Reflections

Journal of the Northern Sydney Astronomical Society Inc.

Volume 23 Number 1 January 2012

Welcome to the delayed first issue of Reflections for 2012.

Due to unforeseen circumstances, I had to rush to France late November and had to stay over there for 2 months.

Well, it's an ill wind that blows nobody any good and this delay has allowed our contributors to hone their articles to perfection.

Now, I expect to publish the next issue in time early April so please send your contributions before March 15th.

Cheerio,

Jean-Luc Gaubicher

In this issue

Vice President's Message

If you were at the NSAS AGM, you might appreciate the humour in my calling this the (Vice) President's Report.

As you remember from my last report, I was just going to nominate for Vice President, but as no-one would step up to the mark for the top job, the Society only has a Vice President at the moment.

I'll be talking to some possible candidates in the new year about taking on the Vice position and I'll stand for President (yet again) to fill the vacancy, with the understanding that if my new academic career gets too much, some kind of swap will be made in the future. In any case, the Committee is much the same, with Irene Justiniano a new member without portfolio and Peter Nosworthy having given notice that he will have to vacate the Secretary's position when he moves to the Blue Mountains.

I won't carry on about the Society members needing to get involved in the running of the Society, as I have done so too often, but I may call on you to do so.

While I was overseas, a good number of you got to the NSAS BBQ, which this year was held in October so as to be as close as possible to the 25th Anniversary of the Society. A few of the original members were in attendance and one of those, John Curdie who is still a member, has produced an excellent history of the Society, which you should have received a copy of with your notice of membership renewal. The BBQ was a good opportunity for many of our longer-serving members to reminisce about earlier days in the Society.

On the subject of membership renewal, you may remember that the Society Constitution has been changed and that renewals are due for payment by the end of the calendar year and that a notice of loss of membership will be sent to those not having renewed after the February Committee Meeting. If you haven't sent in your renewal by the time you receive this Reflections, you are overdue and need to mail it in ASAP.

Just a short review of 2011 before I talk about next year. This year we maintained and even increased our membership slightly but still see well less than 50% of the membership at General Meetings and other events.

We have introduced Field Trips (one to Parkes and one to Coonabarabran) this year and both have had about 20-25 members and partners along, so we will continue to try and come up with new ideas for trips in the future.

Our Outreach programs have been numerous in 2011 and we would expect to continue this next year, with the support of the membership.

Observing has been difficult this year, due to La Nina, but we have had some good nights and have attracted a number of visitors.

General Meeting Speakers have been varied and interesting and I believe the talk by David Malin in November was the highlight. I'll be trying to match this in 2012.

For next year, the Committee will try to come up with some innovations regarding observing, as it's agreed that North Turramurra has become less suitable over the years due to the growth of trees. A number of members have made suggestions for alternative venues, which we have asked them to check out and we will also talk to Kuringai Council and Macquarie University about possible observing sites.

We also plan to repeat our successful Public Star Party, which was part of the Lane Cove Cameraygal Festival.

The Theory Group will continue and we will no doubt restart the NAG sometime in 2012 when there is enough interest. On the subject of interest, the Committee would really like some ideas from the membership on what new things you would like to do, what speakers you would like to hear and any changes to our program that you think would benefit the Society. Just contact any Committee Member or me to discuss this.

In the meantime, we will have our usual break in January (except for Observing), so hope to see all of you at our meetings in February.

Bob Fuller

Calendar

General Meetings:	February 21st	Guest Speaker: Francisco di Mille (AAO) - Stellar jets from Sandeuleak's star and the Magellan Telescope
	March 20th	Guest Speaker: TBA
Theory Group Meetings:	February 14th March 13th	
NAG Meetings:	TBA	
Observing Nights:	Consult NSAS' web site at http://nsas.org.au/observing/	
Deadline:	Please send your contributions to the October issue of Reflections in time to reach the editor **before March 15th** to nsas.editor@ozemail.com.au	

From kitchen sink to rocket propellant or Alice in Space

You should wonder at the sanity of a person who declares that an aluminium saucepan will explode if it is immersed in the kitchen sink. It doesn't happen, does it?

