Want to be a planetarium operator?

In the last newsletter I highlighted the problem of poor planetarium operators. The summer issue of *Gnomon*, the newsletter of the Association for Astronomy Education, reports that a planetarium in Florida is offering a one-year internship. A BSc in Astronomy or a related science, plus two years planetarium administration experience is required. The salary? Just $16,000, which won't go very far in America. ¤ ***DLC***

- or a limerick writer?

Gnomon also suggested astronomical limericks, and gave a couple of (not very good) examples. They will publish the best ones received, so let me have your inspired verse and I will send it in.

Here is one to start you off.

There was a stargazer named Mark
Who wanted to see in the dark.
He tried a small 'scope,
But there was no hope,
'Cos he'd put the clock drive into "park".

Surely you can do better than that! ***DLC***

F.A.S. Newsletters

The June issue of the Newsletter of the Federation of Astronomical Societies arrived just after the last issue of Sagittarius, and could not therefore be included in its delivery. Please pick up your copy from the Observatory. ¤

Advertisements

Do you have anything for sale, or do you want anything (preferably, but not necessarily astronomical)? Advertise here - no charge.

Wanted for the Observatory:

Vacuum cleaner (ours is defunct)

Short step-ladder (e.g. kitchen steps - for use with telescope)

Fire extinguisher

Television (ours is defunct - for use with video player)

Astronomy Section Officers
(and telephone numbers)
Section Secretary: Geoff Falla, 724101
Honorary Treasurer: Peter Langford, 720649
Education Officer: David Williams, 725088

The next newsletter will be published at the end of October. The deadline for publication materials is the 15th October.

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Sagittarius

The Newsletter of the Astronomy Section of La Société Guernesiaise

September/October 1993

Forthcoming events

The American Space Programme in the 1960's - A Personal Experience by David Le Conte
Tuesday, 7th September
8.00 pm at the Observatory

An Evening with John Taylor's New Telescope
Friday, 10th September
(rain dates: 11th, 17th, 18th)
8.00 pm at Boniface, Rocque ès Rousse, L'Ancresse

Video Evening and Star Night
Tuesday, 19th October
8.00 pm, La Houguette School

In this issue

Astronomy education
The Hubble Space Telescope - Part I
Book review
Apochromatic refractors
A visit to William Herschel Museum
The southern summer constellations
Star chart for September/October

Inside

The American Space Programme in the 1960's - A Personal Experience

David Le Conte worked in the American space programme during the 1960's, when it was in its heyday. **At 8.00 pm on the 7th September, at the Observatory**, he will describe his experiences tracking satellites in Florida, Massachusetts, Hawaii and Arizona (as well as Scotland and Wales), for the Smithsonian Astrophysical Observatory under contract from NASA. He also worked at the Smithsonian Institution in Washington D.C., and at Kitt Peak National Observatory in Tucson, Arizona. The talk will be fully illustrated with colour slides.

This will be an opportunity to hear a first-hand inside story about what it was like to work in those exciting times of Apollo, the Saturn V rocket, and the first exploration of the Moon. ¤

An Evening with John Taylor's New Telescope

After a long wait, John Taylor has an excellent, brand new Vixen 6-inch refractor - the envy of many an amateur astronomer, and an especially superb instrument for planetary observing. John has set it up at his home, and Section members can see and use it there **at 8.00 pm on Friday, the 10th September**. If cloudy, the event will be moved to the next evening (11th), then the following Friday and Saturday (17th and 18th) in turn. Saturn should be especially good!

John has described his reasons for his purchase, and his observations of Saturn, in a major article starting on page 9. ¤

Video Evening and Star Night

At 6.00 pm on Tuesday, the 19th October at La Houguette School videos will be shown, and will be followed by a Star Night at the Observatory. Following our successful event on the 20th July, this event will also be open to the public. At the time of printing the videos to be shown had not yet been selected, but you can be sure they will be fascinating. Note the earlier start time than usual - to encourage children and allow everyone to glimpse the Moon before it sets. ¤

U.F.O.s - for and against

On the 29th June Antony Saunders gave a most interesting presentation of the case for and against UFOs to about 20 members. Making ample use of video and published material, he described sightings of unexplained objects over the past four and a half decades, including some from Guernsey. Most strange objects are natural phenomena or man-made, but he said that about 7% have not been explained. Particularly interesting were the pictures of experimental aircraft, some of which could be mistaken for UFOs.

It seems clear that there has been insufficient objective investigation of unusual sightings, and that many people would like to believe in UFOs, and are therefore ready to accept that others see them. Although statistically there is every likelihood that there is life elsewhere in the universe, and it is just possible that "alien forms" have visited the Earth, most telling was the remark that the supposed visits were as if Captain Cook had landed on a strange island only to depart immediately without further exploration. ¤

Good response to introduction evening

We were delighted with the response from the public to our evening of talks introducing astronomy, followed by observing. Despite considerable cover, 60 people turned up and heard David Williams talk on basic astronomical concepts and the Astronomy Section, David Le Conte showing slides of astronomical objects, and Rex Huddle describe telescopes and binoculars for amateur astronomers.

The observing session was hampered by the cloud, although everyone glimpsed Jupiter. Generally, people appeared to have enjoyed the evening and were appreciative of the efforts made for the community to use our now excellent facilities.

Clearly, there is a demand for such events, and we should schedule more in the future. David Williams has suggested one per season (see his article on page 5), and this seems a very worthy idea. It has also been suggested that we might consider regular observing for visitors, at a price. In the meantime, we have the public evening in October to look forward to. ¤

Annual clean-up day

Only four members turned out for the "clean-up" on the morning of the 7th August, so, although quite a lot was accomplished, we could by no means do everything planned. A good start was made on creating work surfaces in the new building and sorting out the problem with the east wall, but this and other work will have to continue in September. Please volunteer to do some of it. ¤

Barbecue and Perseid meteors

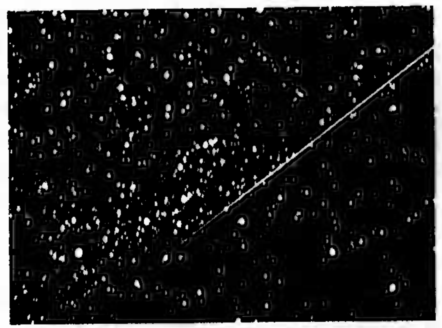
Despite overcast skies and indifferent weather, an excellent barbecue was enjoyed by 15 of us on the 11th August. A stoic few then settled down to get a glimpse of meteors through the rare small breaks in the cloud. We stuck it out to about 1.30 am (BST), but had to admit defeat when the cloud thickened (by morning it was raining). Total count: zero.

