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SciTalk

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Number 2 – April 2015

Patience needed for scientific research

We tell our students 'patience is a virtue'. Indeed, patience and perseverance are very necessary attributes of scientists when doing research.

Astronomers especially, often have to wait many years for results before they get their long-term reward. This will be the case for astronomers on 14 July 2015 when NASA's New Horizons spacecraft flies by the icy dwarf planet, Pluto and its five known moons – Charon, Nix, Hydra, Kerberos and Styx. Launched on 19 January 2006, this spacecraft has taken 9 years to reach its destination.

When New Horizons – roughly the size of a grand piano – passes by Pluto, it will be flying less than 12,500 km from the dwarf planet's icy surface at a speed of ~49,600 kilometres per hour. It has already started sending images of Pluto back to Earth as part of its six month encounter with Pluto. While still 203 million kilometres away, New Horizons observed Pluto and Charon for an entire rotation of each body – a 'day' on Pluto is 6.4 Earth days.

Little is known about Pluto and its moons, or indeed, the entire Kuiper Belt of orbiting objects of which Pluto is a part owing to the distance. Pluto's distance from Earth ranges from 29–49 AU, i.e. it is about 5.7×10^9 kilometres away on average. Unlike the planets, Pluto orbits the Sun off the ecliptic, eccentrically swinging through the plane of the solar system – taking approximately 250 years for each orbit of the Sun.

Cameras on New Horizons will take the first ever close up images that will be much sharper than has been possible with the Hubble Space Telescope or any of the large Earth-based telescopes. When New Horizons arrives at Pluto, its cameras will see features as small as a city block. The probe will also examine what minerals are present on Pluto and its moon Charon, and take long-range images of Pluto's four other moons – as well as look for more.

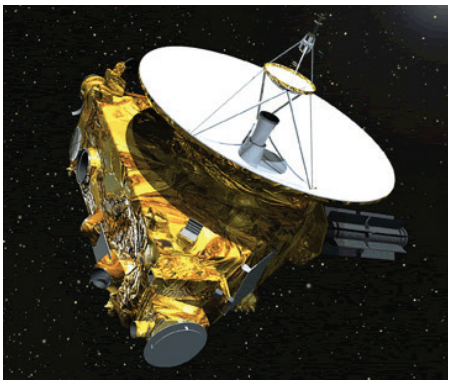

Figure 1 New Horizons spacecraft
[From JHUAPL/SwRI]

New Horizons' scientific instruments – which include cameras, spectrometers, and plasma and dust detectors – will map the geology of Pluto and Charon, determine their surface composition and temperature and examine their atmosphere and surface ice.

New Horizons will collect and record the bulk of the data the week of the flyby in July, but it will continue making observations

... continued page 4

★ 2015 editions Past HSC Questions & Worked Solutions ... see p7 ★

INSIDE THIS ISSUE ▸▸▸▸

★★ ATTENTION ★★

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TO WIN: Send your name, school & school address on an envelope **by 26 June 2015** to: Book Giveaway, PO Box 442, Freshwater 2096

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Winner for *SciTalk 1/15*

Sally Stoddart, Airds High, won *Earth & Environmental Science Past HSC Papers & Worked Solutions 2001-2013 (rrp $39.95)*, published by Odlum & Garner.

Diary Dates

2015 International Year of Light 2015: *www.light2015.org/*

For Shell Questacon Science Circus 2015:
www.questacon.edu.au/outreach/programs/science-circus

APRIL 2015

24, 27	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105
22	International Earth Day. www.earthday.org

MAY 2015

early	Crystal Growing Competition 2015 (RACI NSW) set-up period. Closing date 26 June. Details: schools.raci.org.au/competition/crystal-growing/
1, 22, 25	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105
23 May	Astronomy Open Night & Lectures: Macquarie Uni, www.physics.mq.edu.au/astronomy
b/w 20–27	Big Science Competition: www.asi.edu.au/bigscience/ Ph: 62012552

JUNE 2015

various dates	NSW Titration Competition 2015. For details: schools.raci.org.au/competition/titration/
various dates	Nyholm Youth Lectures 2015. For details: www.raci.org.au/branches/nsw-branch
1, 5, 12, 26	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com
5	World Environment Day
22	Winter Solstice (2:38 am AEST)

JULY 2015

5–8	CONASTA 64 in Perth: 'Science: A kaleidoscope of wonder & opportunity', asta.edu.au/conasta
23	National Chemistry Quiz. schools.raci.org.au/competition/ancq/ ... registrations close 9 June.