Aluminium is the third most prevalent element in the Earth's crust coming after oxygen and silicon. Together, these three constitute a large fraction of the composition of Earth's igneous rocks and, except for the oxygen produced by plants, none of them is found as a free element. There is a reason for that: All three readily combine with each other and with many other elements. That statement may make you wonder why aluminium pots are expected to hang around virtually unchanged for centuries. Well, there is a reason for that too: Aluminium and Chromium are special metals in that they do not conform to the general rules for chemical behaviour unless their normal, very thin and invisible but resistant surface films of oxide are breached.

Puncturing the thin shield on aluminium is quite easy – e.g., by scratching - but also quite temporary as the fresh aluminium surface immediately begins to combine with oxygen from the air to regenerate its protective oxide coating according to the simple chemical equation:

$$4\,Al + 3\,O_2 \longrightarrow 2\,Al_2O_3$$

However, if the oxide protection is penetrated under water, the fresh aluminium surface extracts oxygen from the water and releases hydrogen gas. Actually, two separate reactions begin immediately, both producing hydrogen but with one of them producing grey gelatinous aluminium hydroxide while the other produces a colourless coating of oxide on the exposed surface and so turns off both reactions. The chemical equations are:

$$2\,Al + 6\,H_2O \longrightarrow 2\,Al(OH)_3 + 3\,H_2$$
$$2\,Al + 3\,H_2O \longrightarrow Al_2O_3 + 3\,H_2$$

At the kitchen sink, if you use steel wool to clean a wet aluminium pot, you may notice some bubbles in grey fluid – that will be the hydrogen in gelatinous aluminium hydroxide. Depending on how energetic you are and how coarse the steel wool is, you may produce a grey froth. In any case, you may think that the grey fluid means that you still have more cleaning to do. In fact, you may be just wasting your time and energy as well as the pot. Under controlled conditions, it would be found that these reactions actually release energy in the form of heat – a fact unlikely to be sensed in the kitchen sink.

A natural conclusion from aluminium's "no waiting around" property is that, on Earth, it cannot be produced in air or from solutions in water. Such restrictions hardly need to be considered for extraction of metallic aluminium on the Moon. According to F.S.Taylor's "Inorganic and Theoretical Chemistry" (p 376), the metallic element was first produced in 1824 by using metallic sodium in a fused aluminium compound, usually the chloride. The first electrolytic method came 30 years later but an improved electrolytic method, still used today, took over after another 30 years. Two natural aluminium minerals, bauxite and cryolite, the latter from huge deposits in Greenland, when purified in several steps, are fused together and loaded into an electrically conductive vessel made from graphite. This vessel becomes the cathode and a suitable electric current produces molten aluminium below the fused minerals where it is safe from oxygen. Though the aluminium is actually generated from the cryolite, this mineral is not used up as a very convenient set of chemical cycles releases oxygen and fluorine – the latter decomposes some bauxite and regenerates the cryolite. Without following the complexity of the cycles, the overall result can be summarised by an equation which suggests a simple reaction that belies the reality:

$$\text{Heat energy} + 2\,Al_2O_3 \longrightarrow 4\,Al + 3\,O_2$$

Aluminium can even extract oxygen from oxides of iron, when their mixture, in powdered form, is ignited. So much heat is produced that the resulting iron metal is molten and can be used to fuse two lengths of railway line together. To make the same reaction more energetic for 'thermite incendiary bombs', the ingredients are just made finer.

Continued on page 8

La Pérouse's Incomplete Voyage Round The World 1785 – 1788

With regard to the use of astronomy in his navigation

French navigator Jean François de Galaup, comte de La Pérouse was born at Gô near Albi in the south of France in 1741 and died in a ship wreck on Vanikoro Island in the Solomon Islands in 1788.

He was given control of two ships, La Boussole and L'Astrolabe that set sail from France on 1 August 1785 to explore the Pacific Ocean region and engage in scientific research.

The ships carried 225 men and included about seventeen astronomers, surveyors, botanists and hydrographers. There were also musicians among the crew. On board L'Astrolabe was chaplain and naturalist le père Receveur, who died at Botany Bay and is buried near the Laperouse Museum.

