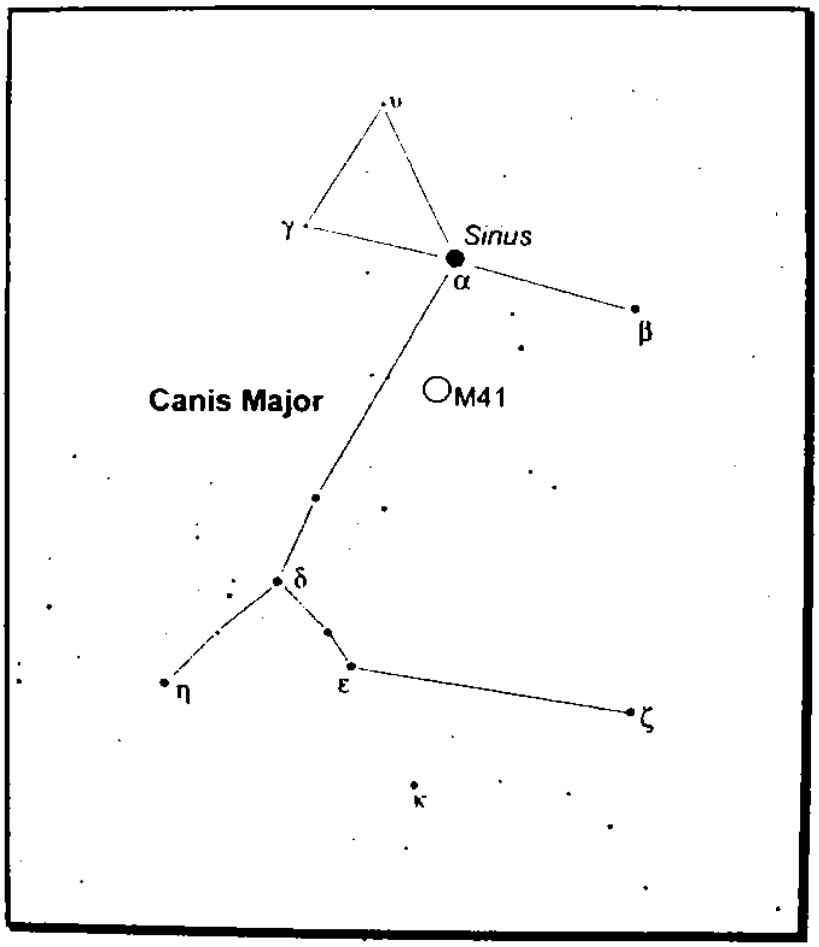
Cowichan Valley

StarFinders

Astronomy Society



March 2006

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Volume 10 Number 7

Stardust

While I am writing this, the Cowichan Valley is still firmly in the grip of Winter. Will there be snow, just as in Torino? Well, the observers night was frosty and clear, thanks to Norm's double jinx. Unfortunately, I could not find my rabbit's foot and ended up soothing my soar back in the hot tub. I gather the hand warmer packs ranked higher than a wide field eye piece. But, good for those (Linda and Norm) who showed up at the 'Frank Survivor' practice event. Consider that it was still 15^0 warmer than at his new Saskatchewan location. I'm sure Meade will come out with a plug-in block heater for the 10“ LightBridge truss tube dobs.

It's not just a big telescope. It's a big telescope that goes any where. New LightBridge truss-dobs from Meade take down and set up quickly. So you can take one of these massive windows on the universe out to your favorite dark sky locations with ease.

Thanks, Brian for bringing it to the meeting AND for setting it up.

If you can think of anyone wanting to become a member ... offer them our 8” loaner dobs + a year's worth of this newsletter for only $20 (Canadian). And your next coffee at Timmy Ho's is on the club. And if you're quick, I'll show you how to find the Beehive with the naked eye before the Big Bear scoops it with the Big Dipper. Because, even if there is life in other galaxies and they want to join our club I refuse to send them the newsletter. I'm sure they would e@mail me with all kinds of interesting stuff ... but by then I'd be stardust.

The big day for memberships is of course **ASTRONOMY DAY** on **May 6**. We will have a booth near the Farmers' Market and show our stuff, sun spots and all, between 9 and 11 am.
ISLAND STAR PARTY will be on **July 21/22** on the Malahat. The RASCals will have theirs on **May 26/27**. The fall party in Merritt takes the September weekend 22/23. For any updates or corrections check out Brian's site.

This newsletter is brimming again with comet size boulder dashes. The popular wide angle *Cut to the Chase News* feature keeps us busy South Islanders informed, since lawn cutting season is just around the corner. And with the Women's Hockey Gold in the bag we can ponder extending the Olympics to the Moon.
As promised, there is lots on comets, a summary of the New Horizons project, and some background on librations. The latter topics were all triggered by our monthly meeting. So like the comet, show your face every once in a while and don't just end up a statistic. You will find out here what you've been missing.

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

Uli

"Be realistic! - how can lumps of rock zooming around in space affect our lives down here?"

Cut to the Chase News

The Spacesuit Satellite
On the 3rd of February the strangest satellite ever constructed will be launched into orbit by astronauts on board the International Space Station (ISS). The satellite, called SuitSat, is an empty old spacesuit. It's equipped with 3 batteries, a radio transmitter and internal sensors to measure temperature and battery power. The satellite will continuously transmit its conditions to Earth while orbiting it. SuitSat will be broadcasting a radio signal that can be easily heard from the ground using an FM radio tuned to 145.990 MHz.

2005 Was the Hottest Year
Did 2005 feel like a scorcher? Well, you're right. According to NASA researchers, 2005 was the warmest year for planet Earth in more than a century. Scientists have used weather stations on land, ships on the ocean, and satellite measurements from space to keep track of average global temperatures. Over the last 100 years, temperatures have risen on average by 0.8° C or about 1.4° F. And the five warmest years were 2005, then 1998, 2002, 2003 and 2004.

Tethys and Tiny Atlas
Two of Saturn's moons are captured in this Cassini image, Tethys and tiny Atlas which is at the centre of the image, just outside Saturn's A ring. At 1,071 kilometers (665 miles) wide, Tethys is much bigger than Atlas, which is a mere 32 kilometers (20 miles) wide. A couple of faint ringlets are also visible in the Encke Gap on the right. This image was take on December 21, 2005, at a distance of nearly 2 million kilometers (1.2 million miles) from Tethys.

Life Doesn't Change Terrain Much
Even through life has flourished on Earth for billions of years, it doesn't seem to make much of an impact on our planet's landscapes. A team of scientists from UC Berkeley did an extensive survey of landscapes across the planet, and couldn't find any place that was obviously modified by lifeforms; from large grazing animals to microscopic bacteria. The only effect seems to be that lifeforms will tend to round off sharp hills. So landscapes once covered with life on Mars might have a higher chance of being smoother and less jagged.

Rhea's Impact Basins
This enhanced colour image of Rhea shows how this Saturnian moon has been pounded by impacts over millions of years. The two large impact basins at the top of Rhea are very old because they're overprinted by many smaller impacts. The ray like structure on the moon's eastern side comes from a relatively recent impact that sprayed material across Rhea's surface. Cassini took this image on December 23, 2005.

Icy Extrasolar Planet Discovered
Astronomers have discovered an extrasolar planet only 5 times larger than the Earth orbiting a star in the Sagittarius constellation. They used a technique called microlensing, where a star briefly passes in front of a more distant star, acting as a lens that magnifies its brightness. In this case, the planet passed in front of the star as well and created a second brightening that allowed astronomers to measure its mass. The planet is likely very cold, as it orbits about three times the distance of the Earth to the Sun, and its parent star is a colder red dwarf.

Prometheus and Dione
Two of Saturn's moons, Prometheus and Dione, are visible in this photograph taken by Cassini. Prometheus is the tiny, irregularly-shaped speck embedded inside Saturn's F ring. Dione, off to the left, is 1,123 kilometers (700 miles) wide. Cassini took this photograph on December 20, 2005 when it was approximately 2.5 million kilometers (1.6 million miles) from Dione and 2.2 million kilometers (1.4 million miles) from Prometheus.

Icy Epimetheus
NASA's Cassini spacecraft took this photograph of Saturn's small icy moon Epimetheus as it faded away behind Saturn's rings and atmosphere. This image was captured by Cassini's narrow-angle camera on December 20th from a distance of 2.3 million kilometers (1.4 million miles) from Epimetheus.

World's Largest Telescope
Europeans have begun funding what will eventually become the world's largest telescope: the Square Kilometre Array. The first step is a four-year study that will consult astronomers and engineers from around the world to decide what will make the best design. It will then be developed in stages, with parts coming operational over the next decade, and completion by 2020. Once complete, this extremely sensitive radio telescope will help probe the nature of dark matter, confirm Einstein's predictions about relativity... and let us watch television shows broadcast from nearby stars.

Asteroid Broke Up 8.2 Million Years Ago
Astronomers think they've found evidence that an asteroid broke up about 8.2 million years ago, scattering dust around the Solar System. The discovery was made by US and Czech Republic researchers who found a layer of helium 3 in oceanic sediment - this isotope is normally quite rare. This evidence matches computer simulations on a group of asteroid fragments in the asteroid belt that were once part of a larger object called Veritas. It was likely the biggest asteroid break up or collision in the last 100 million years.

