April Meeting: Monday May 12th at 8:00pm
Topic to be advised by email. Keep an eye on the website too.

The El Gordo Massive Galaxy Cluster

Explanation: Galaxy cluster ACT-CL J0102-4915 is one of the largest and most massive objects known. Dubbed “El Gordo”, the seven billion light years (z = 0.87) distant galaxy cluster spans about seven million light years and holds the mass of a million billion Suns. The above image of El Gordo is a composite of a visible light image from the Hubble Space Telescope, an X-ray image from the Chandra Observatory showing the hot gas in pink, and a computer generated map showing the most probable distribution of dark matter in blue, computed from gravitational lens distortions of background galaxies. Almost all of the bright spots are galaxies. The blue dark matter distribution indicates that the cluster is in the middle stages of a collision between two large galaxy clusters. A careful inspection of the image will reveal a nearly vertical galaxy that appears unusually long. That galaxy is actually far in the background and has its image stretched by the gravitational lens action of the massive cluster.

Image Credit: NASA, ESA, J. Jee (UC Davis) et al.
Calendar of Events for 2014

May 2014 Programme

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fri</td>
<td>2</td>
<td>7:30pm Young astronomers with Margaret Arthur</td>
</tr>
<tr>
<td>Mon</td>
<td>5</td>
<td>7:00pm Astrophotography Group With Keith Smith</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8:00pm Practical astronomy with Bill Thomas</td>
</tr>
<tr>
<td>Mon</td>
<td>12</td>
<td>8:00pm Society Meeting TBA</td>
</tr>
<tr>
<td>Mon</td>
<td>19</td>
<td>8:00pm Introduction to Astronomy with Bernie Brenner and Peter Felhofer</td>
</tr>
<tr>
<td>Wed</td>
<td>21</td>
<td>7:30pm Council Meeting</td>
</tr>
<tr>
<td>Mon</td>
<td>26</td>
<td>8:00pm Film Night with Gavin Logan. The Seven ages of Starlight</td>
</tr>
</tbody>
</table>

June 2014 Programme

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
<td>2</td>
<td>7:00pm Astrophotography Group with Keith Smith</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8:00pm Practical Astronomy With Bill Thomas</td>
</tr>
<tr>
<td>Fri</td>
<td>6</td>
<td>7:30pm Young astronomers with Margaret Arthur</td>
</tr>
<tr>
<td>Mon</td>
<td>9</td>
<td>8:00pm Society Meeting TBA</td>
</tr>
<tr>
<td>Mon</td>
<td>16</td>
<td>8:00pm Introduction to Astronomy with Bernie Brenner and Peter Felhofer</td>
</tr>
<tr>
<td>Wed</td>
<td>18</td>
<td>7:30pm Council Meeting</td>
</tr>
<tr>
<td>Mon</td>
<td>28</td>
<td>8:00pm Film night with Gavin Logan.</td>
</tr>
</tbody>
</table>

Practical Astronomy Monday May 5 at 8:00pm

Names and catalogues systems for astronomical objects

The Astrophotography group will discuss stacking and processing images with Maxim DL and into GIMP or Photoshop.

Film Night Monday May 26 at 8:00pm

Seven Ages of Starlight

A documentary showing how stars are created, age and eventually die. It covers the different types of stars and discusses what makes them different in terms of lifespan, chemical composition, size, density and luminance. Film is 1 hour and 28 minutes long and will be the only film shown on the night.

Member Notices

The library has copies of the journals from other societies and groups around the country and even Australia. You can borrow these by visiting the library or contacting the librarian, Tony Reynolds.

Andrew has organised a group discount to members for the Australian Sky and Telescope. To take advantage of this offer and confirm the price, contact Andrew Buckingham on 473-5877 or by email at treasurer@astronomy.org.nz.

New members Welcome

Christopher Christian (ordinary)
Karen Chance (ordinary)
Kosala Krishnan (ordinary)
Brett Clark (family)
Ruben Parish (ordinary)
Patrick Sharp (ordinary)
Rick van de Vusse (ordinary)
10 Things you didn't know about Earthquakes

Film Night Report By Gavin Logan

The April Film Night coincided with the Easter weekend but it was still well attended. The audience enjoyed an unusual and interesting film about earthquakes that covered some of the world’s most well-known earthquakes and how they have affected history, including how much of the ancient world has been lost as a result of them. Notable were the city of Helike in Greece, the Temple of Apollo in Corinth and light house at Alexandria in Egypt.

Plate tectonics was discussed next and how the action of these was studied after the devastating San Francisco earthquake. It was after this earthquake that scientists make the link between fault lines and earthquakes. The film also showed how seismologists created a map of the world’s major fault lines as a result of trying to study Soviet nuclear testing during the cold war period.

Among other unusual things covered in this film were earthquakes on the Moon, which apparently are of quite long duration when they happen. The world’s safest building and one of the first accurate predictions of where an earthquake would happen were also shown. Seismologists studying the movement of stress down the North Anatolian Fault in Turkey were able to predict the earthquake that hit the town of İzmit with devastating effect in August 1999. Because they were not able to predict when it would happen they were not taken as seriously as they should have been and over 17,000 people died. They predict that the next earthquake along the North Anatolian Fault will occur near the heavily populated historic city of Istanbul.

The final topic of the film was the mega-thrust type of earthquake that happen in what is known as subduction zones. The one discussed in the film was the Cascadia Subduction Zone offshore on the West Coast of North America near the major cities of Seattle and Vancouver. The last earthquake that occurred by this cause was in the year 1700. Evidence suggests a return interval of 300 to 600 years. Great Subduction Zone earthquakes are the largest known earthquakes and are the only type that can produce long duration earthquakes greater than magnitude 8.5.

This film was followed by the April 2014 sky at night show on the ”sounds of The Universe“. The show also covered the use of smart phones for astrophotography.

Next month’s film night is Monday on May 26th at Stardome at 8 p.m. and will feature film called “Seven Ages of Starlight”. This is a documentary showing how stars are created, age and eventually die. It covers the different types of stars and discusses what makes them different in terms of lifespan, chemical composition, size, density and luminance. Film is 1 hour and 28 minutes long and will be the only film shown on the night.
Library Corner

With Tony Reynolds

The following titles have been recently added to the library.