'Louis XVI giving instructions to Lapérouse', N.A. Monsiau, c.1785. Courtesy Musée de la Marine

La Pérouse received some very sound advice from Louis de Bougainville who had already circumnavigated the world from November 1766 to March 1769. Bougainville's two ships carried 330 crew and returned with the loss of only seven men. His book "Voyage Round the World" published in 1771 was well received having been translated into English.

La Pérouse received enormous encouragement from the King, Louis XVI, who was an avid reader of Cook's voyages to the Pacific.

He endorsed the purchase of the latest and highest quality instruments including a replica of Harrison's H-4 chronometer, telescopes, transits and sextants, obtained from England.

Ferdinand Berthoud, the Swiss clockmaker, who was based in Paris, also supplied chronometers. Berthoud had been sent twice to London by the King to view Harrison's chronometers.

A list of scientific instruments taken on the voyage is appended on page 7.

La Pérouse placed an embargo on all his scientists that they were not to communicate their observations prior to returning to France, so that Louis XVI could read of their work before its general publication.

This instruction meant that all the documents relating to their experiments with tides, magnetic declination, confirmation of latitudes and longitudes of ports and islands visited, were retained on La Boussole and L'Astrolabe and were lost in their wreckage at Vanikoro Island.

The Royal Instructions given to La Perouse, 15 February 1785 were very detailed: "Immediately upon arriving in a harbour, he will select an appropriate site on which to erect the tents and the observatory, and will set up a guard. Separately from observations relating to the determination of latitudes and longitudes, for which every known and practicable method will be used, and those needed to assess the declination and inclination of the dipping needle, he will ensure that any celestial phenomenon which may be visible, be observed; and on every occasion he will give the astronomers all the help and facilities necessary for the success of their work".

La Pérouse did not deviate from the King's instructions. Throughout his journal, he is conscious of the accuracy of the work being done by the scientists. In Dagelet's notes, results based on the lunar tables were compared with the expedition's chronometers and sea timekeepers.

To make such comparisons was one of the specific instructions to the astronomers, both on board ships and ashore.

The instruction was "and he (La Pérouse) will take care that such observations are multiplied so that the average result of different operations can give a more precise determination".

The astronomical observations on board La Boussole were generally made or closely supervised by Dagelet, d'Escures and d'Arbaud.

Dagelet and d'Abaud observed alongside each other, calculating their co-ordinates, using any one of a number of telescopes, sextants and clocks carried by the expedition.

The determination of the longitude of Botany Bay was certainly made with reference to the published lunar and planetary distance tables of Mayer, Maskelyne and Lalande and were calculated using La Caille's logarithms, all of which are known to have been carried on the expedition.

It can be inferred that Dagelet preferred Lalande's tables (Éphémérides) to those produced by Maskelyne and the Board of Longitude, as the final co-ordinates supplied to Dawes had Paris as the origin rather than Greenwich.

These various distance tables were all very accurate, based on and limited only by the then known dimensions of the Earth.

Their accuracy is to the nearest minute of arc; that is, plus or minus half a minute of longitude. La Pérouse praised Dagelet in referring to the crossing from Easter Island to Hawaii where Dagelet, as in all crossings, never let an opportunity slip to make observations of distances. Their agreement with Berthoud's watches was so perfect that the difference was never more than ten to fifteen minutes of a degree. They acted as proofs to each other.

Of Berthoud's gimballed sea clocks, No.18 was allocated to L'Astrolobe and No.19 to La Boussole on which Dagelet sailed. He believed No.19 was the better clock. It is known that the First Fleet of Captain Phillip and La Pérouse both carried the finest quality clocks and chronometers.

Dagelet was responsible for observing compass variation (magnetic declination) throughout the voyage and documented same. Provisions were made for measurements of magnetic dip or inclination, which was difficult to do on a moving ship.

Continued on page 5

Coonabarabran Field Trip

The Society had its second Field Trip of 2011 in November, when 20 members and partners made their way to Coonabarabran on the 25th through heavy rain and no doubt wondering: "why am I driving to an astronomy event when it's raining and cloudy?"

Those who made it early enough on Friday night met up at the Coonabarabran Bowling Club for dinner and were joined by a few members of the Coona Astronomical Society, one of whom was a previous NSAS member!