Stardust Collection Trays are Full of Particles
When NASA scientists first cracked open Stardust's return capsule, they weren't sure what they were going to see; lots of cometary particles or just a few? The results have exceeded everyone's expectations. The scientists estimate they have up to a million cometary particles in the aerogel collection trays, with several as large as the width of a human hair. NASA's Johnson Space Center will begin distributing particles to more than 150 researchers worldwide within the next week.

New Horizons Blasts Off for Pluto
NASA's New Horizons spacecraft finally launched from Cape Canaveral, Florida on January 19th. Travelling away from Earth at a speed of 13 kilometers per second (8 miles per second), the small piano-sized spacecraft will encounter Pluto on July 2015 after a long 9-year journey. Along its way, New Horizons will pass by Jupiter in 2007 and continue its journey to the Kuiper belt after investigating Pluto and its moon Charon.

Hot Halo Surrounds Distant Galaxy
New Chandra observations of spiral galaxy NGC 5746 have revealed a large halo of hot gas surrounding the optical disk of the galaxy. This halo extends for more than 60,000 light years, but the galaxy itself doesn't seem to show any sign of active star formation. Computer simulations show that the hot gas is probably

from the gradual inflow of intergalactic material left over after the galaxy first formed. Halos like this had been predicted on computer, but not seen around a galaxy until now.

Astrophoto: M-81 by Tom Davis
Draw a line from the left bottom star through the top right star of the Big Dipper's bowl then extend it roughly the same distance upward and you'll see the location of this magnificent winter galaxy, the eighty first entry in Charles Messier's catalog, known as M-81. It was first identified in the late 1700's by German astronomer Johann Bode, so it's also sometimes known as Bode's Nebula.
Located only 12 million light years from Earth, a relative stone's throw by intergalactic distances, M-81 is one of the brightest galaxies visible from in the night sky and can be spotted from a dark site, far from any city lights, without need for any optical assistance.
This picture was photographed by astrophotographer Tom Davis, from his Inkom, Idaho home in late January 2006 during a clear-sky break in an otherwise cloudy winter season. Tom photographed through a six inch, f/7 Astro-Physics refractor with a SBIG ST-10XME three mega-pixel camera.
M-81 exhibits beautifully symmetrical spiral arms and numerous dark lanes of dust in this 2.5 hour exposure. Some of these dusty ribbons may be evidence of interaction with its companion galaxy, M-82, which also shows signs of disturbance that is thought to be caused by M-81.

The New 10th Planet Is Larger than Pluto
Astronomers have confirmed that the newly discovered 10th planet is larger than Pluto. Nicknamed 2003 UB313 for now, the new planet has a diameter of 3,000 km (1,850 miles) which is 700 km (435 miles) larger than Pluto. These new observations were made using a sensitive sensor on the IRAM 30-m telescope that measured the heat emitted by the new object, and found it had a similar reflectivity to Pluto. This allowed them to calculate its size.

Binary Icy Asteroid in Jupiter's Orbit
UC Berkeley researchers have performed a detailed analysis on a binary pair of asteroids circling near Jupiter's orbit, and believe they're mostly water ice covered with a layer of dirt. These objects probably started out as small Kuiper belt objects, and then were captured at one of Jupiter's Trojan points - a gravitational eddy in space where solar system material can collect.

Neutron Star Swapping Leads to Gamma-Ray Bursts
Scientists think they're closing in on the cause of gamma ray bursts: merging neutron stars. It was originally believed that this happened when huge stars in a binary system both turned into neutron stars, and eventually smashed into each other. But astronomers think that neutron stars in globular star clusters could eventually pair up. The stars are packed so closely together, that they often exchange partners; a neutron star could swap a regular star out for another neutron star.

Hubble View of a Pinwheel-Shaped Galaxy
This photograph taken by the Hubble Space Telescope shows the pinwheel-shaped galaxy NGC 1309. Some of the interesting features are the bright blue areas of star formation in its spiral arms, the ruddy dust lanes in its structure, and yellowish central population of older stars. NGC 1309 is also home to Type Ia supernovae SN 2002fk, which astronomers are measuring to help determine the rate of expansion of the Universe.

Mega Solar Systems Discovered
NASA's Spitzer Space Telescope has discovered potential solar systems surrounding two massive stars, 30 and 70 times the mass of our Sun. These stars generate intense solar winds, so it's surprising that disks of material could last near them long enough to form planets. Astronomers believe these disk contain massive quantities of icy material, similar to the Kuiper belt in our own Solar System, but extending out 60 times more distant than Pluto's orbit.

Podcast: There Goes New Horizons
Take a look through any book on our Solar System, and you'll see beautiful photographs of every planet - except one. Eight of our nine planets have been visited up close by a spacecraft, and we've got the breathtaking photos to prove it. Pluto's the last holdout, revealing just a few fuzzy pixels in even the most powerful ground and space-based telescopes. But with the launch of New Horizons in January, bound to arrive at Pluto in 9 years, we're one step closer to completing our planetary collection - and answering some big scientific questions about the nature of objects in the Kuiper Belt. Alan Stern is the Executive Director of the Space Science and Engineering Division, at the Southwest Research Institute. He's New Horizon's Principal Investigator.

SUITSAT
There's a new satellite orbiting Earth, and it's a weird one. On Friday, Feb. 3rd, at 6:02 pm EST, astronauts threw an old Russian spacesuit overboard from the International Space Station. The disembodied suit, nicknamed SuitSat, is now circling Earth and transmitting a radio message which you can hear using a police scanner or ham radio tuned to 145.990 MHz (FM). Please visit http://spaceweather.com for more information about SuitSat and how to tune into it.

Watch out for the Comet presentation in April. Will your world be the same after the next meeting?

Book Review: On to Mars 2

Mars is the planet most like Earth. With this accreditation, it has remained one of the likeliest off-world places for people to colonize. There are the usual obstacles; long distance, no water, no infrastructure and a harsh environment. But with any fresh world, there are great opportunities for new technologies, new leadership and new societies. Governments of countries on Earth understandably have no mandate to establish colonies off-world and they've shown little progress. However, their constituents do have both the mandate and desire to pursue this captivating goal. Drawing on this desire is the organization called The Mars Society. Within are thousands of people who regularly contribute to our knowledge base on how people can successfully get to and profit from Mars. In their view, combining opportunities and desires into a concerted effort is one means of having that first human footfall on the Martian surface.

Lacking a government's or business' mandate to step onto Mars, the Mars Society is a ready outlet for people with this desire. Annual conferences allow individuals and teams to come together to spread the word. This book, and its enclosed CD, collect an expansive selection of contributions apparently from a number of conferences between the years 2000 and 2004. Many contributions are reports in scientific format that result directly from two of the Mars Society's research encampments; the Mars Desert Research Station in Utah and the Flashline Arctic Research Station on Devon Island. At these sites, people with no astronaut training or experience but lots of desire can emulate the tasks and challenges of a hypothetical Mars site. In so doing, they can actively add knowledge today to contribute to tomorrow's footfall. Though the analogue sites are the basis for most of the papers, they don't constrain the topics. Given the unique conditions of the sites (e.g. bare rock and hostile climate), people can assess particular aspects of a team on Mars. They can simulate and examine group dynamics amongst the participants, construct storage vaults using local material and measure dust ingress before gears grind to a halt. Contributors with other backgrounds and objectives also have reports. For them, sites may be backyards for greenhouse studies, desks and computers for rocket design or purely their own experience, such as with quality management. In essence, as we're going to have to replicate many of the natural and human contrived processes, the Earth is just one big analogue.

With so much to choose from, there's no wonder that the reports cover a broad selection of topics. This is the book's undoing. All topics relate to Mars but this is the only common thread. Some get very technical, such as discussing bit rates and data packets for computer networks. Others are almost dreamy in their visions of leadership and government. Because of this, it is the authors' passion that rises up to claim the common thread rather than the technical work or the target. As well, a contradiction arises. The book begins by claiming that NASA's constituency driven mandate makes poor results by being random and entropic. Yet, the perception from reading this book is that these individual's efforts are equally random and entropic. Organization and focus are lacking. Nevertheless, if you have any interest in a human presence on Mars, this randomness shouldn't and indeed won't trip you up. This book will empower the average person to get off their duff and lend a hand. As is obvious, much work needs doing and there are many ways to contribute. The international range of authors and the many formats (e.g. reports, poetry and song) demonstrate the many possible routes. The annual conference, the thousands of supporters and this book show that volunteers need not work in isolation or without appreciation.

With Mars never leaving its nearby orbit and shimmering down on us at night, we're always reminded of its proximity. And, we've proven our ability to go into space and walk on the surface of other realms. The book *On to Mars - Volume 2* is a compilation by Frank Crossman and Robert Zubrin containing reports of ideas and results from people who are more than ready to put people on Mars. Their efforts speak loudly, and when that footfall first strikes, assuredly there will be a great chorus of cheers.