Albert Einstein & Relativity for Kids. His Life & Ideas with 21 Activities & Thought Experiments
Jerome Pohlen
Best known for his general theory of relativity and the famous equation linking mass and energy, \( E = mc^2 \), Albert Einstein had a lasting impact on the world of science, the extent of which is illuminated—along with his fascinating life and unique personality—in this lively history.
A great book for all ages (I read it cover-to-cover) with some pretty cool experiments to try (like measuring the speed of light with your Mum’s microwave oven!)
Catalogue section: Youth

Step-By-Step Science Experiments in Astronomy
Janice Pratt VanCleave
Astronomy enthusiasts, science gurus, and all curious minds, are provided nearly two dozen experiments that will certainly garner multiple science-fair awards. You’ll see why light bends in a medium, how to determine the size of the Sun, and how gravity works, and so much more.
Catalogue section: Youth

Astronomy for Every Kid. 101 Experiments That Really Work
Janice Pratt VanCleave
Even more experiments! Go nuts exploring why the planets spin, how hot the Sun is, what keeps the Moon in orbit and 98 other choice things. Learn stuff and make a mess of your parents’ house all at the same time - what could be better?
Catalogue section: Youth

Isaac Newton and Physics for Kids. His Life and Ideas with 21 Activities
Kerrie Logan Hollihan
He might have been a completely weird guy with absolutely no mates whatsoever, but he was also pretty clever and thoroughly original. This is another great biography which will make you just that much smarter by the end.
Catalogue section: Youth

Featured Section – Youth

Of course its the youth section this month - just take a look at those great new books. This section shouldn’t really be called ‘Youth’ because it’s too good to miss just because you’re old. It’s easily our most popular section and not just with kids. Bottom -left on the shelves.

Post-script
I’m stepping aside this year as librarian so this is my last Library Corner article. I’d like to thank you all for giving me the opportunity to run such a fantastic resource as the AAS library.

Regards
Tony Reynolds
Astronomical Society in a very strong position.

*AGM Report By Gavin Logan*

A large attendance of society members at the 2014 AGM received comprehensive updates on how the society is performing. Outgoing president Grant Christie reported progress in almost every aspect of the society’s activities with good attendances at all society meetings. The society has something on almost every week as well as successful star parties at dark skies sites and successful participation in research programs. Treasurer Andrew Buckingham reported that the society now had 569 members and had improved financial position by 50% in the last five years.

Trust board chairman Ross Sharp reported that 125,000 people had visited Stardome last year.

Astronomy New Zealand Limited chairman Dave Wyers reported strong progress and spoke about the new range of products Astronz was offering including Go To telescope mounts most of which were sold prior to delivery. Telescope sales this year were double that of last year.

A new council was elected with a new president. Bill Thomas replaced Grant Christie who stepped down after five in the role. The meeting passed a vote of thanks to Grant Christie for his very successful work over the last five years.

The new council is: President: Bill Thomas, Vice president: Grant Christie, Secretary: Gavin Logan, Treasurer: Andrew Buckingham, Librarian: Jerina Grewar, Editor: Clive Bolt, Curator: Graham Beazley, Councillors: Bernie Bremner, David Britton, Oana Jones, Steve Hennnerley and Jonathan Green.

The Third Variable Star Symposium

Whakatane 9 June, 2014

The Third Variable Star Symposium, sponsored by Variable Stars South (VSS) is being held at Whakatane on 9 June, 2014, in conjunction with the Royal Astronomical Society of New Zealand’s Annual Conference which begins on Friday 6 June. An informal session will be held on Sunday evening beginning about 7.30pm. Fuller details are available on the RASNZ Website.

There will be a wide variety of topics discussed but one of the more interesting will be a Workshop on the use of DSLR cameras in Astronomy. The use of these has been pioneered by Variable Stars South and Mark Blackford of Sydney, who has done considerable work in this field, will chair the discussion. It’s an inexpensive and simple method of engaging in astronomical research, even from a city site.

Apart from this there will be papers and workshops about a variety of eclipsing binary systems, spectroscopy by amateurs - including a considerable amount of research on Nova Centauri. 2013, which first appeared in December 2013 at third magnitude and has behaved in an unusual manner over the six months to now. I’m chairing a discussion of this unusual object.

Stephen Hovell, an ex-Auckland member now up here in Kaitaia, will discuss visual observing - no fancy detectors, just the human eye - with particular emphasis upon cataclysmic variables (CVs) and there will be other items about Mira and Cepheid stars. Aline Homes from Wellington is interested in brighter semi-regular stars, another visual or DSLR set of targets. Betelgeuse and Antares are probably the most famous and well-studied of these objects.

Tom Richards from Melbourne, Director of VSS, and another ex-Auckland member, will present a variety of short items about CCD observing. We’re still receiving papers, both oral and poster, and will do up to the end of May. I’m presently deputising for Tom, who’s in Europe until the end of May, and can be contacted at mailto:astroman@paradise.net.nz. We’d like to see you there.

*Stan Walker*
A n unusual structure with a hexagonal shape surrounding Saturn’s north pole was spotted on the planet for the first time thirty years ago. Nothing similar with such a regular geometry had ever been seen on any planet in the Solar System. The Planetary Sciences Group has now been able to study and measure the phenomenon and, among other achievements, establish its rotation period. What is more, this period could be the same as that of the planet itself. Saturn is the only planet in the Solar System whose rotation time remains unknown.

In 1980 and 1981 NASA’s Voyager 1 and 2 space probes passed for the first time over the planet Saturn, located 1,500 million km from the Sun. Among their numerous discoveries they observed a strange, hexagon-shaped structure in the planet’s uppermost clouds surrounding its north pole. The hexagon remained virtually static, without moving, vis-à-vis the planet’s overall rotation that was not accurately known. What is more, the images captured by the Voyager probes found that the clouds were moving rapidly inside the hexagon in an enclosed jet stream and were being dragged by winds travelling at over 400 km/h.

Thirty years later -- the equivalent of one Saturn year, in other words, the time the planet takes to go all the way around the Sun -- and over more than six consecutive years, researchers in the UPV/EHU’s Planetary Sciences Group, in collaboration with astronomers from various countries, were able to observe Saturn’s northern polar region in detail once again and confirmed that the hexagon continued in place. After measuring the positions of the hexagon vertices with great precision, they determined that its movement remains extremely stable, and on the basis of the cloud movements, that the jet stream inside it remains unchanged. For this study the researchers used images taken from Earth between 2008 and 2014; they used, among others, the astronomical cameras PlanetCam (developed by the Planetary Sciences Group itself) and Astralux, fitted to the telescopes of the Calar Alto Observatory in Almería (Spain); in addition, they used the very high resolution images obtained by the Cassini spacecraft, which has been orbiting Saturn since 2004.

Due to the tilt of approximately 27º of the planet Saturn, its polar atmosphere undergoes intense seasonable variations with long polar nights lasting over seven years, followed by a long period of 23 years of variable illumination. However, the seasonal variations do not affect the hexagon and its jet stream at all, so both are part of an extensive wave, deeply rooted in Saturn’s atmosphere. The UPV/EHU researchers suggest that the hexagon and its stream are the manifestation of a “Rossby wave” similar to those that form in the mid-latitudes of Earth. On our planet the jet stream meanders from west to east and brings, associated with it, the system of areas of low pressure and anticyclones which we have been seeing regularly on weather maps.