As it turned out, the group were greeted on Saturday morning with a clearing sky which rapidly became totally clear as the day progressed.

The plan for the Field Trip was similar to the one at Parkes in June and, in this case, a tour of the Australian Astronomical Observatory (AAO) was organised, with Donna Burton, one of the astronomers from ANU, being our tour guide.

We were first shown the U.K. Schmidt Telescope that has been operational for even longer than the Australian Astronomical Telescope (AAT) and has been a photographic sky survey workhorse for the United Kingdom contingent. Unfortunately, the U.K. has pulled out of the AAO for financial reasons and, unless funding can be found in the future for other projects, the Schmidt Telescope is doing its final projects.

Donna then gave us an incredibly in-depth tour of the AAT and while I had toured it before, we saw things I had not seen before. Owing to the very imaginative engineers in the ANU and other institutions, the AAT, a 4-meter Cassegrain telescope, remains cutting-edge due to such innovative instruments as the 6DF (6-degree field) fibre optic spectroscope. We could see the pride that the users have in the AAT and, as long as the Australian Government continues to support astrophysics, it should continue to contribute to science.

The next major scope at Siding Springs we toured was the ATT, Advanced Technology Telescope, that was build by the UNSW. This 2-meter telescope was an early concept that has now shown up in all the new 8-meter class telescopes, which is a scope which moves in dec only, with the building moving in azimuth.

Finally, we took a tour of all the smaller scopes that are on the northern end of the mountain, many of which are remotely operated from universities outside of Australia.

A final look at the 360-degree view from the trig station on the top of the mountain and we headed back to our motel, the Warrumbungles Mountain Motel, which is on the road from Coona to Siding Springs. While it is a bit rustic, everyone was comfortable in this motel which is also the home for the Two Rivers Dob group when they visit Coona.

After a BBQ hosted by the motel, a large number of our group headed down the road to Peter Starr's Warrumbungle Observatory where he has a setup for the public to observe.

Peter set up 5 telescopes for us, including his new 20" RC on a Paramount ME.

As the night rapidly became one of the best observing nights for months, according to Peter, we had a great time looking through large scopes under a sky full of stars.

Jupiter and many of the clusters that we see poorly in Sydney jumped out of the eyepiece and looking at the Tarantula through a 14" scope under dark skies was a new experience for many of us. I think for many of us, this night rekindled our interest in observing.

On Sunday morning, most of the NSAS group headed back to Sydney, but some were continuing a tour they had started in the northern NSW area the week before. While a Coonabarabran trip may not be an annual event, many of us have come to really like the town and the area, so I'm sure that there will be some private trips in the future.

Bob Fuller

All pictures by Yuko Nosworthy

La Pérouse's Incomplete Voyage

Continued from page 3

On 1 January 1788, La Pérouse ordered the expedition to sail from Samoa, west by southwest, direct for Australia. There was little to be found on the way, except Pylstart Island, now Ata Island, discovered by Abel Tasman nearly 150 years earlier, a lonely island south of the main Tonga group.

Even so, La Pérouse would not have gone near it had the winds not driven him in that direction. It gave him the minor satisfaction of correcting the position James Cook had assigned to it. The Englishman had placed it 6.5 kilometres too far south. It is not recorded who fixed the location, but probably Dagelet was involved.

On arrival at Botany Bay on 24 January 1788, Dagelet set up a temporary observatory. He and Dawes, who was in Sydney with the First Fleet of Captain Phillip, were both eminent astronomers and had been provided by their masters with the finest of instruments.

They each appreciated the scholarship of each other and Dagelet gave Dawes advice on the setting up of his observatory in Sydney.

As was Dagelet's normal procedure, he observed the co-ordinates of the location of his Botany Bay observatory and he advised Dawes of his results. Dawes had access to Captain Cook's K-1 chronometer, made by Larcum Kendall and used by Cook on his second voyage. It appears that the time of Cook's K-1 chronometer was not compared with the English chronometer of Dagelet which was probably made by Thomas Earnshaw.

Dagelet also had the use of two astronomical pendulum clocks for his longitude calculations.

Unfortunately, Dawes' results of his observation have been lost as were those of Dagelet in the shipwreck.

