleiades (Eastern Canada) 8 pm
April 2	Daylight Savings Time
April 5	Two shadows on Jupiter 5:30 am First Quarter Moon near Pollux 9 pm
April 9	Regulus 2.3º S of Moon
April 12	Yuri Gagarin first person in space, 45 years ago
April 16	Easter Sunday, Mars 0.8 º to right of M35 11 pm
April 18	Venus 0.3 º N of Uranus 6 am
April 22	Lyrid meteors peak
April 24	Venus 2.2 º left of Crescent Moon 6am

Book Review: Chasing Hubble's Shadows

Observational astronomy uses a variety of receivers to capture electromagnetic radiation across a broad band of the spectrum. The Hubble Space Telescope is one of the best known. Its well known images include the Hubble Deep Field, the Hubble Deep Field South and the Hubble Ultra Deep Field. From these we realize that black patches of night sky aren't empty but rather have a complex and visually enticing collection of swirling galaxies. Because of their distance, we know they came into being not long after the Big Bang and its evidentiary cosmic microwave background. These, and results from other detectors, have given astronomers more to substantiate their postulations of the changes that shaped our universe. They see, or think they see, the evolution of matter and resulting radiation from moments after the Big Bang, through various dark ages and renaissances and on.

Galactic morphology is a neat phrase and the gist of Kanipe's book. Its purview is to review work on the genesis of galaxies. The presumption is that the Big Bang did occur. After lots of rapid changes took place, galaxies came into being. These then died, moulted, collided or otherwise transfigured to the shapes we

see today. Kanipe concentrates on radiative emissions, in particular redshifts. He offers notes and observations from astronomers working with many of today's premier instruments, including the Keck scope in Hawaii, Europe's Plateau de Bure radio interferometer, and the infrared sensitive Spitzer Space telescope. As Kanipe is a science journalist, it is other people's words that carry the weight. However, with the inclusion of the views of many of today's and yesterday's leading experts, there is no doubting the content's authenticity.

Being a journalist, Kanipe includes pleasant, descriptive prose together with very particular, specialized scientific concepts. For example, he writes that the universe 'makes a bombastic entrance then settles down to a languid, insipid period of expansion'. This is not to imply that hard details are absent, as many particulars abound. There's the Gun Peterson trough described as an absorption feature in high-redshift quasars that can be used to test for reionization of neutral hydrogen. Findings are like detecting the universe's last scattering surface at a redshift of 1100. As well, perhaps to give the reader a breath of air, Kanipe includes a review of his personal journey to the top of Mauna Kea, resplendent with tales of colourful shirts and adventures in oxygen depletion.

Though the majority of this book aims to and succeeds at recording the gains made in the last decade, Kanipe also includes a look into the near future. There's the SKA or a Square Kilometre Array and the purpose it is to fulfill. Also, he includes a description of the Atacama Large Millimetre Array proposed for the Chilean Andes for millimetre and submillimtre observations. With these and others, Kanipe interweaves instruments, theories and people in a finely balanced review and prognosis. As the book's title indicates, Edwin Hubble looked at shadows to differentiate between ghostly errors and landmarks and others continue this activity today.

Though it's easy to describe the contents of the book, it's not as easy to determine the best target audience. For example, mentioning the theory of leaking gravitons that makes our universe naturally self-inflationary demands a certain prior knowledge. Yet it isn't provided therein. On the other hand, the descriptions of many of the stellar events and the ground based research activities would be more appealing to the generalist. It is certainly a busy, well written review of recent and proposed work in observation astronomy. But, the level of writing is uneven. The blend between science and journalism isn't quite smooth enough. Nevertheless, the topic stays on focus with great quantities of relevant information.

The redshift of a galaxy's emission, like the lines on a person's face, give great clues to the source's age. Sliding redshifts in images show us light originating from the very start of existence. Jeff Kanipe in his book *Chasing Hubble's Shadows* tells of the last decade's hunt for larger and larger redshifts amongst galaxies and the chase to find the very first galaxy.

Review by Mark Mortimer

Merging White Dwarfs Create Helium Stars

An international group of astronomers including Dr. David L. Lambert, director of The University of Texas at Austin McDonald Observatory, has used Hubble Space Telescope to determine the origin of a very unusual and rare type of star. The group's studies indicate that the so-called “extreme helium stars” are formed by the merger of two white dwarf stars. The work has been published in the February 10 issue of The Astrophysical Journal.

The team was led by Dr. Gajendra Pandey of the Indian Institute of Astrophysics (IIA) in Bangalore, and also includes Dr. C. Simon Jeffery of Armagh Observatory in Northern Ireland, and Professor N. Kameswara Rao, also of IIA.

“It's taken more than 60 years after the first discovery at McDonald to get some idea of how these formed,” Rao said. He has been studying these types of stars for more than 30 years. “We are now getting a consistent picture.”

The nature of the first extreme helium star, HD 124448, was discovered at McDonald Observatory in 1942 by Daniel M. Popper of The University of Chicago. Since then, fewer than two dozen of these stars have been identified. They are supergiant stars - less massive than the Sun but many times larger and hotter - and remarkable for their strange compositions. They contain almost no hydrogen, the most abundant chemical element in the universe, and the most basic component of all stars. Instead, they are dominated by helium, with significant amounts of carbon, nitrogen, and oxygen, and traces of all other stable elements.

The origin of extreme helium stars cannot be traced back to formation in a cloud of helium gas, since no such clouds exist in our Milky Way galaxy. Nuclear reactions in a star like the Sun convert hydrogen to helium to provide sunlight or starlight. Since the helium is confined the hot core of a star, the star must lose vast amounts of gas before the helium is at the star's surface - and thus detectable by telescopes. No known mechanism inside the star can drive off the overlying layers to expose the helium.

Two decades ago, astronomers Ronald Webbink and Icko Iben of the University of Illinois introduced the theory that extreme helium stars formed from the merger of two white dwarfs.

White dwarfs are the end product of the evolution of stars like the Sun. They don't contain much hydrogen. Some are rich in helium, and others in carbon and oxygen. A pair of white dwarfs can result from the evolution of a normal binary star (two normal stars in orbit around each other).

Webbink and Iben supposed that, in some cases, one star in the binary may evolve as a helium-rich white dwarf, and the other as a carbon-oxygen-rich white dwarf. Over billions of years of orbiting each other, the two stars lose energy and move steadily closer to each other. Eventually, the helium white dwarf is consumed by the more massive carbon-oxygen white dwarf. The resultant single star swells up to become a helium-rich supergiant star.