Review by Mark Mortimer

GREENLAND ICE-LOSS

The loss of ice from Greenland doubled between 1996 and 2005, as its glaciers flowed faster into the ocean in response to a generally warmer climate, according to a NASA/University of Kansas study.The evolution of Greenland's ice sheet is being driven by several factors. These include accumulation of snow in its interior, which adds mass and lowers sea level; melting of ice along its edges, which decreases mass and raises sea level; and the flow of ice into the sea from outlet glaciers along its edges, which also decreases mass and raises sea level. This study focuses on the least well known component of change, which is glacial ice flow. Its results are combined with estimates of changes in snow accumulation and ice melt from an independent study to determine the total change in mass of the Greenland ice sheet.

Rignot said this study offers a comprehensive assessment of the role of enhanced glacier flow, whereas prior studies of this nature had significant coverage gaps. Estimates of mass loss from areas without coverage relied upon models that assumed no change in ice flow rates over time. The researchers theorized if glacier acceleration is an important factor in the evolution of the Greenland ice sheet, its contribution to sea level rise was being underestimated. To test this theory, the scientists measured ice velocity with interferometric synthetic-aperture radar data collected by the European Space Agency's Earth Remote Sensing Satellites 1 and 2 in 1996; the Canadian Space Agency's Radarsat-1 in 2000 and 2005; and the European Space Agency's Envisat Advanced Synthetic Aperture Radar in 2005. They combined the ice velocity data with ice sheet thickness data from airborne measurements made between 1997 and 2005, covering almost Greenland's entire coast, to calculate the volumes of ice transported to the ocean by glaciers and how these volumes changed over time. The glaciers surveyed by those satellite and airborne instrument data drain a sector encompassing nearly 1.2 million square kilometers (463,000 square miles), or 75 percent of the Greenland ice sheet total area.

From 1996 to 2000, widespread glacial acceleration was found at latitudes below 66 degrees north. This acceleration extended to 70 degrees north by 2005. The researchers estimated the ice mass loss resulting from enhanced glacier flow increased from 63 cubic kilometers in 1996 to 162 cubic kilometers in 2005. Combined with the increase in ice melt and in snow accumulation over that same time period, they determined the total ice loss from the ice sheet increased from 96 cubic kilometers in 1996 to 220 cubic kilometers in 2005. To put this into perspective, a cubic kilometer is one trillion liters (approximately 264 billion gallons of water), about a quarter more than Los Angeles uses in one year.

Glacier acceleration has been the dominant mode of mass loss of the ice sheet in the last decade. From 1996 to 2000, the largest acceleration and mass loss came from southeast Greenland.

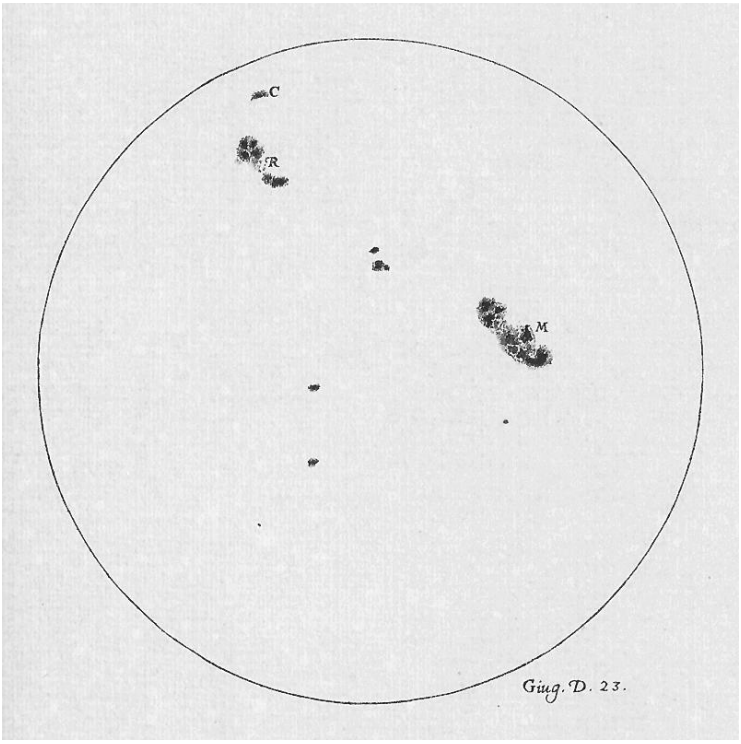
From 2000 to 2005, the trend extended to include central east and west Greenland. “In the future, as warming around Greenland progresses further north, we expect additional losses from northwest Greenland glaciers, which will then increase Greenland's contribution to sea level rise,” Rignot said.

HAPPY BIRTHDAY, GALILEO:

On February 15, 1564, Galileo Galilei was born in Pisa, Italy. If he were alive today he would be 442 years old. Galileo is an important person in the history of space weather. Contrary to popular belief, he didn't discover sunspots, but he was one of the first to observe them using a telescope.

In Galileo's day, many people believed sunspots were satellites of the sun. Galileo proved otherwise. By drawing sunspots every day, he discovered that the sun spins and that sunspots are located on (or very near) the sun's surface. Galileo thought sunspots might be clouds.

Now we know what sunspots really are: great islands of magnetism. Sunspots consist of magnetic force fields poking through the surface of the sun. These fields block the flow of heat from below. Because sunspots are a few thousand degrees cooler than the surrounding inferno, they appear dark. Typical sunspots are a few times wider than Earth. The behemoths Galileo sketched in 1612 were as wide as Jupiter.



Kuiper Belt-Like Disks Around Two Nearby Stars

A survey by NASA's Hubble Space Telescope of 22 nearby stars has turned up two with bright debris disks that appear to be the equivalent of our own solar system's Kuiper Belt, a ring of icy rocks outside the orbit of Neptune and the source of short-period comets.

The debris disks encircling these stars fall into two categories - wide and narrow belts - that appear to describe all nine stars, including the sun, which are known to have debris disks linked to planet formation. In fact, the sharp outer edges of the narrow belts, such as the Kuiper Belt in our solar system, may be a tip-off to the existence of a star-like companion that continually grooms the edge, in the same way that shepherding moons trim the edges of debris rings around Saturn and Uranus.

Research astronomer Paul Kalas, professor of astronomy James Graham and graduate student Michael Fitzgerald of the University of California, Berkeley, along with Mark C. Clampin of Goddard Space Flight Center in Greenbelt, Md., will report their discovery and conclusions in the Jan. 20 issue of Astrophysical Journal Letters.

The newfound stellar disks, each about 60 light years from Earth, bring to nine the number of stars with dusty debris disks observable at visible wavelengths. The new ones are different, however, in that they are old enough - more than 300 million years - to have settled into stable configurations akin to the stable planet and debris orbits in our own solar system, which is 4.6 billion years old. The other seven, except for the sun, range from tens of millions to 200 million years old - young by solar standards.

In addition, the masses of the stars are closer to that of the sun.

“These are the oldest debris disks seen in reflected light, and are important because they show what the Kuiper Belt might look like from the outside,” said Kalas, the lead researcher. “These are the types of stars around which you would expect to find habitable zones and planets that could develop life.”

Most debris disks are lost in the glare of the central star, but the high resolution and sensitivity of the Hubble Space Telescope's Advanced Camera for Surveys has made it possible to look for these disks after blocking the light from the star. Kalas has discovered debris disks around two other stars (AU Microscopii and Fomalhaut) in the past two years, one of them with the Hubble telescope, and has studied details of most of the other known stars with disks.

“We know of 100-plus stars that have infrared emission in excess of that emitted from the star, and that excess thermal emission comes from circumstellar dust,” Kalas said. “The hard part is obtaining resolved images that give spatial information. Now, two decades after they were first discovered, we are finally beginning to see the dust disks. These recent detections are really a tribute to all the hard work that went into upgrading Hubble's instruments during the last servicing mission.”

The small sampling already shows that such disks fall into two categories: those with a broad belt, wider than about 50 astronomical units; and narrow ones with a width of between 20 and 30 AU and a sharp outer boundary, probably like our own Kuiper Belt. An astronomical unit, or AU, is the average distance between the Earth and sun, about 93 million miles. Our Kuiper Belt is thought to be narrow, extending from the orbit of Neptune at 30 AU to about 50 AU.

Most of the known debris disks seem to have a central area cleared of debris, perhaps by planets, which are likely responsible for the sharp inner edges of many of these belts.

Kalas and Graham speculate that stars also having sharp outer edges to their debris disks have a companion - a star or brown dwarf, perhaps - that keeps the disk from spreading outward, similar to the way that Saturn's moons shape the edges of many of the planet's rings.

"The story of how you make a ring around a planet could be the same as the story of making rings around a star," Kalas said. Only one of the nine stars is known to have a companion, but then, he said, no one has yet looked at most of these stars to see if they have faint companions at large distances from the primary star. He suggests that a stray star passing by may have ripped off the edges of the original planetary disk, but a star-sized companion would be necessary to keep the remaining disk material, such as asteroids, comets and dust, from spreading outward.

If true, that would mean that the sun also has a companion keeping the Kuiper Belt confined within a sharp boundary. Though a companion star has been proposed before - most recently by UC Berkeley physics professor Richard Muller, who dubbed the companion Nemesis - no evidence has been found for such a companion.