AUGUST 2015

1	Jeans for Genes Day. www.jeansforgenes.org.au/
5	Chemistry Olympiad Exam. www.asi.edu.au/olympiads/ Close date: 6/7/15. Ph: 6201 2552
7	Earth & Env Science Olympiad Exam. www.asi.edu.au/olympiads/ Close date: 22/7/15.
10	Biology Olympiad Exam. www.asi.edu.au/olympiads/ Close date: 22/7/15. Ph: 6201 2552
12	Physics Olympiad Exam. www.asi.edu.au/olympiads/ Close date: 22/7/15. Ph: 6201 2552
14, 17, 21	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, fax (02) 9939 6105 – come on one of these dates to celebrate National Science Week
15–23	National Chemistry Week. www.raci.org.au Ph: 9663 4960
15–23	National Science Week. Schools theme: Making waves – the science of light. www.scienceweek.net.au/schools/

SEPTEMBER 2015

7, 11	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com
23	Spring equinox (6:20 pm AEST)

OCTOBER 2015

tba	National Schools Titration Competition. www.raci.org.au
11–17	Earth Science Week. www.earthsciweek.org
16, 19, 23, 26, 30	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

NOVEMBER 2015

2, 13, 16	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com
20, 23, 27, 30	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com

DECEMBER 2015

1–16	Physics is Fun at Luna Park Sydney. Enquiries: ph (02) 9939 6107, www.odlumgarner.com
22	Summer solstice (3:48 pm AEDT)

JANUARY 2016 National Youth Science Forum. Forms to local Rotary club by 31/5/15, interviews from July. Only for Yr 11 in 2015. Enquiries: 6125 2777, email: nsss@anu.au, www.nysf.edu.au/

While all dates have been checked to ensure that information in DIARY DATES is correct, no responsibility will be accepted by the publisher or Editor for any omissions or inaccuracies in it.

Update on BOSTES matters

You should regularly check the BOSTES website at *www.bostes.nsw.edu.au* to ensure you have the latest data – on syllabuses, past exam papers, news, Official Notices, Board Bulletins, statistics archive and more.

New/revised personalised HSC materials (BOS 15/15)

BOSTES is continuing to expand the use of personalised exam materials pre-printed with a student's number, centre number and, generally, their name, e.g. from 2015, HSC Chemistry papers will have this.

Multiple Choice in HSC Examinations

To have a more valid and consistent approach across multiple-choice sections of HSC exams, all exam committees have been asked to order the multiple-choice questions according to the level of difficulty. They will start with easier questions and work up to more challenging questions, as already occurs in some science subjects.

Stage 5 and Preliminary course student work samples to be retained

A minimum of three work samples, representing the upper, middle and lower range of achievement of the current cohort, should be retained for each course (Science 7–10, Biology, Chemistry and Physics) in a format that can be uploaded electronically. Each work sample should demonstrate performance towards the end of the stage that is typical of students awarded a particular grade (A to E) by the school.

Revised Stage 5 Course Performance Descriptors (CPDs) (BOS 04/15)

The CPDs have been revised to align with the outcomes and content of the new K–10 Science Syllabus. The CPDs are to be used by schools from 2015 to grade student achievement for the Record of School Achievement (RoSA).

BOSTES enquiries

Ph: 9367 8111, fax: 9367 8484
www.boardofstudies.nsw.edu.au
and *www.bostes.nsw.edu.au*

BOSTES contacts for Science

Inspector Science, K–12

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* * * * *

Thank you to all the teachers who support these projects.

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Further information and bookings:

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E diseasemuseum@unsw.edu.au
W www.diseasemuseum.unsw.edu.au

MUSEUM OF HUMAN DISEASE

UNSW

WHY NOT COMBINE A FUN PARK EXCURSION AT LUNA PARK SYDNEY BOOKED THROUGH PHYSICS IS FUN WITH SEEING A FILM AT IMAX?

Combine your Fun Park Excursion at Luna Park Sydney booked through **PHYSICS IS FUN** with a visit to IMAX for a great action-packed, fun time of interactive learning.