To test this theory, astronomers needed to uncover the exact chemical composition of extreme helium stars. This is what Pandey, Lambert, and their colleagues set out to do. They obtained crucial observations with NASA's Hubble Space Telescope, and made supporting observations from the 2.7-meter Harlan J. Smith Telescope at McDonald Observatory and the 2.3-meter Vainu Bappu Telescope in India.

“As an aside,” Lambert said, “it's interesting to note that the namesakes of these two telescopes, Harlan J. Smith and Vainu Bappu, were the very best of friends in graduate school at Harvard.” Later, Smith served as director of McDonald Observatory from 1963 to 1989. Vainu Bappu founded the Indian Institute of Astrophysics. “Today, with collaborations like this project,” Lambert said, “we're maintaining the important international and personal ties that astronomy thrives upon.”

The group made detailed studies of the ultraviolet light coming from seven extreme helium stars with Hubble Space Telescope's STIS instrument (the Space Telescope Imaging Spectrograph) and of the optical light from the telescopes in Texas and India. This data provided them with the specific amounts of at least two dozen different chemical elements present in each star they studied.

According to Rao, it is the advance in technology of being able to observe the spectra of these stars in ultraviolet light with Hubble that made this breakthrough study possible more than 60 years after extreme helium stars were discovered.
The Hubble results match up well with predicted compositions from models of the composition of a star formed through the merger of two white dwarf stars in which the helium-core white dwarf is torn apart, and forms a thick disk around the carbon-oxygen white dwarf. Then, in a process taking only a few minutes, the disk is gravitationally pulled into the carbon-oxygen white dwarf. What happens next depends of the mass of the new, resulting star. If it is above a certain mass, called the Chandrasekar limit, it will explode (specifically, it will explode as a Type Ia supernova). However, if the mass is below this limit, the new merged star will balloon up into a supergiant, eventually becoming an extreme helium star.

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Fly Through of a Martian Canyon

Mon, 13 Mar 2006 - NASA researchers have created a virtual fly through of Valles Marineris on Mars. This video was created by stitching together images taken by the Thermal Emission Imaging System multi-band camera on NASA's Mars Odyssey spacecraft. The images showed details as small as 300 meters (1,000 feet) across, and were taken during in infrared during the Martian daytime. The final images were coloured on computer to approximate how the landscape would look to the human eye.

Pluto and Its Moons Were Born Together

Mon, 13 Mar 2006 - New photographs from the Hubble Space Telescope provide evidence that Pluto and its three moons probably formed at the same time, out of the same material. Scientists believe that the 4 objects were created when two Pluto-sized Kuiper Belt objects collided together. Hubble revealed that that Pluto and its moons have identical colours; exactly what you'd expect from this kind of an origin.

Early Universe's Rapid Expansion Confirmed

Thu, 16 Mar 2006 - Scientists have gathered new evidence that supports the inflationary theory of expansion thanks new data from NASA's Wilkinson Microwave Anisotropy Probe (WMAP). The spacecraft has been making continuous observations of the cosmic background radiation; the afterglow of the Big Bang. These latest observations produced a map of the sky so detailed that scientists were able to trace how microscopic fluctuations in the primordial Universe were magnified in a trillionth of a second of rapid expansion to create the stars and galaxies we see today.

Astrophoto: The Vela Supernova Remnant

by Loke Kun Tan

Mon, 13 Mar 2006 - About 11,000 years ago, around the dawn of human history, a fantastic stellar explosion took place relatively nearby our place in the galaxy. It left an aftermath covering nearly 40 degrees of the sky (the Moon and Sun extend only 1/2 a degree, for comparison), an aftermath captured by astrophotographer Loke Kun Tan.

Liquid Water Might Be On Enceladus

Thu, 09 Mar 2006 - Scientists have discovered geysers of liquid water streaming off Enceladus, one of Saturn's moons, like a colder version of Yellowstone Hot Springs. Enceladus is one of the few objects in the Solar System that has volcanoes, joining the Earth, Io and possibly Neptune's moon Triton. This occurrence of liquid water, right near the surface, raises the hopes that there could be life, like the ecosystems on Earth which exist around deep sea vents, using geothermal heat for energy.

SOHO Can See Right Through the Sun

Thu, 09 Mar 2006 - NASA researchers have developed a technique that allows them to look right through the Sun to see what's happening on the other side. The Solar and Heliospheric Observatory (SOHO) can trace the sound waves caused by active regions on the opposite side of the Sun. This technique allows the researchers to be more prepared when large sunspots rotate around to face the Earth, and better predict active space weather.

Cometary Globule CG4

Thu, 09 Mar 2006 - This object looks like a comet, but it's actually a star forming region called CG4. Cometary globules like this are relatively small clouds of gas and dust in the Milky Way. CG4 is about 1,300 light years from Earth; its head is about 1.5 light-years across, and its tail is about 8 light-years long. The head of the nebula is opaque, but it's illuminated by the light from the hot newly forming stars.

Dinosaur's Demise

Thu, 09 Mar 2006 - Most scientists agree that a large meteor probably wiped out the dinosaurs 65 million years ago, but two geologists from the University of Leicester think that some homegrown cataclysms might have done the trick for previous extinctions. There just isn't enough evidence that an impact caused the mass extinction that happened 250 million years ago. But one of the largest flood basalt eruptions did occur at that time, and released enough greenhouse gasses to dramatically change the Earth's climate - killing the dinosaurs off in the process.

Say Goodbye to the Polar Ice Sheets

Thu, 09 Mar 2006 - NASA has completed the most comprehensive survey ever made of the Earth's polar ice caps, and confirmed that they're disappearing at increasing rates. These rates match computer climate models precisely, giving climate scientists greater confidence in their predictions about global warming. The survey combined data from airborne maps and measurements from two ESA satellites. NASA's ICESat satellite is taking an even more comprehensive survey of ice levels, which should be available next year.

Spitzer Sees Huge Clouds of Dust Around M82

Thu, 16 Mar 2006 - NASA's Spitzer Space Telescope has revealed a burning hot galaxy blowing out clouds of dust and smoke. The galaxy is M82, and it's well known for vast regions of young, hot stars in stellar nurseries. In visible light, the galaxy looks fairly normal, but in Spitzer's infrared view, it's nestled inside an enormous cloud of dust. These clouds are the largest ever seen around a galaxy, stretching 20,000 light years from the galactic plane in both directions.

