Stargazey Pie!

A slice of Highlands astronomical life!

Tues 3rd March 2009

Introduction

The March meeting had an enormous attendance: 57 people turned up to hear Arthur Milnes discuss the problems of powering satellites and spacecraft. They also heard a report on this year's Astrofest in London from someone who was actually there: Paul Jenkins. And to top it all off, there were various updates and items of news no self-respecting Highland Astronomer could live without. Eric Walker, standing in as Chairman for this meeting, elucidated upon some of the following notices:

- **Welcome! (And abandon hope all ye who enter here…)** A warm welcome is extended to Donald Noble and Paul Jenkins, who have joined the Committee and filled the slots left by Maarten de Vries and Simon Urry. If you are reading this, Donald and Paul, don't worry about that strange clanging noise you just heard: it was just the ominous slamming of a heavy solid door in your minds. The door that led to freedom… Thanks of course go out to Simon and Maarten for all their contributions to the Society.

- **IYA 2009: "4000 years of Astronomy in the Highlands"**. The Mini Science Festival runs from Sat 21st to Sat 28th March. Most of the organisation is being undertaken by Pauline Macrae, so please contact her for more information, or if you would like to volunteer to help at any of the events (which would be very much appreciated). The timetable for the event is as follows:

  Sat 21st: Children's afternoon at Visitor Centre 14:00 – 16:00; Howie Firth talk: "The Bear and the Ship" at St Mary's in the Field Church, Culloden. Doors open 18:45 for start at 19:00.

  Sun 22nd: Douglas Scott "The Clava Cairns" at the Visitor Centre, 14:00 with visit to the Clava Cairns afterwards.

  Mon 23rd – Thu 26th: Talks to four schools.

  Midweek: Events to be confirmed…

  Sat 28th: Planetarium show at Visitor Centre, 10:00 – 16:00; John Brown: Moon-walk and talk, "50 years of astronomy and magic", 19:00 at Visitor Centre.

  Sat 21st – Thu 26th: Public observing sessions at JSL Observatory. 20:00 – 23:00 with last admissions at 22:00, except Friday. The Messier Half Marathon will take place on Friday 27th, 18:30 – late.

- **Observing Sessions:** During the Mini Festival, the observing sessions are open to the public and to members. Contact details are as follows:

  Sat 21st – Maarten de Vries
  Sun 22nd – Rhona Fraser
  Mon 23rd – Antony McEwan
  Tue 24th - Pauline Macrae

Wed 25th – Rhona Fraser
Thu 26th - Lynn Robinson
Fri 27th – Messier Half Marathon (open to HAS and SIGMA members and their guests) – Maarten de Vries

Members Only Sessions:
Fri 3rd Apr – Lynn Robinson
Sat 4th Apr – Antony McEwan

- **Parking Protocol.** If you visit the observatory on club nights we suggest you bring a torch to help you see and use the new combi-lock on the car park barrier. You will be contacted with the code for the lock, and please remember to reattach it as you found it and to scramble the code when you close it. Further details of these procedures will appear on the website.

- **AGM.** Notice of this year's AGM was given. It will take place at the April meeting, Tues 7th at 19:30. The annual reports will be sent out by email or snail-mail about a week before the meeting, to give you time to review them and prepare any comments/observations/tirades. After the AGM business is concluded, there will be either a talk about black holes or a viewing of the DVD "Magnificent Desolation: Walking on the Moon", courtesy of Andy Ferguson.

- **Office Bearers.** Will any member wishing to stand for the positions of Chairperson (2 year post), Treasurer (2 year post) or Secretary (1 year post) please contact Eric Walker. The Committee have put forward the following names, but this does not mean that others cannot also be considered:

  Chairman: Eric Walker
  Treasurer: Paul Jenkins
  Secretary: Pat Williams.

- **"We are making a list..."** The Committee appreciates that many members are quietly working away at tasks for HAS in the background. Lynn Robinson has taken on the task of compiling a list of "who does what". Please could you contact her with details of what you do, if there is anything you would like to do, or any skill you would like to offer.

- **Joint anyone?** A special joint meeting between SIGMA and HAS will take place on Fri 8th May at Nairn Community Hall at 19:30. It will also be open to the public and will feature a talk by UK Director of the International Year of Astronomy (and former Culloden Academy pupil) Steve Owens, on the subject of refuting astrology.

- **HAS Messier Challenge Update.** Please let a Committee member know if you are approaching completion of one of the Messier lists or whether you need help to find any of them.

