Stargazey Pie!
A slice of Highlands astronomical life!
Tues 3rd March 2015

HAS Meeting Notices March 2015

1. **Current News and Dates for your Diary**

- **Solar Eclipse – 20 March, approx 9.35 am**. The moon will pass in front of the sun; as the sun is 400 times larger than the moon, and the moon is 400 times closer than the sun, if you are in the right spot, the overlap is perfect. If you want to see the total eclipse, you will need to go to the Faroe Islands or Svalbard.

  In Inverness, the eclipse starts at 8.32am GMT; is at its maximum at 9.37am, and ends at 10.45am. Although only partial from Inverness, 95.6% of the Sun's disc will be covered so it is definitely worth watching.

  If watching the eclipse on your own, always wear protective eye gear – you can search for eclipse goggles on line or contact an astronomical equipment supplier. Welder's glass or fogged film will **not** do. The next total eclipse in Europe is not until 12 August 2026, so fingers crossed for clear skies on the 20th. More info at: www.solareclipse2015.org.uk

  You are invited to meet at the Observatory at 08.15 to watch the partial eclipse in the hope we have clear skies. Even if cloudy at the start we have two hours during which the Sun may appear so you are welcome to join us at any time.

- **Evening sessions at the observatory** are under way: Forthcoming sessions are:

  Friday 13 March (Public)
  Saturday 14 March (Members)
  Friday 20th March (Public)
  Saturday 21st March (Members)

  Wrap up warm and always check the website (www.spacegazer.com) to see whether the session is running. Clear skies!

- **Lunar Eclipse on 4 April**, - the moon passes within the Earth's shadow, but only if you are lucky enough to be in Western North America, the Pacific, East Asia, Australia or New Zealand. Time for a holiday?

- **The next meeting is on Tuesday 7 April 2015** - this will be our AGM. As part of our charity status, we have to hold an AGM, and a quarter of the membership (approx 27 people) need to attend for the meeting to be quorate. We try to keep the business as short as possible, but there will be a couple of things to vote on. Voting is open to all members aged **16** or over. After the AGM, a talk will be given by Dr John Bridges,

Reader in Planetary Science, Space Research Centre, Leicester University, who is involved in the Mars "Curiosity" exploration/science programme.

If you have any items you would like raised at the AGM, please let one of the Committee members know by the end of March. Also, if you will be unable to attend, please let Liz (Secretary) know so that she can put in your apologies.

- **Events:**
  - 28 March, 9.30am to 5.30pm, Edinburgh - International Year of Light (IYOL) and Magic – a day of FREE talks and demos and discussion by eminent scientists and magicians for the general public (all ages) to celebrate the International Year of Light – lots going on – space rocks, sunspots, planetarium (£3, u/16 £2); further info at: www.johncbrown.org/Sciencesandmagic.html
  - 28 March, 8.30 to 9.30 – Earth Hour: we are all (homes, businesses, landmarks etc.) encouraged to switch off our lights for one hour – more info at: http://earthhour.wwf.org.uk/
  - 9 May 2015, 12 noon to 4pm - Inverness Science Festival Family day at the Inverness Aquadome, Bught Road, Inverness. HAS will have a table – please come along and say hello.
  - 3 – 9 September 2015 – the renowned Orkney Science Festival will be taking place. There is much to see and hear on astronomy subjects this year, but also music, arts, food and drink, and Orkney history. If you have not been before, and you can make it, then attendance is certainly recommended.

- **Suggestion Box** – at reception. Don't forget to let us know if you have any ideas you would like the committee to look at. This is your Society, please help the committee to provide what you are looking for or, of course, speak to a committee member.

- **Aurorae and Telephone alerts** – should you see an aurora, noctilucent clouds, or anything else of astronomical interest, please alert Paul or Pauline. It is never too late at night to let us know. PLEASE NOTE, the wording of the telephone alert is a little strange. If you receive a telephone call with a disembodied voice beginning, "This call will not cost you anything..." - please don't hang up, it is your aurora alert! Alerts can also be sent by text to your mobile – if you would prefer this option please check with Ronnie that we have you signed up for this.

Main Event

Tonight's talk was arranged especially to celebrate our 20th Anniversary and we were very lucky to have Professor Martin Hendry to speak to us about "2020 vision: The Future of Astronomical Observations". Martin Hendry is professor of Gravitational Astrophysics and Cosmology at the University of Glasgow, where he is also currently Head of the School of Physics and Astronomy. He is a member of the LIGO Scientific Collaboration: a global team of more than 900 scientists at the forefront of the quest to detect gravitational waves. A former 'Science in Society' Fellow for the UK Science and Technology Facilities Council, Martin is a passionate enthusiast for science engagement with schools and the public. In 2011 he was elected a Fellow of the Royal Society of Edinburgh in recognition of his ongoing contributions to research, teaching and public engagement with science. He is leading the Scottish programme to celebrate International Year of Light and he is Chair Elect of the Institute of Physics in Scotland. To his great surprise, but equally great delight, he was awarded an MBE for his services to public engagement in science in the 2015 New year's Honours List.