Early Galaxies Looked Similar

Thu, 16 Mar 2006 - An international team of astronomers have performed one of the most detailed surveys of the most distant galaxies. These galaxies are so far away, we see them as they looked when the Universe was less than half its current age. One of the big surprises of this survey; however, is how much these young galaxies match the structures we see in the current Universe. This means that galaxies probably evolved through collisions and mergers much earlier than previously believed.

Moonquakes

Thu, 16 Mar 2006 - During the Apollo Moon missions - between 1969 and 1972 - NASA astronauts placed seismometers at their landing sites to detect if the Moon has earthquakes (moonquakes). The equipment mostly detected minor tremors, but it also experienced some fairly strong ones, measuring greater than 5.5 on the Richter scale. And they lasted for a very long time, sometimes going on for 10 minutes. If the next group of astronauts will be visiting the Moon for any length of time, they'll need a lunar base that can withstand the occasional trembler.

Galaxies Are Colliding All the Time

Wed, 15 Mar 2006 - Dark matter is a mysterious substance that appears to account for 25% of the mass of the Universe. We can't see it, but we can measure the effect of its gravity; this can reveal information about galactic structure and formation. European astronomers have measured the amount of dark matter in several galaxies, and found that a large portion of them are out of balance; their internal motions are very disturbed. This means that many galaxies - as much as 40% - have recently gone through mergers or near collisions.

Discovered

Wed, 15 Mar 2006 - Astronomers have discovered an unusual helix-shaped nebula near the centre of the Milky Way. This peculiar nebula stretches 80 light years, and looks like the classic image of a DNA molecule. The nebula formed because it's so close to the supermassive black hole at the heart of the Milky Way, which has a very powerful magnetic field. This field isn't as powerful as the one surrounding the Sun, but it's enormous, containing a tremendous amount of energy. It's enough to reach out this incredible distance and twist up this gas cloud with its field lines.

Hubble Pins Down Brown Dwarf Masses

Wed, 15 Mar 2006 - One of the most difficult tasks for astronomers is to figure out how massive distant objects are. Once you find objects orbiting one another; however, it's relatively easy to do. The Hubble Space Telescope has helped astronomers measure the mass of a binary pair of brown dwarfs - failed stars - as they orbit one another. One dwarf is 55 times the mass of Jupiter, and the other is 35 times the mass. Each would have to be 80 times the mass of Jupiter before they had enough mass to ignite a fusion reaction.

Giotto Met Halley 20 Years Ago

Tue, 14 Mar 2006 - This week the European Space Agency celebrated the 20-year anniversary of the Giotto spacecraft's encounter with Comet Halley. This was ESA's first deep space mission, which launched on board an Ariane 1 rocket. Giotto flew for 8 months, traveling almost 150 million kilometres. It swept past the comet on March 13, 1986, getting as close as 596 km (370 miles), and delivered the best pictures ever seen of a comet's nucleus.

Some Comet Material Formed Close to the Sun

Tue, 14 Mar 2006 - Scientists studying cometary particles returned by NASA's Stardust spacecraft have come across some surprising results, calling traditional theories about cometary formation into question. Comets are thought to form in the outer reaches of the Solar System, but Stardust returned minerals that only form in the high temperatures near the Sun. How did these minerals get inside Comet Wild-2? It supports a theory that our Sun had strong bipolar jets early on, which flung material into the far reaches of the Solar System.

Replenishes Saturn's E-Ring

Tue, 14 Mar 2006 - Now that Cassini has uncovered how Enceladus is spewing out water ice from geysers at its southern pole, scientists have an explanation for Saturn's E-ring. This is Saturn's outermost ring, which consists of a diffuse cloud of particles stretching from Mimas to Titan. Cassini's magnetometer matched the signature of the ice geysers to the particles in the E-ring, linking one to the together.

Mars Orbiter Survives Its Journey to the Red Planet

Tue, 14 Mar 2006 - Data transmitted back to Earth by NASA's Mars Reconnaissance Orbiter indicates that the spacecraft successfully inserted itself into orbit around the Red Planet. It fired its main thrusters long enough to slow down its speed so Mars could capture it a wide orbit. The spacecraft will spend the next half-year aerobraking to lower down into a nearly circular orbit. Its instruments will be capable of resolving the Martian surface better than any spacecraft currently orbiting Mars.

Next Solar Max Will Be a Big One

It's official: Solar minimum has arrived. Sunspots have all but vanished. Solar flares are nonexistent. The sun is utterly quiet.
Like the quiet before a storm.
This week researchers announced that a storm is coming--the most intense solar maximum in fifty years. The prediction comes from a team led by Mausumi Dikpati of the National Center for Atmospheric Research (NCAR). “The next sunspot cycle will be 30% to 50% stronger than the previous one,” she says. If correct, the years ahead could produce a burst of solar activity second only to the historic Solar Max of 1958.
That was a solar maximum. The Space Age was just beginning: Sputnik was launched in Oct. 1957 and Explorer 1 (the first US satellite) in Jan. 1958. In 1958 you couldn't tell that a solar storm was underway by looking at the bars on your cell phone; cell phones didn't exist. Even so, people knew something big was happening when Northern Lights were sighted three times in Mexico. A similar maximum now would be noticed by its effect on cell phones, GPS, weather satellites and many other modern technologies.