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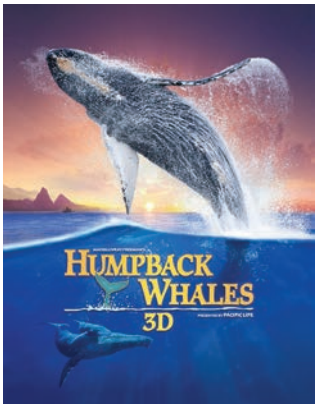

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STAGE 6 CHEMISTRY

This program relates to the *Shipwrecks, Corrosion and Conservation* option. Students attend an AV presentation on conservation and restoration, including footage taken during the recovery of material from HMS *Bounty*. Students then participate in a hands-on workshop focusing on desalination of metal objects, metal and corrosion product identification, methods of protecting metals and rates of corrosion.

This is followed by a guided tour of shipwreck material in the museum. Students may also visit the destroyer HMAS *Vampire* and submarine HMAS *Onslow*.

Program is 4 hours, at a cost of $22.00 per student (teachers free).

Bookings & Information:

Phone: 02 9298 3655 Fax: 02 9298 3660
Email: bookings@anmm.gov.au
Location: 2 Murray Street, Sydney 2000
Website: www.anmm.gov.au/

AUSTRALIAN NATIONAL MARITIME MUSEUM

National Science Week

15–23 August 2015

NATIONAL SCIENCE WEEK

Plan to participate in this annual event, so that your students can enjoy and explore the wonders and benefits of Science. The theme is 'Making waves – the science of light'. There will be many Science Week happenings. Details will be available in 2015 at:

www.scienceweek.net.au

Celebrate the 2015 National Science Week by going on a Science excursion. You could go to a fun park excursion through *Physics is Fun* to Luna Park Sydney on 14, 17 or 21 August 2015, or visit one of the other excursion venues on this page for National Science Week.

... continued from page 1

for months after the encounter. Pluto's huge distance from Earth will limit the rate New Horizons can downlink the contents of its data recorder, and scientists do not expect the full data haul back on the ground until around October 2016. Each communication from Earth to New Horizons takes about 4.5 hours, even though such data is travelling at the speed of light.

This flyby of Pluto caps a five-decade-era that began with Venus and Mars in the early 1960s, to Mercury, Jupiter and Saturn in the 1970s and Uranus and Neptune in the 1980s. Scientists hope New Horizons will keep exploring more distant parts of the Kuiper Belt after passing Pluto.

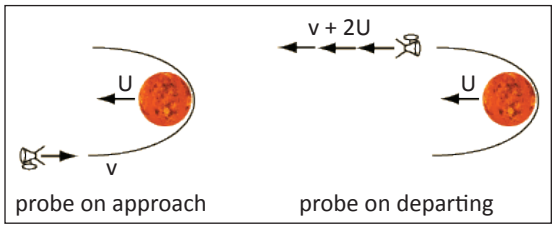

Figure 2 (left) Slingshot effect

[Credit: hyperphysics.phy-astr.gsu.edu/hbase/doubal.html#c3]

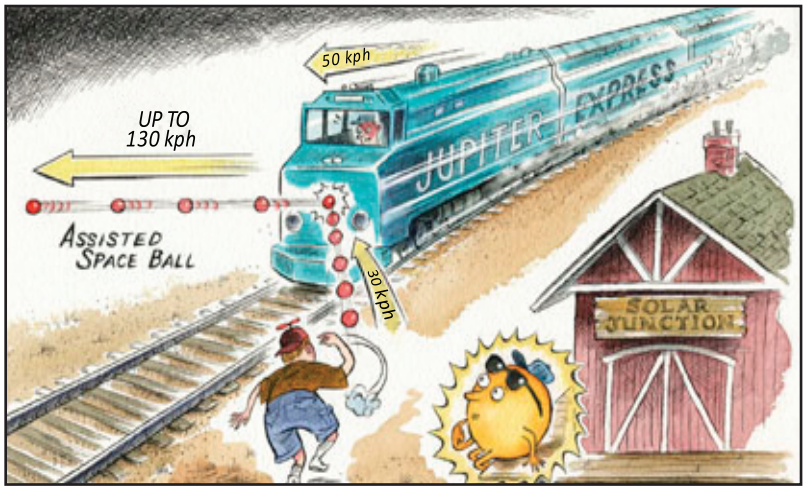

Figure 3 (above) Cartoon analogy for the slingshot effect

[Credit: JPL-NASA, artwork by Gary Hovland]

Now, you might well be wondering: how was the New Horizons spacecraft able to travel such a great distance?