Martin Hendry began by giving us some information about the International Year of Light, http://www.light2015.org/Home.html which marks 150 years since James Clarke-Maxwell published a paper in1865 establishing that light is a phenomenon associated with changing magnetic and electric fields, and this gives us the term' electromagnetic spectrum'. It is also 50 years since the discovery of Cosmic Microwave Background radiation from the big bang, and1000 years since Arab scientist Ibn al-Haytham published a seven volume treatise on optics.

The International Year of Light recognises how important light is in our daily lives and it aims to promote public and political understanding of the role it plays. UNESCO aims to raise awareness that the developing world (more than a billion people on Earth) don't have access to electricity.

There are a number of different aspects to light on the website, one being the Cosmic Light strand, which celebrates the light we get from the sky. It takes a look at the history of the telescope and how this has helped us understand space. 2009 was the International Year of Astronomy celebrating 400 years since Galileo first looked at the sky through a telescope. The Highlands Astronomical Society became Saturn for the day with Glasgow Science Centre representing the Sun to demonstrate the relative distances between the planets in our solar system, and this was something organised by Martin Hendry.

Galileo didn't invent the telescope but he was the first to use it to study astronomy. It was a refractor based on the principle that curved glass can bend light and magnify images. It wasn't very powerful but he was able to see things that no one had seen before and allowed him to build on the knowledge of what was already known about astronomy. His discoveries included the four large moons orbiting Jupiter, which we call the Galilean moons. This caused a problem, as it was believed at the time that everything in the heavens went around the Earth. Thus Galileo brought himself into direct conflict with the Church.

The Yerkes Observatory houses a 40" refractor, which is the largest telescope of its kind ever built and it is still in use today. These large refractors present engineering challenges because the telescope is heavy and unwieldy, and the operator often ends up very high off ground. At the end of the 17th Century, Newton helped to design a different type of telescope

known as a reflector. The glass used for the mirror is not as heavy and it isn't so likely to have chromatic aberration, which can result in coloured fringes around the edge of the image. In the 18th Century the largest reflectors were then about 40" and one was used to find Uranus. The largest was the Leviathan in Northern Ireland. There was no photography at that time so astronomers sketched what they saw. However, before the end of the 19th Century photographic plates began to be used. Gradually the reflectors increased in size: the 100" Hooker reflector in Mt Wilson and later the 200" at Palomar were built. However, moving such large telescopes remained a problem.

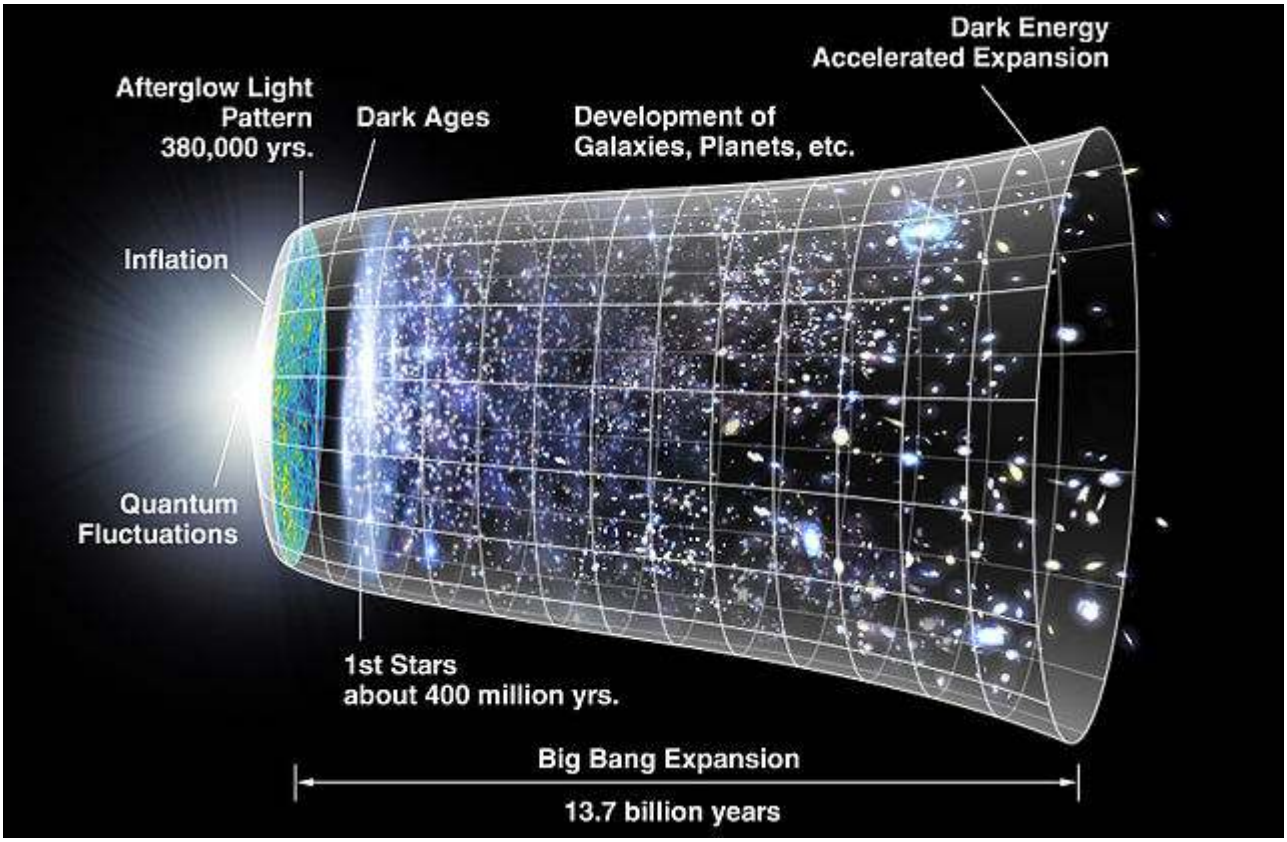
Today, telescopes are much larger and are designed quite differently. They are no longer just round but are usually hexagonal in shape and made out of individual pieces, as it is a huge engineering challenge to construct just one mirror. By the 1990s they could be controlled by computers, which are able to move the telescope smoothly in an altitude and azimuth axes.