La Pérouse had sent an invitation to Captain Phillip to dine on La Boussole but, for some reason, he was unable to attend and he sent Lieutenant Philip King and William Dawes, the astronomer. They sailed or rowed their small boat from Sydney Cove to Botany Bay, about 15 kilometres, on 2 February 1788.

Captain Phillip had chosen these two men because they both spoke French. They dined and stayed for the night on board the ship.

King reported "After dinner I attended ye Commodore and other Officers on shore where I found him quite established, having thrown round his tends, a stockade, guarded by two small guns, in which he is setting up two Long Boats which he has in frames; an observatory tent was also fixed here, in which were an Astronomical Quadrant, Clocks etc. under the management of Monsieur Dagelet, astronomer and one of ye Academie des Sciences at Paris".

The criterion for the English clockmaker John Harrison to win the Board of Longitude prize of £20,000 was that the chronometer should be instrumental in charting longitude to within half a degree of accuracy. Precise determination of the latitudes and longitudes of places visited was more possible than on the voyages of earlier French navigators because of the improved lunar tables and the chronometers available to La Pérouse. With these aids, wrote La Pérouse, the French expedition was never more than half a degree off course. This endorsed Harrison's claim to the prize.

My conclusion is that La Pérouse's voyage was provided with a much larger and probably more highly qualified group of scientists, meteorologists and geographers than Cook. La Pérouse's staff was provided with the best instruments available. La Pérouse's strict discipline in relation to scientific effort is to be applauded and the lack of evidence of their work, due to the shipwreck is to be lamented. There was equally as much reliance placed on La Pérouse's astronomical navigation as his instrumental navigation. They combined to give a self-correcting result.

Arthur Boyd

Acknowledgements

•Much of this information is taken from "Dagelet & Dawes: Their Meeting, Their Instruments and the First Scientific Experiments on Australian Soil" by Dr. D. Morrison and Prof. I. Barko. Appendix 1 of this article includes a biography of Dagelet and of Dawes.

•Prof. E. Duyker has been very helpful in recommending the above-published article, supplying the list of ports and many other pieces of information.

•Extracts from "Oceanography in the Days of Sail" by Ian Jones and Joyce Jones and from "Longitude" by D. Sobel and W.J.H. Andrewes, are acknowledged.

Venus to help fighting Global Warming?

An international team including Jean-Loup Bertaux, CNRS senior researcher, and his colleagues from the Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS) has discovered a layer of sulphur dioxide in the upper atmosphere of Venus. The researchers obtained this result using measurements performed by ESA's Venus Express spacecraft. They propose a new mechanism to explain this unexpected result.

SO2 is of particular interest since this gas could be used to cool down the Earth via a geo-engineering process put forward by Chemistry Nobel Laureate Paul Crutzen.

Venus is entirely covered by a thick layer of clouds, between 50 and 70 km altitude, above which a thinner mist extends to around 100 km altitude. The clouds and mist consist of droplets of concentrated sulphuric acid.

Using ESA's Venus Express spacecraft and its on-board SPICAV instrument (SPectrometer for Investigation of Characteristics of the Atmosphere of Venus), the researchers discovered the presence of gaseous sulphur dioxide high up in the atmosphere.

The researchers believe that the sulphur dioxide derives from the sulphuric acid mist in the upper atmosphere of Venus.

On the day-side of Venus, the temperature increases with altitude above 90 km, which causes the sulphuric acid to evaporate. It then decomposes under the effect of solar radiation, producing sulphur dioxide.

Sulphur dioxide is also found on Earth, released mainly by volcanic eruptions. Sometimes reaching altitudes as high as 20 kilometres, it turns into sulphuric acid, causing the formation of small droplets. The droplets reflect part of the solar radiation back out to space, leading to a fall in surface temperatures. Drawing inspiration from this process, chemist and meteorologist Paul Crutzen, winner of the 1995 Nobel Prize in Chemistry, suggested several years ago that it would be possible to artificially release massive quantities of sulphur dioxide at an altitude of 20 kilometres in order to cool down surface temperatures and offset the growing greenhouse effect.

