



Current Notes

The Journal of the Manchester Astronomical Society
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Editorial

As the new editor of Current Notes, I hope to be able to encourage fellow members of the Manchester Astronomical Society (MAS) to actively contribute to this publication in whatever way they are able. We are a flourishing Society with many enthusiastic and accomplished members, and it is my belief that Current Notes can serve as a record not only of the events and developments occurring within the Society as a whole, but also of our members' personal views and experiences in astronomy.

As I am sure you will agree, many of our members have delighted us in the past with presentations of their own observations, their current or past projects and their views on a range of subjects. Long may this continue.

However, I am aware that some of us may not be as comfortable as others are with public speaking. Additionally, some of us might have ideas, views or information which they would like to communicate to the Society as a whole but consider that a presentation would not be the best way of doing so. This is all perfectly reasonable of course. With this in mind, I hope that Current Notes might be used more readily by members as a forum for communicating with the Society as a whole as an alternative to presentations.

In order to help us all be better informed of the current activities and interests of our fellow members, I conducted a brief survey involving issuing a questionnaire to each MAS member. A number of MAS members have completed and returned this questionnaire. I summarize the results of this survey, so far, in an interim report in this issue of Current Notes. In brief, the results show key interests focus on planetary observing, the Moon in particular, digital imaging – especially webcam imaging – and history of astronomy. A priority for future study appears to be cosmology and variable star observing.

In the light of this knowledge, I hope that this summer's edition of Current Notes goes some way to fulfilling these interests. After the interim survey report there follows an article by Nigel Longshaw on the discovery, in the possession of MAS, of valuable historical books relating to the Moon. A report of a modern determination of the speed of light is also presented by myself, together with an analysis of historical records, and a discussion of the Theory of Special Relativity. A beginners' guide to using a webcam and Registax is presented by Anthony Jennings, as is a guide to satellite imaging. Paul Wood also provides a fascinating article on a clash of scientific minds.

I would like to thank every person who has been kind enough to spare the time to prepare a submission for this issue of Current Notes. Without the goodwill and enthusiasm of our members our Society would not, of course, thrive as it does.

Thank you.

Dr Andrew Fearnside
Editor of Current Notes

Letters and News

MAS at GMR

As President of the Society, I was invited to partake in a live interview on a BBC GMR radio programme on 30 June. The radio show in question was "Michelle Around Midnight", a regular weekday music, comedy and entertainment programme between 10 pm and 1 am, hosted by Michelle Mullane.

After arriving at BBC Manchester at 10.10 pm I was met at reception and escorted through the maze of corridors that criss-cross the building to a small waiting area outside the studio. (The "Green Room"? – except it was basically a dull red colour scheme; presumably the GMR corporate colour). Nursing a BBC coffee (yuk!) in a plastic cup, I was left alone here to cope with my nerves as best as possible. The live feed from the programme is fed through speakers into the Green Room and there is a TV system showing the presenter at work in the studio. This was my "soothing" entertainment.

At 10.35 pm I was invited into the studio and sat in a chair on the other side of the console from Michelle. There were headphones (cans in technical parlance) available to wear, but I decided against donning these, preferring the natural feeling of holding a conversation across a table, although the tabletop was at chest height.

As the clock ticked round to 10.40 pm, Michelle announced a couple of times that the President of Manchester Astronomical Society was in the studio and listeners invited to phone in and ask a question. "Gee, thanks for letting me know!" was my thought. Meanwhile she chatted briefly to me to get the microphone level correctly adjusted.

Bang on 10.40 pm Michelle announced me and proceeded to ask questions about the Society: do we have a website, how can someone join,

what do we do each week, etc.? She then moved on to the possibility of other life in the Universe. Did I think it existed? "Yes", I said, "but I doubt that it will have two arms, two legs and speak English." "Have I ever seen a UFO?" she asked. "I once saw an orange glow slowing passing over Manchester", I answered, "but it was more likely to be the MEN hot-air balloon than an alien craft."

I had been told that the interview would last about 30 minutes, so when Michelle said "Thank you, that's all" I was a little shocked. I had psyched myself up for a half hour of chat about astronomy and here it was; only 10.50 pm. I was just getting warmed up! Still, I guess I'd had my 10 minutes of "fame". Was the experience enjoyable? Yes, I absolutely loved it. Would I do it again? YOU BET!

Graham Hodson

Galaxy Cruising from the Creuse

Whilst on a holiday recently in France, June 2005, I was confronted with unusually cloudy skies for this region, which, hitherto, had always been excellent in this respect. Nevertheless, armed with a trusty 8" Celestron, I did manage to observe (and photograph, although only Venus is visible) the triple conjunction of Venus, Mercury and Saturn on the days either side of the day of minimum separation, 26 June.

More successful was the night when I entertained the family of our French neighbours (none of whom spoke a word of English; fortunately, prior reading of French astronomy magazines had armed with me sufficient vocabulary to be understood) with a tour of the brighter galaxies (same word in French) and globular clusters (les amas globulaires).

Noteworthy were M81, M82, M51, M13, M5 and M3. M51 was just about displaying spiral structure to the naked eye: a remarkable sight. Jupiter, its belts and the "hide and seek" like dance of its satellites also impressed, as did the striking blue colour of nearby Spica. Interestingly, the French do not use the Latin names for the constellations as we do: Ursa Major did not register with them, but they had all heard of Le Grand Ours.

Guy Duckworth

Change of View, or Just Common Sense

You may recall that, in the last issue of Current Notes, I gave a strong view regarding the number of people who were moving from the traditional medium of 35mm film photography, to the more advanced digital revolution, which has taken the dimension of image recording to levels that appear to have no upper limits.

Well, having sat down and given a lot of thought to the issue, I listened to some thoughts of Kevin Kilburn who, having returned from a working trip to the USA, displayed some of his images taken with a digital camera. He pointed out the benefits of having the image available within seconds, the all round cost per film and time to get the results, maybe to find out that the image was not very good. Then one clear evening Mike Oates went up into the dome, and came down and showed images he had taken of Jupiter and declared that "they were the best he had taken", all with a digital camera.

Have my views changed?

NO. If you want the best quality of image the 35mm FILM is still the best medium to work with, but if you want instant views of your shots and you can get your pixels sorted out, the digital camera is a new horizon to try and explore, both with your everyday photography, and last but not least astronomical imaging.

Will I take the plunge and go digital, the answer has got to be "Yes".

Tony Cross

A Trip Down Under

An unexpected invitation to a wedding gave me the opportunity to visit relatives. I looked forward eagerly to seeing the young couple, and to the opportunity of seeing some of the southern hemisphere constellations. A previous visit had whetted my appetite, it being usual to see the curve of the Milky Way spanning the heavens, to see all of Scorpius, Centaurus, and other glittering sights.

Alas, the weather was exceptionally unkind, it being the wettest, coldest June in living memory. However, all was not lost. I plucked up my courage and contacted the Perth, Western Australia branch of the Australian Astronomical Society. Australian hospitality and generosity is legendary, and I was greeted warmly. They even gave me a lapel badge!

I only visited one of their regular monthly meetings when all who can, attend. I estimate that the attendance was 50/60. Mostly mature males, although there were some females. Some of the remainder I guess were in the age bracket 30/40 years. They were to listen to a presentation given by one of the astronomers from the Perth Observatory. They were invited to become involved in a programme of measuring the orbits of asteroids. The more accurately this can be achieved, the greater the understanding of the type and size of the object. This appeared to capture the imagination of the committee who began to discuss ways and means of cooperating with the Observatory.

Some reflections. The branch appeared to be well organized. Although they meet together only once a month, there were several special interest groups: astrophotography, lunar, deep space, and a recently formed section for radio astronomy. The main formal meeting commenced at 8pm, but all of the groups seem to meet at 7pm to chat and share experiences. I was particularly impressed that they also had a beginners' class, which also met at 7pm. I joined this group before attending the presentation. Interested people are expected to attend a couple of these meetings and then formally apply for membership of the Society. Frankly I was a little out of my depth.



There did not appear to be any shortage of volunteers to act as section leaders and I was invited to share in other evenings. Unfortunately this was not possible.

They meet at the South Perth Bridge Club premises, and if you are ever down that way call in. You will not be disappointed.

Robert Edwards

A Survey of the Members of the Manchester Astronomical Society: An Interim Report

Introduction

Several months ago I prepared a questionnaire for the purposes of surveying, among other things, the current activities and future goals of the membership of the Manchester Astronomical Society (MAS). The ultimate aim is to use the results of the survey to better inform not only the Council, but also the Membership as a whole, of what are the interests, experiences and aims of our fellow members, and thereby to inform us of where the activities of the Society might be focused (e.g. lectures, presentations, publications and observing groups/sections).

Each MAS member has been issued a questionnaire, and a sizeably minority (40%) of the total number of members have been kind enough to set aside time to complete and return the questionnaire to me. These respondents account for about 60% of the regular attendees to Thursday evening meetings at the Godlee Observatory.

This interim report is not, of course, intended to conclude the survey as many questionnaires remain to be completed and returned to me for analysis. To this extent, the results presented and discussed here can only serve as a guideline of what the survey might ultimately show once concluded. I urge those readers who have not yet completed and returned their questionnaire to do so if at all possible. This additional input will be very gratefully received.

Results So Far

Clear demographic and intellectual trends are beginning to show themselves already.

Who we are :

Apparently, 47% of respondents joined MAS at or after 2001, and of these 37% joined at or after 2003. Conversely, 53% of respondents joined MAS before 1996. Thus, a five-year gap appears in the MAS membership intake in the mid to late 1990s. Indeed, two group profiles emerge: the new relative novices (myself included) and the experienced long-standing members. This is reflected in the answers to the question: "When did you begin regularly observing?" This found that 37% of respondents have been observing for less than four years, while 53% of respondents have done so for 10 or more years. Many of the newer members (47%) joined MAS in the same year they began observing regularly. This suggests that, after a five-year gap of little growth, the recent new membership attracted

by MAS over the last few years has tended to be relative novices of limited experience.

What we do :

It is notable that the majority of the “novice” members appear to observe at least fortnightly, or “whenever possible” (59%), while a sizeable group of other respondents observe “infrequently” (36%). Of course, there may be some overlap here since “whenever possible” might practically equate to “infrequently”, but, generally speaking, a large minority of respondents observe only “infrequently” and not “whenever possible”. This may explain, to some extent, the high degree of interest in academic (i.e. non-observational) aspects of astronomy, such as history of astronomy. All respondents, with the exception of one, enjoy the benefit of observing from a garden. Presumably, light pollution is not yet an intolerable problem in and around Manchester. Nevertheless, 47% of respondents stated that they did take advantage of a dark-sky site, mostly in locations within the west Pennines and the outskirts of Greater Manchester. I list a few here as general dark-sky locations which have been tried and tested by MAS members: Windy Hill (Denshaw), Crowden; Bowdon; Langdale Valley.