This was unfortunate as excellent coverage on press, radio and television meant that hundreds or perhaps thousands of islanders were looking out for shooting stars. Nevertheless it was good publicity for the Astronomy Section.

The evening was enlightened, however, by Lawrence Guilbert's 80th birthday, celebrated with cake and champagne.

The next night was perfectly clear. A small group gathered again at the Observatory, and counted 126 meteors between 10.00 pm and 12.30 am (BST). Incidentally, on the 10th we observed a fireball, i.e. an extremely bright meteor.

Two photographs of meteors by (Section member) Michael Maunder in Alderney were shown by (Section member) Patrick Moore on *Sky at Night* on 22nd August. ¤



Meteor photo by David Le Conte on 12 August.

Astronomy education

Last December the Astronomy Section participated in a questionnaire, conducted by the Association for Astronomy Education (AAE) and the Federation of Astronomical Societies (FAS). This was designed to assess how local amateur astronomical societies are helping with astronomy education, with a view to providing any required support.

We were asked whether, in the past 12 months we had given talks to primary, middle and secondary school children (yes), viewing evenings with school children (no, although we now have), talks to teacher groups (no, although we now have), provided information on astronomy to schools (yes), circulated our newsletter to schools (yes, although this is limited), interested in developing further our activities with schools (yes), and whether we have teachers belonging to the Section (yes). We were also asked whether we would find useful: an overview of astronomy in the National Curriculum, ideas for talks and demonstrations, and accounts or examples of what other societies are doing in this field (yes, yes and yes). We also pointed out that La Société, including the Astronomy Section, was launching a campaign to assist secondary schools.

The results of the survey have now been published. 58 societies replied, only 6 of them having had no contact with schools (one saying that education should remain the domain of teachers!). 67% have given talks to schools (84% to primary, but just 20% to secondary). 43% have arranged viewing sessions for children (some commenting on the difficulty of arranging such sessions because of the weather). Only 19% have given talks, 64% have »» supplied information to schools (including telescope loans and information packs). Only 7 societies send their newsletters to schools.

Most of the societies would like some help from the AAE and FAS, some feeling that they are working in a vacuum. The AAE hopes to provide some of the information needed, including a guide to the astronomy requirement in the National Curriculum, and the two groups have asked for tips, hints, and ideas from those societies with experience of working with schools.

The Astronomy Section already has a summary of the National Curriculum requirements, a circular for teachers and students describing the Section's facilities and how it can help, and a compendium of educational materials. Details of these will be provided to the AAE and FAS. If any member is able to contribute to this material, or feels they can help in any way, please contact David Williams, the Section's Education Officer. ◘

David Le Conte

Earth in Space guide

Kate Mason (Science Coordinator, Education Development Centre), and Lesley Le Page (teacher at Blanchelande) have compiled a guide for Guernsey primary teachers on *Earth in Space*, the astronomy part of the National Curriculum. It includes basic information and classroom activities on the following subjects: Night and Day, the Seasons, the Moon, Eclipses, and the Solar System. It also includes details of night-time observations: how to find the Plough and Orion, and how to view the planets. It is well put together, and a welcome addition to the material available for teachers. ◘

Astronomy Education - Our role as a Society

David Williams makes some suggestions, and shares a dream.

As you will have seen from the article on the previous page, astronomy societies throughout the country vary in the amount of work they devote to education.

Obviously, as a schoolteacher I have a bias towards this aspect of our work, and I firmly believe that it should play a very important role. We must, I believe, do all we can to encourage, to assist, and to nurture any interest shown by all members of the public, and in particular the schoolchildren of our Island.

Astronomy education in progress: David Williams with children of La Houguette Primary School at the Observatory, March 1993

Astronomy is now a component of the official school curriculum as set out in the National Curriculum, which, you may be aware, is enforced by statute. I must add the rider that it is optional in Guernsey, but it would be wholesale madness on the part of the education authorities to ignore it, and indeed they are not. However, to return to my original point, Astronomy must now be taught in schools. I teach it to 8/9 year-olds, and they love the subject.

I believe we have a pretty good track record, with open evenings, telescope surgery, and only recently our public lectures and viewing sessions. We also have a video evening coming up in »» October. Some time ago I suggested regular seasonal open evenings. I still think it a good idea, and I throw it out to members again for consideration.

The people of Guernsey are very fortunate. They have an active and supportive society, with two rather splendid telescopes. As a boy, my nearest society was 20 miles away in Cardiff! The future, may I suggest, should develop along the lines we have been pursuing, but I believe we need to develop our educational programme, and at the same time develop the other side of our activities: our observational and meetings programme.

We are a lively, active, but still evolving society. We have many experienced members to call upon, but we are now in a position to make a real contribution towards observational astronomy, and to encourage the love of the subject in others.

Robert Goddard, the famed American rocket pioneer, once said:

> *"The dream of yesterday is the hope of today and the reality of tomorrow."*

We are in a position to help many people within this island realise their dreams, and in so doing bring many more people to know and love the interest we all share in the wonders of the night sky. ◘

The Hubble Space Telescope - Part I

Daniel Cave starts a two-part series. Here he describes its history and design.

The Earth's atmosphere absorbs much of the electromagnetic radiation passing through it. This limits observations to small "windows" in the spectrum - hardly ideal for getting a full picture of the universe. In addition to this the turbulent air degrades the images of celestial objects. These are the reasons for space observatories.

The Edwin P. Hubble Space Telescope (named after the discoverer of the expansion of the universe) is the most ambitious and technically difficult space observatory built. It is one of NASA's four Great Observatories, the others being the Compton Gamma Ray Observatory (GRO), the Advanced X-ray Astrophysics Facility (AXAF), and the Space Infra-Red Telescope Facility (SIRTF). The GRO is completed and performing well now; the other two will join it and the HST within a decade (budget cuts permitting).