The two Keck telescopes in Hawaii work together and by combining images, just like our eyes, can achieve a higher angular resolution. They are constructed from segments, which can be moved individually by a computer to change the shape of the mirror to correct for the distorting effects of our atmosphere to produce a sharp image. This is known as an adaptive optic system and is a fantastic new way to improve images using large ground telescopes. The Very Large Telescope (VLT) in the Atacama Desert used adaptive optics to work out the orbit of stars at centre of the Galaxy, and the way they moved helped determine they were orbiting a supermassive black hole.

Since the time of Galileo, telescopes have got bigger and better. Keck and the VLT are the largest at moment; both have the standard altitude and azimuth design and use adaptive optics and these two features will be included in the next telescopes to be developed and include the Thirty Metre Telescope (see left)

and the European Extremely Large Telescope (EELT), (see right) which will be 39m in diameter and built in the Atacama desert. The EELT will be made up of lots of individual mirrors – so many that there will be a constant round of resilvering them. It will cost £88 million but the investment over time is actually very little. Europe will have a major leadership role in development of some of the instrumentation and also the control systems to allow us to change the shape of the mirror. www.eso.org/sci/facilities/eelt and www.bigtelescopes.org.uk

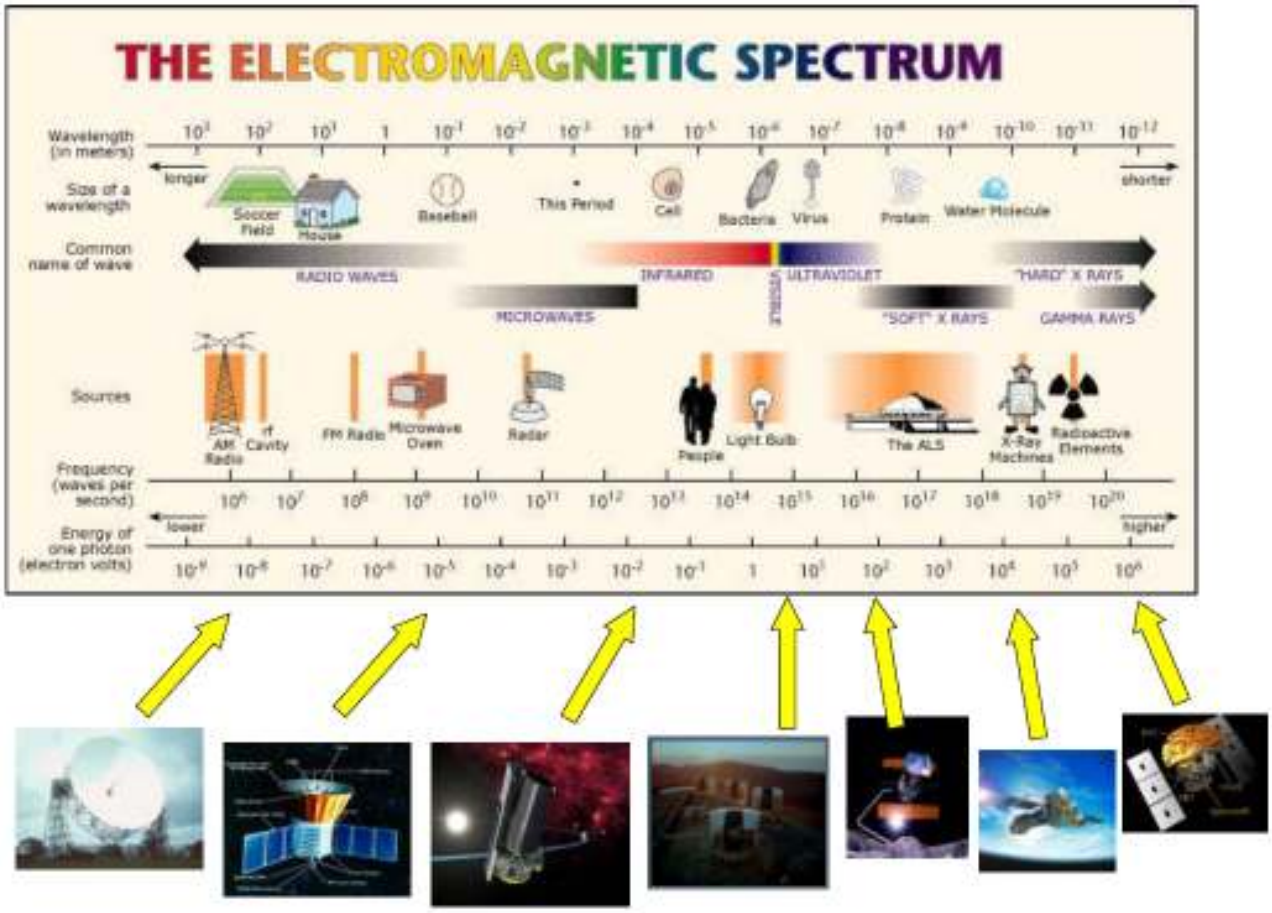
Science with EELT includes finding exoplanets. (See the website about exoplanets Planethunters.org). Kepler is a space based telescope and uses the transit method to search for exoplanets but it is hoped to be able to do this with EELT and more specifically, to find planets in the Goldilocks zone. Another method for searching for exoplanets is by using the wobble of a star but this is so tiny for Earth sized planets that a very large telescope is required and EELT might be able to do this. It will also be able to look at the spectrum of a planet's atmosphere and try to find water, methane and carbon dioxide – the gases that suggest life could be present.



The universe has been expanding since the Big Bang occurred around 14 billion years ago. The rate of expansion is speeding up due to something we call dark energy and it is possible that the EELT may be powerful enough to detect the acceleration.