Source Institut Pierre Simon Laplace
http://www.ipsl.fr/

Paul's Corner

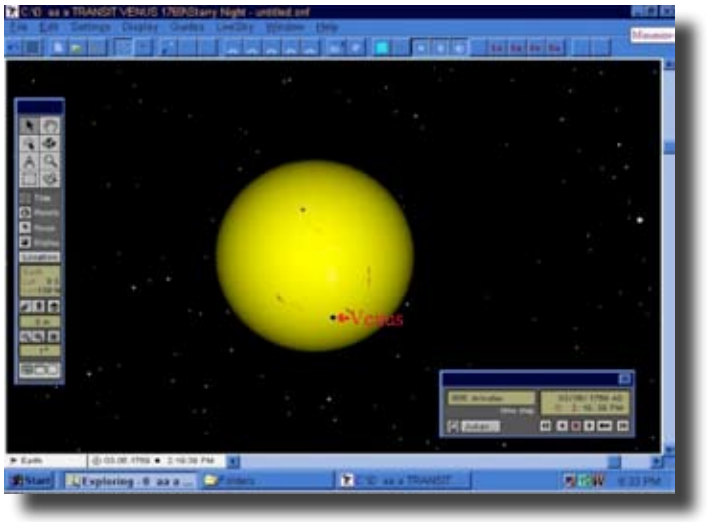
Now being well into the year 2012 and with only a few months to go before this famous event, the transit of Venus, is repeated I thought that we should be up to date with the history of the sightings of this transit.
Firstly the findings by Captain Cook on his journey in 1769 and then secondly the efforts made by the Astronomer H.C. Russell at Sydney Observatory in 1874 that will follow in a separate article later.

I was a bit puzzled by contradictory information on the success of the sighting of the transit of Venus in 1769 by the scientists with Captain Cook on his special journey to Tahiti so decided to see what I could find on the Internet that might resolve the question.
And what better than the Logbook kept by Captain Cook himself on board the H.M. Bark Endeavour?

The many notes in the log book will appear in this article to be written and spelled totally incorrect, please allow for the period times that they were written and do not think my typing has degenerated. The items have all been copy-pasted as they stood and it is intriguing to see how more complicated we have made the language over the last 230 years.

Preparations for the event
Tuesday 30th
We are now very buisy in preparing our Instruments & Ca for the Observation and Instructing such Gentlemen in the use of them as I intend to send to other parts to Observe for fear we should fail here —

Wednesday 31st
Late this Evening the Carpenters finished the Longboat



Computer simulation of the 1769 transit using STARRY NIGHT set to location for Tahiti and date 03/06/1769

Thursday 1st June ^ 1769
This day I sent Lieutenant Gore in the Long-boat to York Island with Dr Munkhouse and Mr Sporing / a Gentleman belonging to Mr Banks / to observe the Transit of Venus, Mr Green having furnished them with Instruments for that purpose Mr Banks and some of the Natives of this Island went along with them —

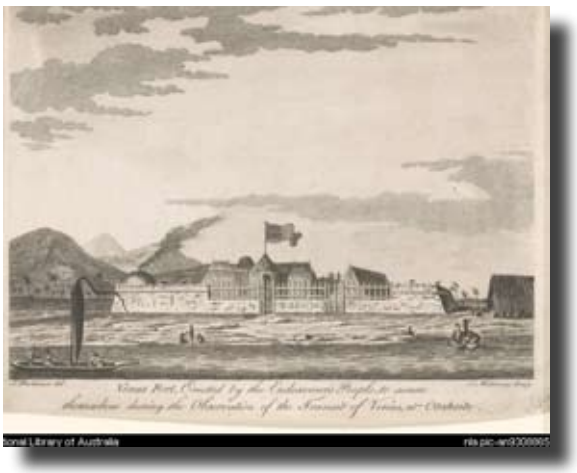
Friday 2nd of June
Very early this morning Lieut[t] Hicks, Mr Clerk, Mr Petersgill and Mr Saunders, went away in the Pinnace to the Eastward, with orders to fix upon some convenient situation on this Island and there to observe the Transit of Venus - they being likewise provided with Instruments for that purpose —