Each of the four Great Observatories was designed to observe a particular range of wavelengths. The HST's task is to look at the visible (and ultra violet) part of the spectrum with a resolution not approached before. The best Earth based telescopes can resolve to about 1 arc second; the HST's design allows it to see detail ten times finer than that, down to 0.1 arc second. Its unique vantage point would also enable views of objects 50 times fainter than before and 7 times further away.

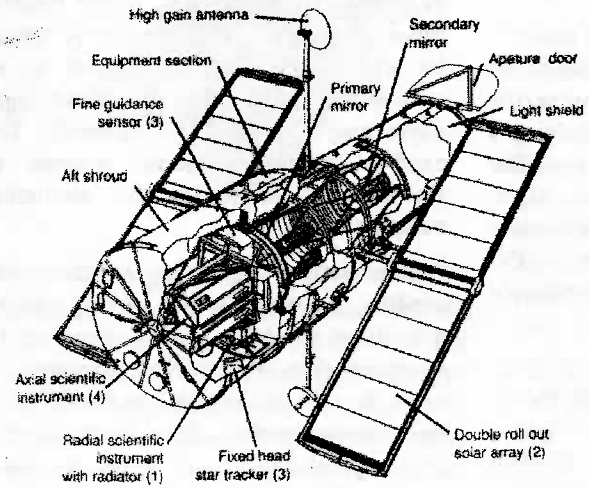
Such performance was needed to »» answer the fundamental questions about the content, scale, structure and evolution of the universe. This telescope does not come cheap - the money spent on the HST to date would be enough to build over 30 ground based telescopes of 8 metres aperture.

While space observatories had been dreamt of before, the first serious suggestion of what became the HST was made in 1946 by Lyman Spitzer in a paper he wrote for the Rand Corporation. The idea slept until around 1969, when at the end of the Apollo moon programme NASA was looking for a project that would have as strong a public appeal as the lunar landings. The Space Shuttle fitted the bill, and one of the major selling points used by its supporters was the ability to launch and service large orbiting satellites, such as the HST.

NASA gave funding for the Shuttle in 1972, but funding for the Large Space Telescope (as it was then known) was not given until 1977 (and only then after much lobbying of Congress, and a reduction of the aperture from 3m to 2.4m). The total budget for the space telescope up to 1983 was given as $575 million - which would have been almost exactly right had this figure been multiplied by two.

The European Space Agency (ESA) footed 15% of the initial cost in return for 15% of the observing time. They furnished the telescope with its solar array (used to provide HST with 2kW of electricity) and one of its scientific instruments. »»

The task of construction of the telescope was divided between a number of centres. The prime contractor was the Lockheed Missile and Space Company - it was assigned the task of building the support



Cut-away drawing of the 2.4m Hubble Space Telescope

The scientific instruments are:
Faint Object and Wide Field/Planetary Cameras
Faint Object and High Resolution Spectrographs
High Speed Photometer

systems, the computers, the telescope framework, etc., and of assembling all the other components ready for launch. Perkin Elmer Corporation was contracted to build the Optical Telescope Assembly (OTA) and the Fine Guidance sensors; these locate faint guide stars and work out which way the telescope should be moved if they are to remain stationary. The science instruments were handled by the Goddard Space Flight Centre; they allocated them to various scientific institutions for design. In payment for this the designers were guaranteed various amounts of observing time on the telescope (the GTOs or Guaranteed Time Observers). In »» addition to these companies, Eastman Kodak was contracted to fabricate a back up primary mirror (in case the Perkin Elmer one was damaged) and Boeing was asked to build the low expansion metering truss to hold the primary and secondary mirrors.

The Optical Telescope Assembly (OTA) is a two-mirrored reflecting telescope. It is a modified cassegrain design known as a Ritchey Chretien. The primary mirror is a concave hyperboloid of 2.4m diameter, and the secondary is a convex hyperboloid 0.31 m across. The primary mirror is made of an Ultra Low Expansion (ULE) glass manufactured by the Corning Glass Company. The mirror has a hollow egg crate design to reduce the total weight to ¼ that of a solid mirror. This was made possible by the glass's "weldability". The egg crate is sandwiched between two thin face plates. One forms the rear of the mirror; the other, once finely ground, polished and coated with aluminium and magnesium fluoride, forms the reflective surface.

After construction, the mirror blank was delivered to the Perkin Elmer Corporation to be transformed into a high precision mirror. The optical system had to be virtually perfect. That meant that once light had passed through the optical system, no part of the wave front must be out of place from the ideal by more than 1/20 the wavelength of light.

As the mirrors were to be used in space, special care had to be taken to ensure »» that the primary did not sag under its own weight while being polished. This would cause the figure of the mirror to acquire a different shape when moved to the zero gravity of orbit. It took 50 engineers three years to build a "zero-gravity simulator".

In order for the glass to become a mirror it must be coated with a thin layer of aluminium. This is done by placing the glass in a high vacuum and evaporating a small amount of aluminium. The aluminium sticks to anything in sight, including the glass mirror. Magnesium fluoride is also deposited in this way, after the aluminium, to protect it and to enhance its reflectivity in the ultra-violet.

The mirror had then to be placed in its mounting. This mounting not only has to be delicate enough to hold the mirror without distortion, but it also has to hold the mirror in position during and after launch. The design and construction of this mount took 1½ years. On completion in May 1983, the figure of the mirror was re-checked and was found to be very nearly what was believed to be the perfect shape.

The secondary mirror was also completed with a very high quality. Such an optical system in space is useless without support systems. These include computers pointing/guiding devices, power supplies and, most importantly, instrumentation. There are five science instruments mounted behind the primary mirror. Each instrument picks off a particular area of the field of view for its exclusive use, and is replaceable, in space, by an astronaut.

The Faint Object Camera (FOC) was designed for viewing dim objects. Built in West Germany for ESA, one of the camera's many tasks would be to count »» the number of white dwarf stars visible in globular clusters, and so refine the present theories on the evolution of stars. The camera can actually count individual photons of light striking it.

The High Speed Photometer (HSP) can sample the brightness of an object 100,000 times per second. This instrument would be able to view an event such as an occultation to obtain a far better light curve than is obtainable from earth. The earth's atmosphere causes sources to fluctuate in brightness, so swamping valuable data.