Our current activities :

The questionnaire asked members to rank, in order of preference (first to sixth), their current, active pursuits and interests. The results so far identify a few clear favourites. Figure 1 (below) illustrates the “Total Score” for each object or subject referred to in the questionnaire, or otherwise identified by respondents. This score is simply the total number of times a given object/subject was given *any* ranking by a respondent, irrespective of that rank. Also shown is the distribution of “First Choice” scores, namely the number of times a given object/subject was assigned first choice by a respondent. Results are graphically presented in four groupings: Solar System; Deep Sky; Recording; Academic. In each grouping, scores are presented in descending order of popularity.

Without doubt, Solar System objects such as the Moon, Jupiter, Saturn and the Sun are favourite observing targets – principally, perhaps, due to the ease with which they can be located and observed even in poor conditions. They are rewarding targets both in terms of the wealth of detail they provide (e.g. the Moon), and the changeability they display (Sun, Jupiter). Deep Sky observing in general, and Galaxies in particular, are also popular activities, though less so than the main Solar System targets. Recording activities principally centre upon film photography, with digital photography a close second. WebCam imaging is comparable in popularity to drawings.

Academic activity is led by history of astronomy which outstrips both Deep Sky observing and film photography in popularity. Popularity in archaeoastronomy comes a respectable second (did somebody just say “double-sunset”?) and, most surprisingly of all, both cosmology and astrophysics have a sizeable following.

Also plotted is the number of first choice scores per subject/object, which does not mirror the total score plot. In this regard it is illustrative of a general observation which became apparent upon analysing the survey results as a whole. That is to say, few people have the same spread of current and active interests. Though many respondents share one or two common favourites, few share the same degree of interest in more than a few subjects. The survey results also appear to have uncovered a minor dichotomy in regular observing habits.

When asked which objects were observed most regularly, 76% of respondents identified the Moon, planets and the Sun as their regular targets, while 24% identified Deep Sky objects, and few identified both. When asked which objects were observed infrequently, 24% identified the Moon, planets and the Sun (generally the regular Deep Sky observers), while 33% identified Deep Sky (generally the Solar System observers).

Thus, though interests may be broad and cover Solar System objects as well as Deep Sky subjects, observing habits tend to be limited to one or the other. This dichotomy seems to be unrelated to the difficulties of Deep Sky observing in light-polluted areas since roughly equal numbers of Solar System observers employ dark-sky sites as do Deep Sky observers.

Future activities :

The questionnaire asked respondents to rank, in order of preference, those objects/subjects about which they wished to learn more. Figure 2 illustrates the results. The same subject groupings and data type are presented in Figure 2 as have been discussed with reference to Figure 1. Without doubt, most respondents wish to learn more about **digital photography**, and **WebCam** imaging, and apparently as a first priority to a large extent. Similarly, **history of astronomy** and **archeoastronomy** are clear topics for further study in general. However, the first priority for future academic study is **cosmology**. Of the observing targets, the **Moon** ranks favourite as a subject of further learning, with both **Mars** and the **Deep Sky** taking second place, and **Jupiter** and the **Sun** close behind. Interestingly, future **variable star** study appears to be on most respondents minds – a subject which has so far received little attention at MAS meetings perhaps.

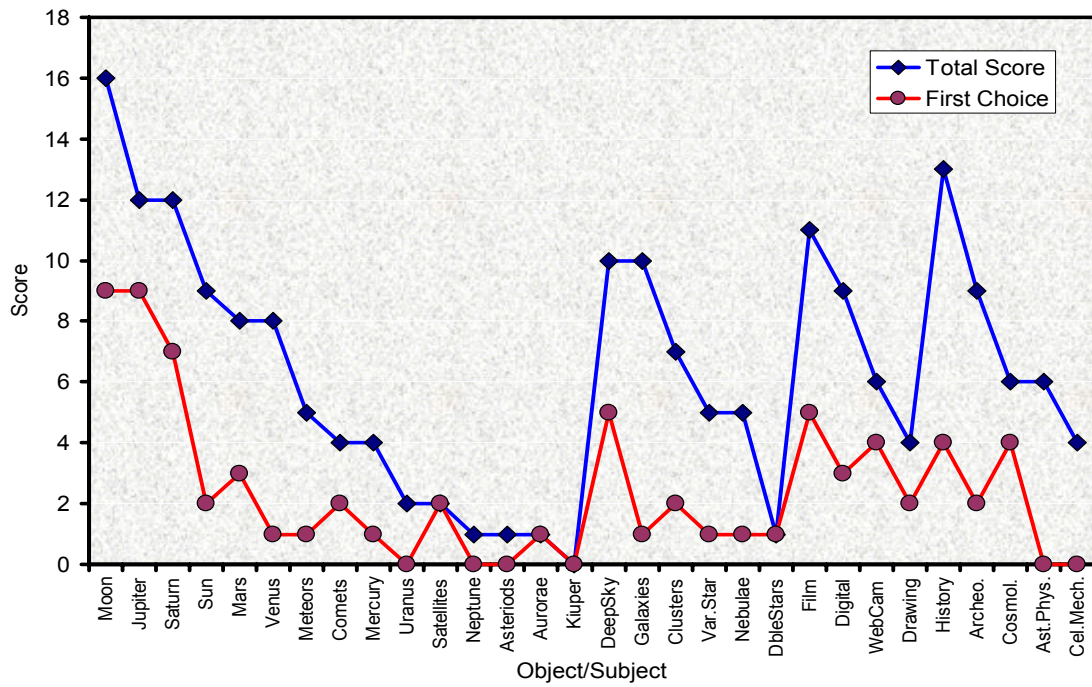


Figure1. A plot of current observing and study activities among respondents.

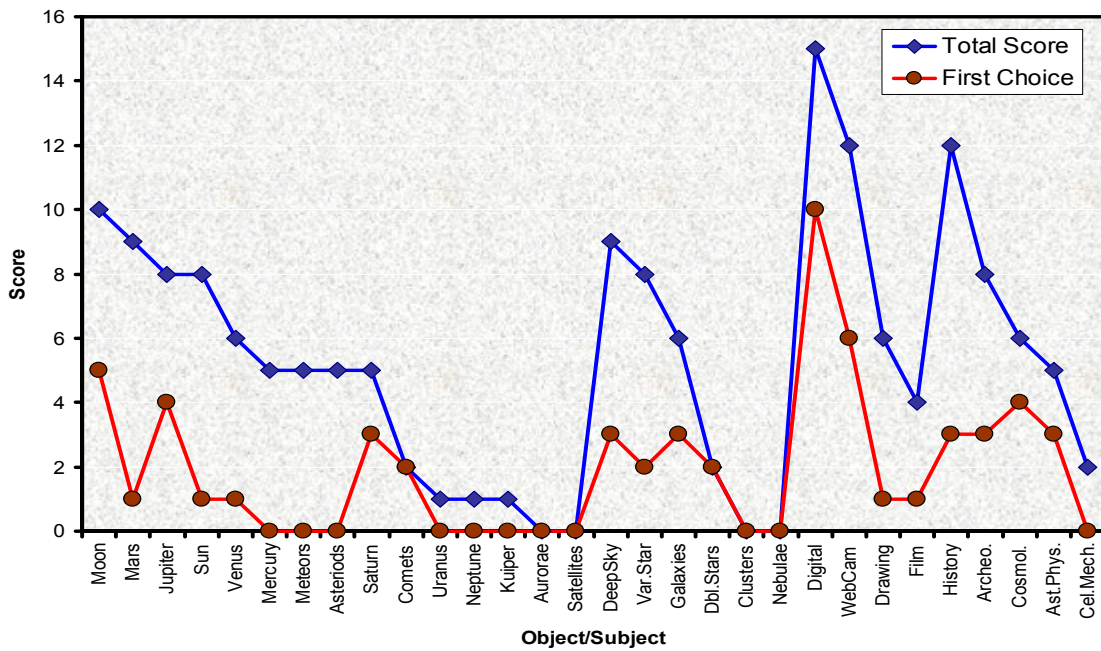


Figure 2. A plot of subjects respondents wish to learn more about.

Our reading habits :

The questionnaire asked respondents to identify their top three books. Bearing in mind the topics identified above as being of particular interest, I list below a few relevant titles:

- Norton's Star Atlas (Ian Ridpath, 20th Ed.)
- Burnham's Celestial Handbook (Vols 1-3)
- Physics and Astronomy of the Moon (Kopal)
- The Moon (Gwyn Elger)
- The Planet Observer's Handbook (Price)
- Advanced Amateur Astronomy (North)
- Compendium of Practical Astronomy (Vols 1-3, Roth)
- Introduction to Digital Astrophotography (Reeves)
- History of the Telescope (King)
- The Victorian Amateur Astronomer (Chapman)
- The First Three Minutes (Weinberg)

Equipment :

Many different telescope and binocular types and specifications are employed by respondents. Figure 3 illustrates how telescope apertures of about 8" to 10" seem to be most popular, with the "first" telescope being the one ranked as first choice by respondents and so forth. About 50% of respondents own two telescopes and of those about half use their smaller scope more than their larger one. This reminds one of the adage: "The best telescope is the one you use the most."

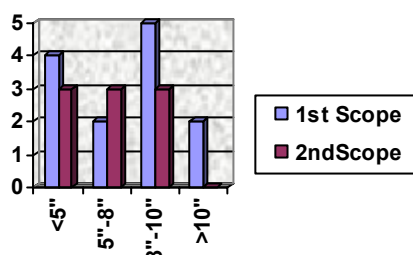


Figure 3. Distribution of telescope apertures (in inches).

About 20% of telescopes are refractors and 80% reflectors. Figure 4 illustrates the distribution of binocular apertures and their preference with respondents. Clearly, greater aperture is most popular in binoculars as a first choice, with apertures in the range 60-100 mm being prevalent, and with magnifications ranging from x6 to x30. The respondent's second choice of binocular is almost always 10x50 or 12x50. Interestingly, 20% of respondents have no telescope, and use binoculars only. These include very experienced and long-standing members of MAS. The same proportion of respondents

have no binoculars. In terms of recording equipment, 50% of respondents have film cameras, while about the same proportion have digital cameras. Of these, about half use both digital and film cameras for astro-imaging. Roughly 25% of respondents have and use WebCams (or equivalent). I list the specific make and model for a number of digital cameras below. Those members considering purchasing one of these might wish to discuss the pros and cons with the member currently owning one. Please just let me know and I shall inform the relevant person.