The event. (Note if we had been discovered it would have been the 4th June in Australia as we would have been across the international date line.)
Saturday 3rd
This day prov'd as favourable to our purpose as we could wish, not a Clowd was to be seen the Whole day and the Air was perfectly clear, so that we had every advantage we could desire in Observing the whole of the passage of the Planet Venus over the Suns disk: we very distinctly saw an Atmosphere or dusky shade round the body of the Planet which very much disturbed the times of the contacts particularly the two internal ones. Dr Solander observed as well as Mr Green and my self, and we differ'd from one another in observeing the times of the Contacts much more than could be expected — Mr Greens Telescope and mine where of the same Mag[n]ifying power but that of the Dr was greater than ours- It was ne[a]rly calm the whole day and the Thermometer expose'd to the Sun about the middle of the Day rose to a degree of heat / 119 / we have not before met with / 119 /

Added bonus: did you know of this eclipse?
Sunday 18th
Variable winds and clear weather — This night we observe'd the Moon totally eclipsed —

Paul Shallow

The complete transcript of Captain Cook's Journal can be found at http://southseas.nla.gov.au/journals/cook/about.html



Venus Fort, erected by the Endeavour's people to secure themselves during the observation of the transit of Venus at Otaheite http://nla.gov.au/nla.pic-an9308865

1st Lindfield Cubs Event

Following a request from Don Burnett, cub leader, NSAS agreed to organize an astronomy evening for the 1st Linfield Cubs on November 19th.
In addition to myself, Peter Nosworthy, Gary Maass, Tim Herridge and Craig Watford supporte the event.

The evening began at about 6pm and, while the Cubs were having various investitures and games, Tim Herridge brought out his scope fitted with a sun filter to allow the boys to view sun spots. This was a very exciting start for the boys and it allowed us assisting to view them as well.
Then followed the PowerPoint presentation on The Solar System. It didn't take long when out of the blue one of the boys asked 'Does Uranus really smell?'
This remained unanswered and we proceeded with the presentation. There were plenty of questions throughout.

At the end the boys were off to a pizza and salad dinner all spread out on trestles outside the front of the hall. We were invited to participate in the dinner, very kind of the leaders.

By this time it was dark enough and the scopes were up.
The viewing was carried out with plenty of supervision and the boys enjoyed every minute of it. Some of them came up to us at the conclusion and personally thanked us for our contribution.
All in all, a very good evening.

Peter Korber.

La Pérouse: List of Instruments of Astronomy and Navigation

- Three astronomical quadrants.
- An instrument for observing the transit of planets.
- Three astronomical time-keepers and two calculators.
- Several astronomical telescopes, night telescopes and prism telescopes.
- An English pocket watch, or chronometer, for the longitudes.
- Four reflecting circles, by M. de Borda, to observe the heights and distances of the stars.
- Three English sextants for the same use.
- Four theodolites, or graphometers, with and without telescopes, to measure the angles on land and construct plans.
- Two assortments of chains and of staves for the same use.
- A steel fathom rod, with its scale, the same which served for the measure of a degree of the meridian at Peru.
- Divers instruments for measuring the length of the pendulum.
- Two English compasses for observing the variations of the magnetic needle.
- Two dipping compasses lent by the English Board of Longitude, the same which were used in Captain Cook's last voyage.
- A compass of the same nature executed by M. Le Dru.
- Several other compasses of different uses, such as miners compasses and others.
- Several suitably chosen magnetic bars, in their cases, to retouch the compass needles in case of necessity.
- Several sand glasses, half hour and half minute.
- A suitable chest, with all the tools in clock and watch-making, and others for repairing the instruments, for the use of the clock and watch-maker eembarked on the expedition.
- Several cases of mathematical instruments for the use of the astronomers and engineers and other instruments suitably chosen for designs and drawing.
- Three quadrants were lent by astronomers.

Information extracted from "A Voyage Round The World – La Pérouse" Vol. 1 written in French in 1797 by Milet-Mureau and translated into English in 1799. The total cost of the instruments of astronomy, of navigation, of physics etc. and of books bought in France amounts to 17,034 livres. There were also about 6,000 livres expended in England for different articles. The total fit-out cost 150,000 livres. At the time twenty three livres was said to equal £1.