Spectroscopy is really the backbone of modern day astrophysics. Much can be told about an object just by observing its spectrum (the composition, temperature, etc.). It is for this reason that the HST has two spectrographs. The Faint Object Spectrograph (FOS) is used for faint objects, but doesn't have a very good spectral resolution. The Goddard High Resolution Spectrograph (GHRS), however, does, at the expense of sensitivity. Both the spectrographs are able to probe wavelengths absorbed and distorted by the earth's atmosphere.

The Wide Field/Planetary Camera (WF/PC) lies in a radial, not parallel position to the optical axis. It is able to produce images of the sky in two modes: the wide field mode giving a field of view of 2.7' square and the planetary mode with a field of 68"x 68". There are 8 cooled CCD chips making up the camera; four are used in each mode. A rotating pyramid of mirrors selects which CCDs are to be used.

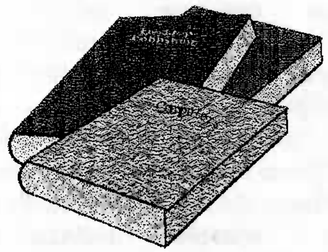
Daniel Cave

In the next issue Daniel describes the launch, the subsequent problems, and the hoped-for cure. ¤

Book Review

Messier's Nebulae and Star Clusters

by Kenneth Glyn Jones



This 427-page hardback is a complete reference book to all the Messier objects. The main part of the book provides full details of each object, together with notes on observing sketches and comments by Messier (and other early astronomers). Most objects have at least two pages devoted to them, with 7 or 8 pages for objects such as M31 and M42.

Messier's life and work is described in a short biography, plus biographical notes on many other astronomers.

The book is a mine of information, with photos, star maps, lists of objects by constellation, type, magnitude and order of discovery, plus observational techniques and background information to the "list" being made up.

At £35.00, it is quite an expensive book, but such a complete and valuable source of reference that it is well worth the outlay. ¤

Debbie Quertier

Messier observing

To date we have observed a total of 36 of the 110 Messier objects with the 11-inch and 14-inch telescopes. ¤

Apochromatic refractors - the ultimate in telescope performance?

John Taylor describes his choice of telescope - a magnificent 6-inch refractor.

When I purchased my previous telescope (a 4-inch traditional refractor) in 1978, the choice of instrument types readily available in the UK was quite limited compared to today; namely - Newtonian reflector, traditional Cassegrain, or achromatic refractor. One of my primary concerns at that time was of owning an instrument which would be maintenance free, and regular re-aluminising of mirror surfaces made reflectors undesirable. Furthermore, by far the most important performance criterion for me was image quality; and I considered a medium size achromatic refractor to be superior at providing this, at the known expense of light grasp and a minimal amount of chromatic aberration.

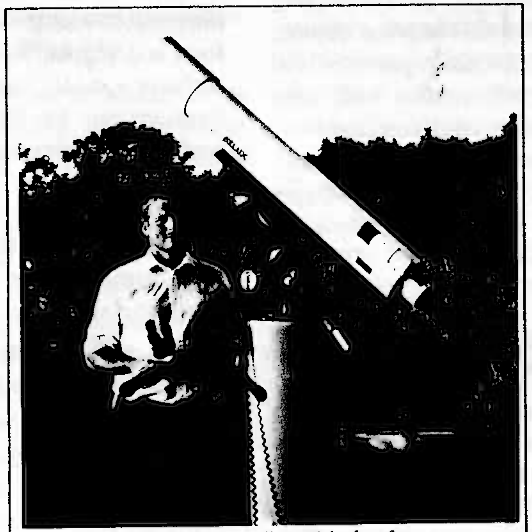
Chromatic aberration is one of the main negative points of refractor performance and is widely known, though poorly understood, by most amateur astronomers. What is less well known are the other aberrations which can affect image quality, of which the most relevant are those defined as the five ***monochromatic aberrations*** of an imaging system:-

- Spherical aberration
- Coma
- Astigmatism
- Curvature of field
- Distortion

»»

No theoretical design of optical system is able to eliminate all of these aberrations at once for all *conjugate ratios* (explained below) and required fields of view, particularly as figuring to completely eliminate one of the errors can often lead to exaggeration of another. The visible effects of these aberrations on the actual image are dependant on the type of image being produced, and are not easy to describe concisely in an article such as this, but suffice to say that the end result is a reduction in image quality.

Conjugate ratio is defined as the distance between the objective lens/ mirror and the object being imaged, divided by the distance between the objective lens/ mirror and the focussed image. In astronomical applications this ratio is infinity, but for terrestrial imaging the ratio becomes finite; particularly for close work. Imaging systems optimised for infinite conjugate ratios may well produce inferior terrestrial views for this reason.



John Taylor's new Vixen 6-inch refractor

It must also be noted that the ***multiple imaging surfaces*** of a typical achromatic lens (4) make error correction easier than that of a single imaging surface. The Newtonian primary mirror is deliberately made aspheric (parabolic) to optimise the image at infinite conjugate ratios and »» with medium to large field (medium to fast optical system - F10 to F4). Increasing field increases the angle of off-axis rays which contribute to the observed image. Off-axis rays and non-parallel rays (finite conjugate ratios) produce significant imaging errors in simple imaging systems. In the Schmidt Cassegrain the primary mirror is spherical and a primary corrector plate is added to the system to enable superior correction of the image defects introduced by off-axis rays - remember, multiple imaging surfaces allow for superior optimisation of the total system. In the Schmidt camera there is yet more imaging correction introduced by deformation of the surface flatness of the film itself!

Having looked at some of the physical parameters of imaging technique, let us now consider the three main "acknowledged" powers of a telescope system; explode the myth of theoretical resolving power; and explore the first order theory of the fourth telescope performance specification known as ***contrast***, and which has the following attributes:-

1. Rarely appears in marketing literature.
2. Is not fully understood. »»

3. Is difficult to quantify.
4. Is, in my view, and in the opinion of an increasing number of amateurs, the most important criterion in telescope choice.