A key uncertainty, Kalas said, is that while we can see many of the large planetesimals in our Kuiper Belt, we can barely detect the dust. "Ironically, our own debris disk is the closest, yet we know the least about it," he said. "We would really like to know if dust in our Kuiper Belt extends significantly beyond the 50 AU edge of the larger objects. When we acquire this information, only then will we be able to place our sun correctly in the wide or narrow disk categories." The star survey by Kalas, Graham, Fitzgerald and Clampin was one of the first projects of the Advanced Camera for Surveys aboard the Hubble, which was installed in 2002. The 22 stars were observed over a two year period ending in September 2004. The stars with debris disks detectable in visible light were HD 53143, a K star slightly smaller than the sun but about 1 billion years old, and HD 139664, an F star slightly larger than the sun but only 300 million years old.

"One is a K star and the other is an F star, therefore they are more likely to form planetary systems with life than the massive and short-lived stars such as beta-Pictoris and Fomalhaut," he noted. "When we look at HD 53143 and HD 139664, we may be looking at astrophysical mirrors to our Kuiper Belt." The disk around the oldest of the two stars, HD 53143, is wide like that of beta-Pictoris (beta-Pic), which was the first debris disk ever observed, about 20 years ago, and AU Microscopii (AU Mic), which Kalas discovered last year. Both beta-Pic and AU Mic are about 10 million years old.

The disk around HD 139664, however, is a narrow belt, similar to the disk around the star Fomalhaut, which Kalas imaged for the first time early last year. HD 139664 has a very sharp outer edge at 109 AU, similar to the sharp outer edge of our Kuiper Belt at 50 AU. The belt around HD 139664 starts about 60 AU from the star and peaks in density at 83 AU. "If we can understand the origin of the sharp outer edge around HD 139664, we might better understand the history of our solar system," Kalas said.

Lunar Olympics

If winter Olympic Games were held on the moon, where would they be?

The lunar Alps, of course.

February 8, 2006: It's only a matter of time. One day, winter Olympics will be held on the moon.

The moon's dust-covered slopes are good places to ski. There's plenty of powder, moguls and, best of all, low-gravity. With only 1/6th g holding them down, skiers and snowboarders can do tricks they only dreamed of doing on Earth. How about an octuple-twisting quadruple backflip? Don't worry. Crashes happen in slow-motion, so it won't hurt so much to wipe out.

And there's a perfect spot for the Olympic Village: the crater Plato. Most people don't know it, but Plato of ancient Greece was not only a philosopher, but also an Olympic champion. Twice he won the pankration competitiona grueling mix of boxing and wrestling. A crater named after Plato sounds like a good place for Olympic athletes to stay. The site is flat-bottomed, filled with raw materials for building stadia and habitats, and like Torino, Italy, the site of this year's games, Plato is near the Alps.

That is, the *lunar* Alps.

The lunar Alps are a range of mountains on the moon named after the Alps of Europe. They are similar to their Earthly counterparts in height, breath and spectacle. Since the modern Olympics began in 1896, most of the winter games have been held in the Alps. Why should the moon be different? You can see the lunar Alps using a small backyard telescope. This week is an excellent time to try: Step outside at sundown and look up at the moon. The Olympic Village, crater Plato, is a conspicuous dark oval on the northern shore of Mare Imbrium, the "Sea of Rains." Your unaided eye is sufficient to see it. Next, train your telescope on Plato. The Alps begin there. They stretch around the rim of the Sea of Rains from Plato through the spectacular Alpine Valley to towering Mont Blanc. Amateur astronomer Alan Friedman of Buffalo, New York, used a 10-inch telescope to take this picture of the scene:

Although the two Alps look much alike, they formed in different ways: The Alps of Earth grew over a period of millions of years. Powered by plate tectonics, sections of Earth's crust pushed together, squeezing the land to produce jagged mountains. The range stretches from France through Italy all the way to Albania; the tallest peak is Mont Blanc, 15,700 ft or 4800 m high. The Alps of the moon were formed in an instant some 4 billion years ago when a huge asteroid struck. The collision blasted out the Sea of Rains, which, contrary to its name, is a big crater, not a big sea. The Alps are "splash" from the impact.

In those early days, lunar Alps were probably as jagged and rough as the Alps of Earth. But in eons that followed, meteoroids relentlessly pounded the moon, smashing rocks into dust and blunting the sharp edges of mountain peaks. Today's lunar Alps are a bit shorter (the moon's Mont Blanc is only 11,800 ft or 3600 m high) and a lot smoother than their terrestrial counterparts, perfect for Olympics.

In the weeks ahead, Science@NASA will publish a series of stories exploring the physics of low-gravity Olympics. Is an octuple-twisting quadruple backflip really possible? Should snowboarders be allowed to pilot lunar landers? How is a bobsled like a spaceship? Stay tuned for the answers to these questions and others with exclusive video from Olympic athletes.

Let the Games begin!

Book Review: Saturn V

The Saturn V richly deserves the many superlatives heaped upon it. The most apt is it being described as nearly 6 million pounds of explosive fuel waiting for a match to set it alight. Striking as this sounds, it was the control of the resulting exothermic reactions that gently pushed man and machine into the space age. However, where the car industry could continually make corrections to correct design flaws, these rockets had to perform nearly flawlessly every time. This ensured the safety of the people and the achievement of the assigned mission. As well, these rockets were at the centre of a race between nations, thus there was an impassioned need to build, test and use them as quickly as possible. Thus, judicious testing ensured that each Saturn V rocket was ready to perform when called upon.

The author's goal is to recover and present the manufacturing steps and test results of the Saturn V stages. They admirably do so. In a manner that would warm many engineers' hearts, though perhaps bore the average reader, the authors list relevant dates, locations and events for each stage produced. That is, there's a review of the 19 S-IC stages, the 27 S-II stages, and, the 26 S-IVB stages. The stages are listed in a numeric, hence chronological, sequence and all reviews follow the same format. There's a short, one paragraph summary of the stage's eventual use, a description of its manufacturing history and a listing of the testing of the complete stage, usually focusing on the all up test that included static firing of the engines. The test results get listed immediately after, as are any abnormalities. With this expansive coverage of the testing, the book well meets its goal of providing a record of Saturn V's manufacturing and tests.

Supporting this compilation is a quick survey of some support elements. There's a review of the J-2 and F-1 engines, the Pregnant Guppy and Super Guppy cargo aircraft, the barges and the relevant development centres. Of interest, the J-2 may be produced again for the Crew Launch Vehicle's upper stage. These short asides are brief but useful additions to help the reader understand the enormity of the project.

Though the book provides extensive information, it's not exhaustive. As the authors note, there's a massive quantity of records in storage, with little to no organization to aid in searching through it. As such, problems encountered while testing are simply stated, such as 'a minor bearing overheating problem was encountered during the move'. There are even slight traces of levity, such as the comment the failure was due to the inability to abort 3.2 million pounds of water. But humour isn't the goal; this book is a collection of information and facts solely.

Accompanying this book's sound review is an excellent potpourri of photographs, videos and historical documents. The book has a centre section with many colour plates of test firings, stage construction or simple transportation. Black and white pictographs are sprinkled throughout the text. The videos and support documentation are in the enclosed DVD. One can easily enjoy the sonic reverberations kicking through the speakers when viewing really close up images of the engine tests!

Though the book is large, the manufacturing and test record pages are a bit less than half. The remainder are reprints of two historical NASA publications, the Saturn V News Reference and the Saturn V Payload Planner's Guide. Both these documentations provide background information. The first provides a ready review of the details of the Saturn V's design, while the later is a marketing brochure that advertises the rockets capabilities, in the unfulfilled hope that many more would be built. By adding these, the book becomes an excellent reference for Saturn V enthusiasts as well as those interested in engineering test programs or large equipment handling and manufacturing.

Though the Saturn was a rocket, it was also a system. Millions of individual pieces, each serving their own function, had to operate in unison. Alan Lawrie and Robert Godwin in their book *Saturn V* recover all the manufacturing steps and test results that together gave the confidence to the engineers to say that this system was worthy to send a human on a journey into space.

Review by Mark Mortimer

Modifying Gravity to Account for Dark Matter

A Chinese astronomer from the University of St Andrews has fine-tuned Einstein's groundbreaking theory of gravity, creating a 'simple' theory which could solve a dark mystery that has baffled astrophysicists for three-quarters of a century.

A new law for gravity, developed by Dr Hong Sheng Zhao and his Belgian collaborator Dr Benoit Famaey of the Free University of Brussels (ULB), aims to prove whether Einstein's theory was in fact correct and whether the astronomical mystery of Dark Matter actually exists. Their research was published on February 10th in the US-based Astrophysical Journal Letters. Their formula suggests that gravity drops less sharply with distance as in Einstein, and changes subtly from solar systems to galaxies and to the universe.

Theories of the physics of gravity were first developed by Isaac Newton in 1687 and refined by Albert Einstein's general theory of relativity in 1905 to allow light bending. While it is the earliest-known force, gravity is still very much a mystery with theories still unconfirmed by astronomical observations in space.