HSC Physics students and teachers will have no trouble answering this question – as they have learnt how the 'slingshot effect' ('gravity-assist' or 'swing-by') can be provided by planets for space probes – in the 'Space' topic (9.2.3).

This slingshot effect (see below) enabled New Horizons to increase its velocity as it passed Jupiter without using any fuel – other than a small amount for manoeuvring. This consequently reduced the time of its trip, as well as the fuel required.

The slingshot effect

The slingshot effect involves steering a probe into a temporary hyperbolic orbit around a planet (or moon or asteroid), so that the planet's gravity pulls the probe in toward it. This enables the probe to gain energy from the planet. Such a manoeuvre is really an elastic collision where the objects involved never hit each other, but are affected by each other's gravity as they pass.

The planet is not stationery, but is orbiting the Sun. Therefore, as the probe is pulled along and swung around the planet by the gravitational field of the planet, it will also have the speed of the planet around the Sun added to its original speed. Hence the probe speeds up with respect to the Sun – it can gain up to 2× the speed of the planet around the Sun (as shown in Figure 2).

To help explain the concept, consider the analogy, illustrated by the cartoon in Figure 3 above. This involves a moving train that represents Jupiter, moving along its track about the Sun. The kid in the propeller beanie throws a tennis ball that represents a spacecraft. It encounters the train, which transfers its momentum into the ball.

It is interesting to note the speeds in the cartoon. The propeller-beanie kid sees his

2015 Nyholm Youth Lectures

An activity of the RACI NSW Branch

The Nyholm Lecture Series commemorates Sir Ronald Nyholm FRS (1917-1971), an outstanding Australian researcher and passionate chemical educator.

These popular lectures are aimed at Year 9 and 10 students. They are loosely linked to the 7-10 Science Syllabus, although others will find the material inspiring. ***A feature of the lectures is their practical content and interactive presentation style***.

The 2015 Lectures will be presented alternately at a range of venues in metropolitan Sydney and country NSW by two outstanding chemical educators. Cost is around $5 per head. Schools may apply for discount bulk ticket purchases.

Glowing in the Dark

Dr Elizabeth New, *a lecturer at the University of Sydney, has studied in Australia, UK and US. Her research is focussed on fluorescence (emission of light from materials that have absorbed light or certain other radiation) and its applications, including fluorescent tracking of molecules in the body to better understand diseases. Liz will explain the fundamentals of fluorescence and reveal some of the amazing uses of fluorescence in medicine and research.*

Sugars, Drugs and Rock & Roll

Dr Michela Simone, *a lecturer at the University of Newcastle, has studied at The University of Oxford. Her research spans medicinal chemistry and chemical biology. Michela will highlight some real-world therapeutic applications of sugars in the design and action of drugs, which are underpinned by the fascinating and still mostly unexplored roles of carbohydrates in nature's biological processes. Her lecture will feature demonstrations of the many and varied properties of sugars.*

Venues with dates and times, from Term 2, will be advertised to local schools and at: www.raci.org.au/branches/nsw-branch
Advance bookings are highly advisable.

For more information: contact RACI NSW Branch Office
E: raci-nsw@raci.org.au T: (02) 9663 4960

tennis ball moving away from him at 30 km/hr. So does the Sun, sitting on the stationary platform. The engineer driving the train sees the ball coming at about 80 km/hr, since the train is moving 50 km/hr with respect to the ground. The train and ball interact at 80 km/hr. The ball rebounds from the front of the train at nearly the same 80 km/hr, which can be added to the 50 km/hr speed of the train, because it acquired it from the train. The result approaches a total of 130 km/hr. This scenario is analogous the velocity of a spacecraft being added to the velocity of the massive speeding planet, and 'rebounding' with a higher velocity still (although the spacecraft's 'rebound' is a gravitational, rather than a mechanical interaction).

References:

- *www.nasa.gov*
- *pluto.jhuapl.edu*
- *www2.jpl.nasa.gov/ & Charles Kohlhase*
- *hyperphysics.phy-astr.gsu.edu/hbase/doubal.html#c3*

[all last accessed 19-4-15]

Life isn't about waiting
for the storm to pass.
It's about learning how
to dance in the rain.