As we look into the distant universe we are looking back in time so galaxies we see at different distances will be seen at different times in the past and this is how we build up a picture as to how the universe is expanding. This, however, is not the same as measuring the rate of change in speed for the same galaxy so Martin Hendry gave a clever analogy: if you are accelerating through a traffic light and photographed by a speed camera it will take a snapshot of you at two different times and then compare the speed at one time with the speed at the next time. This is something we cannot yet do in cosmology but it would give us a more accurate picture and allow us to check if the measurements we have already done are correct to allow us to determine whether the universe will expand forever, rip apart as it speeds up or come back together again in a big crunch. Ideally, we need to observe a galaxy then take another look at it perhaps ten years later, which would require very sensitive measurements, and this is something EELT might be able to do.

Martin went on to tell us that, although he has concentrated on optical telescopes, light is not the only part of the electromagnetic spectrum, which also encompasses radio wavelengths to gamma rays. Telescopes that allow us to further our understanding of the universe use these wavelengths too.



Then he finished his talk by telling us that there are bigger and better optical telescopes yet to come. One of these projects concerns the large synoptic survey telescope (LSST), which will make possible the means to observe the sky over and over to see how it changes. We already have a digital survey of the sky (Sloan digital sky survey) but the LSST will give much more detail and over a quarter of the sky – a much larger area. The LSST is a small telescope at 8m but it has a huge field of view: for example, the Keck telescope has a field of view of 0.2 of a degree but the LSST will have one of 3.5 degrees. The digital camera will contain three billion pixels and the project will produce 30 terabytes of data every night allowing us to find out about the unknown unknowns. It should also be able to see 90% of near earth objects. www.lsst.org

We haven't scratched the surface of all the telescopes coming up but what we do have now shows we have come a long, long way since Galileo.

Thank you Martin for a superb talk on optical telescopes of the past, present and future which will open up an even deeper understanding of the universe.

Next month we will have our AGM, which is more exciting this year because we have another outside speaker, Dr John Bridges, who will be bringing us up to date about the Mars Curiosity Rover. Until then, clear skies.

Pauline Macrae