The 'problem' with the golden laws of Newton and Einstein is whilst they work very well on earth, they do not explain the motion of stars in galaxies and the bending of light accurately. In galaxies, stars rotate rapidly about a central point, held in orbit by the gravitational attraction of the matter in the galaxy. However astronomers found that they were moving too quickly to be held by their mutual gravity - so not enough gravity to hold the galaxies together instead stars should be thrown off in all directions! The solution to this, proposed by Fritz Zwicky in 1933, was that there was unseen material in the galaxies, making up enough gravity to hold the galaxies together. As this material emits no light astronomers call it 'Dark Matter'. It is thought to account for up to 90% of matter in the Universe. Not all scientists accept the Dark Matter theory however. A rival solution was proposed by Moti Milgrom in 1983 and backed up by Jacob Bekenstein in 2004. Instead of the existence of unseen material, Milgrom proposed that astronomers understanding of gravity was incorrect. He proposed that a boost in the gravity of ordinary matter is the cause of this acceleration.

Milgrom's theory has been worked on by a number of astronomers since and Dr Zhao and Dr Famaey have proposed a new formulation of his work that overcomes many of the problems previous versions have faced.

They have created a formula that allows gravity to change continuously over various distance scales and, most importantly, fits the data for observations of galaxies. To fit galaxy data equally well in the rival Dark Matter paradigm would be as challenging as

balancing a ball on a needle, which motivated the twoastronomers to look at an alternative gravity idea.
Legend has it that Newton began thinking about gravity when an apple fell on his head, but according to Dr Zhao, “It is not obvious how an apple would fall in a galaxy. Mr Newton's theory would be off by a large margin - his apple would fly out of the Milky Way. Efforts to restore the apple on a nice orbit around the galaxy have over the years led to two schools of thoughts: Dark Matter versus non-Newtonian gravity. Dark Matter particles come naturally from physics, with beautiful symmetries and explain cosmology beautifully; they tend to be everywhere. The real mystery is how to keep them away from some corners of the universe. Also Dark Matter comes hand- in-hand with Dark Energy. It would be more beautiful if there were one simple answer to all these mysteries”.
Dr Zhao, a PPARC Advanced Fellow at University of St Andrews, School of Physics and Astronomy, and member of the Scottish Universities Physics Alliance (SUPA), continued “There has always been a fair chance that astronomers might rewrite the law of gravity. We have created a new formula for gravity which we call 'the simple formula', and which is actually a refinement of Milgrom's and Bekenstein's. It is consistent with galaxy data so far, and if its predictions are further verified for solar system and cosmology, it could solve the Dark Matter mystery. We may be able to answer common questions such as whether Einstein's theory of gravity is right and whether the so-called Dark Matter actually exists”.
“A non-Newtonian gravity theory is now fully specified on all scales by a smooth continuous function. It is ready for fellow scientists to falsify. It is time to keep an open mind for new fields predicted in our formula while we continue our search for Dark Matter particles.”
The new formula will be presented to an international workshop at Edinburgh's Royal Observatory in April, which will be given the opportunity to test and debate the reworked theory. Dr Zhao and Dr Famaey will demonstrate their new formula to an audience of Dark Matter and gravity experts from ten different countries. Dr Famaey commented “It is possible that neither the modified gravity theory, nor the Dark Matter theory, as they are formulated today, will solve all the problems of galactic dynamics or cosmology. The truth could in principle lie in between, but it is very plausible that we are missing something fundamental about gravity, and that a radically new theoretical approach will be needed to solve all these problems. Nevertheless, our formula is so attractively simple that it is tempting to see it as part of a yet unknown fundamental theory. All galaxy data seem to be explained effortlessly”.

Most Milky Way Stars Are Single

Common wisdom among astronomers holds that most star systems in the Milky Way are multiple, consisting of two or more stars in orbit around each other. Common wisdom is wrong. A new study by Charles Lada of the Harvard-Smithsonian Center for Astrophysics (CfA) demonstrates that most star systems are made up of single stars. Since planets probably are easier to form around single stars, planets also may be more common than previously suspected.
Astronomers have long known that massive, bright stars, including stars like the sun, are most often found to be in multiple star systems. This fact led to the notion that most stars in the universe are multiples. However, more recent studies targeted at low-mass stars have found that these fainter objects rarely occur in multiple systems. Astronomers have known for some time that such low-mass stars, also known as red dwarfs or M stars, are considerably more abundant in space than high-mass stars.
By combining these two facts, Lada came to the realization that most star systems in the Galaxy are composed of solitary red dwarfs.
“By assembling these pieces of the puzzle, the picture that emerged was the complete opposite of what most astronomers have believed,” said Lada.
Among very massive stars, known as O- and B-type stars, 80 percent of the systems are thought to be multiple, but these very bright stars are exceedingly rare. Slightly more than half of all the fainter, sun-like stars are multiples. However, only about 25 percent of red dwarf stars have companions. Combined with the fact that about 85 percent of all stars that exist in the Milky Way are red dwarfs, the inescapable conclusion is that upwards of two-thirds of all star systems in the Galaxy consist of single, red dwarf stars.
The high frequency of lone stars suggests that most stars are single from the moment of their birth. If supported by further investigation, this finding may increase the overall applicability of theories that explain the formation of single, sun-like stars. Correspondingly, other star-formation theories that call for most or all stars to begin their lives in multiple-star systems may be less relevant than previously thought. “It's certainly possible for binary star systems to 'dissolve' into two single stars through stellar encounters,” said astronomer Frank Shu of National Tsing Hua University in Taiwan, who was not involved with this discovery. “However, suggesting that mechanism as the dominant method of single-star formation is unlikely to explain Lada's results.”
Lada's finding implies that planets also may be more abundant than astronomers realized. Planet formation is difficult in binary star systems where gravitational forces disrupt protoplanetary disks. Although a few planets have been found in binaries, they must orbit far from a close binary pair, or hug one member of a wide binary system, in order to survive. Disks around single stars avoid gravitational disruption and therefore are more likely to form planets.
Interestingly, astronomers recently announced the discovery of a rocky planet only five times more massive than Earth. This is the closest to an Earth-size world yet found, and it is in orbit around a single red dwarf star. “This new planet may just be the tip of the iceberg,” said Lada. “Red dwarfs may be a fertile new hunting ground for finding planets, including ones similar in mass to the earth.”
“There could be many planets around red dwarf stars,” stated astronomer Dimitar Sasselov of CfA. “It's all in the numbers, and single red dwarfs clearly exist in great numbers.”
“This discovery is particularly exciting because the habitable zone for these stars - the region where a planet would be the right temperature for liquid water - is close to the star. Planets that are close to their stars are easier to find. The first truly Earth-like planet we discover might be a world orbiting a red dwarf,” added Sasselov.

Natural Particle Accelerator Discovered

A fleet of NASA and European Space Agency space-weather probes observed an immense jet of electrically charged particles in the solar wind between the Sun and Earth. The jet, at least 200 times as wide as the Earth, was powered by clashing magnetic fields in a process called “magnetic reconnection”.
These jets are the result of natural particle accelerators dwarfing anything built on Earth. Scientists build miles-long particle accelerators on Earth to smash atoms together in an effort to understand the fundamental laws of physics. Similar reconnection-powered jets occur in Earth's magnetic shield, producing effects that can disable orbiting spacecraft and cause severe magnetic storms on our planet, sometimes disrupting power stations.
The newly discovered interplanetary jets are far larger than those occurring within Earth's magnetic shield. The new observation is the first direct measurement indicating magnetic reconnection can happen on immense scales. Understanding magnetic reconnection is fundamental to comprehending explosive phenomena throughout the Universe, such as solar flares (billion-megaton explosions in the Sun's atmosphere), gamma-ray bursts (intense bursts of radiation from exotic stars), and laboratory nuclear fusion. Just as a rubber band can suddenly snap when twisted too far, magnetic reconnection is a natural process by which the energy in a stressed magnetic field is suddenly released when it changes shape, accelerating particles (ions and electrons).
“Only with coordinated measurements by Sun-Earth connection spacecraft like ACE, Wind, and Cluster can we explore the space environment with unprecedented detail and in three dimensions,” says Dr. Tai Phan, lead author of the results, from the University of California, Berkeley. “The near-Earth space environment is the only natural laboratory where we can make direct measurements of the physics of explosive magnetic phenomena occurring throughout the Universe.” Phan's article appears as the cover article in Nature on January 12.
The solar wind is a dilute stream of electrically charged (ionized) gas that blows continually from the Sun. Because the solar wind is electrically charged, it carries solar magnetic fields with it. The solar wind arising from different places on the Sun carries magnetic fields pointing in different directions. Magnetic reconnection in the solar wind takes place when “sheets” of oppositely directed magnetic fields get pressed together. In doing so, the sheets connect to form an X-shaped cross-section that is then annihilated, or broken, to form a new magnetic line geometry. The creation of a different magnetic geometry produces extensive jets of particles streaming away from the reconnection site.
Until recently, magnetic reconnection was mostly reported in Earth's “magnetosphere”, the natural magnetic shield surrounding Earth. It is composed of magnetic field lines generated by our planet, and defends us from the continuous flow of charged particles that make up the solar wind by deflecting them. However, when the interplanetary magnetic field lines carried by the solar wind happen to be in the opposite orientation to the Earth's magnetic field lines, reconnection is triggered and solar material can break through Earth's shield. Some previous reconnection events measured in Earth's magnetosphere suggested that the phenomenon was intrinsically random and patchy in nature, extending not more than a few tens of thousands of kilometers (miles). However, “This discovery settles a long-standing debate concerning whether reconnection is intrinsically patchy, or whether instead it can operate across vast regions in space,” said Dr. Jack Gosling of the University of Colorado, a co-author on the paper and a pioneer in research on reconnection in space.
The broader picture of magnetic reconnection emerged when six spacecraft the four European Space Agency Cluster spacecraft and NASA's Advanced Composition Explorer (ACE) and Wind probes were flying in the solar wind outside Earth's magnetosphere on 2 February 2002 and made a chance discovery. During a time span of about two and a half hours, all spacecraft observed in sequence a single huge stream of jetting particles, at least 2.5 million kilometers wide (about 1.5 million miles or nearly 200 Earth diameters), caused by the largest reconnection event ever measured directly.
“If the observed reconnection were patchy, one or more spacecraft most likely would have not encountered an accelerated flow of particles,” said Phan. “Furthermore, patchy and random reconnection events would have resulted in different spacecraft detecting jets directed in different directions, which was not the case.”
Since the spacecraft detected the jet for more than two hours, the reconnection must have been almost steady over at least that timespan. Another 27 large-scale reconnection events with the associated jets - were identified by ACE and Wind, four of which extended more than 50 Earth diameters, or 650,000 kilometers (about 400,000 miles). Thanks to these additional data, the team could conclude that reconnection in the solar wind is to be looked at as an extended and steady phenomenon.
The 2 February 2002 event could have been considerably larger, but the spacecraft were separated by no more than 200 Earth diameters, so its true extent is unknown. Two new NASA missions will help gauge the actual size of these events and examine them in more detail. The Solar Terrestrial Relations Observatory (STEREO) mission, scheduled for launch in May or June of 2006, will consist of two spacecraft orbiting the Sun on opposite sides of the Earth, separated by as much as 186 million miles (almost 300 million kilometers). Their primary mission is to observe Coronal Mass Ejections, billion-ton eruptions of electrically charged gas from the Sun, in three dimensions. However, the spacecraft will also be able to detect magnetic reconnection events occurring in the solar wind with instruments that measure magnetic fields and charged particles. The Magnetospheric Multi-Scale mission (MMS), planned for launch in 2013, will use four identical spacecraft in various Earth orbits to perform detailed studies of the cause of magnetic reconnection in the Earth's magnetosphere.