Traditionally, marketing of telescope performance has always been in terms of three fundamental specifications: magnification, light grasp (area of primary optics), and "theoretical" resolution (diameter of primary optics). None of these gives a true indication of what to expect when an object is observed, and the term ***resolution*** is quite simply misleading.

Magnification is well understood, and most amateurs are fully aware of how to calculate it and what to expect in terms of image size on the more well known astronomical targets. What is not always clear is the image quality that will be present at the eyepiece. What really limits maximum magnification and what limitations does object brightness have on the choice of power?

In principle, ***light grasp*** is simple to understand. Bigger primary optics - more light available to form the image - fainter objects observed. However, there are a few subtle but significant points to consider.

When observing a really faint object the impression of shape and detail in the observed image is often dependant on the difference in brightness between the object and its surroundings. When the sky background is not totally black (due to light pollution, etc.) the background light levels are also increased in proportion to the primary optics area. Result - inability to see clearly a telescopic target within easy reach of the accepted »» "specification". This is independent of telescope type and/or design, and is an example of where reduced ***contrast*** is reducing performance.

The faster the optical system, the worse the effect; therefore large F ratio instruments perform better in this respect, inch for inch, than small F ratios. Advantage refractors and SCTs.

Resolving power is the one area where many amateurs are unaware of the real physical factors affecting theoretical performance. This is largely due to the relatively complex physics associated with diffraction theory - and the dual nature of light in terms of particle and wave characteristics. As a result, resolution specifications are largely accepted as quoted (on nights of good seeing will perform to Dawes limit . . . diffraction limited optical images . . . etc., etc.). Unfortunately, these casually mentioned nights of good seeing are non-existent, as we are all generally aware; what we are not generally aware of is what this means in image quality terms.

Furthermore, this diffraction limited image is also significantly affected by ***central obstructions*** in the optical path, and in practice the observed image will be nothing like that suggested by Dawes resolution angles. The ability to show detail comes down primarily to the ability of the system to provide high contrast images across closely spaced detail, i.e., resolving double stars close to the telescope's aperture limit, observing fine planetary detail, etc..

Since the refractor is the only optical system without a central obstruction, it is the only system which is capable of producing quality image detail near the »» diffraction limits of the aperture. But before we consider the physics of central obstructions, there is another design advantage with refractors which significantly contributes to better contrast.

We have only considered contrast effects across small angular detail. If we define contrast as a ratio of light intensity between two areas within an image, it is obvious that we cannot achieve a better contrast than that which actually exists on the object we are imaging; the closer our telescopic image contrast to reality, the better the "quality" of the image. From this definition it can be seen that contrast is not restricted to proximate detail, but can be spread over the entire image. Any scattering of light within the image will reduce contrast generally across it.

Scattering is a phenomenon that occurs to some extent in any optical system, due to finite achievable surface polishing and surface contaminants; larger surface scratches also contribute to scattering and these inevitably accumulate as the optical system is subjected to the rigours of life.

The effects of scattering are not restricted to on-axis rays, but are also dependant on off-axis rays. When the angle of incidence to the interior tube of a telescope is very small, no amount of blackening or anti-reflection coatings will prevent some rays reflecting through to the image plane at the eyepiece. If the telescope is of open tube construction, the situation is significantly worse. The only way to eliminate rays from outside the image axis is to employ light baffles within the optical train - a technique which can only be used in a refractor system.

Let us now consider the key factor in concluding the main advantages of the refractor system - ***the absence of a central obstruction.***

If we ignore the complexities of diffraction theory, and therefore the physical proof of the Airy disk construction, we are able to evaluate the effect of the diffraction pattern modifications in terms of telescope image.

As most amateurs are aware, the ***Airy disk*** is a small central disk surrounded by a pattern of concentric rings which is formed when a suitably large telescope is made to substantially magnify the image of a medium magnitude star. The circular nature of the central disk and the concentricity of the surrounding ring pattern are good indicators of the optical figuring quality. The physical dimensions of the Airy system are dependant on aperture; the percentage of image light in the various components of the system are dependant on the transmission characteristics across the fundamental aperture (ie. central blockage changes transmission characteristics in aperture centre); and introduction of any cross axis components (spider supports in Newtonians) will cause additional distortions of the Airy system pattern.

With an unobstructed aperture, the central disk contains 84% of the light, the other 16% is distributed in the rings. The brightest (innermost) ring contains 7.2%. In a reflecting telescope the secondary mirror typically blocks 4% of the incoming light. But, more significantly, it actually modifies the diffraction pattern so that the Airy disk now has only 76% of the light, and the first ring 14%. In functional reality, the contrast in the vicinity of the star image has essentially dropped in half.

When observing an extended planetary image, which can be thought of as composed of many overlapping diffraction patterns, a continuous haze spreads across the surface and bleeds over the limb, effectively masking low contrast markings. *Put simply, detail performance (image quality) in a refractor should be equivalent to (and typically better due to other contrast enhancement techniques) than that seen in other optical systems of double the aperture, and of similar focal ratios.*

Up until the early 1980s this theory was all very well, but refractors of sufficient aperture to compete with the sheer light grasp of large Newtonians were very expensive, and, more importantly, suffered from sufficient chromatic aberration to negate most of the advantages gained on most other performance characteristics. ***Apochromatic refractors*** in large aperture required outlays of mortgage type proportions, and suffered from attenuation problems of three optical elements and scattering increases within the optical train due to 6 optical imaging surfaces. In addition, glass is an excellent insulator and the central element is thus well insulated from the environment; consequently it can take many hours for a large aperture objective to attain thermal equilibrium.

At about this time the refractors' lot was dramatically improved by the efforts of one Mr. Roland Christen. As Founder and President of Astro-Physics in the USA, he set about developing a three-element apochromatic objective affordable to the average amateur. Using modern but relatively conventional glass types, he devised the Christen triplet. Being affordable, many amateurs were now able to enjoy some of the discussed benefits of the semi-ultimate refractor system; what is more, the performance expectations of the lenses were being exceeded in the field. 6-inch apo's were producing image quality to beat 12-inch plus reflectors. Planetary details were unbelievable - why were so-called diffraction limited reflector optics being out-performed by half the aperture refractors?

