TRANSIT

The Newsletter of

Cleveland & Darlington Astronomical Society

10th January 2003. Julian Day 2452650

Editorial

December meeting. In a very apposite talk at the Planetarium, Johan Gijsenbergs gave us an illustrated lecture on – Planetaria! He is the same Johan who gave Ray Worthy the Society's very first planetarium projector. A history of the planetarium and its development was followed by a description of the outstanding examples in the World today. The lecture was rounded off with the expected future developments in the field.

Astronomy Guest Houses. Neil has visited a very good one in Norfolk and his report is in this edition. I have been there, too, and thoroughly recommend a visit. Any more recommendations?

Help Appeal. A short piece by the Editor later in Transit details a big job the British Astronomical Association have in hand. Anyone with a computer could help and I hope some of us can do so.

Beagle 2. January 2003 is the month the British-built Mars explorer must be sent to the launch site at Baikonur. Some doubt was expressed at a meeting of the ESA in Toulouse in September that the date would not be met but we look forward to hearing good news.

Next Meeting. 10th January at the Planetarium. Members' Night – Volunteers needed! The meeting will include a planetarium show by Dr. John McCue FRAS, CaDAS Vice-President and Planetarium Director.

Observing Planet Earth from Mars

By Michael Roe

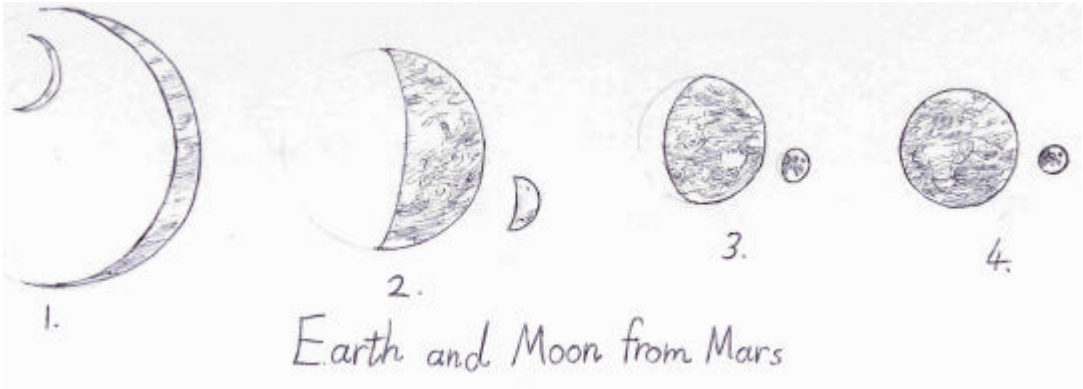
We often observe the other planets with our telescopes but what would our own planet, Earth, look like from Mars - the nearest planet with a clear atmosphere? Of course, the chances of any human setting foot there in the future are very small. However, let's be optimistic and assume not just a landing but an amateur astronomer like ourselves there in a few decades' time. Let him or her take a 10-inch reflector complete with computer controls to aim and guide the telescope. We would need a special, sealed observatory, with a window for seeing the sky with the naked eye. First a few facts. Mars is a top-class observing site, very cold with an extremely thin 7-millibar atmosphere, nearly cloudless though with occasional dust storms. The daytime sky colour is pink near the horizon, blending to dark brown near the zenith. Against a fairly dark sky it is possible that Earth could be seen in the Martian daylight near the equator at maximum elongation, as the Earth is quite bright. At night the sky quickly gets very dark. Our observing target, Earth, is a morning and evening star from Mars, similar to our view of Venus except that it is very blue and has a faint companion star – the Moon. This can be 20 arc-minutes from Earth, but usually much less. The brightness of the Earth is about magnitude –3, varying with phase and distance from Mars and very spectacular in a dark sky. Like our view of Venus, Earth from Mars goes through phases, taking 2 years to complete. The eccentricity of the Mars orbit affects the distance of Earth and its visible size, like Mars from Earth appears largest every 15 to 17 years. It would then be a new Earth phase, almost in front of the brilliant Sun and about 46 arc-seconds across. Its best view is a slim crescent 355 arc-seconds across, down to almost full Earth, only 8 seconds across. Another attraction is, of course, the Moon from Mars. It is around 9" to 2" in size, showing exactly the same phases as Earth and magnitude +0 at best.

In appearance the Earth from Mars through a 10 inch reflector is a quite spectacular sight. Even near the horizon the thin atmosphere hardly affects the view of a gleaming blue globe, with ever-changing swirls and stripes of white clouds and polar caps. The resolution is about 0.4" with our telescope, which also shows sometimes near full phase a bright equatorial spot, the Sun's reflection on the Oceans. Land is more difficult to see, though the cloudless Sahara and Australian deserts show up as coarse orange-yellow patches. The remaining land is disappointing, little more than glimpses of grey-purple areas between the clouds. Britain would be very difficult to see, except maybe as a white triangle in winter when cloud-free and snow covered. Not a common sight!

The Moon would be a disappointing, a tiny disc with a few fuzzy dark markings, more vague than our familiar naked eye view from Earth. Rarely, when eclipsed by the Earth, the Moon would turn darker and orange in colour. Rarer still, the tiny fuzzy spot of the Solar eclipse would appear on the Earth, but probably very difficult to see. I'm afraid even at closest approach; our greatest cities on Earth's night side would be invisible, glowing at magnitude +20, approximately!

Mars would be a paradise for astronomy, even Mercury, though tiny, would appear clearer, looking through such a lack of atmosphere. Asteroids would be more visible. Vesta and Ceres could show discs and the other outer planets would show up far better than on Earth, especially Jupiter. Deep sky observing would be incredible, too.

To end, here are some possible views of the Earth ad Moon from Mars, at x500 magnification.