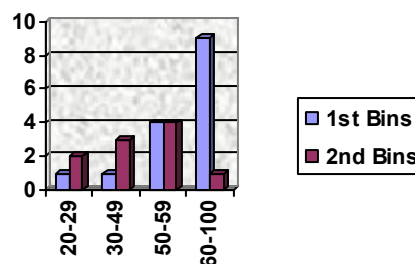


Figure 4. Distribution of binocular apertures (in mm).

Digital camera :

- Nikon Coolpix 4500
- Canon M650
- Canon Powershot (3 Mega pixel)
- Nikon 5200
- Canon 300D
- Fujitsu S7000
- Olympus Camedia (1.3 Megapixel)
- Starlight Xpress

Webcam (or equivalent) :

- Philips ToUcam Pro
- Meade Lunar-Planetary Imager (LPI)

Conclusion

To summarize, interim analysis presents the following trends. MAS members tend to be either novices, or of long-standing and experience. Observing habits focus on either Solar System objects (especially the Moon) or Deep Sky objects, but rarely both. Film photography is currently the preferred recording medium, and academic study is principally in the history of astronomy. Future aims include finding out more about digital photography and WebCam imaging, as well as more about the history of astronomy and archaeoastronomy. The Moon, Mars, Jupiter and the Sun, Deep Sky and also variable stars are topics members are keen to find out more about. Cosmology is a priority. Telescopes are predominantly of 8"-10" in diameter, and many members also possess binoculars having apertures exceeding 60mm. This gives an indication of which future observing projects may feasibly be pursued within MAS.

Andrew Feamside

The “old Moon books” held by the Manchester Astronomical Society

Introduction

On 2 December 2004 I was discussing the work of James Nasmyth, the engineer and amateur astronomer, with Tony Cross, who is working with Kevin Kilburn on a project concerning Nasmyth. We talked about the book co-authored by Nasmyth and Carpenter entitled *The Moon, Considered as a Planet, a world, and a Satellite*.

Tony asked, “Have you seen the old Moon books in the cupboard?” I was intrigued. I found that these books include: *Der Mond* by Beer and Madler, 1837; *Mond-Atlas* by J. N. Krieger, Volume 1, 1898; and Volumes 1 and 2 of J. H. Schroeter’s *Selenotopographische Fragmente* 1781 and 1802. The text in all these works is in German.

As an avid Lunar observer, I knew the importance of these works but had no idea they had such fascinating histories attached to them until I carried out some further research.

Selenotopographische Fragmente, Volumes I and II, by Johann Hieronymus Schroeter

Born in Erfurt, Germany, in 1745, Schroeter has never been given due credit for his contributions to Lunar and Planetary observing. Never a professional astronomer, Schroeter was trained in the legal profession. His life took a turn in 1781 when William Herschel discovered the planet Uranus, after which Schroeter decided to “devote himself to astronomy”.



A contemporary portrait of J. H. Schroeter.

Quickly progressing from a 2.5 inch refractor, to reflectors of 4.75 and 6 inch diameters, Schroeter set about observing all manner of astronomical objects. In the winter of 1787–1788 Schroeter turned his attention to the

Moon. Initially he intended to complete a map of the entire visible surface to a diameter of 46.5 inches, but soon decided this was too arduous a task for one observer. Instead he concentrated on preparing large-scale drawings of sections of the Moon. By 1790 he had enough material to publish, at his own expense, the first volume of his work, *Selenotopographische Fragmente*, running to 676 pages with 43 copper plates.

He continued his Lunar studies until 1797, and during this period he constructed a 9.5 inch reflector and later a massive 19.25 inch, the latter being of rather poor optical quality and a somewhat “unwieldy contraption”. In 1802, again at his own expense, Schroeter published the second volume of *Selenotopographische Fragmente*, a little shorter than the first at 565 pages with 32 copper plates. Schroeter’s observatory at Lilienthal and many of his papers and manuscripts were destroyed following a skirmish between French and Cossack troops after Napoleon’s disastrous Russian campaign in 1813. Schroeter never recovered from this loss, but managed to publish further work relating to his observations of the great comet of 1811 and Mercury. He passed away on the eve of his 70th birthday in 1816.

I don’t think Schroeter has had the recognition he deserves. It is true to say his draughtsmanship was not of the highest standard, but he was seldom inaccurate in the portrayal of the detail he observed. He was the first to make repeated use of the words “rille” and “crater” when describing the Lunar features he observed; however, his use of these terms gave no implication relating to their mode of formation. He introduced around 80 new references for previously unnamed Lunar features, most of which are still in use today.

The Moon, according to Schroeter, was a geologically active body; the features on its surface exhibited changes in their appearance, there was a tenuous atmosphere, and the surface was inhabited by “Selenites”. Thirty-five years later, with the work of W. Beer and J. Madler, our view of the Moon changed, and has remained much the same to this day.

The two volumes of Schroeter’s work held by the Manchester Astronomical Society (MAS) are very similar in terms of their condition. Whilst a little crude in their depiction, the drawings give an overwhelming feeling that they had paved the way for selenology over the next 100 years or so. The frontispiece to Volume 1 is inscribed indicating that both volumes were presented to the Society in 1924 by E. T. Whitelaw F.R.A.S. Mr Whitelaw was head of an important engineering practice and patent office based at 70 Deansgate, Manchester. He became a partner of Julius Allmann & Co. in 1884, and took over the

business when its founder, Mr Allmann, retired in 1890.

Mr Whitelaw worked on a number of engineering projects, some of which were in other countries, and was also head of the international patent side of the business. He had a large clientele both in this country and abroad. Business in this regard was transacted in English, French and German.

We might conclude from Mr Whitelaw's business activities that he may have spent some time abroad, and may have picked up the two volumes of Schroeter's work outside the UK. Mr Whitelaw was president of the MAS from 1904 to 1907.

***Der Mond*, by Wilhelm Beer and Johann von Madler**

Born in Berlin, in 1797, W. Beer trained for a career in banking, while Madler seemed destined for an academic career until an outbreak of typhus claimed the lives of both his parents when he was 19 years old. In order to provide for his four younger siblings, he trained as an elementary school teacher, gave private lessons, and later founded a school in Berlin for children whose parents had limited means.



J. Madler, the main contributor to *Der Mond*

Wilhelm Beer was introduced to Madler by Alexander Humboldt, the explorer and naturalist, and the two men immediately became friends sharing their common passion for astronomy. It was Beer who established his own observatory, equipping it with a fine 3.75 inch Fraunhofer refractor, and the two men set about their Lunar mapping project in 1830.

The map of Beer and Madler was produced in four sections, bounded by the Lunar equator and the prime meridian, with no overlaps. In the space of only six years, the two men completed a monumental achievement; however, it is generally thought that Madler was the one who

carried out the majority of the observations. This chart surpassed anything that had been previously published in terms of its accuracy and detail, and because of this the two men attributed some 130 new names to the features they had recorded. Most of these names are still in use to this day. The chart however was only part of the story.

During the making of the chart Beer and Madler had amassed a huge amount of written notes and measurements of Lunar features. This information they collated and published in a book entitled *Der Mond (The Moon)* published in 1837. The book, written in German, contains just about all that was known about the Moon at the time, along with detailed descriptions of all the features observed by Beer and Madler.

The views expressed in *Der Mond* were completely different from everything that had gone before. The Moon of Beer and Madler was airless, waterless and lifeless and therefore changeless, and because of this the work marked an epoch in the study of the Moon. Madler scorned observers who had preceded him, such as Schroeter, because of their beliefs and "flimsy and insubstantial results".

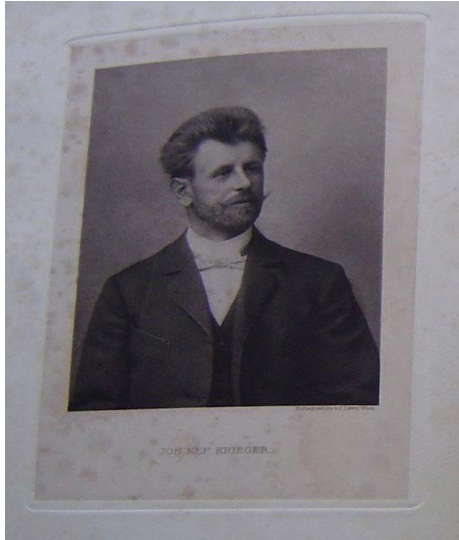
To all intents and purposes *Der Mond* drew a line under Lunar observing as it stood at that point in time creating a new view of our Moon, and this is why it is such an important book. Wilhelm Beer died in 1850. Later, Madler worked at the observatory at Dorpat, which housed a 9.5 inch refractor. Initially he used the instrument to further refine his observations, but he was never happy, and moved back to Germany in 1865; he died in Hanover in 1874.

There are three inscriptions on the inside the copy of the book held by the MAS, which suggest that the book was acquired by F. W. Longbottom in 1904 from W. Murray Dobie, who at the time appears to have been disposing of a number of his selenographical works. F. W. Longbottom was an early astrophotographer and from 1906 to 1926 Director of the British Astronomical Association (B.A.A.) photographic section, while W. Murray Dobie was a frequent contributor to the B.A.A. Mars section.

The book changed hands again in 1916 when it was acquired by Dr H. Whichello, and finally presented to the MAS in 1939 by Dr Whichello. Between the years of 1914 and 1922 Dr Whichello was honorary secretary of the Liverpool Astronomical Society, and between 1923 and 1925, and again between 1931 and 1935 their president. I understand he was also a full member of the MAS and may have served on the council at some time.

***Mond Atlas*, by Johann Nep. Krieger**

Born in 1865 in Bavaria, Johann Nepomuk Krieger can be considered something of an “enigma” in terms of the history of Lunar observing. He is seldom mentioned in the “popular” literature; however, his story is a fascinating and moving one. Son of a master brewer he started observing the Moon as a small boy using a modest refractor.



J. N. Krieger's portrait from the title page of *Mond Atlas* Volume 2, 1912.

He left formal education at the age of 15, and at the age of 21 he visited Professor Klein, Director of the Cologne Observatory and an eminent astronomer in his own right. Klein encouraged Krieger to make the study of the Moon his “life’s work”. Using his inheritance to establish an observatory in the Munich suburb of Gern-Nymphenburg, and equipping it with a fine 10.6 inch Zollinger refractor, Krieger resolved to produce a “definitive Lunar Atlas”. Working at the same period, with the same intentions, was the “aggressive” Lunar cartographer Philipp Fauth. Fauth was a master of careful observation, his drawings of Lunar formations were superb, both in their representation and accuracy, and he quickly became well respected in astronomical circles.