On Saturn, a hydrogen gas planet, ten times the size of Earth, cold in its upper clouds, without a solid surface, and with an atmosphere as deep as that of an ocean, “the hexagonal wavy motion of the jet stream is expected to be propagated vertically and reveal to us aspects of the planet’s hidden atmosphere,” pointed out Agustín Sánchez-Lavega, Head of the Planetary Sciences research group. “The movement of the hexagon could therefore be linked to the depths of Saturn, and the rotation period of this structure, which, as we have been able to ascertain, is 10 hours, 39 minutes and 23 seconds, could be that of the planet itself,” he added. Saturn is the only planet in the Solar System whose rotation period is not yet known.
Star is discovered to be a close neighbour of the Sun and the coldest of its kind

From Science Daily

A "brown dwarf" star that appears to be the coldest of its kind -- as frosty as Earth's North Pole -- has been discovered by a Penn State University astronomer using NASA’s Wide-field Infrared Survey Explorer (WISE) and Spitzer Space Telescopes. Images from the space telescopes also pinpointed the object’s distance at 7.2 light-years away, making it the fourth closest system to our Sun.

"It is very exciting to discover a new neighbour of our solar system that is so close," said Kevin Luhman, an associate professor of astronomy and astrophysics at Penn State and a researcher in the Penn State Center for Exoplanets and Habitable Worlds. "In addition, its extreme temperature should tell us a lot about the atmospheres of planets, which often have similarly cold temperatures."

Brown dwarfs start their lives like stars, as collapsing balls of gas, but they lack the mass to burn nuclear fuel and radiate starlight. The newfound coldest brown dwarf, named WISE J085510.83-071442.5, has a chilly temperature between minus 54 and 9 degrees Fahrenheit (minus 48 to minus 13 degrees Celsius). Previous record holders for coldest brown dwarfs, also found by WISE and Spitzer, were about room temperature.

Although it is very close to our solar system, WISE J085510.83-071442.5 is not an appealing destination for human space travel in the distant future. "Any planets that might orbit it would be much too cold to support life as we know it" Luhman said.

"This object appeared to move really fast in the WISE data," said Luhman. "That told us it was something special." The closer a body, the more it appears to move in images taken months apart. Airplanes are a good example of this effect: a closer, low-flying plane will appear to fly overhead more rapidly than a high-flying one.

WISE was able to spot the rare object because it surveyed the entire sky twice in infrared light, observing some areas up to three times. Cool objects like brown dwarfs can be invisible when viewed by visible-light telescopes, but their thermal glow -- even if feeble -- stands out in infrared light.

After noticing the fast motion of WISE J085510.83-071442.5 in March, 2013, Luhman spent time analysing additional images taken with Spitzer and the Gemini South telescope on Cerro Pachon in Chile. Spitzer’s infrared observations helped to determine the frosty temperature of the brown dwarf.

WISE J085510.83-071442.5 is estimated to be 3 to 10 times the mass of Jupiter. With such a low mass, it could be a gas giant similar to Jupiter that was ejected from its star system. But scientists estimate it is probably a brown dwarf rather than a planet since brown dwarfs are known to be fairly common. If so, it is one of the least massive brown dwarfs known.

Combined detections from WISE and Spitzer, taken from different positions around the Sun, enabled the measurement of its distance through the parallax effect. This is the same principle that explains why your finger, when held out right in front of you, appears to jump from side to side when you alternate left-eye and right-eye views.

In March of 2013, Luhman’s analysis of the images from WISE uncovered a pair of much warmer brown dwarfs at a distance of 6.5 light years, making that system the third closest to the Sun. His search for rapidly moving bodies also demonstrated that the outer solar system probably does not contain a large, undiscovered planet, which has been referred to as "Planet X" or "Nemesis."

"It is remarkable that even after many decades of studying the sky, we still do not have a complete inventory of the Sun’s nearest neighbours," said Michael Werner, the project scientist for Spitzer at NASA’s Jet Propulsion Laboratory (JPL), which manages and operates Spitzer. "This exciting new result demonstrates the power of exploring The Universe using new tools, such as the infrared eyes of WISE and Spitzer."
First potentially habitable Earth-sized planet confirmed by Gemini and Keck observatories

From Science daily

The first Earth-sized exoplanet orbiting within the habitable zone of another star has been confirmed by observations with both the W. M. Keck Observatory and the Gemini Observatory. The initial discovery, made by NASA’s Kepler Space Telescope, is one of a handful of smaller planets found by Kepler and verified using large ground-based telescopes. It also confirms that Earth-sized planets do exist in the habitable zone of other stars.

“What makes this finding particularly compelling is that this Earth-sized planet, one of five orbiting this star, which is cooler than the Sun, resides in a temperate region where water could exist in liquid form,” says Elisa Quintana of the SETI Institute and NASA Ames Research Center who led the paper published in the current issue of the journal Science. The region in which this planet orbits its star is called the habitable zone, as it is thought that life would most likely form on planets with liquid water.

Steve Howell, Kepler’s Project Scientist and a co-author on the paper, adds that neither Kepler (nor any telescope) is currently able to directly spot an exoplanet of this size and proximity to its host star. "However, what we can do is eliminate essentially all other possibilities so that the validity of these planets is really the only viable option."

With such a small host star, the team employed a technique that eliminated the possibility that either a background star or a stellar companion could be mimicking what Kepler detected. To do this, the team obtained extremely high spatial resolution observations from the eight-meter Gemini North telescope on Mauna Kea in Hawaii using a technique called speckle imaging, as well as adaptive optics (AO) observations from the ten-meter Keck II telescope, Gemini’s neighbour on Mauna Kea. Together, these data allowed the team to rule out sources close enough to the star’s line-of-sight to confound the Kepler evidence, and conclude that Kepler’s detected signal has to be from a small planet transiting its host star.

*The Keck and Gemini data are two key pieces of this puzzle," says Quintana. *Without these complementary observations we wouldn’t have been able to confirm this Earth-sized planet.*

The Gemini “speckle” data directly imaged the system to within about 400 million miles (about 4 AU, approximately equal to the orbit of Jupiter in our solar system) of the host star and confirmed that there were no other stellar size objects orbiting within this radius from the star. Augmenting this, the Keck AO observations probed a larger region around the star but to fainter limits. According to Quintana,

*These Earth-sized planets are extremely hard to detect and confirm, and now that we’ve found one, we want to search for more. Gemini and Keck will no doubt play a large role in these endeavours.*

The host star, Kepler-186, is an M1-type dwarf star relatively close to our solar system, at about 500 light years and is in the constellation Cygnus. The star is very dim, being over half a million times fainter than the faintest stars we can see with the naked eye. Five small planets have been found orbiting this star, four of which are in very short-period orbits and are very hot. The planet designated Kepler-186f, however, is earth-sized and orbits within the star’s habitable zone. The Kepler evidence for this planetary system comes from the detection of planetary transits. These transits can be thought of as tiny eclipses of the host star by a planet (or planets) as seen from Earth. When such planets block part of the star’s light, its total brightness...
diminishes. Kepler detects that as a variation in the star’s total light output and evidence for planets. So far more than 3,800 possible planets have been detected by this technique with Kepler.