Other manufacturers tackled the problem of three-element objectives by developing two-element objectives made with exotic materials. The most well known is ***fluorite***, which has a very low dispersion value across the full visible spectrum, and is able to transmit light well into the ultraviolet region. ***Dispersion*** is the measurement of a glass type's fluctuation in refractive index with wavelength. The fundamental reason why conventional glass was unable to produce chromatic free images without three or more elements is that the dispersion values were too high for adequate correction across the full visible spectrum. Typically corrected at the hydrogen C line of 656.3 nanometres (red) and the hydrogen F line at 486.1 nanometres (turquoise), a conventional achromatic objective introduces maximum spectral focussing errors in the yellow and purple regions; hence the characteristic purple and orange yellow fringes which are the bane of the achromat. Although relatively expensive, the fluorite objectives were allowing the ultimate optical systems to be manufactured; but although optically faultless, fluorite is not a glass but an artificially grown crystal which as a material is unstable and not resilient to the environmental elements. It is attacked by mild acids and airborne contaminants. One solution was to sandwich the fluorite element within two other lenses to produce a perfect apochromatic lens, but this was departing from the two element »» advantages which were desirable to keep. Despite this, the small 4-inch fluorite refractors were setting new optical standards in the world of medium aperture telescopes. Due to the cost and difficulty of manufacture, larger fluorites were rare.

It would appear that the answer to the problem was developed in the late 1980s. Modern glass making technology enabled the production of ***extra low dispersion glass*** types. Although still considered exotic, they are genuine glass material as opposed to artificial crystals, and are easier to manufacture, and, more importantly, are as stable and resilient as conventional optical glass types. Although refractors made from lenses of this type are still expensive, they are within the reach of any observer who has strict criteria on performance parameters.

As a closing comment on this excursion into the world of the modern refractor, I will quote another amateur astronomer:

> *"To me, telescope viewing is primarily an aesthetic experience - a private journey in time and space. Stars look like tiny pin-points to the unaided eye, and that's the way I want my telescope to show them. Planets should appear as sharp edged globes that focus to perfect clarity when the seeing is good. A faint star and a faint galaxy should always appear completely different. In wide field viewing the images should be in focus over the entire field.*
>
> *Those are my (extremely high) criteria for a pleasurable viewing experience. I don't want to see fuzz, flares, and waviness caused by mediocre optics or incessant tube currents. I want images as close to the real thing as possible. Now that I am seeing them in my new apochromatic refractor, I'm spending more time than ever at the eyepiece. You may not agree with my priorities; I expect that most amateur astronomers won't. Apochromatics aren't as compact as Schmidt Cassegrains, nor can they compete with the brute aperture of large Newtonians (Dobsonians); but they come closest to my idea of a perfect telescope."* ***Terence Dickenson***

For me, Terence Dickinson has summed up the apochromatic refractor.

The proof of the pudding . . .

As most of the active members in our group are probably aware, I decided to upgrade my telescope after careful consideration of what I wanted in terms of overall performance. For me that means uncompromised image quality and sufficient aperture to be able to go deep-sky observing. My existing 4-inch achromat did not satisfy these requirements and some of the new generation apochromatic refractors did!

After investigating the options and discussing the performance of these apo's with supplier and field users alike, I was convinced that the Vixen ED 6-inch apochromatic refractor was the clear choice. The order was formally placed in April 1992 and after a delay of over 15 months, which stretched my patience to unspeakable limits, I have finally been united with my purchase. In preparation, I had obtained a large Fullerscope Mk 4 equatorial (German type), and spent three weeks setting a suitable pillar in place to mount the entire system. The mount is motor driven in RA and DEC, and has been aligned to Polaris for the time being (more than adequate for general viewing). The system is now virtually ready for "launch", and preliminary observations have been unbelievable. Any interested members are welcome to come and sample the pudding!

John Taylor

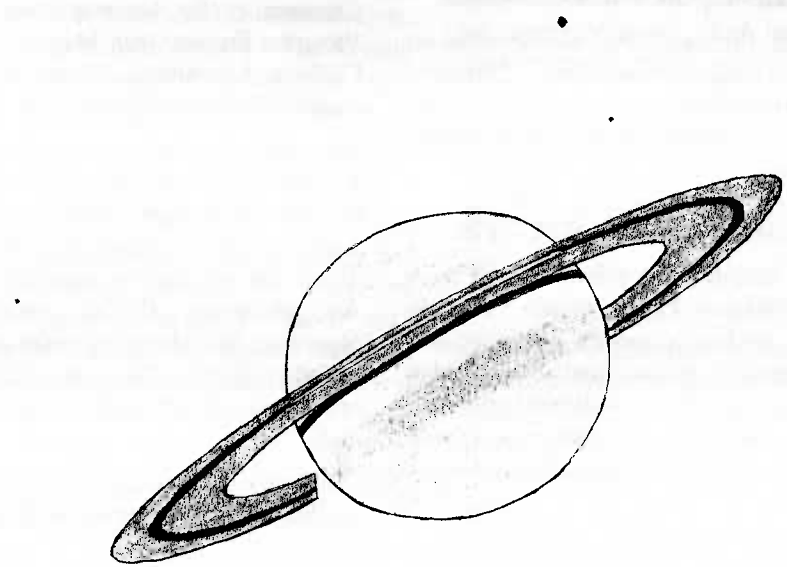
Observation of Saturn with John Taylor's new telescope

The planet's position was just East of due South, and was not at a particularly high elevation from the horizon. Observations earlier in the evening (2100 UT and 2230 UT) were unfavourable due to excessive atmospheric turbulence and windy conditions. By 0000 UT (1st August), the atmospheric conditions had improved markedly, and the wind had dropped.

Planetary details were quite stunning, with the ring structure showing almost perfect form. Degradation of the image was intermittent, and due to a residual amount of atmospheric turbulence causing the planetary vista to drift in and out of focus. For most of the observed period, from 0000 to 0030 UT, the detail was consistent with the large-scale drawing below, and the telescope was able to provide excellent images with powers right up to x340 (4mm Lanthanum). The best image was with the 9mm Orthoscopic (x150), as this provided the best compromise between image magnification and overall contrast.