Not a shy man, Fauth delighted in letting everyone know his observations were second to none and that he was routinely able to observe finer details than those using larger instruments than his own. Whilst Fauth’s approach to Lunar cartography was in the traditional manner of hand drawn representations, Krieger favoured a different method. He obtained, through Klein, negatives of the Moon taken at the Lick and Paris observatories. These low-resolution images were enlarged and formed the basis of Krieger’s drawings, thus ensuring an unparalleled level of proportion and positional accuracy.

Krieger added the details he observed at the telescope over a number of observing sessions and used the drawings as the basis for his superb charcoal, ink and graphite pencil drawings. These drawings were “superior” to any which had previously been produced. Fauth was quick to deride Krieger’s work, presumably fearing that his own work would be overshadowed by this new method of preparing observational drawings.

In order to bring some continuity to his observations Krieger “standardized” his equipment by continually using a power of 260 and stopping down the aperture of his instrument to 6.5 inches. He worked frantically to produce the drawings for his proposed atlas of the Moon. However, he paid a high price for his long hours at the telescope and in his study and after a few short years Krieger’s health deteriorated dramatically. He died in 1902. Krieger completed 28 plates for the publication of Volume 1 of his atlas, which he lived to see published in 1898. The remaining plates were collated and published some 10 years after his death in 1912.

Philipp Fauth continued to rise in the esteem of the astronomical community, particularly in Germany, his 600 page treatise (*Our Moon*) was published in 1936, and remains his best known work outside Germany. His Lunar Atlases of 1895 and 1936 are testimony to his skill and perseverance as an observer. However, one wonders if there would have been a different history if Krieger had lived a long and productive life.

As well as the books left by Krieger, his memory lives on in the numerous new names he gave to the Lunar features he observed, such as Lamont, Prinz and Yerkes, which are still in use to this day.

The MAS owns Volume 1 of a three volume set (it’s hardly surprising that there is not a full set of three volumes considering the latter two were published some 14 years after the first).

Bibliography

In addition to having the pleasure of studying the above-mentioned books themselves, the following have been consulted during the preparation of this brief history.

The MAS and Liverpool Astronomical Society web sites.

The Manchester Astronomical Society, a History, by Kevin Kilburn.

Personal correspondence from Richard Baum. B.A.A. Lunar Section Memoirs.

Men of the Period, Lancashire. The records of a Great County, portraits and pen pictures of

leading men 1900 – from the notes on E. T. Whitelaw F.R.A.S.

Explorers of Space, by Patrick Moore.

The Face of the Moon, by Linda Hall Library 1989.

Mapping and Naming the Moon, by E. W. Whitaker.

Epic Moon, by W. P. Sheehan and T. A. Dobbins.

The Astronomical Scrapbook, by Joseph Ashbrook.

The latter three volumes are a must for anyone interested in the history of Lunar observation.

Finally, my thanks go to Kevin Kilburn for his information in relation to the “characters” associated with the MAS and for his comments on the text of this paper, and last but not least to Tony Cross, without whom one can only guess how long these books might have lay hidden in that “cupboard in the back room”!

Nigel Longshaw

The Speed of Light

Introduction

An assumption of the constancy of the speed of light is a central plank of Albert Einstein's Theory of Special Relativity. It is the factor by which inertial mass (M) and its equivalent form, energy (E), are related by the iconic equation $E=Mc^2$.

But what, precisely, is meant by the “constancy” of the speed of light? At its most general, Einstein's postulate was that light is always propagated in empty space (anywhere) with a definite speed which is independent of the state of motion of the light source. Thus, whomsoever measures the speed of light will always arrive at the same value, irrespective of their location and motion in space and time, according to Einstein.

This apparently mild postulate, once accepted, leads to a wealth of physical consequences many of which are wholly incompatible with our everyday experience. The dilation of time, the compression of space and the accumulation of mass in respect of an observed object at increasing speed relative to the observer are just a few examples of such consequences. Nevertheless, bizarre though these consequences may seem, their predicted existence carries a force of logical and mathematical inevitability that cannot apparently be resisted in those terms. That is to say, once one *does* accept Einstein's postulate of the constancy of the speed of light, the consequences identified above flow directly and inexorably from relatively simple mathematics, geometry and logic.

Thus, to test or question the Theory of Special Relativity, one might reasonably begin with a test of its central postulate. In particular:

- (1) Does light still currently have the speed assigned to it by previous measurements?
- (2) If the answer to (1) is yes, does the new measurement occur at a different location in space and time, and at a different state of motion as compared to the previous measurement?

An answer in the affirmative to both questions would provide clear support for a view that Einstein's postulate is correct, and that the speed of light is constant in its value, whoever measures it, wherever and whenever they do so.

To best test the postulate it is preferable to compare a contemporary determination of the speed of light with a historical one which is most distant both in terms of the date and the location in space at which it took place. Thus, should the speed of light in fact not be constant as postulated but, rather, vary with time and/or

the location of the light within the Universe when measured, then such a comparison between contemporary and historical measurements should hold the greatest chance of revealing such variation.

The First Determination of the Speed of Light

In September 1676, Danish Astronomer Ole Roemer (then at Paris Observatory) announced to the Academy of Sciences, in Paris, that Io, the innermost moon of Jupiter, was due to emerge from an eclipse on 9 November 1676 at a time 10 minutes later than would be expected purely on the basis of previous such eclipses. Roemer proposed that this delay arose purely due to the finite speed of the propagation of light, a speed which was considered by many of Roemer's contemporaries to be infinite in value.



Ole Roemer

Once Roemer's prediction was confirmed by observation, he announced that the speed of light was of such a magnitude as to require 22 minutes to traverse the whole diameter of the Earth's orbit. The absence of an accurate value for the Astronomical Unit prevented Roemer from quantifying this speed further (e.g. in metres per second).

At times of the year other than those at which Jupiter lies at opposition to the Sun, the shadow cast behind Jupiter's sunlit disk extends in a direction somewhat oblique to the Earth-bound view, thereby "revealing" the shadow to the "view" of the terrestrial observer. Roemer's methodology required determining the orbital period of Io, and then the times at which Io was seen to either emerge into view from within Jupiter's shadow (a shadow "emersion event"), or to disappear from view into Jupiter's shadow (a shadow "immersion event"). By determining the time interval between multiple successive emersion (or immersion) events, and subtracting from that time interval the relevant multiple of Io's orbital period, a positive remainder was generally found to occur (i.e. the former interval exceeds the latter) which Roemer observed to vary periodically in phase with the Earth's orbital

motion and which he attributed to the correspondingly periodic variation in the distance required to be traversed by reflected sunlight propagating from Io to the Earth.

This methodology is well within the competence of an amateur astronomer and has been adopted here to determine a contemporary value for the speed of light.

Observations of Emersion Events

Using a Meade ETX125 Maksutov-Cassegrain 5" reflecting telescope, the Io emersion event occurring on 28 June 2005 was recorded using a Meade Lunar and Planetary Imager (LPI) CCD camera at prime focus. Digital images of Jupiter and its host of Galilean satellites were taken at approximately 30-sec intervals before, during and after the emersion event.

Figure 1 illustrates examples of such images. Each image frame included an image of the Jovian moon Ganymede.

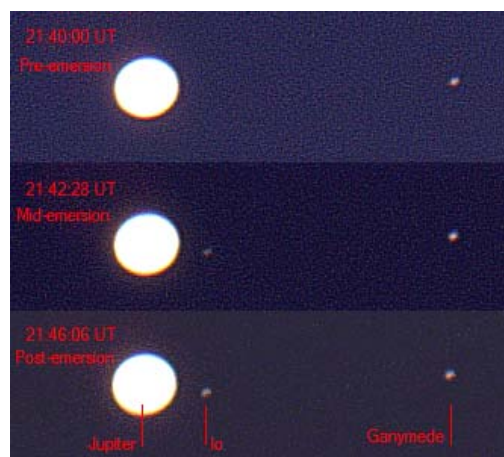


Figure 1. Image frame sequence taken during the course of the Io emersion event of 28 June 2005.

Using the photometry software package "IRIS", the following measurements were taken from each image frame. A measurement was taken of the total pixel value of a 10-pixel diameter circle within a given frame centred upon the location of Io, but excluding Jupiter and any other discernable celestial object. Using the same circular diameter, measurements were made of the corresponding pixel value of empty space immediately adjacent Io, and the latter subtracted from the former to produce a pixel value (brightness) attributable to Io alone. The same procedure was carried out upon the image of Ganymede within the same frame to produce a brightness value for Ganymede. As Ganymede was, at that time, far from Jupiter and its shadow, its intrinsic brightness can be assumed to be effectively constant during the observation period. Thus, any variation in the apparent brightness of Io due to atmospheric or optical causes should apply equally to the apparent brightness of Ganymede within the

same image frame. The ratio of the brightness of the two moons, within a given frame, should, in principle, be independent of those variations. Thus, Ganymede was used as a “standard candle” as it were. Calibration measurements of the LPI CCD camera have shown it to have a linear response to the light intensities involved.

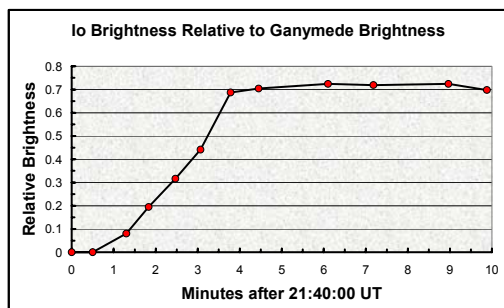


Figure 2. Light curve for Io emersion event of 28 June 2005.

Figure 2 illustrates the Io/Ganymede brightness ratio as it varied over the minutes leading up to, during and after the emersion event of 28 June 2005. The first point to note is that the emersion event is not instantaneous – Io does not simply “pop into view” – rather, a relatively slow and steady increase in brightness occurs over a period of about 200 sec during which Io brightens from zero intensity to a final and settled brightness of about 72% the brightness of Ganymede. Astronomers have found that the brightness of the Galilean moons is dependent upon their orbital phase [1]. At the particular orbital phases of Io and Ganymede considered here, the magnitudes of Io and Ganymede are expected to be 5.1 and 4.75, respectively. The corresponding ratio of brightness thus amounts to 72%. The settled brightness of Io as shown in Figure 2 is in good agreement with this. Mid-emersion is estimated to occur at about 21h 42min 38sec UT.