Fieldview Astronomy Centre

By Neil Haggath

A couple of Transits ago, Alex asked for reports from anyone who had stayed at an astronomical guesthouse. Well, I recently spent one night at one – the Fieldview Astronomy Centre in Norfolk – and did so for free!

How come? Well, the centre's owners, Simon Batty and Christine Parker, are long-time friends of mine. Chris is also the Secretary of North Norfolk Astronomical Society; she invited me to give a talk to the society, and as it's a three-hour drive from my home, she and Simon put me up for the night.

Fieldview, established in 1996, is situated a couple of miles from the small Norfolk town of Fakenham, 20 miles east of Kings Lynn. It's a very smart house, which can accommodate up to 16 people on a B&B basis, and of course there are plenty of telescopes available. The main observatory houses a 12-inch Newtonian, equatorially mounted and driven. They also have three good-sized Dobsonians, the biggest being a 14-inch, and several smaller portable scopes.

Unfortunately, I didn't get to do any observing there; by Sod's Law, on the night I was there, it was raining – though they claim to get about 50% clear nights. But I did get the impression that the sky there is incredibly dark – probably about as dark as it's possible to get anywhere in England! Light pollution is negligible; the nearest town of any size is Kings Lynn, 20 miles away, and there is no heavy industry within 100 miles! Chris and Simon have established good relations with some nearby businesses, which cooperate by turning their lights off late at night.

There's a little skyglow to the south, from Fakenham and other small towns, but nothing worth worrying about. To the north, the sky is *absolutely black*. The site is 8 miles from the north coast of Norfolk, with just a few small villages in between; north of that coast, there is nothing but sea between you and the North Pole! Some of their visitors have told them that the site is darker than the famous COAA in Portugal!

Sorry that I didn't manage any observing experiences to tell you about. Now that I've seen the place, I definitely intend to spend a full weekend at Fieldview before too long – and then, hopefully, I'll be able to give you a more complete report.

If anyone is interested, their contact details are:

Tel.: 01328 820083
E-mail: fieldview@earthandsky.co.uk
Web site: www.fieldview.uklinux.net

Astronomy and the Internet

from Rod Cuff

Picking up a couple of items in last month's *Transit*, this time I'm listing some websites about atmospheric phenomena and about black holes. On the news front, there's the December 4 total solar eclipse, observations to carry out on Jupiter's moons, and new ideas on the speed with which giant planets form.

If you have any particular areas that you'd like me to tackle for a future issue, please e-mail me (rod@wordandweb.co.uk).

Atmospheric phenomena

John Crowther's 12/02 *Transit* article, which included Peter Walker's piece from the Whitby Church magazine, talked about sundogs and rainbows. Sundogs are indeed the brighter parts of a solar halo, as John suggests.

- There is a good photo of a sundog at www-2.cs.cmu.edu/afs/cs.cmu.edu/user/zhuxj/www/astro/html/bestsundog.html
- There is a terrific collection of photos of atmospheric phenomena at www.meteoros.de/indexe.htm : halos, pillars, green flashes, coronas, noctilucent clouds and many more.
- You can download a program to simulate your own solar halos from www.sundog.clara.co.uk/halo/halosim.htm
- Peter Walker said that a rainbow with colours reversed "can" occur during a double bow; in fact, this is *always* so, as can be seen from a full but accessible explanation of rainbows at www.unidata.ucar.edu/staff/blynds/rnbw.html

Black holes

Last month Ray Worthy sent in a NASA press release about the discovery of *two* black holes in NGC 6240, thanks to the Chandra X-ray observatory.

- Many of the questions you might want to ask about black holes are answered at http://physics7.berkeley.edu/Education/BHfaq.html
- More details, though, are available through a series of linked pages from the University of Illinois at http://archive.ncsa.uiuc.edu/Cyberia/NumRel/BlackHoles.html

- … and everything you could possibly want to know, including discussion of Chandra, is linked from http://directory.google.com/Top/Science/Physics/Relativity/Black_Holes
- Some short video simulations at http://antwrp.gsfc.nasa.gov/htmltest/rjn_bht.html enable you to see certain effects associated with black holes.

Recent news

- The solar eclipse of 4 December was visible over a swathe of the Southern Hemisphere from West Africa to Australia (which was the place to be). See http://skyandtelescope.com/news/current/article_804_1.asp for general news coverage, and http://home.mira.net/~reynella/skywatch/ecl_re02.htm for a real feeling of what it was like to prepare for and see; and you can replay the actual live webcast by visiting www.csiro.au/helix/eclipse/live
- For a few months every six years or so, the orbits of Jupiter's Galilean moons as seen from Earth are aligned such that the moons appear to pass behind or in front of each other. We're into that season now, and there's a list of times for occultations and eclipses at http://skyandtelescope.com/observing/objects/planets/article_771_1.asp
- New research discussed at http://spaceflightnow.com/news/n0211/29planets suggests that gas-giant planets may form in a period as short as a few hundred years.

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A 'large Moon near the horizon' effect

From John Crowther

This effect doesn't just occur with the Moon but also with other objects seen in unfamiliar settings. For example, approaching Redcar by road, a ship waiting to enter the Tees may sometimes, due to the line of sight effect, appear to be floating on a grassy bank. This occurs near the Kirkleatham roundabout or on the banks of the Stray between Marske and Redcar. The ship then appears to be magnified. Further on, when it is seen to be back on the sea, it appears to have shrunk back to its normal size. Here is a piece from a recent Times, discussing a possible explanation:-

Why does the Moon seem bigger when it is on the horizon?