From kitchen sink to rocket propellant

Continued from page 2

The reason is that the finer ingredients have a much larger total surface area for the reaction to occur.For the commonest oxide of iron, haematite, the thermite equation is:

$2\,Al + Fe_2O_3 \longrightarrow Al_2O_3 + 2\,Fe + Heat$

In nature, bauxite is produced by deep weathering of igneous rocks under tropical conditions – wet and warm - lasting for thousands of years. Natural nitric acid in rain [following electrical storms] along with dissolved atmospheric carbon dioxide and other compounds from biological action in overlying soil combine to form and leach away compounds of potassium, sodium, calcium, magnesium and even some of the aluminium (as clay). This leaves a residue of silica, iron oxides and hydroxides and aluminium oxide mostly in a hydrated form. [Because of bauxite's method of formation, it is not expected that it would be available on the Moon or on Mars though suitable parent rocks seem to be abundant on both.]

Now for the rocketry:
Propellants are typically controlled explosions of a fuel and an appropriate oxidant that, under its conditions of use, readily provides oxygen to combine with the fuel. Under special conditions, the necessary oxygen may come from an unexpected source. [Some propellants have only one compound which is pressure-sprayed onto a plate covered with a catalyst to produce a continuing explosive decomposition.] The majority of propellants use just a pair of compounds whose burning has to be initiated by a method appropriate to that pair. Solid propellant mixtures cannot be turned on and off like liquid propellants and once ignited, they burn to completion.

Noting that aluminium readily and energetically enters into chemical reactions when it is in powdered form, modern scientists asked questions including "Just how reactive would it be in nano-sized particles?" and "Would the reaction with water be remarkably enhanced with the heat released quickly enough to flash-boil the water and so produce a sudden and large increase in volume?" With good reason, only small amounts of aluminium were used in initial trials just in case the suspected result actually eventuated.

The ALICE flight-vehicle assembled on its launch rail actually represents tens of millions of dollars in research funding. Credit: Dr. Steven F. Son, Purdue University

Plenty of testing eventually showed that the nano-particles of aluminium and a small volume of very cold water could produce a stable mixture with the consistency of toothpaste without any reaction. If the mix was then frozen, it could be kept for a considerable time. The resulting product has been given the name ALICE and in August of 2009 it was successfully tested as a solid propellant in a small rocket in the USA. NASA and the Air Force Office of Scientific Research in conjunction with staff and research students from a couple of Universities prepared a skinny rocket 'nine feet long' for launch from a vertical rail. It was fired and reached a height of over '1200 feet' (365 metres) over a farm property belonging to one of the Universities.

In view of the possibility of problems with their absorption by human lungs, some questions have been asked about the dangers due to the size of the aluminium oxide particles produced by ALICE. In defence, some scientists working on optimising ALICE by addition of oxidants (for combustion of the hydrogen produced from the water) have pointed the finger at some little publicised facts about the solid propellant used in the launch boosters of the Shuttles. E.g., Every launch produced over 230 tonnes (NOT kg) of HCl – hydrogen chloride or hydrochloric acid gas – which can produce many more tons of liquid hydrochloric acid by combination with the moisture in the atmosphere. Those solid rocket boosters used the explosive, ammonium perchlorate, as oxidant and HCl gas is its most environmentally offensive by-product.

With currently limited supplies of water established on our Moon, we can expect plenty of dollars to be spent on finding new ways of producing aluminium there. Clearly, solar electricity is plentiful but bauxite and cryolite are not expected to be available. Only when such production is achieved, can the ALICE promoters claim that they have produced a truly successful 'green' propellant that would allow return space flights from the Moon without the expense of carrying extra fuel from Earth on the outward run.

The future of aluminium may include a new "cycle" though different from the cycles associated with our atmospheric gases: viz., 'the nitrogen cycle' and 'the carbon dioxide-oxygen cycle'. Considering our source of aluminium in bauxite and its possible exit from a rocket as aluminium oxide, we may even have a new meaning for the phrase, ' from dust to dust'!

Bob Roeth

Ref. for the rocketry: http://www.science20.com.news_articles/alice_environmemtallyfriendly_rocket_propellant

Reflections is published quarterly by the Northern Sydney Astronomical Society Inc
PO Box 56 Lane Cove 1595 Tel: 0423 971 374 E-mail: nsas@nsas.org.au Web site: www.nsas.org.au