A further series of such measurements, using the same method, was made in respect of a subsequent Io emersion event occurring on 6 August 2005, and mid-emersion was estimated to occur at 20h 16min 30sec UT. The time interval between these two mid-emersion events is 38 days 22h 33min 52sec (i.e. 3364432 sec). Given that Io has an orbital period of 152853.5 sec, the time interval corresponds to 22 full Io orbits – with a remainder or excess of 1654.5 sec.

To what can this excess of time be attributed? Certainly, one contributing cause must be the steady angular advance of the position at which Jupiter’s shadow intersects with the orbital path of Io as Jupiter advances in its orbit around the Sun. The rate of shadow advance is predicted to be about 0.147 degrees per Io orbit. As a result of this shadow advance, it can be shown that, as a consequence of having to “chase” Jupiter’s shadow, Io will emerge from that shadow about 62.4 sec later than expected

each orbit. Consequently, this “shadow delay” amounts to about 1372.8 sec accumulated over the 22 orbits of Io which occurred between 28 June and 6 August 2005. Subtracting the “shadow delay” from the total excess of 1654.5 sec leaves a time excess of 281.3 sec attributable to the time required by light to traverse the extra distance placed between Jupiter and the Earth during the time interval between the two emersion events in question. A “light delay”. Table 1 summarizes the results.

Date	Emersion time (h:m:s)	Jupiter–Earth distance (AU)	Time excess (sec)	Shadow delay (sec)	Light delay (sec)
28/6/05	21:42:38	5.316			
6/8/05	20:16:30	5.894	1654.5	1372.8	281.7

Table 1

Accordingly, an estimate of the speed of light may be deduced from the ratio of the change in the Jupiter–Earth distance (i.e. 0.578 AU) and the “light delay” (i.e. 281.7 sec), this estimate being given in astronomical units per second. Of course, to convert this result into metres per second requires knowledge of the astronomical unit in metres: a quantity unavailable to Roemer.

The Astronomical Unit

Fortunately, the transit of Venus across the solar disk of 8 June 2004 provided an ideal opportunity to determine a value for the astronomical unit, denoted a_0 . The author has developed a method by which this quantity may be determined using measurements taken from photographs of that part of the transit leading up to and including third contact as the silhouette of Venus egresses the solar disc.

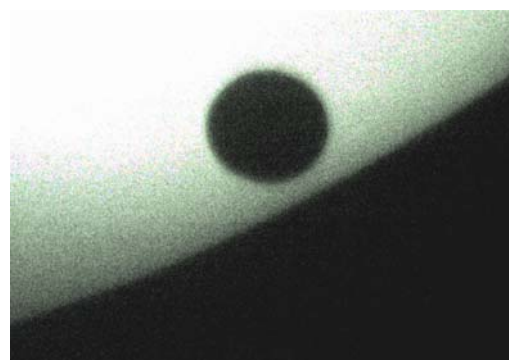


Figure 3. The silhouette of Venus approaching limb of Sun on 8 June 2004.

The method does not require simultaneous observations of the transit by two geographically widely separated observers. Only a single observer is required, and using a

series of about two dozen digital photographs of the transit at egress taken by the author, such as shown in Figure 3, a value for the astronomical unit was found to be

$$a_0 = 1.4405 \times 10^{11} \text{ metres.}$$

Full details of this method were submitted to MAS in a paper of July 2004 [2], and any MAS member wishing a copy is welcome to one on request to the author. Thus, the extra distance of 0.578 AU traversed by light during the 6 August 2005 Io emersion event, as compared to the emersion event of 29 June 2005, is estimated as being 0.83521×10^{11} metres.

The accepted accurate value for the astronomical unit is $a_0 = 1.49597 \times 10^{11}$ metres.

The Speed of Light

Using the "light delay" and the value for the astronomical unit, as determined by the author, one arrives at an estimate of the speed of light, denoted c , of

$$c = 2.9649 \times 10^8 \text{ metres per second.}$$

The currently accepted value for the speed of light is

$$c = 2.9979 \times 10^8 \text{ metres per second.}$$

Converting Roemer's original determination of the speed of light – namely, 2 AU in 22 minutes – into metres per second, results in an estimate of

$$c = 2.27 \times 10^8 \text{ metres per second.}$$

This is significantly less than both the presently estimated value and the currently accepted value for the speed of light. Why is this?

Roemer's Observations

Referring to Figure 2, it is clear that there is no well-defined instant at which Io can be said to make the transition from invisibility to full visibility. As a result, any visual determination of the time interval between Io emersion events will be subject to errors caused by seeing conditions and the optical quality of the observer's eyes and telescope. In the 200, or so, seconds required for Io to brighten from invisibility to full brightness, the intervening instant at which a given observer is able to distinguish Io must surely vary.

For example, in good seeing conditions, perhaps Io becomes distinguishable at, say, 50% of its full brightness (e.g., at mid-emersion). However, in poorer seeing conditions, when observing a subsequent Io emersion even, the same observer may only be able to distinguish Io at 75% of its full brightness (e.g. about 50 sec after mid-emersion). Accordingly, the time interval

between these successive observations is not the same as the time interval between successive mid-emersion times, the former will exceed the latter by about 50 sec. It is tentatively suggested that Ole Roemer may have been prey to such errors.

Figure 4 (at end of article) illustrates a facsimile copy of Ole Roemer's observing log from January 1668 to January 1678 in respect of the times of emersion ("*Emer*") and immersion ("*Imm*") of Io from and into Jupiter's shadow, respectively [3]. The striking thing about these records is that Roemer recorded the times of immersion and emersion *to the second*, with no indication of error margins. One can only assume that the times in question refer to those times at which Roemer was first able to distinguish Io (emersion), or first unable to do so (immersion). Only for the observations of 11 and 20 February does Roemer give an indication of errors, by annotating those entries with the abbreviation "*dub*" – presumably meaning "dubious". Jupiter was at opposition around the dates in question and its shadow edge would be virtually coincident with its bright limb thereby rendering immersion difficult to distinguish. There is no clear indication that the recorded times refer specifically to mid-emersion or mid-immersion times.

So, how accurate or consistent was Roemer in determining the appearance or disappearance of Io at the same point within successive 200-sec immersion/emersion events? Table 2 lists a series of observations of emersion events conducted by Roemer during early 1672.

Roemer employed a 24-hour clock system using local solar time in which the day began at 12 noon. This is evidenced by a report in *Philosophical Transactions* [5] dated 25 June 1677 which refers to the observations conducted at Paris Observatory, in respect of the predicted emersion event of 5h 35min 45sec on 9 November 1676, as occurring "at Night". The report is a translation of an original French report which refers to the observation occurring "du soir", i.e. in the evening. Table 2 also lists the relevant emersion times in Universal Time (UT), obtained by adding 12 hours to the times listed by Roemer, then subtracting the "equation of time" [4] from the relevant resulting dates and times. The table lists the time interval since the previous emersion observed by Roemer in terms of the number of intervening orbits of Io. The shadow delay is also shown, as is the residual light delay. The values of light delay are, therefore, the time delay beyond the expected time of an emersion event as measured from Roemer's recorded time for the previous emersion event - taking account of the relevant number of intervening Io orbits and the relevant expected shadow delay.

Date in 1672	Emersion time (solar)	Emersion time (UT)	Time interval (Orbits)	Shadow delay (sec)	Light delay (sec)
23/3	06:18:14	18:24:40	5.00204	312	30
(28)29/3	13:45:30	01:50:16	3.00115	187	-12
30/3	08:14:46	20:18:58	1.00045	62	6
6/4	10:11:22	22:13:26	4.00166	250	4
(13)14/4	12:08:08	00:08:02	4.00179	250	15
22/4	08:34:28	20:32:29	5.00256	312	71

Table 2

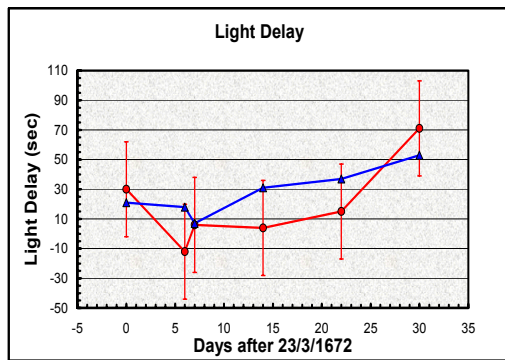


Figure 5. Roemer's observed (red) light delay with ± 32 sec error margin; expected (blue) light delay.

Figure 5 plots the light delay according to Roemer's observations (red line). If the speed of light was constant in Roemer's time, and had he been able to distinguish the appearance of Io at the same point within each 200-sec emersion event (e.g. mid-emersion), then the resulting light delay would always be positive (the Earth was receding from Jupiter at the dates in question). This is not seen in Figure 5, which shows a negative light delay value for the emersion event of 28–29 March 1672. Clearly, either Roemer had difficulty in consistently distinguishing Io at the same point within successive emersion events, or Roemer's observations are accurate and the speed of light varied wildly during the spring of 1672. It is to be expected that the former case is the true cause of the variations in Roemer's light delay values, especially when considering the form of the light curve of Figure 2 which shows a fairly linear increase in Io brightness over about 200 sec, and a mid-emersion period of about 65 sec (i.e. the middle third of the rising slope of the light curve). Within this region of the light curve, Io rises by about one magnitude from mag 6.5. It is likely that Io would be

distinguishable somewhere within this 65 second period – depending upon seeing conditions and optics – but may well not be clearly distinguishable before then, especially when one considers the proximity of Io to the glare of Jupiter. Consequently, it is tentatively submitted that one can reasonably expect Roemer's recorded observation timings to be subject to an error margin of about ± 32 sec.

How do Roemer's results compare with a presumed constant speed of light of 2.9649×10^8 metres per second, when suitable error margins are taken into account? Figure 5 also plots the light delay (blue line) Roemer would have observed had he been immune from any observational error and could distinguish Io at exactly the same point (e.g. mid-emersion) within each emersion event he observed, and assuming the speed of light was 2.9649×10^8 metres per second. We can see that Roemer's observations variously overestimate and underestimate the expected light delay values, and are sometimes rather close, but are *always* within the ± 32 sec error margin.

Conclusion

What can we deduce from Roemer's works?

They are consistent with an assumption that the speed of light is finite, and when due account is taken of the errors to which Roemer's observations must surely have been subject, they are also consistent with the current estimate of the speed of light deduced by the author. However, it must be conceded that Roemer's results do not provide compelling evidence that the speed of light was 2.9649×10^8 metres per second in his day.