The Gemini data utilized the Differential Speckle Survey Instrument (DSSI) on the Gemini North telescope. DSSI is a visiting instrument developed by a team led by Howell who adds, "DSSI on Gemini Rocks! With this combination, we can probe down into this star system to a distance of about 4 times that between Earth and the Sun. It’s simply remarkable that we can look inside other solar systems." DSSI works on a principle that utilizes multiple short exposures of an object to capture and remove the noise introduced by atmospheric turbulence producing images with extreme detail.

Observations with the W.M. Keck Observatory used the Natural Guide Star Adaptive Optics system with the NIRC2 camera on the Keck II telescope. NIRC2 (the Near-Infrared Camera, second generation) works in combination with the Keck II adaptive optics system to obtain very sharp images at near-infrared wavelengths, achieving spatial resolutions comparable to or better than those achieved by the Hubble Space Telescope at optical wavelengths. NIRC2 is probably best known for helping to provide definitive proof of a central massive black hole at the centre of our galaxy. Astronomers also use NIRC2 to map surface features of solar system bodies, detect planets orbiting other stars, and study detailed morphology of distant galaxies.

"The observations from Keck and Gemini, combined with other data and numerical calculations, allowed us to be 99.98% confident that Kepler-186f is real," says Thomas Barclay, a Kepler scientist and also a co-author on the paper. "Kepler started this story, and Gemini and Keck helped close it," adds Barclay.

---

Mars: Meteorites yield clues to Red Planet's early atmosphere

From Science Daily

Geologists who analysed 40 meteorites that fell to Earth from Mars unlocked secrets of the Martian atmosphere hidden in the chemical signatures of these ancient rocks. Their study, published April 17 in the journal Nature, shows that the atmospheres of Mars and Earth diverged in important ways very early in the 4.6 billion year evolution of our solar system.

The results will help guide researchers' next steps in understanding whether life exists, or has ever existed, on Mars and how water -- now absent from the Martian surface -- flowed there in the past.

Heather Franz, a former University of Maryland research associate who now works on the Curiosity rover science team at the NASA Goddard Space Flight Center, led the study with James Farquhar, co-author and UMD geology professor. The researchers measured the sulphur composition of 40 Mars meteorites -- a much larger number than in previous analyses. Of more than 60,000 meteorites found on Earth, only 69 are believed to be pieces of rocks blasted off the Martian surface.

The meteorites are igneous rocks that formed on Mars, were ejected into space when an asteroid or comet slammed into the red planet, and landed on Earth. The oldest meteorite in the study is about 4.1 billion years old, formed when our solar system was in its infancy. The youngest are between 200 million and 500 million years old.

Studying Martian meteorites of different ages can help scientists investigate the chemical composition of the Martian atmosphere throughout history, and learn whether the planet has ever been hospitable to life. Mars and Earth share the basic elements for life, but conditions on Mars are much less favourable, marked by an arid surface, cold temperatures, radioactive cosmic rays, and ultraviolet radiation from the Sun. Still, some Martian geological features were evidently formed by water -- a sign of milder conditions in the past. Scientists are not sure what conditions made it possible for liquid water to exist on the surface, but greenhouse gases released by volcanoes likely played a role.

Sulphur, which is plentiful on Mars, may have been among the greenhouse gases that warmed the surface, and could have provided a food source for microbes. Because meteorites are a rich source of information about Martian sulphur, the
researchers analysed sulphur atoms that were incorporated into the rocks.

In the Martian meteorites, some sulphur came from molten rock, or magma, which came to the surface during volcanic eruptions. Volcanoes also vented sulphur dioxide into the atmosphere, where it interacted with light, reacted with other molecules, and settled on the surface.

Sulphur has four naturally occurring stable isotopes, or different forms of the element, each with its own atomic signature. Sulphur is also chemically versatile, interacting with many other elements, and each type of interaction distributes sulphur isotopes in a different way. Researchers measuring the ratios of sulphur isotopes in a rock sample can learn whether the sulphur was magma from deep below the surface, atmospheric sulphur dioxide or a related compound, or a product of biological activity.

Using state-of-the-art techniques to track the sulphur isotopes in samples from the Martian meteorites, the researchers were able to identify some sulphur as a product of photochemical processes in the Martian atmosphere. The sulphur was deposited on the surface and later incorporated into erupting magma that formed igneous rocks. The isotopic fingerprints found in the meteorite samples are different than those that would have been produced by sulphur-based life forms. The researchers found the chemical reactions involving sulphur in the Martian atmosphere were different than those that took place early in Earth’s geological history. This suggests the two planets’ early atmospheres were very different, Franz said.

The exact nature of the differences is unclear, but other evidence suggests that soon after our solar system formed, much of Mars’ atmosphere was lost, leaving it thinner than Earth’s, with lower concentrations of carbon dioxide and other gases. That is one reason why Mars is too cold for liquid water today -- but that may not always have been the case, said Franz.

“Climate models show that a moderate abundance of sulphur dioxide in the atmosphere after volcanic episodes, which have occurred throughout Mars’ history, could have produced a warming effect which may have allowed liquid water to exist at the surface for extended periods,” Franz said. “Our measurements of sulphur in Martian meteorites narrow the range of possible atmospheric compositions, since the pattern of isotopes that we observe points to a distinctive type of photochemical activity on Mars, different from that on early Earth.”

Periods of higher levels of sulphur dioxide may help explain the red planet’s dry lakebeds, river channels and other evidence of a watery past. Warm conditions may even have persisted long enough for microbial life to develop.

The team’s work has yielded the most comprehensive record of the distribution of sulphur isotopes on Mars. In effect, they have compiled a database of atomic fingerprints that provide a standard of comparison for sulphur-containing samples collected by NASA’s Curiosity rover and future Mars missions. This information will make it much easier for researchers to zero

---

**Searching for dark energy with neutrons: With neutrons, scientists can now look for dark energy in the lab**

*From Science Daily*

It does not always take a huge accelerator to do particle physics: First results from a low energy, table top alternative takes validity of Newtonian gravity down by five orders of magnitude and narrows the potential properties of the forces and particles that may exist beyond it by more than one hundred thousand times. Gravity resonance spectroscopy, a method developed at the Vienna University of Technology, is so sensitive that it can now be used to search for Dark Matter and Dark Energy.

All the particles we know to exist make up only about five percent of the mass and energy of The Universe. The rest -- "Dark Matter" and "Dark Energy" -- remains mysterious. A European collaboration led by researchers from the Vienna University of Technology has now carried out extremely sensitive measurements of gravitational effects at very small distances at the Institut Laue-Langevin (ILL) in Grenoble. These experiments provide limits for possible new particles or fundamental forces, which are a hundred thousand times more restrictive than previous estimations.

Neutrons between parallel plates can test hypothetical forces in The Universe.  Credit: TU Vienna
Undiscovered Particles?

Dark matter is invisible, but it acts on matter by its gravitational pull, influencing the rotation of galaxies. Dark energy, on the other hand, is responsible for the accelerated expansion of the Universe. It can be described by introducing a new physical quantity -- Albert Einstein's Cosmological Constant.