On wormholes, warp drives , and time machines

Wow, don't we all know what we're talking about here? Yes, and we are certain that a few years from now we can pick up a universal remote control (URC) from Radio Shack. This device will let us open a wormhole at will to dispose off our old TV set followed by some stale fries and Christmas cake. Moreover, The Source, as you have noticed, will have changed its name back to Radio Shack. That happened during their time travels to check up on old school stuff. There, the guys from the future were wrestled down by the dudes from 2001, and now they are running the show.
Of course, you're still with me, since past experience has shown us that it is only a matter of time before SciFi stories and movies become the stuff of everyday life, e.g. Jules Verne, *The Moon-Voyage*, Frank Herbert, *Dune*, and Isaac Asimov, *Foundation*.
And in late breaking news, NASA is exploring warp drive technology, which has us treckies smug in the bosom of the enterprise.

Unfortunately, there came the wake up call. This was only the gist of the beginning of Don Witt's lecture. He followed it up by a tour de force deploying rapid fire salvoes of weird geometries, bed time stories of Flatland, and mathematical short cuts. If we let c=1, and G=1, then that reduces tensor formulae to word equations, like

"Curvature" = Matter

But, before my hair has time to frizz and grey like Einstein's, a new power point slide presents us with the 1993 result that Don and his witty friends had arrived at:

The topology of any physically reasonable space time cannot be actively probed.

Gotcha! So, the idea of leaving the room through a door and simultaneously coming through the opposite wall is out the window.

The reason behind this result is topological censorship. Topology, a branch of mathematics that studies qualitative questions about geometrical structures, has advanced to such an extent, that it is able to assume the role of Über-judge on matters too difficult to solve in other disciplines. Imagine, this branch is able to make use of an 1884 story by E.A. Abbott. *In Flatland*, Abbott describes the life of a mere square wrestling with the quest of the illusive 3rd dimension. Dr. Witt added a few handles to flatland, analogous to wormhole images in our world, and proved to us the inability to send starlight through the handle and seeing it coming from behind. The transformations required for such a feat would make the handle shrink and disappear before our eyes. No magic, no bunny, no go.

However both quantum and string theory seem to agree on the probability of curled up worm holes which might finally clarify the problem of lost socks in our dryer. While the air holes there are too small for the socks, quantum dilation and the uncurling of the seventh dimension time arrow have great possibilities for exploring this exotic effect in our temperate climate. Is it not rather the missing sock that drives you crazy in the morning than the lost time travel opportunity to see the election results on Canada's East coast?

Finally, to all those seeking decorating ideas for their space: don't bother so much about accessories, just change the ***space***. You have a wide selection to choose from there are Minkowski, Schwarzschild, Rindler, de Sitter, anti de Sitter, or any of them with the name Einstein in combination spaces. Of course, you can also stay in your approximately Euclidean space, especially if the others sound Greek to you. All of them may or may not have walls to put up your *Star Trek* poster, or a ceiling to suspend a *Stargate* through which you can throw your dirty clothes. But in all of them you have to pick them up yourself and do your own laundry. And I believe this to be true even for our myth busting Dr. Witt.

respectfully submitted by your editor,
who survived another lecture

Planets Running in Reverse

Call it the biggest beltway ever seen. Astronomers have discovered a newly forming solar system with the inner part orbiting in one direction and the outer part orbiting the other way.

Our solar system is a one-way boulevard. All the planets - from Mercury out to Pluto and even the newly discovered objects beyond - revolve around the Sun in the same direction. This is because the Sun and planets formed from the same massive, rotating cloud of dust and gas. The motion of that cloud set the motion of the planets.

The fact that a solar system can have planets running in opposite directions is a shocker.

"This is the first time anyone has seen anything like this, and it means that the process of forming planets from such disks is more complex than we previously expected," said Anthony Remijan of the National Radio Astronomy Observatory.

Remijan and his colleague Jan Hollis of NASA Goddard Space Flight Center in Greenbelt, Md., used the National Science Foundation's Very Large Array radio telescope to make the discovery. Call it one of the largest road construction projects, too. This solar system, about 500 light-years from Earth in the direction of the constellation Ophiuchus, is a work in progress. At its center is a young star. No planets have formed yet and likely won't for millions of years. What Remijan and Hollis saw were two flat and dusty disks rotating around the equatorial plane of the central star in opposite directions. "The solar system that likely will be formed around this star will include planets orbiting in different directions, unlike our own solar system," Hollis said.

How did this rare scenario come to be?

"We think this system may have gotten material from two clouds instead of one, and the two were rotating in opposite directions," Remijan said. There is sufficient material to form planets from both parts of the disk, he added. The budding solar system is in a large, star-forming region where chaotic motions and eddies in the gas and dust result in smaller cloudlets that can rotate in different directions. Remijan and Hollis study star-forming clouds by analyzing radio waves emitted by molecules within the clouds at specific, known frequencies. The motion of the molecules will cause the frequency to shift to a higher or lower frequency, depending on the direction of the motion. This is called a Doppler shift. Actually, it is the same technology that police officers use to nab speeders on a beltway.

The VLA observations of the "beltway" solar system revealed the motion of silicon monoxide (SiO) molecules. These emit radio waves at about 43 GigaHertz (GHz). When Remijan and Hollis compared new VLA measurements of the motion of SiO molecules close to the young star with earlier measurements of other molecules farther away from the protostar, they realized the two were orbiting the star in opposite directions.

This is the first time such a phenomenon has been seen in a disk around a young star. Yet who's to say the arrangement is uncommon? As astronomers find more and more extra-solar planets (over a hundred so far and counting), they are realizing that solar systems come in many shapes and sizes.

The Case of the Stolen Stars

Based on observations with ESO's Very Large Telescope, a team of Italian astronomers reports that the stellar cluster Messier 12 must have lost to our Milky Way galaxy close to one million low-mass stars.

“In the solar neighbourhood and in most stellar clusters, the least massive stars are the most common, and by far”, said Guido De Marchi (ESA), lead author of the study. “Our observations with ESO's VLT show this is not the case for Messier 12.” The team, which also includes Luigi Pulone and Francesco Paresce (INAF, Italy), measured the brightness and colours of more than 16,000 stars within the globular cluster Messier 12 with the FORS1 multi-mode instrument attached to one of the Unit Telescopes of ESO's VLT at Cerro Paranal (Chile). The astronomers could study stars that are 40 million times fainter than what the unaided eye can see (magnitude 25).

Located at a distance of 23,000 light years in the constellation Ophiuchus (The Serpent-holder), Messier 12 got its name by being the 12th entry in the catalogue of nebulous objects compiled in 1774 by French astronomer and comet chaser Charles Messier. It is also known to astronomers as NGC 6218 and contains about 200,000 stars, most of them having a mass between 20 and 80 percent of the mass of the Sun. “It is however clear that Messier 12 is surprisingly devoid of low-mass stars”, said De Marchi. “For each solar-like star, we would expect roughly four times as many stars with half that mass. Our VLT observations only show an equal number of stars of different masses.”