Dikpati's prediction is unprecedented. In nearly-two centuries since the 11-year sunspot cycle was discovered, scientists have struggled to predict the size of future maximaand failed. Solar maxima can be intense, as in 1958, or barely detectable, as in 1805, obeying no obvious pattern.
The key to the mystery, Dikpati realized years ago, is a conveyor belt on the sun.
We have something similar here on Earththe Great Ocean Conveyor Belt, popularized in the sci-fi movie The Day After Tomorrow. It is a network of currents that carry water and heat from ocean to ocean--see the diagram below. In the movie, the Conveyor Belt stopped and threw the world's weather into chaos.
The sun's conveyor belt is a current, not of water, but of electrically-conducting gas. It flows in a loop from the sun's equator to the poles and back again. Just as the Great Ocean Conveyor Belt controls weather on Earth, this solar conveyor belt controls weather on the sun. Specifically, it controls the sunspot cycle.
Solar physicist David Hathaway of the National Space Science & Technology Center (NSSTC) explains: “First, remember what sunspots are--tangled knots of magnetism generated by the sun's inner dynamo. A typical sunspot exists for just a few weeks. Then it decays, leaving behind a 'corpse' of weak magnetic fields.”
Enter the conveyor belt.
“The top of the conveyor belt skims the surface of the sun, sweeping up the magnetic fields of old, dead sunspots. The 'corpses' are dragged down at the poles to a depth of 200,000 km where the sun's magnetic dynamo can amplify them. Once the corpses (magnetic knots) are reincarnated (amplified), they become buoyant and float back to the surface.” Prestonew sunspots!
All this happens with massive slowness. “It takes about 40 years for the belt to complete one loop,” says Hathaway. The speed varies “anywhere from a 50-year pace (slow) to a 30-year pace (fast).”
When the belt is turning “fast,” it means that lots of magnetic fields are being swept up, and that a future sunspot cycle is going to be intense. This is a basis for forecasting: “The belt was turning fast in 1986-1996,” says Hathaway. “Old magnetic fields swept up then should re-appear as big sunspots in 2010-2011.”
Like most experts in the field, Hathaway has confidence in the conveyor belt model and agrees with Dikpati that the next solar maximum should be a doozy. But he disagrees with one point. Dikpati's forecast puts Solar Max at 2012. Hathaway believes it will arrive sooner, in 2010 or 2011.
“History shows that big sunspot cycles 'ramp up' faster than small ones,” he says. “I expect to see the first sunspots of the next cycle appear in late 2006 or 2007and Solar Max to be underway by 2010 or 2011.”
Who's right? Time will tell. Either way, a storm is coming.

Night of the Living Dead... Stars

Tiny stellar 'corpses' have been caught blasting surprisingly powerful X-rays and gamma rays across our galaxy by ESA's gamma-ray observatory Integral.
This discovery links these objects to the most magnetically active bodies in the Universe and forces scientists to reconsider just how dead such stellar corpses really are.
Known as anomalous X-ray pulsars (AXPs), the stellar corpses were first spotted pulsing low-energy X-rays into space during the 1970s by the Uhuru X-ray satellite. AXPs are extremely rare with only seven known to exist. The X-rays were first thought to be produced by matter falling from a companion star onto the AXP. An alternative was that each AXP is the spinning core of a dead star, known as a neutron star, sweeping beams of energy through space like a cosmic lighthouse. When these beams cross Earth's line of sight, the AXP blinks on and off.
However, this scenario required the AXP's magnetic field to be a thousand million times stronger than the strongest steady magnetic field achievable in a laboratory on Earth. Nevertheless, the Integral observations show that the magnetic solution is correct.
The newly detected emission, known to astronomers as a 'hard tail', of high-energy ('hard') X-rays and gamma rays also comes in the form of regular pulses every 612 seconds depending upon which AXP is observed.
Discovered in three of the four AXPs studied, the hard tails have a distinctive energy signature that forces astronomers to consider that they are produced by super-strong magnetic fields.
“The amount of energy in the hard tail is ten to almost one thousand times more than can be explained by a kind of magnetic friction between the spinning AXP and surrounding space,” said Wim Hermsen of SRON, the Netherlands Institute for Space Research, Utrecht, who together with SRON colleagues made the observations. This leaves so-called 'magnetic field decay' as the only viable alternative.
Neutron stars with super-strong magnetic fields are dubbed 'magnetars'. Created from the core of a gigantic star that has exploded at the end of its life, each magnetar is only around 15 kilometres in diameter yet contains more than one and a half times the mass of the Sun.
Magnetars are also responsible for the 'soft gamma-ray repeaters' (SGRs), which explosively release massive quantities of energy when catastrophic reorganisations of their magnetic fields spontaneously take place. The big difference between an SGR and an AXP is that the process is continuous rather than explosive in an AXP and less energetic.
“Somehow these objects are tapping the enormous magnetic energy contained beneath their surfaces and funnelling it into space,” said Hermsen.
Exactly how that happens is the focus of future work. It is possible that SGRs, of which five are known, turn into AXPs once they have exploded enough of their energy into space.
All known AXPs except one are clustered towards the plane of our galaxy, the Milky Way, indicating that they are the result of recent stellar explosions; some are even wreathed in the exploded gaseous remnants of their former stars.
The other known AXP is in a satellite galaxy of the Milky Way.
The hard tails were discovered by Integral serendipitously, thanks to its unique wide-field camera, the Imager on-Board Integral Satellite (IBIS).
“This is one of the things you hope for when you run an observatory like Integral,” said Christoph Winkler, ESA's Integral project scientist. As the AXPs prove, the stellar afterlife is more alive than astronomers once thought.

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NASA'S STARDUST FINDINGS MAY ALTER VIEW OF COMET FORMATION

Samples from comet Wild 2 have surprised scientists, indicating the formation of at least some comets may have included materi

als ejected by the early sun to the far reaches of the solar system. Scientists have found minerals formed near the sun or other stars in the samples returned to Earth by NASA's Stardust spacecraft in January. The findings suggest materials from the center of the solar system could have traveled to the outer reaches where comets formed. This may alter the way scientists view the formation and composition of comets. “The interesting thing is we are finding these high-temperature minerals in materials from the coldest place in the solar system,” said Donald Brownlee, Stardust principal investigator from the University of Washington, Seattle. Scientists have long thought of comets as cold, billowing clouds of ice, dust and gases formed on the edges of the solar system. But comets may not be so simple or similar. They may prove to be diverse bodies with complex histories. Comet Wild 2 seems to have had a more complex history than thought.

“We have found very high-temperature minerals, which supports a particular model where strong bipolar jets coming out of the early sun propelled material formed near to the sun outward to the outer reaches of the solar system,” said Michael Zolensky, Stardust curator and co-investigator at NASA's Johnson Space Center, Houston. “It seems that comets are not composed entirely of volatile rich materials but rather are a mixture of materials formed at all temperature ranges, at places very near the early sun and at places very remote from it.”

One mineral found in the material brought back by Stardust is olivine, a primary component of the green sand found on some Hawaiian beaches. It is among the most common minerals in the universe, but scientists were surprised to find it in cometary dust. Olivine is a compound of iron, magnesium and other elements. The Stardust sample is primarily magnesium. Along with olivine, the dust from Wild 2 contains high-temperature minerals rich in calcium, aluminum and titanium.