This is a puzzle, which has been around since at least the time of the ancient Greeks, although the standard explanation emerged only relatively recently. It centres on an optical effect first pointed out in 1913 by Mario Ponzo, an Italian perceptual psychologist. When we look into the distance, parallel lines, such as railway tracks and roads, seem to converge at the so-called "vanishing point" as they disappear into the distance. We thus tend to think of objects close to the vanishing pint as being far away. In addition, objects look smaller the farther away they are and, according to Ponzo, this can cause problems when we see something that we *think* is far away, yet has not changed in size.

This is just what happens with the Moon. Its size and distance from us are fairly constant but, when it appears close to a vanishing pint, the brain decides that it must be far way and so is forced to conclude that the reason the Moon still takes up the same amount of sky is because it has expanded.
That said, it is unclear how the Ponzo effect explains why pilots above the clouds, and unable to see any vanishing point, still observe the Moon as looking bigger when it is close to their horizon. This makes me suspect that the Moon illusion arises simply because, in everyday experience, seeing an object on the horizon tells us that it is farther away than if it is overhead. Regardless of vanishing points, this alone would fool our brains into thinking that the Moon on the horizon is further away than it normally seems and thus must have expanded in order to cover the same amount of sky.
P.J.Challen.

[Note from the Editor: This reminds me that no-one responded to the puzzle about the appearance of the Moon from Ray Worthy (Transit 12th April, 2002).]

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A Ray Worthy Email

As many of you will know, Ray is a member of a worldwide community of planetarium designers and makers. His meeting with Johan Gijsenbergs, our speaker at the CaDAS December 2002 lecture, led directly to the building of the Planetarium. When I asked for an example of his email exchanges around the World, he gave me this one. Ray said, "You have to remember that Saul (pronounced Saool) is a Spanish speaking Mexican. He does brilliantly with his English ".

From sgrijalva@yahoo.com
To: "Raymond Worthy" raymond@stargazr.demon.co.uk
Subject: RE: Your New Projector.

Dear Raymond, Here are the answer to your questions;

1. You are using the bright bulb from WA. Is your black sky background black enough? I think I can see the colour of the photo negative starball.

****

Yes, I am using the bright bulb form WA rated at 100 lumens. The background sky is black but scatter some light. You tell me almost a year a go that the litho film scattered light but nothing to worry about. I have to tell you something about the pictures of the starball illuminated. They are overexposed pictures for more than 40 seconds!, so they aren't really. The starball illuminated do not look like the pictures it look black with only the starholes illuminated.

2. In the picture you sent, I do not fully understand what the bright white lights are. Are they reflections or are they coming through the transparency?

****
The little dots are the starholes where the light from the bulb shines out, they seems to be lines but that is because the camera was moved during the exposition. The big oval to the right left is actually an image of the Andromeda Galaxy with my technique to place deep space objects on the litho film. Again, it looks like a big hole but this is because the overexposed picture. The big light at the center is the bulb shining through the film. The only reflection is on the left edge, is a reflection of a window open.

3. In the picture proto 7, I am not sure what I am seeing, when I see the brighter parts.
****
You are seeing the Milky Way. Is hard to appreciate the structure of the Milky Way, but it has zones brighter and dimmer like the real Milky Way. The Milky Way is composed of little dots (300, 200, 150, 75, 50, etc dots per inch) the dots are to small to be projected but all together give the appearance of diffuse light, some regions brighter and some dimmer. Again the picture is overexposed so is more bright than the reality.

4. How many stars are lost in the frames?
****
Actually no one important. They are like 4 or 5 star (very important ones!) that are placed near de edges so I cut off a little piece of the frame (I reduce the wide of the frame in this regions) to let the star shine.

5. I can see that the frames are standing out as black against the panels. I think this answers my question No 1.
****
The problem, I think is that the pictures where overexposed. The film scatters some light but not like the pictures! If you visit the site of Carlos Zalbagoitia, you will see some pictures of the CUBEX in the dark with the light on. You'll see the cube very bright too, that's the problem with the litho film. I am sending an image of the cubex too.

6. With this design you can get a better contrast by using two, or even three transparencies glued together very carefully. Because they are flat and the variable radius factor does not apply.
****
You have just given me a great idea! Thanks for the Tip. Another option is to enlarge the starball. I enlarged the starball. The starball in the pictures is 30cm tall and the new one is 37cmm.

7. Once again, I would love to see this amazing creation to see its effect on a dome.
****
I have a little surprise; I made an inflatable dome to test my projectors. Is a 5 meters diameter dome silver coated nylon but I don’t like how the images were projected,

they where too dim, so I painted the interior of the dome with white vinylic paint making it more reflective. I will send you some pictures.

8. Can I show these pictures to Susan Button the IPS Mobile Dome person? She would love to see them. You would get a write up in the Planetarian.
****

Of course you can!, and send the text of the Constellation Program too to let know the planetarium community what we are doing here in this region of Mexico. I don't know if you know Nicolas Gulino but this guy contacted Antonio and offered he to show our work in the IPS 2002 meeting. Maybe you will see pictures and information about the constellation program.

Congratulations.
****

Thank you so much, all my work is thanks to you. Tomorrow the 19th is going to be a year since I posted a message asking for help to build a planetarium and this 23rd is going to be a year since I meet you. Thank you.

PS. How do you find the time when you have a shop to look after?
****

On free times. I put a screw now, later I paint here, tomorrow I will be drilling and so on. In my home I make the master drawings and glueing. But most of the time I am thinking new ideas. I think if I work full time on the planetarium and have all the materials at once, I could build a complete projector in a week!

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Variable Star Data
Can you help?

At a meeting of members some time ago, Roger Pickard, the Director of the Variable Star Section of the British Astronomical Society, appealed for help in converting the paper records of the Section into digital computer records. There are millions of amateur observations of the magnitudes of variable stars stored by the Association. They could be made widely available to both professionals and amateurs, if only they were computer-readable. You can imagine the advantages of records on cd – much easier to store, easily distributed and convenient for computer searches, manipulation and calculation.