However, in 1694 Halley published the results of immersion/emersion observations of his own [6] from which he concluded that the velocity of light was such as to require 8 min 30 sec to travel one astronomical unit of distance. This equates to a velocity of

$$c = 2.92 \times 10^8 \text{ metres per second.}$$

This value is in close agreement with the value estimated by the author 311 years later and approximately 0.25 light years separated. It also agrees closely with the currently accepted value of 2.9979×10^8 metres per second.

What bearing does this have upon a test of the postulate of Special Relativity? Put frankly, it rather leaves the question open if only Roemer's results are to be compared with the author's. Halley's results are in much closer agreement. Nevertheless, the present study can conclude that Roemer's results (within observational error margins), Halley's results and the author's results are not only consistent with each other but are at least consistent with the postulate. The comparison is favourable,

and does *indicate*, but by no means proves, that the value of the speed of light has been unchanged by the great separation in both space and time between the two measurements made of it by Roemer and Halley, and then by the present author. It is to be noted that the position of the solar system has changed within our galaxy by about 0.25 light years in the 333 years between 1672 and 2005, when one considers the speed with which the Sun is estimated to orbit about the galactic core. The speed of light through that part of the space-time occupied by Roemer in 1672 (Halley in 1694) appears to be the same *finite* value as through that part of space-time we currently occupy – as the postulate would require, but our “everyday” experience would not.

As a final note, it is worth remembering that in his day, Roemer’s contemporaries considered the speed of light to be *infinite*. Their everyday experience led them to conclude that since there is no discernible time delay between a thing emitting/reflecting light, and an observer seeing that light, the delay cannot exist, it was thought.

Johannes Kepler (1571–1630) considered light to be immaterial and therefore to require no time to propagate through space since, being immaterial, it could not be subject to any resistance to its motion. Galileo (1564–1642) conducted experiments to determine whether light propagated instantaneously or at finite speed, but was unable to detect any evidence of the latter. Descartes, a powerful influence on the mindset of Roemer and his contemporaries, was sure that the speed of light was infinite – simply because to suggest otherwise would contradict his everyday experience – which had never shown him light to be finite in speed. Indeed, Roemer’s superior at Paris Observatory, its director Giovanni Cassini (1625–1712), strongly objected to the notion of a finite speed of light, preferring to explain the observed delay in Io’s immersion and immersion events as resulting from inadequate understanding of its orbit. Nevertheless, in England, the likes of Flamsteed, Halley and Isaac Newton each acceded to Roemer’s view. In response to Cassini’s assertion that the light delay in question arose due to imperfect knowledge of Io’s orbital parameters, none other than Isaac Newton rebutted this claim in *Optics*, stating that: “*Some inequalities of time may arise from the eccentricities of the orbs of the satellites [of Jupiter] ... But this inequality has no respect to the position of the Earth, and in the three interior satellites is insensible, as I find by my computation from the Theory of Gravity.*”

In England, Robert Hooke alone was not convinced by Roemer. In his view, light was “*so exceeding swift t’is beyond imagination*”. Apparently, the mere fact that the speed in

question exceeded his comprehension meant that it must be infinite in value. A philosophically bankrupt argument it must be said, and one against which Isaac Newton was likely to rail – the two men were arch enemies (*Ed: see article by Paul Wood*).

I end with a quote by Albert Einstein:

“*Two things are infinite: the Universe, and human stupidity; and I’m not sure about the Universe.*”

References

- [1] *Solar System Photometry Handbook* (Genet): Chapter 2, pp. 2–3.
- [2] *Measurements Relating to the Transit of Venus of 8 June 2004* (A S Fearnside): July 2004.
- [3] *Roemer and the First Determination of the Velocity of Light* (Cohen).
- [4] *Norton’s Star Atlas*: 20th Edition, p.17. The equation of time was calculated for the relevant dates and times using “Maxclock” software which provides these values for any date within the range 9999BC to 9999AD. This software is freely available on the Internet.
- [5] *Philosophical Transactions*: Vol. XII, No.136, 25 June 1677, pp.893-4.
- [6] *Philosophical Transactions*: Vol. XVIII, No.214, Nov-Dec 1694, pp.237-56.

Andrew Fearnside

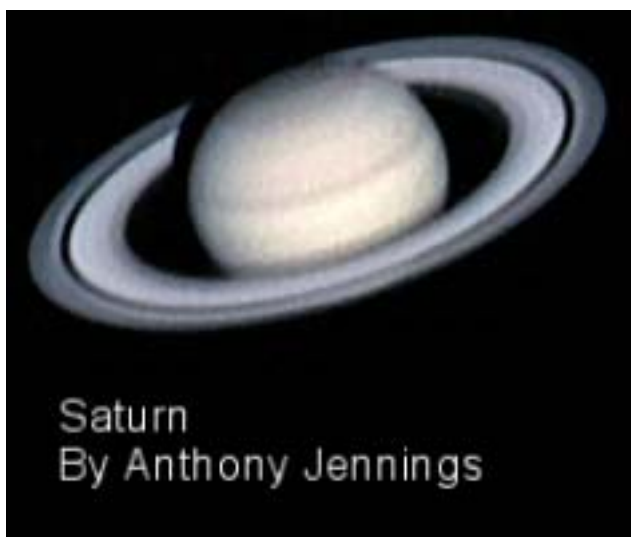
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parisijs.

Year	Month	Day	Hour	Minute	Second	Notes
1668	Oct	22	10	41	33	Emeritio in bnd 45
1669	No. 26		16	26	40	Imm
1671	Martij	19	9	1	44	Emeritio re vultu
1671	Apr.	27	7	42	30	Em
1671	Maij	4	9	42	30	Emer
1671	Oct	24	18	15	0	Imm
1671	Dec.	18				
1672	Jan.	3	12	42	36	Imm
1672	Jan.	10	14	32	14	Imm
1672	Jan.	12	8	59	22	Imm
1672	Feb.	11	10	57	6	Imm dub
1672	Feb.	20	7	20	26	Imm dub
1672	Mart.	7	7	58	25	Emer
1672	Mar.	14	9	52	30	Emer
1672	Mar.	23	6	18	14	Emer
1672	Mar.	28	13	45	30	Emer
1672	Mar.	30	8	14	46	Emer
1672	Apr.	6	10	11	22	Emer
1672	Apr.	13	12	8	8	Emer
1672	Apr.	22	8	34	28	Emer
1672	Apr.	29	10	30	6	Emer
1672	Nov.	28	9	37	5	Imm
1673	Feb.	4	17	31	10	Imm
1673	Feb.	6	12	0	0	Imm
1673	Feb.	13	13	53	20	Imm
1673	Feb.	27	17	40	10	Imm
1673	Mar.	1	12	9	1	Imm
1673	Mar.	15	16	0	48	Imm
1673	Mar.	17	10	28	16	Imm
1673	Mar.	24	12	24	30	Imm
1673	Apr.	18	9	22	0	Emer
1673	Apr.	25	11	18	5	Emer
1673	Maij	2	13	12	40	Emer
1673	Maij	11	9	17	39	Emer
1673	Maij	18	11	32	44	Emer
1673	Aug.	4	8	30	41	Emer
1673	Decem.	17	6	39	14	Imm
1674	Mai.	23	16	74	12	Emer
1674	Jul.	31	9	19	2	Emer
1675	Jul.	20	8	22	42	Emer
1675	Julij	27	10	17	31	Emer
1675	Oct.	29	6	7	22	Emer
1676	Maij	12	14	49	42	Imm
1676	Jun.	13	10	56	11	Imm
1676	Aug.	7	9	49	50	Emer
1676	Aug.	14	11	45	55	Emer
1676	Aug.	23	8	11	13	Emer
1676	Nov.	9	5	45	35	Em.
1677	Junij	9	12	23	24	Imm
1677	Junij	16	14	16	14	Imm
1677	Jul.	9	14	21	54	Imm
1677	Jul.	19	10	47	0	Emer
1677	Jul.	25	12	37	10	Imm
1677	Aug.	26	11	31	50	Emer
1677	Sept.	11	9	54	30	Emer
1677	Sept.	18	8	41	0	Contestatio p. r.
1677	Sept.	18	8	46	0	Contestatio p. r.
1677	Sept.	19	11	51	46	Emer
1677	Sept.	19	8	14	0	Contestatio p. r.
1677	Sept.	19	8	18	30	Contestatio p. r.
1677	Nov.	5	6	59	0	Emer
1678	Jan.	6	5	25	47	Emer

Figure 4. Ole Roemer's observing log from 1668 to 1678.

Picture Gallery

Images produced by Anthony Jennings using a Philips ToUcam and processed using Registax as described in his article "Guide to Imaging Planets with the Philips ToUcam".



Saturn
By Anthony Jennings

Date: 2nd April 2005, 21:21 (Local Time)
Location: Rhodes, North Manchester
Telescope: 8" LX90 SCT
Camera: Philips ToUcam (3x Barlow)
Image: Stacked 403 Frames
Processing Software: Registax 3 & Paintshop Pro 8



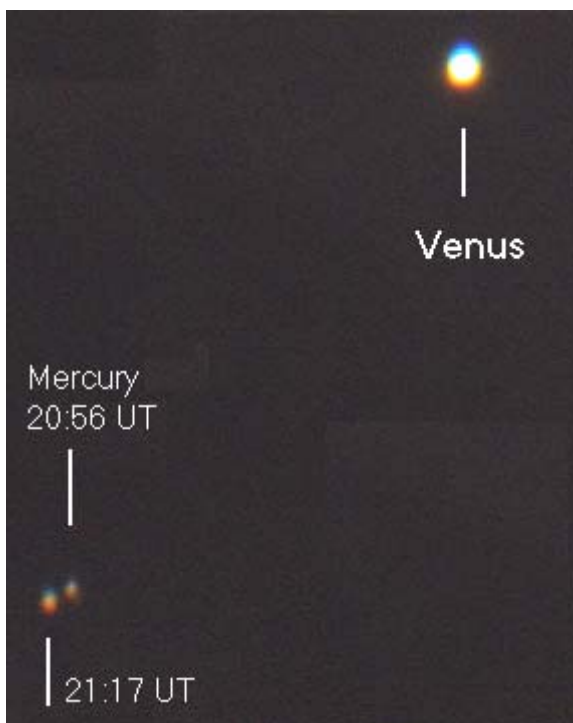
Mosaic Moon (37% Phase)

Date: 14th May, 2005 ,23:26
Location: Rhodes, North Manchester
Telescope: 8" LX90 SCT
Camera: Philips ToUcam
Image: Over 8 Individual Images
Processing Software: Registax 3 & Paintshop Pro 8
Image By: Anthony Jennings & Kat Clark



Clavius: by Anthony Jennings

Picture Gallery



This image of Venus and Mercury in conjunction on 27 June 2005 comprises two image frames taken 21 minutes apart and then stacked into one image using Registax. The later of the two image frames has the image of Venus aligned with the image of Venus in the earlier image frame. The result is a visible record of the orbital motion of Mercury relative to Venus over a period of just 21 minutes. The two planets are separated by about 5 minutes of arc. Venus is deliberately overexposed to permit Mercury to be seen. By Andrew Fearnside.