Globular clusters move in extended elliptical orbits that periodically take them through the densely populated regions of our Galaxy, the plane, then high above and below, in the 'halo'. When venturing too close to the innermost and denser regions of the Milky Way, the 'bulge', a globular cluster can be perturbed, the smallest stars being ripped away.

“We estimate that Messier 12 lost four times as many stars as it still has”, said Francesco Paresce. “That is, roughly one million stars must have been ejected into the halo of our Milky Way.”

The total remaining lifetime of Messier 12 is predicted to be about 4.5 billion years, i.e. about a third of its present age. This is very short compared to the typical expected globular cluster's lifetime, which is about 20 billion years. The same team of astronomers had found in 1999, another example of a globular cluster that lost a large fraction of its original content (see ESO PR 04/99).

The scientists hope to discover and study many more clusters like these, since catching clusters while being disrupted should clarify the dynamics of the process that shaped the halo of our home galaxy, the Milky Way.

The Smell of Moondust

Moondust. “I wish I could send you some,” says Apollo 17 astronaut Gene Cernan. Just a thimbleful scooped fresh off the lunar surface. “It's amazing stuff.” Feel it. It's soft like snow, yet strangely abrasive. Taste it“not half bad,” according to Apollo 16 astronaut John Young. Sniff it“it smells like spent gunpowder,” says Cernan.

How do you sniff moondust?

Every Apollo astronaut did it. They couldn't touch their noses to the lunar surface. But, after every moonwalk (or “EVA”), they would tramp the stuff back inside the lander. Moondust was incredibly clingy, sticking to boots, gloves and other exposed surfaces. No matter how hard they tried to brush their suits before re-entering the cabin, some dust (and sometimes a lot of dust) made its way inside.

Once their helmets and gloves were off, the astronauts could feel, smell and even taste the moon. The experience gave Apollo 17 astronaut Jack Schmitt history's first recorded case of extraterrestrial hay fever. “It's come on pretty fast,” he radioed Houston with a congested voice. Years later he recalls, “When I took my helmet off after the first EVA, I had a significant reaction to the dust. My turbinates (cartilage plates in the walls of the nasal chambers) became swollen.” Hours later, the sensation faded. “It was there again after the second and third EVAs, but at much lower levels. I think I was developing some immunity to it.”

Other astronauts didn't get the hay fever. Or, at least, “they didn't admit it,” laughs Schmitt. “Pilots think if they confess their symptoms, they'll be grounded.” Unlike the other astronauts, Schmitt didn't have a test pilot background. He was a geologist and readily admitted to sniffles. Schmitt says he has sensitive turbinates: “The petrochemicals in Houston used to drive me crazy, and I have to watch out for cigarette smoke.” That's why, he believes, other astronauts reacted much less than he did.

But they did react: “It is really a strong smell,” radioed Apollo 16 pilot Charlie Duke. “It has that taste -- to me, [of] gunpowder -- and the smell of gunpowder, too.” On the next mission, Apollo 17, Gene Cernan remarked, “smells like someone just fired a carbine in here.” Schmitt says, “All of the Apollo astronauts were used to handling guns.” So when they said 'moondust smells like burnt gunpowder,' they knew what they were talking about.

To be clear, moondust and gunpowder are not the same thing. Modern smokeless gunpowder is a mixture of nitrocellulose ($C_6H_8(NO_2)_2O_5$) and nitroglycerin ($C_3H_5N_3O_9$). These are flammable organic molecules “not found in lunar soil,” says Gary Lofgren of the Lunar Sample Laboratory at NASA's Johnson Space Center. Hold a match to moondust--nothing happens, at least, nothing explosive.

What is moondust made of? Almost half is silicon dioxide glass created by meteoroids hitting the moon. These impacts, which have been going on for billions of years, fuse topsoil into glass and shatter the same into tiny pieces. Moondust is also rich in iron, calcium and magnesium bound up in minerals such as olivine and pyroxene. It's nothing like gunpowder.

So why the smell? No one knows. ISS astronaut Don Pettit, who has never been to the moon but has an interest in space smells, offers one possibility: “Picture yourself in a desert on Earth,” he says. “What do you smell? Nothing, until it rains. The air is suddenly filled with sweet, peaty odors.” Water evaporating from the ground carries molecules to your nose that have been trapped in dry soil for months.

Maybe something similar happens on the moon. “The moon is like a 4-billion-year-old desert,” he says. “It's incredibly dry. When moondust comes in contact with moist air in a lunar module, you get the 'desert rain' effect--and some lovely odors.” (For the record, he counts gunpowder as a lovely odor.)

Gary Lofgren has a related idea: “The gases 'evaporating' from the moondust might come from the solar wind.” Unlike Earth, he explains, the moon is exposed to the hot wind of hydrogen, helium and other ions blowing away from the sun. These ions hit the moon's surface and get caught in the dust.

It's a fragile situation. “The ions are easily dislodged by footsteps or dustbrushes, and they would be evaporated by contact with warm air inside the lunar module. Solar wind ions mingling with the cabin's atmosphere would produce who-knows-what odors.”

Want to smell the solar wind? Go to the moon.
Schmitt offers yet another idea: The smell, and his reaction to it, could be a sign that moondust is chemically active. “Consider how moondust is formed,” he says. “Meteoroids hit the moon, reducing rocks to jagged dust. It's a process of hammering and smashing.” Broken molecules in the dust have “dangling bonds”--unsatisfied electrical connections that need atomic partners.
Inhale some moondust and what happens? The dangling bonds seek partners in the membranes of your nose. You get congested. You report strange odors. Later, when the all the bonds are partnered-up, these sensations fade.
Another possibility is that moondust “burns” in the lunar lander's oxygen atmosphere. “Oxygen is very reactive,” notes Lofgren, “and would readily combine with the dangling chemical bonds of the moondust.” The process, called oxidation, is akin to burning. Although it happens too slowly for smoke or flames, the oxidation of moondust might produce an aroma like burnt gunpowder.
(Note: Burnt and unburnt gunpowder do not smell the same. Apollo astronauts were specific. Moondust smells like burnt gunpowder.) Curiously, back on Earth, moondust has no smell. There are hundreds of pounds of moondust at the Lunar Sample Lab in Houston. There, Lofgren has held dusty moon rocks with his own hands. He's sniffed the rocks, sniffed the air, sniffed his hands. “It does not smell like gunpowder,” he says.
Were the Apollo crews imagining things? No. Lofgren and others have a better explanation: Moondust on Earth has been “pacified.” All of the samples brought back by Apollo astronauts have been in contact with moist, oxygen-rich air. Any smelly chemical reactions (or evaporations) ended long ago.This wasn't supposed to happen. Astronauts took special “thermos” containers to the moon to hold the samples in vacuum. But the jagged edges of the dust unexpectedly cut the seals of the containers, allowing oxygen and water vapor to sneak in during the 3-day trip back to Earth. No one can say how much the dust was altered by that exposure.
Schmitt believes “we need to study the dust in situ--on the moon.” Only there can we fully discover its properties: Why does it smell? How does it react with landers, rovers and habitats? What surprises await?
NASA plans to send people back to the moon in 2018, and they'll stay much longer than Apollo astronauts did. The next generation will have more time and better tools to tackle the mystery.
We've only just begun to smell the moondust.

Two Stars Kicked Out of the Milky Way

TV reality show contestants aren't the only ones under threat of exile. Astronomers using the MMT Observatory in Arizona have discovered two stars exiled from the Milky Way galaxy. Those stars are racing out of the Galaxy at speeds of more than 1 million miles per hour - so fast that they will never return.
“These stars literally are castaways,” said Smithsonian astronomer Warren Brown (Harvard-Smithsonian Center for Astrophysics). “They have been thrown out of their home galaxy and set adrift in an ocean of intergalactic space.”
Brown and his colleagues spotted the first stellar exile in 2005. European groups identified two more, one of which may have originated in a neighboring galaxy known as the Large Magellanic Cloud. The latest discovery brings the total number of known exiles to five.
“These stars form a new class of astronomical objects - exiled stars leaving the Galaxy,“ said Brown.
Astronomers suspect that about 1,000 exile stars exist within the Galaxy. By comparison, the Milky Way contains about 100,000,000,000 (100 billion) stars, making the search for exiles much more difficult than finding the proverbial ”needle in a haystack.“ The Smithsonian team improved their odds by preselecting stars with locations and characteristics typical of known exiles. They sifted through dozens of candidates spread over an area of sky almost 8000 times larger than the full moon to spot their quarry.
”Discovering these two new exiled stars was neither lucky nor random,“ said astronomer Margaret Geller (Smithsonian Astrophysical Observatory), a co-author on the paper. ”We made a targeted search for them. By understanding their origin, we knew where to find them.“
Theory predicts that the exiled stars were thrown from the galactic center millions of years ago. Each star once was part of a binary star system. When a binary swings too close to the black hole at the galaxy's center, the intense gravity can yank the binary apart, capturing one star while violently flinging the other outward at tremendous speed (hence their technical designation of hypervelocity stars).
The two recently discovered exiles both are short-lived stars about four times more massive than the sun. Many similar stars exist within the galactic center, supporting the theory of how exiles are created. Moreover, detailed studies of the Milky Way's center previously found stars orbiting the black hole on very elongated, elliptical orbits - the sort of orbits that would be expected for former companions of hypervelocity stars.
”Computer models show that hypervelocity stars are naturally made near the galactic center,“ said theorist Avi Loeb of the Harvard-Smithsonian Center for Astrophysics. ”We know that binaries exist. We know the galactic center holds a supermassive black hole. So, exiled stars inevitably will be produced when binaries pass too close to the black hole.“
Astronomers estimate that a star is thrown from the galactic center every 100,000 years on average. Chances of seeing one at the moment of ejection are slim. Therefore, the hunt must continue to find more examples of stellar exiles in order to understand the extreme environment of the galactic center and how those extremes lead to the formation of hypervelocity stars.
The characteristics of exiled stars give clues to their origin. For example, if a large cluster of stars spiraled into the Milky Way's central black hole, many stars might be thrown out at nearly the same time. Every known hypervelocity star left the galactic center at a different time, therefore there is no evidence for a ”burst“ of exiles.
Hypervelocity stars also offer a unique probe of galactic structure. ”During their lifetime, these stars travel across most of the Galaxy,“ said Geller. ”If we could measure their motions across the sky, we could learn about the shape of the Milky Way and about the way the mysterious dark matter is distributed.“
The first newfound exile, in the direction of the constellation Ursa Major, is designated SDSS J091301.0+305120. It is traveling out of the galaxy at a speed of about 1.25 million miles per hour and currently is located at a distance of about 240,000 light-years from the earth. The second exile, in the direction of the constellation Cancer, is designated SDSS J091759.5+672238. It is moving outward at 1.43 million miles per hour and currently is located about 180,000 light-years from the earth.
Both stars, although traveling at tremendous speeds through space, are located so far from the earth that their motion cannot be detected except with sophisticated astronomical instruments.