... Vivian Greene

DNA time capsules can store data

Scientists have found a way to preserve the world's data for millions of years, by storing it on a tiny strand of DNA preserved in glass.

If humans want to leave messages for future generations to read, the most powerful message would surely be our billions of terabytes of data. However, our hard drives, Blu-ray discs and USB sticks are unlikely to survive more than a few hundred years.

Scientists may have the solution – having developed a way to encode information on a DNA strand. The simplest method treats the DNA bases A and C as a '0' and G and T as a '1'. In theory, just 1 gram of DNA is theoretically capable of holding 455 exabytes – enough for all the data held by Google, Facebook and in fact, most websites, with room to spare. It has been shown that DNA is very durable and can store large amounts of information in a compact manner – and will last for thousands or millions of years, if stored at the right temperature.

Further research went into finding out how fossils can keep a DNA sequence intact and then working out how to mimic this, to see if it would help them create a long-lasting DNA hard drive. It was found that all water from the environment needed to be excluded, so they enclosed the DNA in microscopic spheres of glass.

Researchers led by Robert Grass, a lecturer at ETH Zurich's Department of Chemistry and Applied Biosciences, have revealed how the long-term, error-free storage of information can be achieved, potentially for more than a million years. First, they encapsulate the information-bearing segments of DNA in silica (glass) and second, they use an algorithm in order to correct mistakes in the data.

To test how long this storage system might last, they encoded two venerable documents, totalling 83 kilobytes: the Swiss federal charter from 1291, and the Archimedes Palimpsest, a 10th-century version of ancient Greek texts. DNA versions of these texts were kept at 60, 65 and 70°C for a week to simulate ageing. They remained readable without any errors.

The researchers compared these glass spheres against other packaging methods by exposing them to temperatures of between 60 and 70°C – conditions that replicated the chemical degradation that would usually occur over hundreds of years, all crammed into a few destructive weeks.

They found that even after this sped-up degradation process, the DNA inside the glass spheres could easily be extracted using a fluoride solution, and the data on it could still be read. In fact, these glass casings seem to work much like fossilised bones.

Based on their published results, the team predicts that data stored on DNA could survive over a million years if stored in low temperatures, such as below -18°C, as found in the Global Seed Vault in the Arctic. However, it would only last 2000 years if stored at 10 °C – a similar average temperature to central Europe. In contrast, data projected onto microfilm can be preserved only for an estimated 500 years.

The tricky part of this whole process is that the data stored in DNA needs to be read properly in order for future civilisations to be able to access it. Despite advances in sequencing technology, errors still arise through chemical degradation and mistakes in DNA sequencing. The team overcame this by embedding a method for correcting any errors within the glass spheres, based on the Reed-Solomon Codes, which help researchers transmit data over long distances.

The cost to generate DNA to store all the world's current knowledge for future generations is prohibitively expensive. It cost around £1000 (~AUD$1900) to encode the 83 kilobytes, so doing the same with Wikipedia for example would run to billions.

References: • *www.sciencedaily.com (12-2-15)*
• *www.newscientist.com (15-2-15)*
• *www.sciencealert.com (17-2-15)*

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2/15.CLO

Einstein's twin paradox

NASA's astronaut Scott Kelly blasted off on the 28 March 2015 with two Russian cosmonauts to spend a year on the International Space Station (ISS), for the ISS's first ever year-long mission. Interestingly, Scott has an identical twin brother, Mark Kelly, who is also a NASA astronaut, but he is staying on Earth.

On first appearances, this would appear to provide a chance to test Einstein's 'twin paradox'. Unfortunately, the ISS does not move at a high enough velocity for a noticeable effect as Scott will return to Earth only about 10 milliseconds younger than Mark after a year in space. However, NASA will compare data on the twins' health in an effort to distinguish between the effects of space flight and the effects of genetics.

Scott Kelly being 10 milliseconds younger than his twin is an example of time dilation, as described in Einstein's 'twin paradox'. This was experimentally verified in 1971 when four caesium atomic clocks were flown twice around the world by planes on different paths, while a fifth caesium atomic clock remained in Washington DC. Although on different flight paths, in every case the moving atomic clocks had a different time that was faster than the stationary caesium atomic clock as time dilation had occurred, as predicted by Einstein.