Stardust passed within 149 miles of comet Wild 2 in January 2004, trapping particles from the comet in an exposed gel. Its return capsule parachuted to the Utah desert on Jan. 15. The science canister with the Wild 2 sample arrived at Johnson on Jan. 17. Samples have been distributed to approximately 150 scientists for study.

“The collection of cometary particles is greater than we ever expected,” said Stardust Deputy Principal Investigator Peter Tsou of NASA's Jet Propulsion Laboratory, Pasadena, Calif. “The collection includes about two dozen large tracks visible to the unaided eye.”The grains are tiny, most smaller than a hair's width. Thousands of them appear to be embedded in the glass-like aerogel. A single grain of 10 microns, only one-hundredth of a millimeter (.0004 inches), can be sliced into hundreds of samples for scientists. In addition to cometary particles, Stardust gathered interstellar dust samples during its seven-year journey. The team at Johnson's curatorial facility hopes to begin detailed scanning of the interstellar tray within a month. They will initiate the Stardust at Home project. It will enable volunteers from the public to help scientists locate particles.

After registering, Stardust at Home participants may download a virtual microscope. The microscope will connect to a server and download “focus movies.” The movies are images of the Stardust Interstellar Dust Collector from an automated microscope at the Cosmic Dust Lab at Johnson. Participants will search each field for interstellar dust impacts.

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NASA SATELLITE GLIMPSES UNIVERSE'S FIRST TRILLIONTH OF A SECOND

Scientists peering back to the oldest light in the universe have new evidence to support the concept of inflation. The concept poses the universe expanded many trillion times its size in less than a trillionth of a second at the outset of the big bang.

This finding, made with NASA's Wilkinson Microwave Anisotropy Probe (WMAP), is based on three years of continuous observations of the cosmic microwave background (CMB), the afterglow light produced when the universe was less than a million years old.

WMAP polarization data allow scientists to discriminate between competing models of inflation for the first time. This is a milestone in cosmology. “We can now distinguish between different versions of what happened within the first trillionth of a second of the universe,” said WMAP Principal Investigator Charles Bennett of the Johns Hopkins University in Baltimore. “The longer WMAP observes, the more it reveals about how our universe grew from microscopic quantum fluctuations to the vast expanses of stars and galaxies we see today.”

Previous WMAP results focused on the temperature variations of this light, which provided an accurate age of the universe and insights into its geometry and composition. The new WMAP observations give not only a more detailed temperature map, but also the first full-sky map of the polarization of the CMB. This major breakthrough will enable scientists to obtain much deeper insight into what happened within the first trillionth of a second of the universe. The WMAP results have been submitted to the Astrophysical Journal and are posted at

http://wmap.gsfc.nasa.gov/results

Big bang physics describes how matter and energy developed over the last 13.7 billion years. WMAP's observation of the blanket of cool microwave radiation that permeates the universe shows patterns that mark the seeds of what grew into stars and galaxies. The patterns are tiny temperature differences within this extraordinarily uniform light. WMAP discerns temperature fluctuations at levels finer than a millionth of a degree.

WMAP can resolve features in the cosmic microwave background based on polarization, or the way light is changed by the environment through which it passes. For example, sunlight reflecting off of a shiny object is polarized. Comparing the brightness of broad features to compact features in the microwave background, or afterglow light, helps tell the story of the infant universe. One long-held prediction was the brightness would be the same for features of all sizes. In contrast, the simplest versions of inflation predict the relative brightness decreases as the features get small, a trend seen in the new data.

“This is brand new territory,” said WMAP team member Lyman Page of Princeton University in Princeton, N.J. “The polarization data will become stronger as WMAP continues to observe the microwave background. WMAP's new results heighten the urgency of seeking out inflation's gravitational wave sign. If gravitational waves are seen in future measurements, that would be solid evidence for inflation.”

With a richer temperature map and the new polarization map, WMAP data favor the simplest versions of inflation. Generically, inflation posits that, at the outset of the big bang, quantum fluctuations - short-lived bursts of energy at the subatomic level - were converted by the rapid inflationary expansion into fluctuations of

matter that ultimately enabled stars and galaxies to form.
The simplest versions of inflation predict that the largest-sized fluctuations will also be the strongest. The new results from WMAP favor this signature.
Inflation theory predicts that these same fluctuations also produced primordial gravitational waves whose distortion of space-time leaves a signature in the CMB polarization. This will be an important goal of future CMB measurements which, if found, would provide a stunning confirmation of inflation.
“Inflation was an amazing concept when it was first proposed 25 years ago, and now we can support it with real data,” said WMAP team member Gary Hinshaw of NASA's Goddard Space Flight Center in Greenbelt, Md. WMAP, a partnership between Goddard and Princeton, was launched on June 30, 2001. The WMAP team includes researchers in U.S. and Canadian universities and institutes. For images and information on the Web about WMAP, visit:
http://www.nasa.gov/vision/universe/wmap_pol.html