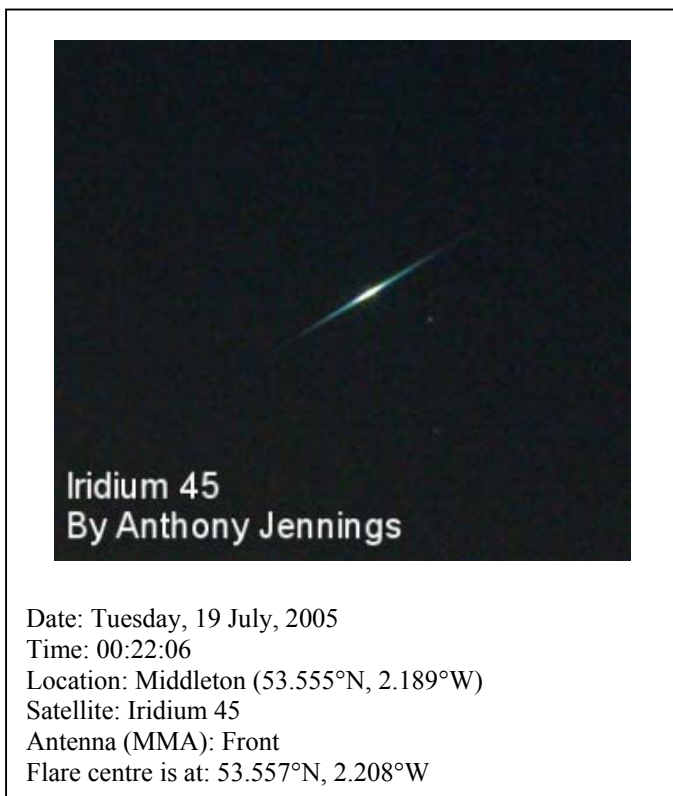


Image by Anthony Jennings: see article "How to Observe / Photograph Iridium Flares".

Date: Tuesday, 19 July, 2005
Time: 00:22:06
Location: Middleton (53.555°N, 2.189°W)
Satellite: Iridium 45
Antenna (MMA): Front
Flare centre is at: 53.557°N, 2.208°W

What are Double Stars?

Introduction

The appellation “double star” might at first be considered somewhat misleading. The term is commonly applied to a system of two gravitationally bound stars in mutual orbit. Of course, this condition may also arise in triple or quadruple systems.

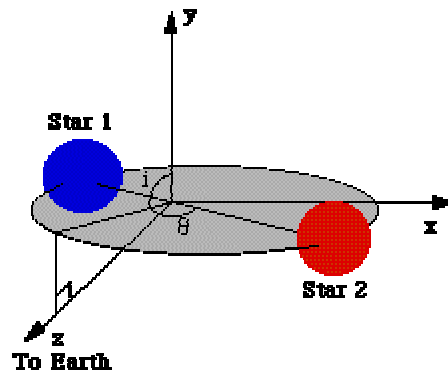
Double Star Types

There are five basic types of double star:

- i. **Visual double stars** comprise visibly separate, gravitationally bound component stars orbiting each other and having orbital periods typically ranging from several years to many centuries. A good example of this type of double star is Gamma Virginis. This double star comprises two component stars of magnitude 3.6 and 3.7, respectively, which complete one orbit in 172 years. The component stars are currently closing in on each other, and by the year 2008 they will be very close. A visual separation of these two component stars, at that time, may well prove a challenge for users of smaller telescopes;
- ii. **Optical double stars** are in fact not double stars in the true sense of the term. Rather, optical double stars comprise two component stars which merely appear, due to the particular line of sight of the observer, to be in relatively close proximity to each other. In fact, the component stars are greatly separated and are not in mutual orbit. In other words, the double star appearance of optical double stars is an optical illusion;
- iii. **Spectroscopic double stars** comprise component stars which are too close together (or too distant from us) to permit the component stars to be seen individually. By observing the periodic Doppler shift (movement) of spectral lines in the combined spectrum of the unresolved pair, one can measure the individual motion of each component star. The star Zeta Ursae Majoris was discovered to be of this type. Already a visual double star, each component star has been found to be a spectroscopic double star. This enabled astronomers

to establish Zeta Ursae Majoris as a quadruple star.

- iv. **Astrometric double stars** are detectable by irregularities in the proper motion of the one visible star of the pair. Sirius is the most famous example of this type of double star which are typically difficult to detect. This is particularly so in the case of Sirius because its relatively meek companion shines at magnitude 8.5 against a scorching Sirius at magnitude -1.6 . This roughly translates to the lesser companion being 7800 times dimmer than its partner. In addition, it can be detected with the Godlee refractor.
- v. **Eclipsing double stars** are detectable by irregularities in the brightness of the binary star as each component star periodically eclipses the other of the pair. These stars comprise component stars which are too close together (or too distant from us) to permit the component stars to be seen individually.



Schematic representation of a double star indicating the plane of mutual orbit

Conclusion

What is important in observing double stars one may ask. First of all, the separation of the two component stars of a visual binary star is an important observation in itself, in astronomical terms. Secondly, the ability, or otherwise, of an observer to visually distinguish close component stars of a visual double star is sensitive to the aperture and optical quality of the telescope being used, and may serve as an indicator of optical quality of the telescope.

Dennis Jones

Guide to Imaging Planets with the Philips ToUcam

Introduction

The advent of colour CCD webcams for well under £100 means that you can image planets cheaply. Philips ToUcam's are now the imaging device of choice for the planets! Their secret is the shooting of video sequences, i.e. hundreds of images in quick succession. Free software is available to extract the best images and combine them together to produce stunning results.

What You Will Need

Telescope, Philips ToUcam Webcam (with and adaptor) and a PC.



The Philips ToUcam



The ToUcam Adaptor

Initial Set-up

Run the included Phillips Installation CD; you only need to install "*Phillips Tools and Driver*". Follow the installation directions.

Remove the lens on the ToUcam (it simply unscrews) and screw the adapter in its place. DO NOT OVERTIGHTEN as this may damage the CCD chip.

Run the "*Capture*" program.

Getting Started

I would suggest starting by imaging the Moon because it's an easy target. Centre it in the field of view using a high power eyepiece (the ToUcam field of view is approximately equivalent to a 4mm eyepiece). Focus your eyepiece view, and then replace the eyepiece with the ToUcam.

Run Philips "*Record*".

Click "*Options*", then select "*Video Format*" and set the resolution of 640x480.

Next click "*Options*" yet again and select "*Video Properties*". Make sure "*Control/Full Auto*" is unchecked. Under "*Camera Controls*" leave White Balance on "*Auto*", and uncheck Exposure "*Auto*". Starting points might be, depending on your set-up (for the Moon), Shutter speed at 1/200, Gain around 40–50%. Go back to "*Image Controls*" and set Gamma to 0%, Saturation at 100%, and Brightness to 60% for now. It will be easier to set focus if the image is a little brighter than what you will actually use during the video capture. *** Note that actual values for Gain, Gamma, Saturation and Brightness are not displayed, the values given for the slider positions are approximations ***.

Focus the telescope, with the webcam attached, and take your time making slight adjustments and letting the telescope settle. A higher frame rate will make it easier to focus. If you are using an SCT, always make sure to focus in a counterclockwise direction to load the primary mirror, otherwise the mirror might shift changing the focus during the video capture.

Reset the frame rate to the value you intend to use for the capture, then adjust Brightness at about 50%, and then adjust the Gain until you get a nice image, not so bright as to wash out the white areas, not so dark as to lose detail in the shadows. Somewhere between 160 and 200 on the power scale should do nicely. The image of the Moon you'll see on your PC will appear somewhat grainy; that's ok, this will smooth out after you process the AVI file with RegiStax. Keep in mind that the higher you set the Gain and/or Gamma, the more noise you are going to get and that the slower the Shutter speed, the more blur you are going to get if there is any turbulence or if the target is moving. Click "*OK*" to close the window.

Click "*File*" and select "*Set Capture File*".

Set the directory to which you want to send your AVI capture files, and the file name for your captured file (or just accept the default directory and name). Make sure sequential numbering is

checked, then click OK. I usually set a directory name using the date, and file name using the object.

Using the buttons, select either 5, 10, or 15 frames per second capture rate in the "Video Properties" (the slower the rate, the better the quality of images, but the longer it will take to capture a given sequence length, try 300 frames initially). *** DO NOT exceed 2000 frames as Registax struggles to process after that. ***

Click "Capture" and select "Start Capture"; to begin capturing click the "OK" button. *** Note that the bottom of the window frame shows the number of frames being captured. *** When you have 300 images captured, click "Capture" and select "Stop Capture" and the capture will end.

You Have Your "Captured File" – Now What?

All image processing can be done during daytime so it's advisable to continue various settings and objects renaming capture files as you create new ones. There are two main image processing programs available, I prefer to use Registax but others prefer to use K3CCDTools. Both are free to download from the Internet (K3CCDTools has a 30-day trial period setting) from the following addresses:

registax.astronomy.net
Registax (current version 3)

www.pk3.org/Astro/index.htm
K3CCDTools (current version 2.4.7)

The following guide refers to Registax. For a more in-depth use of Registax download the user files at the following website

registax.astronomy.net/html/download.html

Alternatively try

www.threebuttes.com/RegistaxTutorial/RegistaxTutorial.htm

To process your captured ToUcam images, follow the procedure set out below.

Download and install Registax.

Here is a simple way to use Registax.

- 1) Run Registax.
- 2) Hit the "Select Input" button and open the AVI you wish to process.
- 3) Make sure the "Colour Processing" box is checked.
- 4) Select an alignment box that will fit around the object, centre the box over the object and then click the mouse.