- **Lunar Postcards.** Essential and yet cheap, the Moonphase postcard is recognised as one of the must-have items for any style-conscious solar system traveler. Ignore this at your peril, or better yet just give the Society £1 (Earth money) and be safe in the knowledge that when your papers are examined at interplanetary checking stations, you ***will*** be advanced to the head of the queue…

- **Seeing Stars.** This month's 'Seeing Stars' article ("On The Trail of a Comet") is by Antony McEwan and is about comets and satellites. It is published in the Fri 6th edition of the Inverness Courier and has been uploaded to the website here too: http://www.spacegazer.com/index.asp?pageid=126102.

- **Youngstars.** The children's session at each meeting takes place from 19:00 to 19:30. If you know someone who would like to come along and attend, please encourage them to do so.

Observatory Update

Observatory Manager Lynn Robinson gave us a short resume of observatory activities in the last month. And it was quite short, as the weather has really not been kind to us recently! However, she did raise a few good points. First was that when the observatory is used, for any reason, could the people there please remember to remove any organic waster that they may produce. We're talking teabags here. If one of the members present could just do a quick check of the bins before leaving, taking any rubbish that will decompose with them and putting a fresh bin bag in its place. That would make the observatory atmosphere much more pleasant for the next person to walk in the door, perhaps after a week or two…

Lynn also went into some detail about the process of opening and shutting the barrier that blocks the car park entrance. As you will probably know by now, there is a Society combination lock on the chain and all members will be aware of the combination code. Lynn will put detailed instructions on the website for using the combination lock, but in essence the procedure is simple. Remember to lock it behind you, and remember to scramble the code when you do so. Also, remember to attach the lock so that it joins the NTS lock to chain (not chain to chain) and everything will be well.

Finally, Lynn revealed her special gift to the observatory – a brand new homemade donations box! Her first attempt at marqetry, the box is inlaid with a picture of the observatory and the asterisms of the big and little dippers shining down from the night sky above it. The donations are placed in the slot – which is located in the dome aperture itself! This is a brilliant addition to the observatory, and big enough to hold all the vast amount of donations that we hope to acquire over the coming months and years.

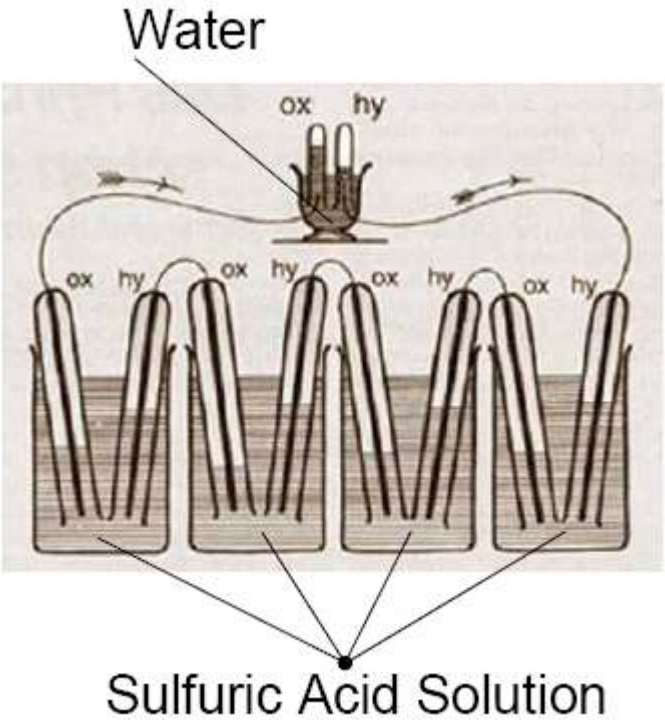
The Main Event
'Powering Satellites and Spaceships' by Arthur Milnes

Arthur has spoken to us many times before, starting at a meeting in the Spectrum Centre when Arthur stepped in to fill a void with an impromptu talk, which was very well received. In his talks, Arthur draws on his knowledge and experiences garnered as a working pilot, both Fleet Air Arm and commercial, and sticks to subjects that reflect his own personal interest in science and astronomy.
Arthur started off by talking about how we take electrical power for granted. We flick a switch and expect the kettle to boil, lights to go on, entertainment to flood into our brains, etc, with no thought to the efficiency of the processes involved in generating the required power. That may be ok on Earth, but in space there is no electricity grid to rely on, and scientists have to think very carefully about how the power for satellites and spaceships is produced. Thrift is the key when every watt counts!

There are basically three ways of powering space vehicles: Fuel Cells, Solar Power, and Nuclear Power. Each has its own advantages and disadvantages and is best suited for particular applications, as Arthur demonstrated.

Vehicles that operate in near-Earth environments have a particular set of power demands. An example is the Space Shuttle. The flights are usually **of** short duration, and always manned. The Apollo moon missions were similar, though did venture further away from Earth. With people on board, the power requirements multiply. Heat and light are needed, as well as life-support systems, as well as the computers that actually enable the vehicle to function. No surprise then that the Space Shuttle originally flew with three independent fuel cells, each capable of a continuous output of 12kW, and if necessary up to 16kW. Later missions used cells that could produce 21kW continuously.