References:

- *nasa.gov/content/one-year-crew [accessed 31-3-15]*
- *NewScientist 28 March 2015*
- *hyperphysics.phy-astr.gsu.edu [accessed 18-4-15]*

Resistance developing in malaria parasites

The emergence of drug-resistant parasites is thwarting efforts to control human malaria.

So far, no preventative vaccination against malaria exists, and its control depends heavily upon antimalarial drugs that kill parasites inside the human body.

Early indicators of the malaria parasite developing resistance to artemisinin drugs, the most effective drug available have been confirmed by researchers. This resistance has spread across Burma, reaching the Indian border and is also present in parts of Africa.

Investigators have found *Plasmodium falciparum*, the most deadly form of the malaria parasite, with a mutation that makes them less sensitive to artemisinin.

The malaria parasite is constantly evolving to evade our control efforts. Over the years, the malaria parasite has developed resistance to quinine, then to chloroquine and later to sulfadoxine-pyrimethamine. If resistance to artemisinin spreads, we could be facing a grave situation.

The World Health Organisation estimates more than half a million people die from malaria every year, mostly children under five.

References:

- *Science Daily 17-4-2015 [accessed 18-4-15]*
- *NewScientist 28 February 2015*

Rethink on allergy

In research that contradicts years of health advice, British scientists now claim that babies at risk of developing a childhood peanut allergy can avoid it if they are given peanuts regularly during their first 11 months. The study, the first to show that eating certain foods is an effective way of preventing allergy, showed an 80% reduction in the prevalence of peanut allergies among high-risk children who ate peanuts frequently from infanthood, compared to those who avoided them.

In results published recently in the *New England Journal of Medicine*, fewer than 1% of the children who ate peanut regularly as required had become allergic by the end of the study, while 17.3% in the avoidance group had developed peanut allergy. Hence a re-think about peanuts may be needed.

In another recent study in Australia, over 60 peanut allergic children in the study were either given a dose of a probiotic, *Lactobacillus rhamnosus*, together with peanut protein in increasing amounts, or a placebo over 18 months to assess whether children would become tolerant to peanut. Astoundingly, researchers found over 80% of children who received the oral immunotherapy treatment were able to tolerate peanut at the end of the trial, compared to less than 4% of the placebo group.

References:

- *NewScientist 28 February 2015*
- *www.mcri.edu.au 28-1-15 [accessed 18-4-15]*

Camembert used to be green

Camembert is a soft, creamy, surface-ripened cow's milk cheese. It was first made in the late 18th century at Camembert, Normandy in northern France.

Cheeses such as Camembert and Brie are produced using the fungus *Penicillium camemberti*. This is a species of fungus in the family Trichocomaceae. Colonies of this fungus form a hard, white crust on the outside of these cheeses. The distinctive taste of these cheeses is due to this fungus. *P. camemberti* is also responsible for the soft, buttery texture of Brie and Camembert, but a too high concentration may lead to an undesirable bitter taste.

When making a soft cheese that involves *P. camemberti*, the fungus may be mixed into the ingredients before being placed in the moulds, or it may be added to the outside of the cheese after it has been removed from the cheese moulds.

Fortunately, an allergy to penicillin does not necessarily imply an allergy to cheeses made using *P. camemberti*.

But here's a curious fact: the original Camembert and Brie cheeses would have looked different to their counterparts today – according to Tufts University microbiologist Benjamin Wolfe, who studies how microbes from food (mostly cheese!) interact, in order to tease out the ecological and evolutionary forces that shape microbial diversity.

In his cheese lab, Wolfe has cultured the *P. camemberti* fungus, which has a blue-green colour. According to Wolfe, the original Camembert cheeses would have been that same colour, their rinds entirely colonised by Wolfe's 'green' microbes. Indeed, in nineteenth-century newspapers, letters, and advertisements, Camembert cheeses are routinely described as green, green-blue, or greenish-grey. The pure white Camembert we know and love today did not become the norm until the 1920s and '30s. What happened, according to Wolfe, is that if you grow the wild microbe 'in a very lush environment, like cheese is, it eventually starts to mutate. And along the way, these white mutants that look like the thing we think of as Camembert popped up.'