- 5) Hit the "Align" button and the initial alignment will be performed.
- 6) Hit the "Optimize" button.
- 7) After optimization completes, click on the "Stacking" tab to move on to the next step.
- 8) Now you can refine which frames are stacked into the final image. Move the slider for the vertical red line and it will set a cut-off.
- 9) Hit the "Stack" button and the selected frames will be stacked.
- 10) After the stacking process completes the "Wavelet Processing" tab will appear. Select this tab to move on to the next step. Below you can see the result of the stacked frames before any additional processing has been done.
- 11) Now I tweak the wavelet settings to sharpen the image. I like to use the linear mode with a step size of 1. For most of my images I normally only make adjustments to layers 2 and 3. For this image I only tweaked layer 2. The wavelet adjustments just take a lot of experimenting. The tweaks will vary based on your image scale and the quality of the image. Plus everyone has a different taste when it comes to sharpening. I try not to over sharpen my images since I prefer a more natural smooth look.
- 12) Select the "Final" tab to finish up.
- 13) Here you can rotate the image if needed to achieve the desired angle. There are also boxes for flipping the image horizontally or vertically.
- 14) Adjust the Hue, Saturation, and Lightness to your taste. Using the advanced HLS feature you can really tune these settings to target different wavelengths in the colour spectrum. Personally I haven't used these features much.
- 15) Finally remember to save your work!

Try Experimentation with Registax don't worry as you cannot alter the original captured file.

Happy Imaging.

Anthony Jennings

How to Observe/Photograph Iridium Flares

Introduction

A group of relatively small communications satellites, collectively known as "Iridium Satellites", have individually been providing spectacular visible reflective flares/glints to observers on the ground. With each satellite having only a normal brightness of +6 magnitude (binoculars are useful to spot them), occasionally some of the Iridium satellites provide reflective flares/glints of magnitude -8 . For comparison, Venus can be as bright as magnitude -4.9 ; thus, reflections can be up to 30 times brighter than Venus.

The flares/glints can last anywhere from 5 to 20 seconds before the satellite once again becomes almost invisible to the naked eye. Some flares have been observed during the daylight hours, which is very unusual for reflective glares from satellites. Knowing where to look to observe these flares during the daylight hours is essential.

The Satellites

Initially, each Iridium satellite was placed in a circular orbit at an altitude of approximately 500 km. Normally, over a two-week period the satellites were individually raised to a circular orbit of approximately 780 km. With its job done, the satellite dispenser at the 500 km altitude was placed in a lower eccentric orbit to accelerate decay and re-entry. During the first such launch of an Iridium satellite, provided by Boeing's Delta II, the dispenser failed to achieve a lower eccentric orbit and went into a higher eccentric orbit



The Iridium constellation of 77 satellites

Iridium Satellite LLC (www.iridium.com) is the company providing the global Iridium satellite network. The Iridium network delivers communications services to and from remote areas where no other form of communication is available. The Iridium satellites make this

possible by forming a constellation of 66 low-earth orbiting (LEO), cross-linked satellites and 11 in-orbit spares (77 satellites in all). Note that the element Iridium has 77 electrons orbiting a central nucleus; hence, the use of this name for the satellite network.

The mechanism resulting in observed flare/glint is the Main Mission Antenna (MMA) on each of the satellites. These antennae (of which there are three, being 120 degrees apart, and each 188 cm wide x 86 cm long x 4 cm thick) are highly reflective aluminium flat plates (treated with silver-coated Teflon for thermal control) that are angled 40 degrees away from the axis of the body of the satellite.

Where and when to look

To predict these flares is very easy, all you need is access to an accurate clock and the Internet.

The best website to provide information on Iridium Flares is www.heavens-above.com. If this is your first visit to the site you will need to complete the New User Registration Form. This is free and you will need to provide an accurate location of where you intend to view these flares from. Once you have completed the form, logon entering your username and password. You will be presented with a page to view a number of objects. (ISS, Envisat, daytime flares, radio amateur satellites and much more)

Choose the "*Iridium Flares*" option to view the next 24 hours or the next seven days. You will be presented with a table such as is illustrated in Figure 1. Figure 1 shows the predictions in respect of a particular Iridium flare. Before you start this, make sure you have a watch set very accurately (to the second) with either an Atomic Clock via your PC or with the Talking Clock. Using a compass and protractor we can aim our view to that location to view the flare. For example, look 350 degrees North at an altitude of 22 degrees you will see a -1 magnitude flare at 21h 36 min 39 sec on 18 August 2005. Alternatively, you can aim a camera at that location to record the flare. I use a digital camera to record these. Please note that the time that is shown in Figure 1 is the time when the flare is at its brightest; to image the entrance and exit of the flare an exposure time of approximately 40 sec is needed. Aiming the camera at the centre point of the flare, start the camera off approximately 15 to 20 seconds before flare is due and wait until the flare has completely gone before finishing the shot. If you have never seen these before I would advise that the first time you do this, do not use your camera but ENJOY. Happy Hunting.

Anthony Jennings

Search Period Start: 21:39, Thursday, 18 August, 2005
 Search Period End: 22:39, Friday, 19 August, 2005
 Observer's Location: Manchester (53.4830°N, 2.2490°W)
 Local Time: British Summer Time (GMT + 1:00)

Date	Local Time	Intensity (Mag)	Alt.	Azimuth	Distance to flare centre	Intensity at flare centre (Mag.)	Satellite
18 Aug	21:36:39	-1	22°	350° (N)	30.5 km (W)	-6	Iridium 22
18 Aug	23:47:33	-3	33°	243° (WSW)	25.5 km (E)	-8	Iridium 95
19 Aug	03:57:33	-6	19°	92° (E)	14.1 km (W)	-6	Iridium 41

Figure 1

Sir Isaac Newton and Robert Hooke: A Clash of Minds

Introduction

On 5 July 1687 the book that has been described as the greatest science book ever written was published, known as *Philosophiæ Naturalis Principia Mathematica* or simply *Principia*.

The book was written by the leading English physicist, mathematician, astronomer, philosopher and alchemist, Sir Isaac Newton, and confirmed his reputation in history. In *Principia*, Newton set forth his Theory of Universal Gravitation, as well as his laws of motion which laid the ground work for classical mechanics. Sir Edmond Halley was so impressed when he read *Principia* that he paid for the publication of the book out of his own pocket. However, when *Principia* was finally published, all references to another leading scientist, and contemporary of Isaac Newton, namely Robert Hooke, were removed. This was a result of a number of bitter disputes between the two leading scientists, creating severe resentment of each other that lasted throughout their lifetimes.

Robert Hooke

Robert Hooke was born on 18 July 1635 and, while working as an assistant to physicist Robert Boyle, designed and construct an air pump with which he performed experiments establishing that air was necessary for life and combustion.



Robert Hooke

Boyle was instrumental in helping Hooke become the curator of experiments for the Royal Society. Hooke is credited with being the first to report the Great Red Spot of Jupiter and he was also the first to establish the rotation of Jupiter. Hooke went on to develop a theory of planetary motion as a problem whose solution resided in mechanics. Thus, he pioneered a trail that would enable Newton to formulate the laws of gravitation. In 1665 Hooke published his book *Micrographia* which contained numerous drawings and sketches of objects as seen when viewed under a microscope.

Sir Isaac Newton

Sir Isaac Newton was educated at Grantham Grammar School before moving on to Trinity College, Cambridge.



Sir Isaac Newton

There he was introduced to the teachings of Descartes, Galileo, Copernicus and Kepler. In 1665 Cambridge University closed down as a precaution against the great plague and whilst at home Newton worked on calculus, optics and gravitation.

Confrontation

The first confrontation between the two scientists occurred in 1672 after Newton had written a paper expounding the view that white light was not a simple indivisible entity, but a mixture of differing rays that are refracted (by, e.g., a prism) at different angles and that each type of ray is associated with a different spectral colour.

Newton devised this theory by observing chromatic aberration in a telescope and experimented by observing a thin beam of sunlight refracted through a glass prism. He noted the spectrum of colours that was formed as a result. This theory was certainly revolutionary at the time, as every other scientist since the time of Aristotle had believed that white light was a basic single entity. After being elected in 1672 as a fellow of the Royal Society Newton, he published his scientific paper concerning light and colour in the *Philosophical Transactions of the Royal Society*.

Newton's theory met with an extremely powerful rebuff from Robert Hooke who, along with Christian Huygens, objected to Newton's attempt to prove by experimentation alone that light consisted of the motion of small particles instead

of waves. Hooke, in the mean time, had also developed his own theory of light and claimed Newton's idea needed further detail. The fact that Newton's corpuscular theory was accepted until wave theory was revived well into the 19th century was probably down to Newton's standing at the time. (Ed: *With the advent of Quantum Mechanics in the 20th century, Newton's corpuscular theory of light gained acceptance once more in the form of the photon.*)

The relationship between the two scientists went further downhill in 1675 when Hooke accused Newton of stealing some of his ideas regarding light. This would lead to Newton turning away from the Royal Society and the delay in publication of his subsequent work, *Opticks*, until 1704, a year after Hooke had died. The next very open disagreement between the two men occurred in 1684, and concerned *Principia*. Hooke claimed to have made a contribution to the work, while Newton asserted that Hooke had no involvement in it at all. However, numerous historians have since taken a closer look at the events that took place just before *Principia* was published, and evidence suggested that Hooke was indeed involved in this work.

Conclusion

When looking at the differences between these two leading scientists it has been suggested that the source of their mutual animosity may reside in the personality traits they shared rather than in any scientific differences of opinion. Both Newton and Hooke were extremely suspicious of other people's motives. This suspicion bordered on paranoia and, whereas Newton is considered by historians to have always been that way, it is thought that Hooke developed this trait in later life. In other ways, the two scientists were completely different. Whereas Newton was reclusive, Hooke enjoyed frequenting coffee shops and dining out with friends. These differences showed when it came to performing experiments. Newton would work tirelessly on one project until it was completed whereas Hooke drifted on from one subject to another, leaving himself open to the accusation that his work was often disjointed.

Paul Wood

Manchester Astronomical Society

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Fax: 0161 228 7040

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Dr Andrew Fearnside, B.Sc. (Hons), Ph.D.
currentnotes@manastro.co.uk

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MANY THANKS, to all the members that have contributed to this issue of Current Notes. Apologies to those who, for one reason or another, might not be included in this issue. Contributions are welcomed from all members of the Society, and can cover any area of astronomy, from beginners' initial experiences, to more advanced and specialized aspects. Remember, this is your forum for letting other members know who you are and what you're up to.

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**Manchester Astronomical Society
Godlee Observatory
University of Manchester
Sackville Building, Sackville Street
Manchester
M60 1QD**