The fuel cells they use can trace their ancestry back to the work of Christian Schonbein and William Groves in 1838. The image here shows how passing an electric current through the assembly will separate the water in the acid to oxygen and hydrogen, making it a battery of potential current. By reconnecting the input/output wires, the gases recombine and a current flows – the battery produces electricity.



The work continued through the 1950's, resulting in highly efficient (50%) cells that also produce as a by-product, water. This is very useful for manned spaceflights where water is an essential requirement. As liquefied gases power the cells, the amount of the raw materials that the cells hold also limits the possible flight duration. They are also quite heavy, contributing greatly to total vehicle weight. Despite this, these cells have been used on numerous very successful space missions, including all Shuttle missions and the Apollo landings. For the latter, they powered not only the Command Modules that transported the astronauts through space, but also the landing modules and even the lunar rovers that enabled motorised exploration of the Moon's surface.

So in summary, fuel cells are highly efficient (with further research in progress, aimed at making them even more so), produce useful water as a side effect of their functioning, and are relatively small. Their main downside is that the fuel they use i.e. liquefied hydrogen and oxygen, limit the flight duration.

Solar power is better suited to missions that require a longer vehicular lifespan – communications or scientific satellites for example, which have expected operational lifespans of ten years or more. You would think that the Sun would produce a huge abundance of power for anything equipped with a solar panel or two floating around Earth orbit, but it's not quite that simple.

In Earth orbit, the "solar radiance" is 1.37k per square meter and modern solar cells have an efficiency of 12-22%. If therefore a satellite requires 5kW power supply, then at 20% cell efficiency we would need 32.5 square metres of solar panel; probably more, to allow for inefficiencies in other components. As the distance from the Sun increases, so the solar radiance decreases (by the inverse square law), and so even larger areas of solar panel become necessary. A good example of a satellite in Earth orbit that uses solar power is the Hubble Space Telescope. It is in low orbit, about 600km above us, and needs a 4.4kW power supply, obtained by two 25-foot solar arrays. Some of the energy gathered is stored in on-board batteries, which are about as powerful as twenty car batteries, so that the satellite remains powered when it is in the Earth's shadow.

This is one of the main problems with solar-powered satellites. Depending on exactly what orbit they are in, they may spend some time in the Earth's shadow. As Hubble has demonstrated, storing some of the energy generated by the solar panels in nickel cadmium or nickel hydrogen batteries is a good way of allowing the vehicle to remain operational until it can re-emerge into life-giving sunlight. If the satellite is in a high enough orbit, say 10,000 to 25,000 miles or more, as is the case with a lot of communications, GPS and TV satellites, then the problem is much reduced. In geo-stationary orbit, they orbit the Earth in the plane of the equator, inclined by 23 degrees to the ecliptic, so will only spend a very minimal time in Earth's shadow. That time comes when Earth approaches the spring equinox, when satellites such as these will spend periods of up to 72 minutes in shadow. Careful positioning of these satellites can mean that they will spend their 'downtime' at periods when power reduction is most tolerable. For example, TV satellites will be positioned so that it coincides with late night or early morning broadcast times.

So, solar power is useful in that it makes use of an already present power supply and is relatively efficient to produce. Excess heat build-up can be a problem though, and the excess has to be radiated away from the satellite. Also, the drop in the Sun's power as we move away from Earth is quite drastic, so for all intents and purposes the limit of solar power supply is really Mars, with anything beyond being untenable.

They are robust though, and indeed have to be, as they have to endure the cold vacuum of space, and the constant barrage of micrometeorite impacts, with repair missions being out of the question.

But what if we want to venture out to Mars with a manned mission? Or beyond, whether the mission be manned or unmanned? Fuel cells and solar power would both be unusable, with their insufficient power generation and limited flight duration. We need something that lasts a long time, can supply a constant usable power supply, and is not dependent on large amounts of fuel or solar radiation. How about nuclear energy?

Well, it would be impossible to launch a fission reactor into space at the moment, because of the size of the number of components required to convert the energy released into electricity. It would also be well nigh impossible to shield those components (or human occupants) from terminal amounts of radiation!

The solution is to use a RTG, or Radioisotope Thermoelectric Generator. It uses Plutonium 238 for its fuel, which has a half-life of 87.7 years, therefore is a long lasting power supply capable of providing energy for the lifetime of any currently conceivable space mission. The radiation it emits is in the form of high-speed alpha particles, which are easy to shield against and are harmless to humans exposed to it, unless it is ingested or inhaled – probably unlikely that any astronaut would eat their spaceship's power supply. Did you know that most smoke detectors contain the alpha emitter material Americium-241? This shows how reliable and safe alpha emitters are in everyday situations.