Super Earths Might Be Common

Astronomers have discovered a new “super-Earth” orbiting a red dwarf star located about 9,000 light-years away. This newfound world weighs about 13 times the mass of the Earth and is probably a mixture of rock and ice, with a diameter several times that of Earth. It orbits its star at about the distance of the asteroid belt in our solar system, 250 million miles out. Its distant location chills it to -330 degrees Fahrenheit, suggesting that although this world is similar in structure to the Earth, it is too cold for liquid water or life.
Orbiting almost as far out as Jupiter does in our solar system, this “super-Earth” likely never accumulated enough gas to grow to giant proportions. Instead, the disk of material from which it formed dissipated, starving it of the raw materials it needed to thrive.
“This is a solar system that ran out of gas,” says Harvard astronomer Scott Gaudi of the Harvard-Smithsonian Center for Astrophysics (CfA), a member of the MicroFUN collaboration that spotted the planet.
The discovery is being reported today in a paper posted online at http://arxiv.org/abs/astro-ph/0603276 and submitted to The Astrophysical Journal Letters for publication.
Gaudi performed extensive data analysis that confirmed the existence of the planet. Further analysis simultaneously ruled out the presence of any Jupiter-sized world in the distant solar system.
“This icy super-Earth dominates the region around its star that, in our solar system, is populated by the gas giant planets,” said first author Andrew Gould (Ohio State University), who leads MicroFUN.
The team also calculates that about one-third of all main sequence stars may have similar icy super-Earths. Theory predicts that smaller planets should be easier to form than larger ones around low-mass stars. Since most Milky Way stars are red dwarfs, solar systems dominated by super-Earths may be more common in the Galaxy than those with giant Jupiters.
This discovery sheds new light on the process of solar system formation. Material orbiting a low-mass star accumulates into planets gradually, leaving more time for the gas in the protoplanetary disk to dissipate before large planets have formed. Low-mass stars also tend to have less massive disks, offering fewer raw materials for planet formation.
“Our discovery suggests that different types of solar systems form around different types of stars,” explains Gaudi. “Sun-like stars form Jupiters, while red dwarf stars only form super-Earths. Larger A-type stars may even form brown dwarfs in their disks.”
Astronomers found the planet using a technique called microlensing, an Einsteinian effect in which the gravity of a foreground star magnifies the light of a more distant star. If the foreground star possesses a planet, the planet's gravity can distort the light further, thereby signaling its presence. The precise alignment required for the effect means that each microlensing event lasts for only a brief time. Astronomers must monitor many stars closely to detect such events.
Microlensing is sensitive to less massive planets than the more common planet-finding methods of radial velocity and transit searches.
“Microlensing is the only way to detect Earth-mass planets from the ground with current technology,” says Gaudi. “If there had been an Earth-mass planet in the same region as this super-Earth, and if the alignment had been just right, we could have detected it. By adding one more two-meter telescope to our arsenal, we may be able to find up to a dozen Earth-mass planets every year.”
The OGLE (Optical Gravitational Lensing Experiment) collaboration initially discovered the microlensed star in April 2005 while peering in the direction of the galactic center, where both foreground and background stars are widespread. OGLE identifies several hundred microlensing events per year, however only a small fraction of those events yield planets. Gaudi estimates that with one or two additional telescopes located in the southern hemisphere to monitor the galactic center, the planet count could jump drastically.
The discovery was made by 36 astronomers, including members of the MicroFUN, OGLE, and Robonet collaborations. The name of the planet is OGLE-2005-BLG-169Lb. OGLE-2005-BLG-169 refers to the 169th microlensing event discovered by the OGLE Collaboration toward the Galactic bulge in 2005, and “Lb” refers to a planetary mass companion to the lens star.
Crucial roles in the discovery were played by OGLE team leader Andrzej Udalski of Warsaw University Observatory and graduate students Deokkeun An of Ohio State and Ai-ying Zhou of Missouri State University. Udalski noticed that this microlensing event was reaching a very high magnification on May 1, and he quickly alerted the MicroFUN group to this fact, since high magnification events are known to be very favorable for planet detection. MicroFUN's regular telescopes were unable to get many images, so MicroFUN leader Gould called the MDM Observatory in Arizona where An and Zhou were observing. Gould asked An and Zhou to obtain a few measurements of the star's brightness over the course of the night, but instead An and Zhou made more than 1000 measurements. This large number of MDM measurements was crucial for the determination the observed signal must really be due to a planet.

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The Legend of Aquila

Aquila: this star group is always associated with rain. In many cultures this constellation foretold the coming of the summer monsoon season. The bright star Altair is part of the super constellation, the Northern Triangle, formed with Vega in Lyra and Deneb in Cygnus.

Mesopotamia: the hero, Etana, wanting to ease the pain his wife was feeling during childbirth, rode on the back of the god Shamash'eagle to the heavens to retrieve a medicinal plant that would relieve her pain. The magical plant was only found in the upper reaches of heaven where Anu lived. While Etana rode on the back of the eagle he noticed that the earth was becoming smaller and smaller, lost his nerve, and according to some versions of the story, his grip. One description of the legend has him living for 1,560 years and leaving only two children. A second version has him crashing to earth for daring to attempt to enter the realm of Anu. The mythical plant may actually be the poisonous mountain arnica which, when taken in controlled doses, does ease the pain of childbirth.

India: the mythical drink of the gods, soma, was brought to Indra the sun by Aquila. At the time of the summer solstice when the celebration of light and good over darkness and evil occurs, the moon god Chandra, who gives soma to the sun to drink, just enters the constellation of the eagle. *See the Indian legends of* Aquarius, Hydra and Pegasus.

Greece: known as the bird who brought rain and the keeper of Zeus' lightning bolts.

Persia: the Sultan Schemiram was sitting with his son Behiram and others when an eagle appeared and circled the Sultan's head. A serpent was wrapped around the eagle's neck strangling it. The Sultan ordered that the snake should be killed without harming the eagle. His son shot the snake, killing it. The grateful eagle returned the next year with a gift of unknown seeds which were sown and protected. An unknown fruit was produced from the plants. As they fermented, a liquid was produced which was given to a prisoner to taste. The prisoner became giddy, asked for more and fell asleep. This is the way that wine was brought to man.

China: the bright star Altair in Aquila represents the beautiful and modest She-niu, a girl gifted with wonderful weaving skills. She fell in love with a young shepherd, represented by the star Vega in the constellation Lyra. The two were separated by a river between their two lands which he would cross to meet with his love. The shepherd left on a trip to another land and the maiden renounced all others. She died of loneliness and a broken heart, believing he had found another. Unknown to her, the shepherd had died while away. The emperor, recognizing the importance of devotion and pure love, transported the young lovers to the sky where their stars, Altair and Vega, are separated by the river of the Milky Way. Once a year, on the seventh day of the seventh moon, the constellations join as magpies fly up to the heavens and allow the shepherd to join his love. *See the Chinese legend of* Lyra.

The Legend of Draco

Draco the Dragon: star group that twists between the constellations of the Great Bear and the Little Bear. Its star, Thuban, found within the body of the dragon, was once the pole star. Draco's strange, winding shape can be explained if Thuban and the rest of the sky is precessed back to their respective positions in the time of ancient Egypt. Draco's body joins with that of the snake held by Ophiuchus, which in turn connects to Hydra. Hydra delineated the celestial equator, and Ophiuchus' serpent followed the equator until it intersected the meridian of the fall equinox. It then bent in a right angle and followed the meridian at the base of Draco's tail until it marked the zenith with the pole star at Thuban. The upper coils and head of the beast wrapping about the pole star. By astronomical chance, the Dragon's Head and Dragon's Tail marked the positions of the lunar nodes, those points where the paths of the solar and lunar orbits intersect and where solar and lunar eclipses may occur. The Dragon's head refers to the ascending node, the Dragon's tail the descending node. In several cultures, an eclipse was attributed to the disappearance of the moon or sun as they were swallowed by a dragon. The fact that the stars of this circumpolar constellation never set plays an important part in its mythologies.