Interestingly, when choosing a particular plane through M31, we find 15 out of 16 dwarfs between us and Andromeda. Chance, or design? Are they in the process of changing party affiliation? Or can we rephrase Einstein: The universe does play politics! Moreover, somehow the variety around M31 is not representative of our low mass dwarfs. What makes our spiral different? Does local environment play a role? And can we model it to fit the results we observe?

Cosmology and galactic dynamics are fields of study that try to establish basic rules and structures for the beginning that will result in and somewhat fit the present day look of our universe. If we understand the spatial distribution of the Galactic satellite system and are able to model it successfully we have a key to unlocking the mystery of galaxy halo formation and a glimpse at the dynamical aspects of the early universe.

The Isaac Newton Wide Field survey, able to probe fainter surface brightness, shows Andromeda's dwarfs to be generally larger than previously recognized. The size of the M31 dwarfs exceeds that of the Galactic population by at least a factor of 2. However, distance and brightness from the host correlates the same in both populations, i.e. the farther the dwarf spheroidals are from the host the higher their central surface brightness. **And I**, for example, shows tidal disruption with clearly visible S-shaped tidal tails. **Cetus**, on the other hand due to its isolated location, shows no evidence of tidal truncation. While the surface brightness profile tends to reveal the tell tale signs of tidal effects the expected signature of other candidates might be found at a lower threshold (i.e. more funding, bigger scopes). **And II**, 185 kpc from M31, has a King tidal radius of 4.2 kpc. A circular orbit would account for its appearance since M31's tidal field should be small at that distance. Now a few results from our spheroidals.

Tucana, 870 kpc from our galaxy, had only a single star formation burst during the epoch of the Galactic globular cluster star formation. Its location at the border of the local group would suggest young populations (Van den Bergh). However, maybe galactic winds expelled the interstellar medium at early epochs.

Phoenix, 820 kpc, experienced an early star formation episode on a larger scale than the subsequent burst. Blue stars from the most recent burst, .6 Gyrs ago, are concentrated in clumps near the galactic center.

The broadband photometry of **Fornax**, 730 kpc, yielded copious data from 40,000 stars allowing for more in depth study of various branches in the color magnitude diagram. For example, the red giant stars belong either to metal rich intermediate age stars (70%) or old metal poor stars (30%). This superposition explains the exceptional color width of that branch.

Leo I: The discovery of a definitely old population in the predominantly young dwarf spheroidal galaxy points to a sharply defined first epoch of star formation common to all of the Local Group dwarf spheroids as well as to the halo of the Milky Way.

Allowing for various size dark matter halos can of course help explain certain effects that beg for answers. Understandably, one can feel the desire of young theoretical physicists to discover the holy grail. Right now the grail seem to overflow with dark matter solutions. However, it's ongoing analysis of new data in the traditional Galileo fashion that will allow the cosmologists among astronomers to weave the different strands into an artful quilt that can be appreciated , and maybe even understood, by most of us. Particularly, if we give them time and if we step far enough away from it.

In the meantime, we will continue to enjoy the celestial objects we are able to pull down with our humble equipment for what they are and leave the Monte Carlo simulations of royal tidal radii to Alan and his colleagues at UVic. Keep up the good work!

** Comets **
of Clouds, Gaps, and Belts

The general view on the creation of what we see around us usually applies the dust bunny theorem. It goes like this: dust is everywhere. In the presence of humans, dogs, cats, and mites an abundance of skin bits, hair, and saliva traces form a homogenous and isotropic environment on cupboards, picture frames, and under beds. Disturbances from open doors, dashing cats, or attempts to broom create vortexes that lead to accumulation of these particles in loose, but stable fluff balls the dreaded dust bunnies!
How does this apply to comets? First of all, we usually connect comets with their appearance in the sky. We remember Machholz and the faithful Halley. But, showing of a coma and tail is not a prerequisite anymore. Over the years, an incredible amount of observations have been made, within our solar system and as far beyond Pluto as our telescopes can reach, to find those dull, dark hunks of matter that did not make it to planet status. In descending order, planetoids, asteroids, comets, meteroids, chunkoids, grains, and dust are the elements that orbit our Sun together with the big guys and their moons. Since scientist excel at classifying, there is no surprise in discovering a plethora of groups and subgroups with names that rival the flavours of quarks. However, if you're familiar with the Greek background of the constellation stories, you'll have no trouble applying the themes of Helen of Troy to this battle field. Trojans, Phocaeas, Hildas, Marias, and Hungarias are recognized families of the zoo between Mars and Jupiter. Centaurs, Cubewanos, Twoones, and Twotinos are of the exotic variety that humor the guys and gals that stay up way past their bed time to hunt down these remnants.
If we all agree that flossing does not create the gap in your front teeth, but just helps to keep it clean, we're well on our way in understanding the gaps in planetary ring systems as well as the large scale gaps within the solar system. Bode's Rule was the first attempt to predict (with hindsight) the orbital distances among the planets. He had used a formula that required successive integers to calculate the mean radius of a planet. The 'gap' between 4 and 6 (Mars and Jupiter) was neatly filled by the Asteroid Belt, assuming 5 as their collective number. 8 was later correctly associated with Neptune and for Pluto this system failed to make him legitimate. Of course, Kepler's Laws, proofed by Newton, fix the orbit periods and radii of any planet by relating the square of the period to the cube of the radius. This is one of the tools required to pinpoint the distance of these objects.
Now let's move on to Kirkwood's Gaps. Certain areas of the asteroid belt seem to be largely void of matter. Imagine a child on a swing. If pumping has not been acquired, the child will need a push every so often. And that's the idea. For example, if an asteroid after every two orbits appears to be in the same alignment with Jupiter (after one) the gravitational pull will have a similar effect as the push on the child, i.e. adding momentum to the asteroid. The speeding up will then result in a new distance not in sink with the 2/1 ratio from before. And that clears up a swath of space with hardly noticeable effort on behalf of the big guy Jupiter. Fortunately, in the parent child case, we are required to keep pushing against friction. Moreover, the swing is constrained by the length of the rope or chain. Yes, it's good to stay with your little ones for safety, but most of all for sharing a great time together.
Now to the cloud and another belt. While dust was everywhere in the beginning*, the tireless orbiting of the planets has managed to sweep our system clean enough for us to see the stars and distant galaxies. The obvious remainder of our genesis lies in the asteroid belt. And like Saturn's ring system it became the Sun's very own. However, comet data, collected over the centuries, pointed Dutch scientists towards other sources of origin. Oort's hypothesis of a cloud of asteroid like objects arose from the facts that some comets had highly eccentric orbits as well as that they were not limited to the plane of the solar system. Kuiper followed by suggesting another belt that would account for the supply of comets of lesser eccentricity and from within our plane. While the cloud is still beyond our reach of direct observation, Kuiper Belt objects are being identified on a 'daily' basis.
That leaves us with the graveyard inside the orbit of the gas giants. Here, burnt out comets live out their days criss-crossing the 'empty' space, disintegrating into the stuff that supplies our meteor showers, and giving rise to fears of deep impact movies. Therefore, like the HR diagram, that gives stars a place according to their age, size, and development, comets will go through their life cycle by spending time in the various clouds and belts just like those dust bunnies in your home. And remember, they like the comets are highly flammable and best handled with a vacuum. So, get on with the spring cleaning and leave the fireworks to the Perseids come August.

* The other principle in effect, but not mentioned here, is of course the soap bubble principle. The bigger ones will grow at the expense of smaller ones.

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