The RTG consists of a slug of Plutonium 238 in the form of its oxide, surrounded by many thermocouples - junctions of two semi-conductors with one end heated by exposure to the fuel rod. Each thermocouple is only 4% efficient, but with space in the assembly for many of them RTG's are expected to generate several hundred watts over a lifetime of perhaps ten to twenty years. The Cassini probe that journeyed to Saturn uses three such devices, each generating 300W (though you may remember there was some controversy at the launch of a vehicle using nuclear power as its fuel supply).

Now this 900W (supplied by 350lb of Plutonium 238) would be nowhere near enough power for a manned mission. The problem is the inefficiency of the individual thermocouples. They, rather than the power source, limit the amount of power supplied and the mission time as well, as eventually they are degraded by exposure to the Plutonium. For example, the Voyager probe was launched in 1977 with RTG's supplying 470W. By 2001 it was down to 315W, mainly due to thermocouple radiation damage.

Work is ongoing that will hopefully improve the efficiency and lifespan of the thermocouples. Thermionic converters are one alternative, but require that the energy source be 'hot', with a shorter half-life and therefore much more highly radioactive. Another idea with potential is D.I.P.S. That stands for Dynamic Isotope Power Systems, with the idea being to use the heat from the fuel source to heat a fluid, generating high pressure vapour that could then be converted into electric energy via a turbine or other heat engine. This is aimed at being four times as efficient as the current RTG's so could deliver power supplies of 500W to 3kW.

For future missions that require power supplies in the multi kilowatt range this might just be the answer, provided the funding can be obtained and continued – it's not a cheap project! The current price per watt of power produced varies between $1000 and $3000 US depending on the power source! It seems possible that despite the formidable problems with nuclear fission, it may well end up being used in space missions, but how will they overcome the problems of lethal radiation, shielding and mass? We will just have to keep an eye open on the developing world of space mission power supplies, and if we are lucky, Arthur will keep us informed – and empowered – with all the updates!

Highland Skies – March 2009

Seen Comet Lulin yet? There is loads of information about it on the Internet, including our own website, and finder charts to locate it are easily found. Although relatively bright, remember that as a 'fuzzy' object you will get better views if you are dark-adapted and observing from a dark sky site. Try to avoid moonlit nights too, as the moonlight can savagely cut into the amount of detail that you can see.

There are several brilliant photographs of the comet that have been taken by local enthusiasts, including members of HAS and SIGMA. Check out our own image gallery and that of SIGMA as well.

Believe it or not, you could be forgiven for starting to think that the observing season is drawing to a close! Well, it's not quite on top of us yet, but the evenings are drawing out and the clocks will change soon. It's only a matter of time before true darkness starts to fall noticeably later each evening.

So the race is on. How many objects can you see before the summer sky is above us again and the lack of true astronomical darkness limits our observable objects to a very small handful? Maybe you desperately need to bag a few Messier objects to complete one of the challenge sheets. In that case, attending the HAS Messier Half Marathon would be a great idea for you.

There are a very few nights each year, when, assuming the weather co-operates, it is possible to see more Messier objects than on other nights. We have organised a MHM before, and it was a great success, with members using a variety of telescopes to hop from object to object, ticking them off as they went. But it's not just a straight race against the clock. There are gaps in the schedule where you may have an hour or more 'free' between objects, and then you can spend time doing detailed observation of your favourite or most intriguing target. Did I mention a certain comet? Or a favourite gas giant with edge-on rings?

Given that the MHM covers a lot of time (at least six hours, probably more) you may also want to have a rest and something to eat or drink. When we had our first attempt at a Messier Marathon at the Culloden battlefield car park a few years ago, we didn't have the facilities that an observatory offers. We didn't have a lighted and heated room where we could rest and thaw out. We didn't have drink-making facilities and a kettle. For that matter, we didn't even have an on site toilet, and yet it was an event that was very much enjoyed by those who attended.

If it was fun before, with all those limitations, imagine how much better it will be now that we have some creature comforts to put to good use in the spells between locating Messier objects in the cold dark Highland skies. I hope that you can attend the MHM on Fri 27th, and I hope that having done so you will realise that the event may be based on ticking off a checklist, but it's a lot more than just that – it's also a lot of fun!

Next Time

The next meeting will take place at the Green House on Tues 7th April at 19:30. The 'Youngstars' junior group will meet from 19:00 to 19:30. This will be the 2009 AGM so please come along and see what changes take place within the Society structure. There will be entertainment after the AGM business (see notices above) and there will also be the usual tea, biscuits and chat.

Hope to see you at some of the Mini Festival events or viewing sessions before then!

Dark Skies,

Antony