Cassini's division was narrow but clear, and the planetary disc was visible through it as the ring structure crossed the planetary surface; at the image extremes, the division was a black slit between the two main rings. The ring system threw a clear shadow across the planetary surface, and the planetary disc threw a small but clear shadow on the ring system as it disappeared behind the planet. Surface detail was in the form of subtle banding, with one of the bands being very prominent. The system was accompanied by what appeared to be three moons, with one moon (probably Titan) being very bright. At x340 there was a hint of a disc on this object.

Come and see for yourself. The Astronomy Section will be at John's house on the 10th September (or the 11th, 17th or 18th, depending on the weather). See notice on page 2.



A Fresh FRAS!

I was:-

Surprised when Chris George of the Guernsey Evening Press told me in the afternoon of the 27th August that he would see me at the Observatory that evening.

Pleased to see an excellent turnout for an ordinary Tuesday meeting.

Astonished to see the Observatory become crowded with over 20 people.

Interested when David Williams started making an announcement.

Cautious when it became apparent that his announcement had something to do with me.

Delighted when it was obvious that he was going to announce some kind of award.

Astounded when he announced that I had been elected a Fellow of the Royal Astronomical Society.

Gratified at the recognition, not only of my work in astronomy and with La Société, but particularly of the achievements of the Astronomy Section.

Shocked when the award was splashed on the front page of next day's Guernsey Evening Press! ¤

David Le Conte (FRAS)

Patrick's telescope eye

Two postcards have been received from Section member Patrick Moore. In early August he had a second eye operation necessitated by his accident with a cricket ball last year. A get well card was sent, and we all hope he makes a speedy recovery - especially as it is his "telescope eye". ¤

Conventions, etc.

News of several Astronomical Conventions and other events has been received.

The first is the **Federation of Astronomical Societies Convention on Saturday the 25th September at the Cavendish Laboratory in Cambridge.** It starts at 10.00 am, costs £3.50, and the speakers are expected to be: Professor Andrew Fabian (Cambridge U.), Dr. Carole Jordan (Oxford U.), Dr. Bob Lambourne (Open University), Iain Nicolson (U. of Hertfordshire), and Dr. Ken Smith (University of Kent). There will also be tours of the University of Cambridge Institute of Astronomy and the Mullard Radio Observatory.

The second is the **21st Anniversary Convention of Solent Amateur Astronomers on Saturday the 9th October in the Physics Block, Southampton University.** It costs £6.50, starts at 10.30 am, and the speakers are: Neil Bone on Meteors, Dr. Malcolm Coe on Gamma Ray Astronomy, Dr. Allan Chapman on the Amateur Astronomer in Victorian England, and Maurice Gavin on CCDs in Astronomy. There will be trade stands at both Conventions.

The JAS is running an **Astronomy Weekend in Amersham, from the 5th to the 7th November**, including observing with a 30 cm telescope and CCD system. There will be talks on supernovae, deep-sky observing, CCDs, variable star observing, and observing under conditions of light pollution. The cost is £52.50 (£50 under 18), including accomodation and meals.

Full details of these and other meetings are available from the Section Secretary. ¤

A visit to . . . the William Herschel Museum

The Astronomical Room in the William Herschel Museum, Bath

Herschel House at No. 19, New King Street in Bath was the 18th century home of William Herschel, and the place where he discovered the planet Uranus on the 13th March 1781. Although it is a little difficult to find, the search is well worth it. The house and the museum it contains are run by the William Herschel Society, which was formed in 1977. The Society opened the house to the public 200 years to the day after the discovery of Uranus.

This was in fact my second visit; the first time it was closed! Even this time I arrived shortly before closing time, so the kind custodian didn't bother to charge me the usual modest entrance fee. There are several rooms elegantly filled with interesting pieces of period furniture, astronomical instruments and displays, and mementos of Herschel's musical prowess. Of particular interest is the workshop where Herschel cast his metal mirrors. There is plenty to see here. »»

The back garden, where Herschel first observed Uranus has changed greatly since his time, being now much smaller, but it interesting to stand on this historic spot.

One room is devoted to an astronomical exhibition, including a replica of his 7-foot long reflecting telescope, and a model of his largest telescope which had a 49-inch diameter mirror and a length of 40 feet.

If you are visiting Bath I would heartily recommend seeing Herschel House. One can really sense what it must have been like when Herschel and his sister Caroline (who was herself a successful astronomer and comet discoverer) lived there.

David Le Conte

The William Herschel Museum is open daily from March to October between 2.00 pm and 5.00 pm, and on Saturdays and Sundays only from November to February. Information is available in the Section library. ¤

Double summer time - a follow-up

Following my article on double summer time (Central European Time) in the last issue, I received the summer issue of *Gnomon*, the newsletter of the Association for Astronomy Education, containing an article entitled *Mucking about with clocks* by Dr. Fiona Vincent of the Mills Observatory, Dundee.

She argues against a move to Central European Time, largely because of the very limited hours of daylight in the British winter as Britain is further north than most European countries. She also points out that Greece and the Eastern European countries which are hoping to join the European Community are an hour ahead of Central European Time, while the United Kingdom, Ireland and Portugal are an hour behind. Therefore Europe already has three time zones, and the United States, with four time zones (actually more, counting Alaska and Hawaii) has little problem.

The Editor of *Gnomon*, Eric Zucker, also argues against a change, and both he and Fiona Vincent emphasise the importance of the "natural" time zones being the ones where 12 noon occurs when the Sun is close to due south. I wonder if this heralds a movement amongst astronomers against a change in our time system. ¤ *DLC*

. . . and Jodrell Bank

In the last issue I described a visit to Jodrell Bank. *Popular Astronomy* for July announces a major change in the Jodrell Bank Science Centre, including a new front and refurbished exhibitions. It might be worth a return visit! ¤ *DLC*

Peter Rouse

It was with great sadness that we learned of the death of Peter Rouse on the 29th June. Peter was a good friend of the Astronomy Section. As a reporter for Channel Television he was always ready to put in a word for our activities. Many members will remember the evening we enjoyed in July 1990 when he demonstrated satellite communications and weather satellites, and gave us a tour of the television studios.

Peter jumped at the chance to interview Heather Couper and Nigel Henbest when they opened the Observatory in 1991, and he did an excellent job. He was also on hand when Patrick Moore came this year and was interviewed by CTV. At that time he offered to give us a further demonstration of satellite communications with improved radio equipment and computer software, and it is sad that we will be unable to enjoy such an experience.