The use of the white mutant form of *P. camemberti* to make Camembert and Brie cheeses is thought to have been due to human selection – because following Louis Pasteur's discoveries in germ theory at the start of the twentieth-century, there was a prejudice against the original 'mouldy'-looking green Camembert rinds, and a preference for the more hygienic-seeming pure white ones. Camembert's green origins have since been almost entirely forgotten, even by the most traditional cheese-makers.

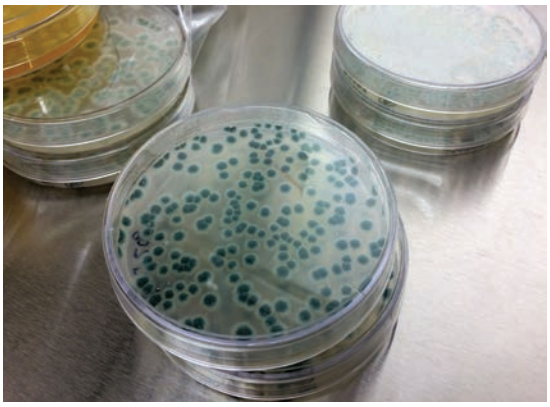

Figure 4 Penicillium camemberti growing in a petri dish in Ben Wolfe's lab. [Photograph by Nicola Twilley]

Figure 5 **Camembert cheese**

[Photograph: Halldora, Wordpress.com]

Making cheeses

Cheese-making is an art that has been in practice for more than 9000 years. Cheeses are produced by concentrating and changing the proteins (caseins) and fats in milk. This process depends on the actions of microbes to drive this transformation. The key steps in the manufacturing of cheese include milking, fermentation, coagulation, curd and whey separation, salting, and ripening. Microbes contribute to the final flavour, smell, texture, and colour of cheese. Specific microbes impart the characteristics of particular cheeses (e.g. holes in Swiss cheese).

References:

- *Gastropod: 'The Secret History of Cheese' – a podcast by Cynthia Graber and Nicola Twilley, on 23 March 2015*
- *http://academy.asm.org/images/stories/documents/FAQ--cheese.pdf [accessed 18-4-15]*

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Looking up to the heavens during Term 2

... Robert Garner

As we progress from autumn into winter, the nights will be getting longer as we approach the winter solstice. It will also be colder, so rug up, get away from the lights and start looking up!

The Planets

Mercury is always difficult to observe, never being far above the horizon, and only at either dawn or dusk. At the start of May, it will appear briefly in the western sky at dusk, but even when at its greatest separation from the Sun on 7 May, Mercury is only 6° above the horizon when the Sun is 6° below it towards the end of twilight. So, Mercury is hard to see against the bright background. In June, Mercury is visible in the NE pre-dawn sky in *Taurus*. In late June, Mercury will wander through the Hyades star cluster and will be quite close to the bright, orange-red star Aldebaran (the eye of the bull in *Taurus*) on 23 and 24 June. Mercury will be at its greatest height above the horizon on 25 June. Then, it will rapidly sink towards the horizon to be hidden from early July until it reappears in the evening twilight again in early August.

Venus will be a brilliant 'evening star' this winter. It will be in the NW evening sky, appearing a little brighter and a little higher each night until it is about 45° above the horizon on 7 June when it reaches its greatest angular separation from the Sun. Venus continues to get brighter each night until 10 July. Around the end of June and early July, Venus and Jupiter will be very close (<0.5° apart on 1 July). On 14 June, Venus will be adjacent to the Beehive cluster. This appears as a small cloud to the unaided eye, although Galileo realised its true nature 400 years ago and was able to see ~40 stars with his small telescope in 1609. Binoculars will show ~75 stars. Modern telescopes show ~350 stars down to 17th magnitude in brightness. By the end of July, Venus will be low in the sky. It disappears into the Sun's glare at the beginning of August and will reappear as the 'morning star' by the end of winter.

Mars will not be seen over this period as it will be behind the Sun approaching conjunction. Mars will not reappear until late August, when it will be visible in the early dawn sky.

Jupiter will be high in the north-western skies in June before sunset and will set around 11 pm. In July, it will set around 8 pm and soon after sunset in early August. On 20 June, Jupiter, Venus and the 4 day old new Moon will be very close to one another. For a few days at the end of June and early July, Venus and Jupiter will remain within 1° of one another – Venus will be the brightest. By 19 July, Venus, the bright star, Regulus and the new Moon will all be close together in the early western sky, with Jupiter below them.