Roger Pickard has the problem of how to get the massive task of conversion done. It is a manual job of typing the records into a simple computer text file in the required format. The sheets of records do not seem to be in a form suitable for rapid scanning. Hence his appeal to VSS members. I volunteered to put some time into this work, wishing to make a return to the world of astronomy for some of the pleasure I have had from observing eclipsing binary stars, which come under the heading of variable stars after all. Every so often a bumper package of original record sheets drops through my letter box. Whenever I have a bit of spare time, I sit at the keyboard and get typing. I've converted the records

for 5 stars so far and I suppose there must be hundreds in the data-base. Some of the people who have sent in records are local observers and some have familiar names – a young Patrick Moore, for example.

Would anyone in CaDAS like to take part in this job? The size of the task is such that lots of people are required. The reward is knowing that the massive data-base you are contributing to will be so much more accessible to everyone. Another motive for me, I must confess, is that the American Association of Variable Star Observers is engaged in the same task of digital conversion and to beat them to it would be very satisfying. This work is going on all over the World, of course – Amateur Astronomical Associations in New Zealand, Australia and Europe are doing the same. There is also a big effort going into an International Agreement on how amateurs record data, using the same methods and comparison stars with agreed magnitudes, in which the BAA is a leading member.

If you feel you could put some time into this work, please contact the Editor (see Transit Tailpiece for telephone and email address). I will be pleased to introduce you to the people involved and help with the details of exactly how to do the job. It's really very easy and you will learn a lot about how the magnitudes of variable stars are recorded. You may even be inspired to send in some observations of your own.

A Menarry

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Astronomy Basics

by Neil Haggath

No. 8: The Electromagnetic Spectrum

For thousands of years, astronomy was conducted only in visible light – the kind of radiation to which our eyes are sensitive. Everything we knew about the Universe was deduced by studying the light emitted by astronomical objects. But visible light is only one very tiny part of the vast range of radiations which pervade the Universe! Just within the last century or so, we have developed methods of detecting all those longer and shorter wavelengths which are invisible to our eyes; during that time, we have learned far more about the Universe than in all the millennia which went before. Today, astronomers utilise radiation of every imaginable wavelength – the full range of the *Electromagnetic Spectrum*.

We talk about a number of different kinds of radiation – gamma rays, X-rays, ultraviolet, visible light, infrared, microwaves and radio waves. All of these types can provide us with important information about astronomical objects. Putting it simply, the different types are generally emitted by different types of objects and physical processes, and require different kinds of instruments to detect them. But in fact, they are not really different at all; all of the above are simply *electromagnetic waves*, which differ only in their frequencies and wavelengths.

Before I explain electromagnetic waves, I'll say a little about waves in general. Any kind of wave motion – be it sound waves, the waves in the sea, or electromagnetic waves such as light or radio waves – can be described by two parameters. Its *frequency*, denoted by f, is the number of vibrations or cycles per second, or the number of wavefronts which pass a given point per second. Its *wavelength*, denoted by λ, is the length of each cycle of the wave, or the distance between successive wavefronts (Fig. 1). It's pretty obvious that multiplying the frequency by the wavelength gives us the velocity v at which the wave travels, i.e.

$$f \lambda = v$$

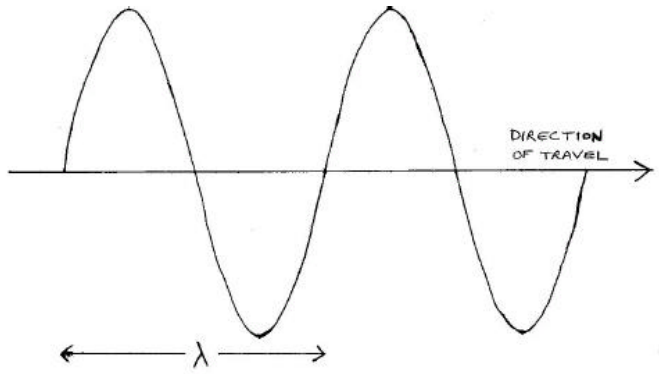

Fig. 1

Frequency is measured in hertz (Hz), where one hertz equals one cycle per second, so multiplying the frequency in hertz by the wavelength in metres gives us the velocity in metres per second. The higher the frequency, the shorter the wavelength.

All wave motions are produced by some kind of periodic vibration or oscillation, whereby some property of the medium through which the wave travels varies in amplitude, as shown in Fig. 1. For example, waves in the sea consist of a variation in the height of the water surface, driven by gravity, while sound waves consist of a variation in the pressure of the air, water or other conducting medium.

If Fig. 1 represents a sound wave, then the x-axis represents distance along the direction of travel, and the y-axis represents pressure. The graph shows two *cycles* of the wave; the distance between the corresponding points on successive cycles being the wavelength. If we were to plot the pressure at a given location against time, the graph would look identical; the time interval between successive cycles is the reciprocal of the frequency. The shape of the graph is, of course, that of the mathematical sine function; we say that the height, pressure, or whatever, varies *sinusoidally*.

Now, electromagnetic waves are a bit more complicated. As their name suggests, they consist of vibrations in electrical and magnetic fields in space. Unlike sound, they don't require a material medium through which to propagate; they can travel through a vacuum. Instead of a simple wave like that in Fig. 1, they actually consist of two vibrations, one in the electric field and one in the magnetic field; these take place in two planes at right angles to each other, and are in phase, i.e. their cycles are aligned with each other.

All electromagnetic waves, regardless of their frequency and wavelength, travel with the same velocity; this is usually referred to as the velocity of light, and denoted by c. This is an incredible speed - roughly 300000 kilometres per second! To be precise, it's equal to 2.997924591×10^8 ms^{-1}.