Mesopotamia: considered the female monster, Tiamat, symbol of chaos, defeated by Marduk when he cut her in two following an epic battle that describes the creation of earth as seen by the people of Sumer. One half became the constellation of the dragon and the other became the Hydra. *See the Mesopotamian legends of* Andromeda, Cetus, Hercules, Hydra and Perseus.

Egypt: part of the constellation of the Crocodile that represented Set, ruler of darkness, the dead and the circumpolar stars. Several of the pyramids at Abousseir and Giza were oriented to the position of the star Thuban. The Great Pyramid of Cheops was built with a narrow passage having a length of 126 meters and at an inclination of 26°17' over the horizon. Every night Thuban shown directly through this passage into the chamber of the sarcophagus.

Greece: representation of the vigilant dragon that protected the golden apples of the Hesperides, as well as the dragon who guarded the Golden Fleece in the Garden of Ares. *See the Greek legends of* Aries and Hercules.

China: part of the constellation of Yuen Wei

Christian legend: the serpent who tempted Eve in the Garden of Eden.

Ursa Major
A Visual Guide To The Objects

Object 1 - Bright Star Alioth
We begin our journey through Ursa Major with a slewed GO TO to the bright star ALIOTH. Obviously, “epsilon Ursa Majoris” as it is also known is bright enough to locate with the naked eye, marking the “inside-most bright star of the ”dipper's handle.“ Actually, at magnitude 1.79, Alioth is the brightest star of Ursa Majoris....NOT Duhbe, which has the distinction of its ALPHA designation. Alioth derives its name from the Arabic and can be translated curiously as either ”bright eye,“ or strangely....”fat tail.“ It is an ”A“ spectral type star, very similar to our own sun although some 80 times more luminous.
Object 2 - Multiple Stars Alcor and Mizar (Zeta Ursa Majoris)
This has the distinction of being the first double star ever recorded.....in more ways than one. Mizar is a double in itself, which was discovered in 1650....prior to that legend has it that the pair with Alcor had them as the ”horse and rider“ to native North American people. The star purportedly was used as an eyesight test for young warriors...those who could make out the ”rider“ (Alcor) atop his ”horse“ (Mizar) was deemed suitable for the trials of manhood. Alcor and Mizar present my absolute FAVORITE color contrasts of the sky, surpassing even the famed ”Albireo“ in Cygnus. Mizar is a distinctive yellow-white color, contrasting beautifully with Alcor, which shows itself as a green or blue star, depending on who is looking. Alcor, at magnitude 4.0, is the fainter of the two and is immediately east of Mizar; the pair is easy at the lowest power in the ETX 60 and up. Medium power in the ETX 90 and up will reveal ”MIZAR B“, a bit fainter than Mizar and appearing much closer than Alcor to the primary star; all three can be seen in the same field of view with the ETX 125 and LX 90, with clear separation of Mizar, but with still enough field to accommodate Alcor with a wide angle eyepiece. The faint galaxy Messier 101 (# 9 on our list) is immediately EAST of Mizar.
Object 3 - Bright Star & Multiple Star Duhbe (Alpha Ursa Majoris)
A relatively easy star to see, a companion star encircles the bright star Duhbe at about 6 minutes arc. This 7th magnitude star reveals itself in all the telescopes, but ONLY with fairly high magnification to overcome the glare of the 2nd magnitude Duhbe. the name “Duhbe” is also Arabic, signifying the “back of the great bear.” Although Duhbe is itself a double, only very large telescopes can reveal this difficult double star. Although Duhbe system is only 3 times more massive than our sun, the system puts out an incredible luminosity almost 150 times brighter than the sun.
Object 4 - Double Star Tania Australis (Mu Ursa Majoris) and Nearby Galaxy ngc 3184
This is an incredible object for all telescopes and a good target for the ETX 60, 70 and 90. Always observe this nice double with low magnification for an outstanding and curious difference in color! The main component of Mu is a very, very red RED GIANT star of the M-class, contrasting nicely to the more mainstream and yellow component. Mu itself is magnitude 3.1. Due WEST of this interesting star, don't miss the opportunity (in the same field of view of your 26mm eyepiece!) to see the small spiral galaxy, ngc3184. In very large scopes and photographically, this is one of the most beautiful face-on spirals there is, with delicate rotating spiral arms from a highly concentrated central nucleus. In the ETX 125 and LX 90 it appears as a uniform round (very small) glow with a concentrated brightness in the center; the smaller

scopes will show this galaxy a medium-high power, but typically will NOT reveal the nucleus.
Object 5 - Nice, but difficult Double Star Alula Australis (XI Ursa Majoris)
The beautiful name denoting “First Spring” is rivaled only by the beauty of this very close and equal magnitude double star. Both stars are about 4.5 magnitude and extremely difficult, except in the LX 90. Under steady skies and when overhead (high power) the ETX 90 will show some elongation to the pair, and the ETX 125 might see a bit of a thread of darkness between these two stars. Both stars are very similar to our own sun. In about 15 years, these stars will appear farther apart from Earth (over 3“ arc) and thus be easily resolved in all telescopes under high power.
Object 6 - Double Star 57 Ursa Majoris
This is an outstanding double star, and typically resolvable in even the smaller telescopes under very high power on a good night. They are solar-type stars at magnitude 5 and magnitude 8 and are separated by about 5.5 seconds arc. Because of the relative faintness of the companion star, this is truly a TEST for the ETX 60 and 70, but it can be seen on very good nights.
Object 7 - Lalande 21185 - One of the Closest Stars Outside Our Solar System
This is a star that - in your lifetime - you can actually chart as it moves! It is so close to Earth, at only 8.3 light years (!) that it shows great ”proper motion“ as it moves against more distant stars behind it. It moves almost 5” arc annually due southward (due north of this interesting object is the nice double star “51 Ursa Majoris, so be sure and check that out while in the neighborhood). Lalande 21185 is the fourth-closest of all stars outside of our sun. At magnitude 7.6, this might be a hard star to spot....but use the following chart to help you (magnitudes of some nearby stars are given). ALSO, you can find this star easily by remembering that it is CRIMSON RED, being a nice example of a true RED DWARF star. The grid marks on the following chart are 1 degree; the ETX 125 and ETX 90 provide just under and over (respectively) a one-degree field with the 40mm Super Plossl eye

piece for reference; the LX 90 will require the 32mm Super Wide to achieve the same field, whereas the LX 60 and 70 give so much **field that you might be confused by all you see!**