Saturn is at opposition (on the opposite side of the Earth to the Sun) on 23 May, so it will be seen low in the east soon after sunset and will be visible all night as it crosses the sky from east to west setting before dawn in June. As the year progresses, the rise and set times of Saturn will get earlier with each day that passes.

Solstice

The southern winter solstice occurs at 2:38 am on 22 June 2015. This is when the Sun appears to reach its most northerly position relative to the equator. A few days later, on 7 July at 6 am, the Earth will reach its furthest distance from the Sun in its orbit (aphelion).

Meteor showers

The eta-Aquarids are normally one of the year's best southern showers. However, it will be close to the full Moon when they peak around 6 May. So viewing conditions will be far from ideal. It still could be worth observing, as there are usually around 50+ meteors per hour. The southern Delta-Aquarids and alpha-Capricornids both peak on 30 July – however, this is also close to a full Moon. So this winter will probably be poor for meteor viewing.

Constellations

The constellation *Leo* (king of the beasts) will be setting low in the western evening sky during May. However, it will disappear in the twilight by early June. The brightest star in *Leo* is Regulus – it was given this name by Copernicus as it means 'little king' in Latin. Regulus is more massive than the Sun and therefore hotter and brighter. Unseen by the naked eye, Regulus has two very faint companions – an orange dwarf star and a red dwarf star.

The winter constellations, *Sagittarius* (with its renowned Teapot) and *Scorpio*, will be high and prominent in the eastern sky this term. *Scorpio* is one of the few constellations to actually look like its name. A curved line of bright stars on the right represents its tail. Lying on its side, the claws are pointing upwards on the left. The heart of the scorpion is the red star, Antares.

To the south, the pointers, α Centauri (a yellow star) and β Centauri (a blue star) will be to the left of the inverted *Crux* (Southern Cross) constellation. The pointers and Southern Cross will be at their highest above the horizon over winter, so it is a good time to look at them more closely. These stars provide a good example of differences in the colours of stars – the colours will be easily seen with the naked eye, but are even more obvious using binoculars. In the *Crux* constellation, α Crux (at the bottom) and β Crux (at 9 o'clock) are both blue stars, while γ Crux (at the top) is an orange star. Australians usually depict them as white stars, while New Zealanders usually depict them as red stars – look at the two flags!

Situated very close to β Centauri is a cluster called the Jewel Box. It gets its name from the multitude of different colours shown by its 100+ stars when viewed using binoculars or a small telescope. It was described by astronomer Sir John Herschel as being like 'a casket of variously coloured precious stones'.

Using a Sky Chart / Planisphere

Remember, viewing the night skies is much simpler if you have a Sky Chart or Planisphere. See Box 1 to easily obtain one of these.

Box 1: Sky Charts & Planispheres

- You can download free sky charts each month to explore the night sky from: *www.skymaps.com/downloads.html* Make sure that you scroll down to 'Southern Hemisphere Edition'.
- A planisphere (star wheel) helps to find stars and locate constellations. These are inexpensive and available from astronomy shops, or you can download one – make sure it is for the Southern Hemisphere. While the site itself is out-of-date, there is a planisphere (star wheel) to print and use at: *http:/members.ozemail.com.au/~starrylady/resources.html*

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There are also **planetarium sessions** on the first Thursday of each month (except June) from 6:30-7:30 pm at Macquarie Uni. Tickets must be booked online at: *physics.mq.edu.au/community-schools/planetarium/*

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Pearson Science New South Wales 7–10

by Greg Rickard, et al

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***SciTalk 1/15* winner:** Marissa Ripper, Jindabyne Central School, won a *Pearson Science New South Wales* Stage 4 Combo Pack, published and donated by Pearson.

QUIZ QUESTION: After 9 years travel from Earth, what spacecraft is due to reach Pluto on 14 July?

SciTalk 1/15 answer: Resistance

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CONTRIBUTIONS

SciTalk **is due into schools mid-term. All contributions for *SciTalk* should be directed to the Editor (contact details are below).**

CLOSING DATES

- ***SciTalk*** **No. 1–February 2015 … Dec 19**
- ***SciTalk*** **No. 2–May 2015 … April 2**
- ***SciTalk*** **No. 3–August 2015 … June 26**
- ***SciTalk*** **No. 4–October 2015 … Sept 18**

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