More accurately, this is the velocity of electromagnetic waves *in vacuum*. When they travel through any material medium, they are slowed down by a factor equal to the refractive index of that medium. When we refer to "the speed of light", we almost always mean its velocity in vacuum. This velocity is a constant; it's always the same, as measured by any observer, anywhere in the Universe. (This is one of the fundamental principles upon which Einstein's Special Theory of Relativity is based - but that's another story.) It's one of the most important constants in physics, and one of the most accurately measured. It's also the absolute speed limit of the Universe; it's impossible for anything to travel at a speed greater than c, and no material object can reach a speed *equal to* c.

The velocity of light was first measured as long ago as 1675, by Ole Romer, who deduced it from astronomical observations of Jupiter's satellites. How he did it is beyond the scope of this article – ask me at a meeting, if you're interested – but his answer was remarkably close to the correct value. During the 19th and 20th Centuries, the value was refined by electrical methods.

But the *nature* of light puzzled scientists for many centuries. Sir Isaac Newton believed that it consisted of a stream of particles of some unknown kind, which travelled through space in straight lines. But in 1865, James Clerk Maxwell found that the velocity of propagation of an electric current was the same as that of light, and correctly deduced that light was a kind of wave, produced by oscillations of electric and magnetic fields.

But in a way, they were both right! We now know that light, and other electromagnetic waves, have a strange dual nature, and behave like both waves *and* particles! Some of their properties, such as refraction, diffraction and polarisation, can be explained by thinking of them as waves, but in other respects, such as their interactions with atoms and subatomic particles, they behave as if they are composed of particles.

Please don't ask me why this is; it requires delving into the bizarre realm of quantum physics, which I have no intention of doing, either here or anywhere else! (I readily admit that I don't understand it; it was my worst subject at University.) But to put it simply, an electromagnetic wave behaves as if it consists of a stream of discrete "packets", or *quanta*, of energy, which we call *photons*. A photon can be thought of as a kind of particle, which has no mass, and travels with a velocity of c. The energy of each photon is directly proportional to the frequency of the radiation (and therefore inversely proportional to the wavelength); it's given by

$$E = hf$$

where h is a constant known as *Planck's Constant*.

The electromagnetic waves which are produced naturally by astronomical objects cover an immense range of frequencies and wavelengths – about 24 orders of magnitude! Their frequencies vary from the order of 1 Hz to 10^{24} Hz, and their wavelengths from the order of 10^{-16} m to 10^8 m. We call this entire range the Electromagnetic Spectrum, and divide it

into a number of regions, as shown in Fig. 2, which plots frequency and wavelength on a logarithmic scale.

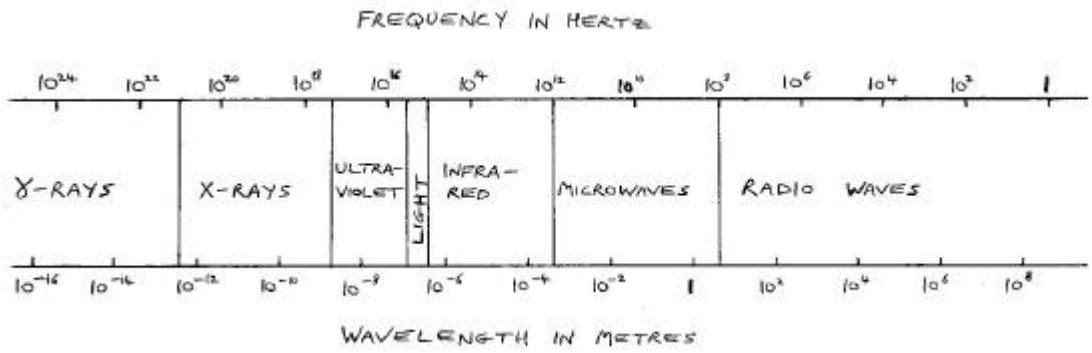

Fig. 2

These divisions of the spectrum are quite arbitrary, and not sharply defined; they roughly correspond to the ranges of wavelengths which require specific kinds of detectors to observe them. Note how narrow the band marked “light” is; this is the range of wavelengths of visible light, within which all our observations were confined for most of history!

From the equation above for the energy of a photon, you can see that the waves with the shortest wavelengths – those at the left end of the diagram – are the most energetic. It follows, therefore, that they are produced by the most energetic physical processes – which is more or less the same as saying that they are associated with matter at the highest temperatures. In fact, every astronomical object emits radiation over a wide range of wavelengths, but its emission is strongest within a fairly narrow range, which depends on its temperature.

The least energetic waves, long-wavelength radio waves, are generally produced by the coolest matter in space, such as interstellar gas and dust clouds. Warmer matter emits radio waves of shorter wavelengths. The radio waves, which we humans use for communication, vary in wavelength between a few centimetres and hundreds of kilometres, or in frequency between a few kilohertz and a few gigahertz.

There is no real difference between radio waves and microwaves; the latter are simply radio waves with wavelengths in centimetres or millimetres. Those at the millimetre end of the scale are utilised in microwave ovens, as well as by astronomers.

Next comes the infrared band, familiar to us as heat radiation. This is emitted by warmer interstellar matter, such as that in gaseous nebulae and star-forming regions, and also by the coolest red dwarf stars and substellar brown dwarfs. Most infrared wavelengths are strongly absorbed by the Earth’s atmosphere, so we need to site infrared telescopes on the tops of high mountains. For some wavelengths, even that is no good, and only satellite-borne telescopes will work.

“Average” stars like the Sun, with surface temperatures of a few thousand degrees, have their emission peaks in the visible region of the spectrum, at wavelengths of a few nanometres. It is, of course, no coincidence that our eyes are sensitive to those particular wavelengths! We perceive light of different wavelengths as different colours – red at the

longest wavelengths, violet at the shortest. It's quite obvious that the Sun emits most strongly in the yellow.