Object 8 - The Whirlpool Galaxy (actually in Canes Venatici)
Although this is a favorite, both visually and photographically, this is a pretty tough object UNLESS you are observing on a very dark night away totally from city lights. In suburban conditions, even the ETX 125 or the LX 90 will show little detail, other than the bright central core of this face-on galaxy and the other smaller "companion" galaxy that appears to be attached to one arm of this famous sight. In very dark conditions, even the ETX 60 and 70 will clearly show both of these components at medium power and as well will show the one large spiral arm leading down to the "companion." Some detail other that this one arm and a clear dark "lane" between it and the galaxy center will be revealed to the ETX 125 and the LX 90 at about 120x under very, very dark conditions. HOWEVER...do not expect to see what Lord Rosse "saw" (uh-huh.....) in his massive 72 inch reflecting telescope over 130 years ago, as shown in the rare drawing shown below.
Clearly Mr. Rosse had much greater "mental resolving power" than perhaps he did "visual acuity" resolving power. Nonetheless, it is interesting to look at his clearly-recorded spiral nature of this object decades before the true nature of spiral galaxies and their structures were even eluded to!

Object 9 - Galaxy: Messier 101
Due east of Mizar, this is a very difficult galaxy, even for the LX 90 under normal suburban conditions; it is shown clearly under dark sky conditions in both the ETX 125 and the LX 90 however. It is not an object that should worry users of the ETX 60, 70, or 90 however, although it can be glimpsed as a "smudge" in the latter telescope on very dark nights. It is a relatively large (7' arc) face-on galaxy which exhibits no features at all in any of these telescopes; however, large scopes with long-exposure photographs reveal a beautiful spiral structure exhibiting many huge star clouds within this galaxies spindle-like arms. On the very DARKEST nights, the LX 90 may reveal globules of stars that are, in fact, images of these huge star swarms. Lord Rosse (see M-51 above) was the first to note the spiral structure of this object in his giant 72-inch reflector.

Object 10 - NGC 2841, a Nice Elongated Galaxy
This may be the finest example of a tightly-wound spiral type Sb galaxy; in the ETX 90 and larger scopes you can clearly see its elongated elliptical shape. This spiral has many, many distinct arms that can only be made out with the largest telescopes. This "whorls" can be glimpsed on very steady and dark nights with the LX 90, but not easily. It is a large (6' x 2' arc) elliptical shape, very bright across its entire length. Even at magnitude 10.2, this galaxy CAN be glimpsed at medium power with the ETX 60 and 70 scopes.

Objects 11 - Famous Messiers 81 and 82
Messier 81 is a bright, compact spiral galaxy; its two outer, very delicate, arms may be glimpsed in fleeting moments with the 8" scope under extremely dark skies; the ETX 125 fails to show these. Medium power (about 20x per inch) shows the best views in all scopes. This is the larger and brighter of the M81-M83 pair which can be framed nicely in the SAME FIELD of the ETX 60 and 70 even under medium power. On a dark night, this provides a spectacular sight. Look for a white, very uniform brightness for M-81 and elongated in a NE-SE direction only very slightly. A brighter center 1/2 of this object can be seen clearly in the ETX 90 in dark skies. Immediately about 1/2 degree NORTH of M-81 is the slightly less bright Messier 82, a very chaotic, eruptive and much more interesting sight than M-81. Even with the ETX 90 and a power of about 160x, much "mottling" of this cigar-shaped patch of light can be witnessed; in the ETX 125 and LX 90 on a very dark night, the sight of this cataclysmic system is sometimes overwhelming. I recently had my best view of this from the Mountain with the LX 90 and a magnification of about 230x. Seven distinct bright "globular" masses could be discerned and much dark matter in between; at that magnification, M-82 almost filled 1/2 of the field of view. Although dimmer and a bit smaller than its M-81 companion, I have always found M-82 to be a much more rewarding object telescopically. The ETX 60 and 70 will clearly show the cigar-shape of this galaxy under high power, although no discernable detail should be expected.

Object 12 - Messier 109 and Galaxy ngc3953
Messier 109, just east off the bright star Phecda in the "bowl" of the dipper, is the toughest of all objects on this list....forget sighting it with the ETX 60 and 70 and expect much difficulty and a disappointing view (if you DO see it) in the ETX 90 and ETX 125; the LX 90 really does not do much for it either. I have put it here only because it is one of the many Messier objects, although this is controversial to Messier's original list of 100. This, curiously, is one of the largest galaxies on this list at a size of 6.5' x 3.5' arc, but it is very faint at nearly magnitude 11. It is a tightly-wound type Sb spiral, but only reveals its nature in long-exposure photographs through very large telescopes.

Object 13 - Galaxy Messier 108
Not a cake-walk either, but also very large (over 7.5' across!) this galaxy's brightness is spread over so large an area to render it only about magnitude 10.7. In many ways it is more difficult than M-109, above. This galaxy in the LX 90 under very, very dark skies can be clearly made out to be pencil-shaped, and edge-on galaxy with a clearly-defined character in medium-high power; the ETX 125 shows it well, but lacks the aperture to clearly show the 7' arc length of this curious object.

Object 14 - The Famous "Owl Nebula", Messier 97
Concluding our GO TO TOUR or Ursa Major is the famous planetary nebula (gas cloud shell remnant from a supernova explosion) Messier 97, also known as the "Owl Nebula." It's name comes from two dark ovals equally spaced off-center that resemble the two "black eyes" of an old hoot owl. This is a VERY large object, measuring 4' x 3' arc and thus its magnitude of only 11.8 (I think that official magnitude is a bit too low) is spread out to make this a most difficult object. I have seen the "black eyes" only a few times with the ETX 125 and the LX 90....I have never been able to discern any detail with the smaller scopes, although the nebula is clearly seen.