Alternatively, so-called quintessence theories have been put forward: "Perhaps empty space is not completely empty after all, but permeated by an unknown field, similar to the Higgs-field," says Professor Hartmut Abele (TU Vienna), director of the Atominstitut and group leader of the research group. These theories are named after Aristotle's "quintessence" -- a hypothetical fifth element, in addition to the four classical elements of ancient Greek philosophy.

If new kinds of particles or additional forces of nature exist, it should be possible to observe them here on earth. Tobias Jenke and Hartmut Abele from the Vienna University of Technology developed an extremely sensitive instrument, which they used together with their colleagues to study gravitational forces. Neutrons are perfectly suited for this kind of research. They do not carry electric charge and they are hardly polarisable. They are only influenced by gravity -- and possibly by additional, yet unknown forces. Theoretical calculations analysing the behaviour of the neutrons were done by Larisa Chizhova, Professor Stefan Rotter and Professor Joachim Burgdörfer (TU Vienna). U. Schmidt from Heidelberg University and T. Lauer from TU Munich contributed with an analytic tool.

Forces at Small Distances

The technique they developed takes very slow neutrons from the strongest continuous ultracold neutron source in the world, at the ILL in Grenoble and funnels them between two parallel plates. According to quantum theory, the neutrons can only occupy discrete quantum states with energies which depend on the force that gravity exerts on the particle. By mechanically oscillating the two plates, the quantum state of the neutron can be switched. That way, the difference between the energy levels can be measured.

"This work is an important step towards modelling gravitational interactions at very short distances. The ultracold neutrons produced at ILL together with the measurement devices from Vienna are the best tool in the world for studying the predicted tiny deviations from pure Newtonian gravity," says Peter Geltenbort (ILL Grenoble).

Different parameters determine the level of precision required to find such tiny deviations -- for instance the coupling strength between hypothetical new fields and the matter we know. Certain parameter ranges for the coupling strength of quintessence particles or forces have already been excluded following other high-precision measurements. But all previous experiments still left a large parameter space in which new physical non-Newtonian phenomena could be hidden.

A Hundred Thousand Times Better than Other Methods

The new neutron method can test theories in this parameter range: "We have not yet detected any deviations from the well-established Newtonian law of gravity," says Hartmut Abele. "Therefore, we can exclude a broad range of parameters." The measurements determine a new limit for the coupling strength, which is lower than the limits established by other methods by a factor of a hundred thousand.

Even if the existence of certain hypothetical quintessence particles is disproved by these measurements, the search will continue as it is possible that new physics can still be found below this improved level of accuracy. Therefore, Gravity Resonance Spectroscopy will need to be improved further -- and increasing the accuracy by another few orders of magnitude seems feasible to the Abele's team. However, if even that does not yield any evidence of deviations from known forces, Albert Einstein would win yet another victory: his cosmological constant would then appear more and more plausible.
BOSS makes the most precise measurement yet of The Universe's expansion

From Science Daily

The Baryon Oscillation Spectroscopic Survey (BOSS), the largest component of the third Sloan Digital Sky Survey (SDSS-III), pioneered the use of quasars to map density variations in intergalactic gas at high red shifts, tracing the structure of the young universe. BOSS charts the history of The Universe’s expansion in order to illuminate the nature of dark energy, and new measures of large-scale structure have yielded the most precise measurement of expansion since galaxies first formed.

The latest quasar results combine two separate analytical techniques. A new kind of analysis, led by physicist Andreu Font-Ribera of the U.S. Department of Energy’s Lawrence Berkeley National Laboratory in Berkeley, California, and his team, was published late last year. Analysis using a tested approach, but with far more data than before, has just been published by Timothée Delubac, of EPFL Switzerland and his team. The two analyses together establish the expansion rate at 68 kilometres per second per million light years at red shift 2.34, with an unprecedented accuracy of 2.2 percent.

“This means if we look back to The Universe when it was less than a quarter of its present age, we’d see that a pair of galaxies separated by a million light years would be drifting apart at a velocity of 68 kilometres a second as The Universe expands,” says Font-Ribera, a postdoctoral fellow in Berkeley Lab’s Physics Division. “The uncertainty is plus or minus only a kilometre and a half per second.” Font-Ribera presented the findings at the April 2014 meeting of the American Physical Society in Savannah, GA.

BOSS employs both galaxies and distant quasars to measure baryon acoustic oscillations (BAO), a signature imprint in the way matter is distributed, resulting from conditions in the early universe. While also present in the distribution of invisible dark matter, the imprint is evident in the distribution of ordinary matter, including galaxies, quasars, and intergalactic hydrogen.

“Three years ago BOSS used 14,000 quasars to demonstrate we could make the biggest 3-D maps of The Universe,” says Berkeley Lab’s David Schlegel, principal investigator of BOSS. “Two years ago, with 48,000 quasars, we first detected baryon acoustic oscillations in these maps. Now, with more than 150,000 quasars, we’ve made extremely precise measures of BAO.”

The BAO imprint corresponds to an excess of about five percent in the clustering of matter at a separation known as the BAO scale. Recent experiments, including BOSS and the Planck satellite study of the cosmic microwave background, put the BAO scale, as measured in today’s universe, at very close to 450 million light years — a “standard ruler” for measuring expansion.

BAO directly descends from pressure waves (sound waves) moving through the early universe, when particles of light and matter were inextricably entangled; 380,000 years after the big bang, The Universe had cooled enough for light to go free. The cosmic microwave background radiation preserves a record of the early acoustic density peaks; these were the seeds of the subsequent BAO imprint on the distribution of matter.

Previous work from BOSS used the spectra of over a million galaxies to measure the BAO scale with a remarkable one percent accuracy. But beyond red shift 0.7 (roughly six billion light years distant), galaxies become fainter and more difficult to see. For much higher red shifts like those in the present studies, averaging 2.34, BOSS pioneered the “Lyman-alpha forest” method of using spectra from distant quasars to calculate the density of intergalactic hydrogen.

As the light from a distant quasar passes through intervening hydrogen gas, patches of greater density absorb more light. The absorption lines of neutral hydrogen in the spectrum (Lyman-alpha lines) pinpoint each dense patch by how much they are red shifted. There are so many lines in such a spectrum, in fact, that it resembles a forest — the Lyman-alpha forest.

With enough good quasar spectra close enough together, the position of the gas clouds can be mapped in three dimensions — both along the line of sight for each quasar and transversely among dense patches revealed by other quasar spectra. From these maps, scientists extract the BAO signal.

Although introduced by BOSS only a few years ago, this method of using Lyman-alpha forest data, called autocorrelation, by now seems almost traditional. The just-published autocorrelation
results by Delubac and his colleagues employ the spectra of almost 140,000 carefully selected BOSS quasars.

Font-Ribera and his colleagues determine BAO using even more BOSS quasars in a different way. Quasars are young galaxies powered by massive black holes — extremely bright, extremely distant, and thus highly red shifted. Instead of comparing spectra to other spectra, Font-Ribera’s team correlated quasars themselves to the spectra of other quasars, a method called cross-correlation.