Peter showed considerable courage in his battle with leukæmia, and we will miss him. ¤

Vectis Astronomical Society

We already exchange newsletters with the Jersey Astronomy Club, and we now have good contact with the Vectis Astronomical Society in the Isle of Wight. They have a lively newsletter and programme of events. They would undoubtedly welcome any Astronomy Section members who visit the Isle of Wight. Details are available at our Observatory.

Incidentally, one of our members (Gareth Coleman) was once a member of the Vectis Society. ¤

Channel Four Astronomy

Starting in September, Channel 4 will be transmitting a large number of prgrammes for school children, including some of relevance to both children and adults interested in astronomy. The published schedule is as follows. The relevant terms are:

Autumn:	Weeks 1-5, 20th September to 22nd October 1993.
	Repeat week, 25th to 29th October 1993.
	Weeks 6-10, 1st November to 3rd December 1993.
Summer:	Weeks 1-2, 18th to 29th April 1994.
	Weeks 3-5, 9th to 27th May 1994.

Your World: Autumn term, Mondays, 11.18 am to 11.28 am, repeated Wednesdays 11.18 am to 11.28 am.

Summer term, Wednesdays, 11.50 am to 12.00 noon, and Thursdays, 11.18 am to 11.28 am (repeat of the Autumn term).

This series is a "data bank of memorable moving pictures", with miminum commentary. It includes *the Sun, Stars and Planets*, and *Humans in Space*, as well as topics about the Earth. It is designed for Key Stages 2 and 3 (ages 9-14 years).

Earth - The Home Planet: Summer term, Mondays, 10.18 am to 10.38 am.

The third and fourth of the five programmes are entitled *Leaving the Planet* and *Our Neighbours in Space*. They are for Key Stage 3 (ages 11-15 years).

Equinox: Summer term, Tuesdays and Thursdays, 10.00 am to 10.52 am.

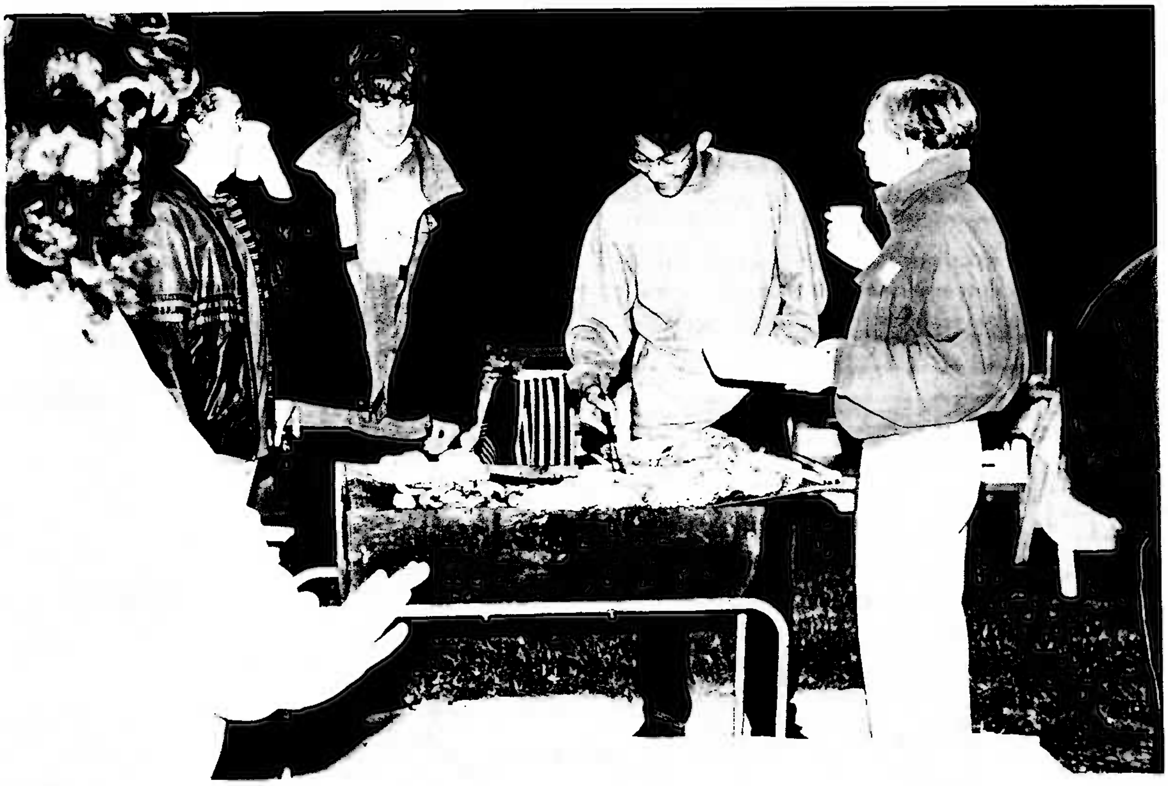
This is Channel 4's "long-established mainstream science and technology series". These are repeats of programmes already shown. *Space Suit*, about the design of space suits, should be on the 21st April 1994; *ET Please Phone Earth*, about the search for extra-terrestrial life, on the 19th May 1994; and *Unravelling the Universe*, about the fundamental nature of matter and the universe, on the 26th May 1994. The series is recommended for ages 16 years and up.

A brand new series of *Equinox* started on the 15th August 1993.

Eureka! The Earth in Space: Autumn term (weeks 6-10), Tuesdays, 9.30 am to 9.45 am, repeated Fridays, 9.30 am to 9.45 am.

There is a block night-time transmission of all five programmes in this series on the 26th November 1993, 4.00 am to 5.30 am (need to set the video recorder for this one!). The five programmes are: *The Universe and Us*; *Sun, Earth and Moon*; *Fire and Earth*; *Air and Water*; and *Living Earth*. They are for Key Stage 2 (ages 9-11 years). ¤

The gathering at the Observatory on the 27th July 1993. David Williams presents David Le Conte with a letter announcing his Fellowship of the Royal Astronomical Society (Photo by Chris George, GEP)



Members enjoy the barbecue held on the 11th August 1993