At still shorter wavelengths, we have ultraviolet light. "Near" ultraviolet – at wavelengths only slightly shorter than visible light – easily penetrates our atmosphere; it's what causes sunburn. "Far" ultraviolet doesn't; again, we need to use telescopes in space. The hottest blue and blue-white stars, with surface temperatures of around 14000-20000^{o}C, are strong emitters of ultraviolet.

The most energetic radiations of all, X-rays and gamma rays (again, the distinction between the two is pretty vague), are produced by the most energetic processes and events in the Universe, such as supernovae and the accretion discs around black holes, where matter is heated to temperatures of millions or even billions of degrees. The study of these events is often referred to as "high-energy astrophysics", and researchers often talk about observing at a particular *energy* (i.e. energy per photon), rather than referring to the frequency or wavelength.

Again, the atmosphere is opaque to these wavelengths, so we need to use satellite-borne telescopes to detect them. Paradoxically, though, gamma rays at the very highest energies *can* be detected from the Earth, by indirect methods. When very high-energy gamma ray photons interact with subatomic particles high in the atmosphere, they initiate a chain of reactions, producing a "shower" of particles and lower-energy photons, which can be detected by instruments on the ground.

So that concludes our tour of the Electromagnetic Spectrum. It's really quite remarkable that astronomy progressed as far as it did, while confined to just one narrow window of the Spectrum. It's only in the last few decades that we have really been able to see "the Big Picture"!

Author's note: I'm enjoying writing the Astronomy Basics series; there are more to come, and I hope some readers are finding the articles useful. Of course, those who have joined the society within the last few months will have missed some of the earlier ones. If anyone has missed any of the series, and would like to read them, please e-mail me at neil.haggath@ntlworld.com, and I'll gladly send them to you.

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The Apollo Hoax

Recently, for reasons which are difficult to find, there has been a large number of newspaper column-inches devoted to speculation about whether the Apollo Programme and the Moon landings were or were not an elaborate hoax perpetrated by NASA. An incident in which an ex-Moon walking Astronaut, when asked to swear on the Bible that he did in fact walk on the Moon, replied by punching the questioner on the nose, was given wide publicity. The Editor assumes we are all interested in this debate and would like to know what arguments are being used, what questions raised and what answers are reasonable ones.

We will serialise over the next few editions one web-site devoted to this subject, which raises the questions and then answers them. It would be most interesting to hear your comments on this series.

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No 1 The Preamble:

The Frequently Asked Questions regarding the Apollo Record and the manned Moon landings of 1969 to 1972. Written by Nathan Jones.

Forward and Intent

In recent years there have been many criticisms and refutations made in various media of the Apollo record, the so called proof of the Apollo space missions that allegedly landed astronauts onto the surface of the Moon during the period 1969 to 1972. The criticisms and refutations by authors such as David Percy, Ralph Rene, the late James Collier, Bill Kasing and others take the form of analysis of the photographic record and video footage shot by NASA astronauts and questions about the viability of other aspects of the operation such as the flight worthiness of the lunar module (LM) and the radiation risk posed to astronauts who venture outside of the Earths protective shield - the Van Allen belts.

Critiques of the Apollo record have sprung up all over the internet in various websites and in the form of books, television documentaries and video presentations such as James Colliers "Was it only a Paper Moon?". Counter claims and arguments have also appeared in websites such as:

www.badastronomy.com/bad/tv/foxapollo.html

www.uwgb.edu/dutchs/pseudosc/conspiracytheoryDidWeGototheMoon.htm.

www.clavius.org/techengine.html is another often quoted web site.

These sources of information regularly deal with the same questions and principles but in many instances they fail to correctly describe the situation. The purpose of this piece is to correctly answer those questions.

Questions to be asked

(1) What does it take to prove we went to the Moon?
(2) The public are dumb, they'll buy into any idea.
(3) No stars are visible in the images, where are they?
(4) The flag waves.
(5) There's no dust on the lander footpads.
(6) Why is no engine noise audible in the LM radio broadcasts?
(7) Where are the flames from the landers engines?
(8) What about the shape of the exhaust and its effects?
(9) Was the Lunar Module (LM) tested on Earth?
(10) Where's the blast crater?
(11) Dust kicked up by the Rover wheels acts strange.
(12) Radio telemetry proves man went to the Moon right?
(13) Laser ranging reflectors on the Moon are proof right?
(14) Why don't they point the HST at the landing sites?
(15) The Russians had to be in on it right?
(16) What about Apollo 8, 9 and 10?
(17) The radiation hazards facing the missions.

(18) The lunar surface brightness misconception.
(19) Photographic anomalies, heiligenschein and perspective.
(20) What still film was used?
(21) In a vacuum there is no heat?
(22) The noon day temperature misconception.
(23) How much insulation does it take to keep an astronaut warm?
(24) Can the Moon rocks be faked?
(25) Unmanned retrieval of Moon rocks possible? -definitely.
(26) Supporting websites

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A History of the Cleveland and Darlington Astronomical Society

Chairman of the Society, respected historian and author Barry Hetherington is in the process of writing a History of the Society. As the project develops, Barry has agreed to the text being serialised in Transit. Over the next few editions coherent portions will be published and the author has said that he will be pleased to receive any comments or additional material which could be included in the final version. Please send your comments to the Editor (see Transit Tailpiece) or directly to Barry himself.

Extract 1 The Beginnings

Cleveland Astronomical Society for Schools

The Cleveland Astronomical Society for Schools was founded on the 20th December 1979. Although it was aimed mainly at school children, adults were always welcomed. Membership was free. Their magazine, *Astro Info*, was sold to members at 15p, and first appeared in March 1980.

At the March meeting John McCue announced that the Society now owned a good 6-inch reflecting telescope which was available for members to borrow.