“Quasars are massive galaxies, and we expect them to be in the denser parts of The Universe, where the density of the intergalactic gas should also be higher,” says Font-Ribera. “Therefore we expect to find more of the absorbing gas than average when we look near quasars.” The question was whether the correlation would be good enough to see the BAO imprint.

Indeed, the BAO imprint in cross-correlation was strong. Delubac and his team combined their autocorrelation results with the cross-correlation results of Font-Ribera and his team, and they converged on narrow constraints for the BAO scale.

Autocorrelation and cross-correlation also converged in the precision of their measures of The Universe’s expansion rate, called the Hubble parameter. At red shift 2.34, the combined measure was equivalent to 68 plus or minus 1.5 kilometres per second per million light years.

“It’s the most precise measurement of the Hubble parameter at any red shift, even better than the measurement we have from the local universe at red shift zero,” says Font-Ribera. “These results allow us to study the geometry of The Universe when it was only a fourth its current age. Combined with other cosmological experiments, we can learn about dark energy and put tight constraints on the curvature of The Universe — it’s very flat!”

David Schlegel remarks that when BOSS was first getting underway, the cross-correlation technique had been suggested, but “some of us were afraid it wouldn’t work. We were wrong. Our precision measures are even better than we optimistically hoped for.”

Mars: Gusev Crater once held a lake after all, scientist says

From Science Daily

If desert mirages occur on Mars, “Lake Gusev” belongs among them. This come-and-go body of ancient water has come and gone more than once, at least in the eyes of Mars scientists.

Now, however, it’s finally shifting into sharper focus, thanks to a new analysis of old data by a team led by Steve Ruff, associate research professor at Arizona State University’s Mars Space Flight Facility in the School of Earth and Space Exploration. The team’s report was just published in the April 2014 issue of the journal Geology.

The story begins in early 2004, when NASA landed Spirit, one of its two Mars Exploration Rovers, inside 100-mile-wide Gusev Crater. Why Gusev? Because from orbit, Gusev, with its southern rim breached by a meandering river channel, looked as if it once held a lake — and water-deposited rocks were the rover mission’s focus. Yet, when Spirit began to explore, scientists found Gusev’s floor was paved not with lakebed sediments, but volcanic rocks.

Less than two miles away however, stood the Columbia Hills, 300 feet high. When Spirit drove up into them, it indeed discovered ancient rocks that had been altered by water. But to scientists’ chagrin, no lake sediments were among them. Instead, scientists discovered evidence of hydrothermal activity — essentially hot springs like those in Yellowstone National Park.

But there’s hope yet for Lake Gusev, thanks to a Columbia Hills rock outcrop, dubbed Comanche. This outcrop is unusually rich in magnesium-iron carbonate minerals, a discovery made in 2010 that Ruff played a major role in. While Comanche’s carbonate minerals were originally attributed to hydrothermal activity, the team’s new analysis points to a different origin.

Cool waters

Says Ruff, “We looked more closely at the composition and geologic setting of Comanche and nearby outcrops. There’s good evidence that low temperature surface waters introduced the carbonates into Comanche rather than hot water rising from deep down.”

Comanche started out as a volcanic ash deposit known as tephra that originally covered the Columbia Hills and adjacent plains. This material, Ruff explains, came from explosive eruptions somewhere within or around Gusev.

Then floodwaters entered the crater through the huge valley that breaches Gusev’s southern rim. These floods appear to have ponded long enough to alter the tephra, producing briny solutions. When the brines evaporated, they left behind residues
of carbonate minerals. As the lake filled and dried, perhaps many times in succession, it loaded Comanche and its neighbour rocks with carbonates.

"The lake didn't have to be big," Ruff explains. "The Columbia Hills stand 300 feet high, but they're in the lowest part of Gusev. So a deep, crater-spanning lake wasn't needed."

Today, the Columbia Hills rise as an island of older terrain surrounded by younger lava flows, Ruff says. "Comanche and a neighbour outcrop called Algonquin are remnants of the older and much more widespread tephra deposit. The wind has eroded most of that deposit, also carrying away much of the evidence for an ancient lake."

Return to Gusev?

Mars rover Spirit fell silent on a winter night in March 2010, and it has never been heard from since. Spirit left most of the Columbia Hills and other Gusev targets unexplored. Ruff says that as NASA evaluates landing sites for its new sample-collecting rover in 2020, Gusev Crater deserves serious consideration.

"Going back to Gusev would give us an opportunity for a second field season there, which any terrestrial geologist would understand," argues Ruff. "After the first field season with Spirit, we now have a bunch more questions and new hypotheses that can be addressed by going back."

Because the Mars 2020 rover mission will collect and cache samples for potential return to Earth, that makes going to an already visited site more important, says Ruff.

"Scientifically and operationally it makes sense to go to a place which we know has geologically diverse -- and astrobiologically interesting -- materials to sample," Ruff argues. "And we know exactly where to find them."

The Largest Structure in the Universe

From Slashdog.org

KentuckyFC writes "Until now, the largest known structure in the Universe was the Huge-LQG (Large Quasar Group), a cluster of 73 quasars stretching over a distance of 4 billion light years.

Now astronomers say they’ve spotted something even bigger in data from gamma ray bursts, the final explosions of energy released by stars as they die and The Universe’s most energetic events. Astronomers have measured the distance to 283 of these bursts and mapped their position in The Universe. This throws up a surprise.

At a distance of ten billion light years, there are more gamma ray bursts than expected if they were evenly distributed throughout The Universe. This implies the existence of a structure at this distance that is about ten billion light years across and so dwarfs the Huge-LQG.

What’s odd about the discovery is that the Cosmological principle--one of the fundamental tenets of cosmology--holds that the distribution of matter in The Universe will appear uniform if viewed at a large enough scale. And yet, structures clearly emerge at every scale astronomers can see.

The new discovery doesn’t disprove the principle but it does provide some interesting food for thought for theorists."
The Solar System has a new most-distant member, bringing its outer frontier into focus.

New work from Carnegie’s Scott Sheppard and Chadwick Trujillo of the Gemini Observatory reports the discovery of a distant dwarf planet, called 2012 VP113, which was found beyond the known edge of the Solar System. This is likely one of thousands of distant objects that are thought to form the so-called inner Oort cloud. What’s more, their work indicates the potential presence of an enormous planet, perhaps up to 10 times the size of Earth, not yet seen, but possibly influencing the orbit of 2012 VP113, as well as other inner Oort cloud objects.

Their findings are published March 27 in Nature.

The known Solar System can be divided into three parts: the rocky planets like Earth, which are close to the Sun; the gas giant planets, which are further out; and the frozen objects of the Kuiper belt, which lie just beyond Neptune’s orbit. Beyond this, there appears to be an edge to the Solar System where only one object, Sedna, was previously known to exist for its entire orbit. But the newly found 2012 VP113 has an orbit that stays even beyond Sedna, making it the furthest known in the Solar System.

“This is an extraordinary result that redefines our understanding of our Solar System,” says Linda Elkins-Tanton, director of Carnegie’s Department of Terrestrial Magnetism.

Sedna was discovered beyond the Kuiper Belt edge in 2003, and it was not known if Sedna was unique, as Pluto once was thought to be before the Kuiper Belt was discovered. With the discovery of 2012 VP113 it is now clear Sedna is not unique and...
is likely the second known member of the hypothesized inner Oort cloud, the likely origin of some comets.

2012 VP113’s closest orbit point to the Sun brings it to about 80 times the distance of Earth from the Sun, a measurement referred to as an astronomical unit or AU. For context, the rocky planets and asteroids exist at distances ranging between .39 and 4.2 AU. Gas giants are found between 5 and 30 AU, and the Kuiper belt (composed of thousands of icy objects, including Pluto) ranges from 30 to 50 AU. In our solar system there is a distinct edge at 50 AU. Only Sedna was known to stay significantly beyond this outer boundary at 76 AU for its entire orbit.

“The search for these distant inner Oort cloud objects beyond Sedna and 2012 VP113 should continue, as they could tell us a lot about how our Solar System formed and evolved,” says Sheppard.

Sheppard and Trujillo used the new Dark Energy Camera (DECam) on the NOAO 4 meter telescope in Chile for discovery. DECam has the largest field-of-view of any 4-meter or larger telescope, giving it unprecedented ability to search large areas of sky for faint objects. The Magellan 6.5-meter telescope at Carnegie’s Las Campanas Observatory was used to determine the orbit of 2012 VP113 and obtain detailed information about its surface properties.

From the amount of sky searched, Sheppard and Trujillo determine that about 900 objects with orbits like Sedna and 2012 VP113 and sizes larger than 1000 km may exist and that the total population of the inner Oort cloud is likely bigger than that of the Kuiper Belt and main asteroid belt.

“Some of these inner Oort cloud objects could rival the size of Mars or even Earth. This is because many of the inner Oort cloud objects are so distant that even very large ones would be too faint to detect with current technology,” says Sheppard.

Both Sedna and 2012 VP113 were found near their closest approach to the Sun, but they both have orbits that go out to hundreds of AU, at which point they would be too faint to discover. In fact, the similarity in the orbits found for Sedna, 2012 VP113 and a few other objects near the edge of the Kuiper Belt suggests that an unknown massive perturbing body may be shepherding these objects into these similar orbital configurations. Sheppard and Trujillo suggest a Super Earth or an even larger object at hundreds of AU could create the shepherding effect seen in the orbits of these objects, which are too distant to be perturbed significantly by any of the known planets.

There are three competing theories for how the inner Oort cloud might have formed. As more objects are found, it will be easier to narrow down which of these theories is most likely accurate. One theory is that a rogue planet could have been tossed out of the giant planet region and could have perturbed objects out of the Kuiper Belt to the inner Oort cloud on its way out. This planet could have been ejected or still be in the distant solar system today. The second theory is that a close stellar encounter could have put objects into the inner Oort cloud region. A third theory suggests inner Oort cloud objects are captured extra-solar planets from other stars that were near our Sun in its birth cluster.

The outer Oort cloud is distinguished from the inner Oort cloud because in the outer Oort cloud, starting around 1500 AU, the gravity from other nearby stars perturbs the orbits of the objects, causing objects in the outer Oort cloud to have orbits that change drastically over time. Many of the comets we see were objects that were perturbed out of the outer Oort cloud. Inner Oort cloud objects are not highly affected by the gravity of other stars and thus have more stable and more primordial orbits.
The Evening Sky in May 2014

By Alan Gilmore

Bright planets are spaced across the north sky at dusk. Bright stars light up the west and south. Jupiter is the ‘evening star’, appearing in the northwest soon after sunset. Mars, orange-red, is visible in the northeast soon after. Saturn is in the eastern sky. In the middle of May, Mercury appears low in the northwest at dusk, moving a little higher by the end of the month.

As the sky darkens Sirius appears in the west with Orion below it. Canopus is southwest of the zenith. Crux, the Southern Cross, and the Pointers are southeast of overhead. Well to the right of Mars is bluish-white Spica, the brightest star in Virgo. Below them, low in the northeast is Arcturus, a bright orange star whose colour is often separated into flashes of red and green.

Below Sirius are Rigel and Betelgeuse, the brightest stars in Orion. Between them is a line of three stars: Orion’s belt. To southern hemisphere star watchers, the line of three makes the bottom of ‘The Pot’, now tipped on its side. Sirius, ‘the Dog Star’, marks the head of Canis Major the big dog. Sirius is the brightest star in the sky though planets Venus, Mars and Jupiter can be brighter.

Crux, the Southern Cross, is southeast of the zenith. Left of it are Beta and Alpha Centauri, often called ‘The Pointers’. Alpha Centauri is the closest naked-eye star, 4.3 light years away. It is a binary star: two Sun-sized stars orbiting each other in 80 years. Beta Centauri, like most of the stars in Crux, is a blue-giant star hundreds of light years away. Canopus is also very luminous and distant: 13 000 times brighter than the Sun and 300 light years away.

To the right of Saturn, low in the east, is the orange star Antares, marking the heart of the Scorpion. Antares means ‘rival to Mars’ in Greek. It is a red-giant like Betelgeuse; 600 light years away and 19 000 times brighter than the Sun. Arcturus, in the northeast, is the brightest red star in the sky (ignoring the planet Mars) but, at 37 light years, is much closer than Antares. It is about 120 times brighter than the Sun.

The Milky Way is brightest in the southeast toward Scorpius and Sagittarius. In a dark sky it can be traced up the sky past the Pointers and Crux, fading toward Sirius. The Milky Way is our edgewise view of the galaxy, the pancake of billions of stars of which the Sun is just one. The thick hub of the galaxy, 30 000 light years away, is in Sagittarius. The nearby outer edge is by Orion. A scan along the Milky Way with binoculars shows many clusters of stars and some glowing gas clouds, particularly in the Carina region, to the right of Crux, and in Scorpius.

The Clouds of Magellan, LMC and SMC, are midway down the southern sky, easily seen by eye on a dark moonless night. They are small galaxies. The Large Magellanic Cloud is 160 000 light years away and is about 5% the mass of our Milky Way galaxy. The Small Cloud is around 200 000 light years away and 3% the mass of our galaxy. That’s still many billions of stars.

At the beginning of May Jupiter sets around 9:40 pm, reducing to 8 pm by the month’s end. Jupiter is 870 million km away. It is always worth a look in a telescope. Its four big moons look like faint stars near the planet. Mercury is below Jupiter at the end of May. It is 110 million km away; just a tiny crescent in a telescope. Mars is 105 million km away mid month and small in a telescope. Saturn is a great sight in any telescope. The full moon passes in front of Saturn on the 14/15th. Times vary over NZ with the planet hidden longer in the south. From Auckland disappearance is around 11:53 p.m.; reappearance 12:39 a.m. Wellington 11:46 to 12:52. Dunedin 11:36 to 12:51.