The second edition of *Astro Info*, dated summer 1980, was available at the last meeting of the first year, on the 27th June, and carried an article by David Roberts (Langbaurgh School) describing a coach outing to Grubb Parsons, in Newcastle, on the 26th April. The members were shown the various machines used in the making of telescope optics. Of particular interest were two professional telescopes that were destined for the observatory at La Palma; a 40-inch reflector and the Isaac Newton telescope that was in for refurbishment, having had a new 102-inch mirror fitted and its polar axis adjusted. At that time this telescope was the 11th largest in the world.

By this meeting the Society had acquired a second telescope – a 4½inch long focal length reflector. There was also a small library.

The first meeting of the new session was on the 26th September when David Bayliss gave a talk on meteors and other *Visitors from Space*.

By the time issue number three of *Astro Info* appeared there were two observing sections in existence – the Deep Sky Section (Mark and Colin Rodgers), and a Planetary Section (David Roberts and Richard Blackburn). Most of this issue contained the member's observations of the Sun for 1980.

For the meeting of December 1980 Patrick Moore sent an audiotape explaining the results of the Voyager Project, and his contribution and visit to the Jet Propulsion Laboratory (JPL), Pasadena. A transcript of the tape appeared in the March 1981 magazine.

A committee meeting on the 3rd December 1980 changed the name of the Society to *Cleveland Astronomical Society*. It was also agreed to form a solar section, with Richard Blackburn as director.

At the meeting of the 23rd January 1981 a Society subscription was introduced. The 'observation' meeting of the 14th February saw the distribution of the first CAS sweatshirts, bearing a yellow Saturn surrounded by the words Cleveland Astronomical Society.

The committee meeting held in February saw the formation of the fourth observing section, entitled Comets, Meteors & Variable Stars, with John Waggott as director.

By the time the March 1981 magazine appeared there were a number of changes to report, apart from the new name. The magazine was renamed *Polaris* and carried a price of 30p (20p to members). The cover included a photograph of the Orion Nebula by John Nichol. Thereafter most magazine covers included members photographs. The editorial announced that Jack Youdale had agreed to accept the position of President of the Society. Jack had given his first talk to the Society, on the subject of mirror grinding, in March 1980.

For National Astronomy Week the Society set up a display in the Cleveland Centre on Friday 24th April, which brought in 27 new members [giving a total membership of 76]. The following day an Open Night was held at Marton College where Jack Youdale gave a talk on space flight; this being followed by a planetarium display using the Marton College planetarium.

In May the Society acquired the Waddington Library of valuable old astronomical books, as well as a variety of instruments including an equatorially mounted 3-inch refractor.

Issue number five of *Polaris* was dated June 1981 and ran to 32 pages of section reports and articles.

The first meeting of the new session, on the 11th September 1981, had an attendance of 85. The following week, on the 18th September, the Society held its first 'all-night' star party at Clay Bank. Nineteen members enjoyed a cloud-free night which included a display of the aurora borealis.

In the March 1982 edition of *Polaris* appeared a summary of the impressive equipment used by some of the members. Mark and Colin Rodgers were busy setting up their 12-inch reflector, Bob Wyndell was working on a 10-inch reflector, David Roberts was completing his 8¾inch reflector, while Jack Youdale was figuring a corrector for a 10-inch Maksutov.

April saw the installation of an observatory at the Leeds University Adult Centre, Harrow Road, Middlesbrough. The first observing meeting was held there on the 22nd May and was a big success.

As reported in the June 1982 issue of *Polaris*, John McCue contacted the astronomy department of the Soviet Academy of Sciences asking how he could obtain a copy of their General Catalogue of Variable Stars, listing over 20,000 variables. Not long afterwards all four volumes arrived on his doorstep.

Herstmonceux 82 was a conference organised by the Federation of Astronomical Societies at the Royal Greenwich Observatory on the 2nd October. Four of our Society members attended, journeying down there the day before and staying overnight in Eastbourne. They were Carol Haswell, Neil Haggath, Dave Roberts and Donald Martin. They had an enjoyable time attending the talks and the guided tour of the site before returning home the following day.

It was in 1982 that an annual astronomical quiz was started, between Darlington, the Cleveland Society, and the Society from Peterlee and Easington; the winners being presented with the Thomas Wright Trophy which, this year, was the Cleveland Astronomical Society. For the next seven years the Darlington and Cleveland societies were the regular contestants, with other societies joining in whenever they could raise a team.

In the September 1983 edition of *Polaris* it was announced that the Society had been given, on loan, the Teesside Polytechnic's 10-inch Cassegrain reflector. It was being housed at the Adult Education Centre, Harrow Road, Middlesbrough, the venue for the Middlesbrough meetings, where it was available to members who had to bring their own eyepieces, as there were none with the telescope. A sturdy permanent mounting, as well as a dark site, was being considered for its permanent erection.

On the 2nd December 1983 the Darlington and Cleveland societies joined battle at the Darlington Arts Centre where, once again, the Cleveland Society carried off the Thomas Wright Trophy.

On the 7th December 1984 the third annual Thomas Wright Trophy was held at the Stockton Sixth Form College with the Cleveland Society going for the hat trick. It turned out that it was not to be, with Darlington coming out on top with a score of 134 to Cleveland's 99.

On the 15th October 1988 we hosted a special one-day conference entitled *Cosmos North-East*, mainly organised by Neil Haggath. The venue was Teesside Polytechnic, Middlersbrough, and was attended by over 160 people from all over Britain. The speakers were astronomer and TV star Heather Couper - *How Big is Space*; Nigel

Henbest - *Supernova - Death of a Star*; Peter Rea - *The Golden Age of Planetary Exploration*; Dr. David Gavine - *The Aurora and History*; Neil Bone - *Astrobiology - Origin of Life*; and Paul Money - *Mars - Past, Present and Future*. The admission charge was £3.50.