Venus (not shown) is the brilliant ‘morning star’, rising due east around 4 a.m. It is 160 million km away, moving to the far side of the Sun. The Moon is close to Venus on the 26th. This helps to find the planet by eye in the daytime sky. At 10 a.m. on the 26th Venus will be 10 Moon diameters above and left of the thin crescent Moon. The pair will be due north and midway up the sky at that time.

A light year (l.y) is the distance that light travels in one year: nearly 10 million million km or $10^{13}$ km. Sunlight takes eight minutes to get here; moonlight about one second. Sunlight reaches Neptune, the outermost major planet, in four hours. It takes four years to reach the nearest star, Alpha Centauri.
The Night Sky for May 2014

The chart is oriented for
April 15 at 10 p.m. NZST
May 1 at 9 p.m. "
May 15 at 8 p.m. "
June 1 at 7 p.m. "

Evening sky in May 2014

To use the chart, hold it up to the sky. Turn the chart so the direction you are looking is at the bottom of the chart. If you are looking to the south then have 'South horizon' at the lower edge.

As the earth turns the sky appears to rotate clockwise around the south celestial pole (SCP on the chart). Stars rise in the east and set in the west, just like the sun. The sky makes a small extra westward shift each night as we orbit the sun.

Golden Jupiter is the 'evening star' in the northwest sky at dusk. Mars, orange-red, is midway up the north sky and Saturn is bright in the east. Sirius, the brightest true star, is midway down the western sky. Directly below it is Orion with bright stars Rigel and Betelgeuse, and 'The Pot'. Canopus is southwest of overhead. Low in the northeast is Arcturus, twinkling red and green. Crux, the Southern Cross, and The Pointers (Alpha and Beta Centauri) are southeast of the zenith.

Chart produced by Guide 8 software; www.projectpluto.com. Labels and text added by Alan Gilmore,
Mt John Observatory of the University of Canterbury. www.canterbury.ac.nz
Solar System Events April 2014

From the RASNZ Website

- **apogee**: Furthest point in the orbit of a body orbiting the Earth
- **conjunction**: Two astronomical objects are ‘lined up’ (have the same right ascension) when viewed from Earth
- **declination**: ‘Latitude’ for celestial objects. The distance in degrees above (north) or below (south) the celestial equator.
- **perigee**: Nearest point in the orbit of a body orbiting the Earth

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 1</td>
<td>Aldebaran 2.0 degrees south of the Moon</td>
<td>May 16</td>
<td>Moon southern most declination (-19.0 degrees)</td>
</tr>
<tr>
<td>May 2</td>
<td>Moon northern most declination (19.0 degrees)</td>
<td>May 18</td>
<td>Pluto 2.3 degrees south of the Moon</td>
</tr>
<tr>
<td>May 4</td>
<td>Jupiter 5.4 degrees north of the Moon</td>
<td>May 21</td>
<td>Mars stationary</td>
</tr>
<tr>
<td>May 6</td>
<td>Moon at apogee</td>
<td>May 22</td>
<td>Moon at perigee</td>
</tr>
<tr>
<td>May 7</td>
<td>Moon first quarter</td>
<td>May 24</td>
<td>Neptune 4.7 degrees south of the Moon</td>
</tr>
<tr>
<td>May 8</td>
<td>Regulus 4.9 degrees north of the Moon</td>
<td>May 25</td>
<td>Uranus 1.8 degrees south of the Moon</td>
</tr>
<tr>
<td>May 10</td>
<td>Saturn at opposition</td>
<td>May 10</td>
<td>Mercury greatest elong E(23)</td>
</tr>
<tr>
<td>May 11</td>
<td>Mars 2.8 degrees north of the Moon</td>
<td>May 11</td>
<td>Venus 2.1 degrees south of the Moon</td>
</tr>
<tr>
<td>May 12</td>
<td>Spica 1.7 degrees south of the Moon</td>
<td>May 12</td>
<td>Moon new</td>
</tr>
<tr>
<td>May 14</td>
<td>Saturn 0.5 degrees north of the Moon Occn Moon full</td>
<td>May 14</td>
<td>Aldebaran 2.0 degrees south of the Moon</td>
</tr>
<tr>
<td>May 15</td>
<td>Venus 1.2 degrees south of Uranus</td>
<td>May 15</td>
<td>Moon northern most declination (19.0 degrees)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>May 20</td>
<td>Mercury 5.8 degrees north of the Moon</td>
</tr>
</tbody>
</table>

Society Astronomical Equipment for Rent

The Society has a wide variety of equipment available for rental to members, from beginner friendly Dobsonian telescopes, through to more advanced computerised GOTO systems. All rental equipment is of high quality and regularly maintained.

Rental periods are normally in 4 week blocks, but other arrangements may be available if you have a specific requirement. Full training and support is given for all equipment, including advice if equipment is suitable for your needs, or experience level.

Current rental equipment includes:

* 200mm Astronz Dobsonian Telescopes ($10/week)
* Celestron Nexstar 5 127mm Schmidt Cassegrain Alt/Az GOTO Telescope ($12.50/week)
* iOptron Minitower multipurpose Alt/Az Mount with Celestron C5 127mm OTA ($15/week)
* Meade 90mm Achromatic Refractor ($7.50/week)

Also, newly added to the rental stock

* Coronado PST 40mm Hydrogen-Alpha Solar Telescope ($12.50/week)
* iOptron ZEQ25 Computerised Equatorial Mount (Coming Soon!)

We are often adding items to our rental equipment, and we’re really keen to hear what other items may be useful to members - any ideas, or for any information regarding availability or how to rent equipment, please contact Steve Hennerley at rental@astronomy.org.nz or on 027 245 6441
SOCIETY MEMBERS ONLY SPECIAL!

MAD MAY DOB SALE

Don’t wait any longer to be able to view the beautiful autumn and winter night skies, because we’re offering all Auckland Astronomical Society members a full 10% discount off our already unbeatably priced Dobsonian telescope range.

Until the end of May, all members can get a fantastic discount off the Astronz price of a new 153mm (6”), 200mm (8”) or 254mm (10”) easy to use Dobsonian mount telescope.

10% OFF

200mm or 254mm
- 200mm (8”) f/8 or 254mm (10”) f/5 Newtonian Optical Tube Assembly
- 9mm Plossl 1.25” Eyepiece
- 30mm Superview 2” Eyepiece
- 2” 10:1 Crayford Focuser with 1.25” adapter
- Dobsonian base (assembly required)
- 8x50 Finder Scope
- Cooling Fan

153mm
- 153mm (6”) f/8 Newtonian Optical Tube Assembly
- 9mm Plossl 1.25” Eyepiece
- 25mm Plossl 1.25” Eyepiece
- 1.25” Crayford Focuser
- Dobsonian base (assembly required)
- 6x30 Finder Scope

ASTRONONZ
www.astronomy.co.nz

Newtonian/Dobsonian Telescopes
High Grade Ritchey-Chretien Telescopes
Eyepieces, Diagonals, Barlows, Filters
Computerised GOTO Mounts
email: sales@astronomy.co.nz
ph: 09 473 5877