The annual competition for the Thomas Wright Trophy took place on the 9th December 1988 at the Cleveland Scientific Institute, Middlesbrough, where, after a tight contest, Darlington came out winners.

The 100th meeting of the Society was held on Saturday 11th November 1989 at the Highland Lad, Norton, where Paul Money gave a talk on "Neptune".

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The A to Z of Astronomy

Selections from the Oxford Dictionary of Astronomy

January 2003 A

Aberration of starlight. The small apparent difference between the observed direction of a star and its true direction. It is due to the combined effect of the observer's motion across the path of the incoming starlight and the finite velocity of light. The actual amount of displacement and its direction depends on the observer's speed and direction of motion. Aberration of starlight resulting from the Earth's orbital motion is termed 'annual aberration'; the much smaller effect resulting from the Earth's rotation is called 'diurnal aberration'. 'Planetary aberration' is a combined result of the observer's motion and the time taken for light to travel from a body in the Solar System and the observer.

Active optics. A system that compensates for the deforming effects of gravity on a telescope's mirrors, maintaining their surface accuracy and alignment. The image of a guide star is examined as the telescope tracks it across the sky. Actuators behind the mirror control moveable supports to preserve the mirror's shape and alignment. The first large telescope to employ active optics was the New Technology Telescope at the European Southern Observatory.

Adaptive optics. An optical design that can rapidly counteract the effects of atmospheric seeing on an image. This may be done by deforming a mirror in the light path of a telescope to keep a star's image as point-like as possible. The system may use as a reference a real star or an artificial star produced by shining a laser up through the layers of that are causing the bad seeing. Any extended objects in the field, such as galaxies, will also be sharpened. This technique can increase the resolution of a ground-based telescope by a factor of 40.

(A selection from the 250 A entries)

Book Review

The Peripatetic Astronomer. The Life of Charles Piazzi Smyth

By H.A.and M.T.Bruck.

When I was interviewing Chris Walker, he spoke of Piazzi Smyth and, when I confessed ignorance, Chris lent me this book. It was published by the Institute of Physics in 1988, so it may be out of print. Chris said "Smyth" is pronounced "Smith", as opposed to the long vowel pronunciation when there's an 'e' on the end. Piazzi, as he seemed to be known, was Astronomer Royal for Scotland and Professor of Practical Astronomy in Edinburgh University. His main claim to fame was that he pioneered observations from the tops of mountains. It seems strange now but, in the middle of the 19th Century, it wasn't obvious or accepted that to be as far out of the atmosphere as possible was a good idea. The story of how he got a large amount of equipment to the top of Mount Tiede, in Tenerife, and made his observations there is typical Victorian eccentricity and improvisation.

Mid-Eighteenth century astronomy was obsessed with the positions of stars and their proper motions. He made a big contribution to this field before moving on to other things. One consequence was his responsibility for the measurement of time by the stars. He designed a system of sending electrical signals to fire canons in Edinburgh Castle, as well as to Glasgow, Newcastle and lots of other places, so that time was co-coordinated for mariners everywhere. Spectroscopy was just getting under way at the time. Smyth designed and had built spectroscopes capable of measuring 1/40th of an angstrom unit in the separation of lines in the solar spectrum. The controversy at the time was which lines were generated by the Sun and which added by the Earth's atmosphere. His contribution to this subject is a fascinating story.

A surprise to me was the description of what a Scottish Astronomer Royal actually did. Not for him the "fetch and carry" type of direction of a Department. He did everything himself - designed and ordered equipment from manufacturers, assembled instruments himself, took all the observations, even paid for most things out of his own pocket. There was a constant battle to get money from the Government to sustain an Official Scottish Observatory. There is also a detailed description of how Smyth's fascination with very non-scientific Egyptian Pyramidology harmed his reputation and career.

The book is not what I would judge as well written. It is not easy to read in places, although knowing Edinburgh and Scotland adds interest to the read. Recall that the centre for astronomy in Britain is now in Edinburgh, at the Observatory on Blackford Hill. I recommend the book because of the insight it gives into how astronomy was done in those days and what was exercising the minds of the astronomical community at that time. The authors have clearly well researched all the documents of the time, bringing out the personalities of that era and how they interacted.

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Transit Tailpiece

Quote/Unquote

I do not feel obliged to believe that the same God who has endowed us with sense, reason and intelligence has intended us to forgo their use.
Galileo Galilei

When the Universe was created, we were not consulted.
Andre Linde

Wanted Jan 2002 Sky and Telescope. Michael Roe is looking for a copy of this edition of the magazine. Please contact Michael or the Editor.

Custom Telescopes UK. For your telescopes, binoculars and accessories of all kinds, go to Glen Oliver, a long-time member of the Society. He operates from Hartlepool and has a website www.goliver.freeserve.co.uk. Glen also supplies Astronomy and Space books of all kinds. Don't forget to visit his website soon.

CaDAS Website Now at www.planetarium.btinternet.co.uk and the society email address is planetarium@btopenworld.com . Everyone is encouraged to visit the site and tell your friends about it.

Sunderland AS Contact them at www.sunderlandastrosoc.com to see how they are progressing with the new Observatory at Washington Wildlife Centre. If you wish to attend their meetings you are assured of a friendly welcome.

York AS have a website at www.yorkastro.freeserve.co.uk and an excellent programme of lectures, if you wish to go along.

Post and Email If anyone wishes to change the way they receive their Transit, please let me know.

Articles Please send contributions for the newsletter to Alex Menarry, 23, Abbey Road, Darlington, DL3 7RD, 01325 482597 (a.menarry@virgin.net) or to John McCue, 01642 892446 (john.mccue@ntlworld.com). Copy deadline date is the 1st of each month.
