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of the

XIX National Australian Convention of Amateur Astronomers

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2000 April 21-24

held at
Murdoch University
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Hosted by
Astronomy WA

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John Perdrix

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Preface

I wrote an erudite Preface to these *Proceedings*: however, I shredded it.

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A light curve for 4183 Cuno

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Abstract
CCD Observations of 4183 Cuno on June 19, 1998 yielded a light curve with two maxima and two minima. The maximum amplitude of the light curve is 0.65 magnitudes A possible synodic period of 3.62 hours (± 0.03) is interpreted, but more observations are required.

1 Introduction

Minor planet 4183 Cuno was discovered from South Africa by Hoffmeister in 1959. The preliminary designation was 1959LM, with the official name being announced in Minor Planet Circular 18307. It has an orbital period of 2.79 years and an assumed diameter of 8.7 km making it one of the larger Apollo asteroids. However, this assumed diameter may in fact be considerably smaller – in the order of 5 km or so. Even so, it is indeed one of the larger Near-Earth asteroids and is classed as a potentially hazardous asteroid (PHA) because of its Earth-crossing orbit.

2 Observational Circumstances

Our attention was drawn to this particular minor planet by the Minor Planet Bulletin (Harris & Zappala, 1998), where it is listed as a prime candidate for rotational period determination. The apparent V magnitude at this opposition on June 17, 1998 was quoted as 13.6, making it an easy target for CCD photometry. Both the period and the amplitude of any light variations were listed as unknown and no data for this asteroid were found in the Minor Planet Lightcurve Parameters database (Harris, 1997). As the declination at this opposition was –26 degrees, it was well placed for a team of southern observers.

All observations were conducted from the Southern Sky Observatory in Sydney (Figure 1) and attempts were made to observe on several nights, back to back. However, this plan was frustrated by the weather and only one night's observation was possible at the time. These are the results reported on herein.

We made use of a C14 Schmidt Cassegrain telescope with digital setting circles (Figure 2) and an ST8 CCD camera. Our use of a focal reducer meant we had a field of view of approx. 24 arc minutes on the CCD diagonal. To maximize our choice of comparison stars as the asteroid moved during the night, the CCD long axis was oriented East-West.

During our observations on June 19, 1998 the asteroid was at Ecliptic Longitude 19° 51' and Ecliptic Latitude –20° 8', the solar phase angle being approximately 60 degrees. At this time the asteroid was moving with an apparent motion of nearly 7 arcmin/h as it made its close pass (0.2 AU) of Earth. This rapid motion (nearly double that of main belt asteroids) meant we re-centred the asteroid every hour in the field of view.

To assist in identification of this minor planet finder charts were made using the "Guide" software and comparison stars were picked from the Guide Star Catalogue using these finder charts. Several comparison and check stars were chosen per frame and these were changed as the asteroid moved across the star field during the night. As far as possible, these stars were chosen to have 'asteroid colours' ($0.6<(B-V)<0.9$) to minimize colour mismatch of target and comparison stars.

3 Results

For these observations the CCD temperature was set at –10° C, about 20 to 25 degrees below ambient. Lacking a set of standard photometric filters, we chose to observe in the instrumental bandpass of the ST8, that is with no filters in the light path. Thus, we observed (very approximately) in the R bandpass.

Each observation of the minor planet (approximately every 20 minutes) consisted of three consecutive 90-second integrations. Sufficient counts were thus obtained to achieve a satisfactory signal to noise ratio yielding an internal measurement precision of better than 0.01 magnitudes.

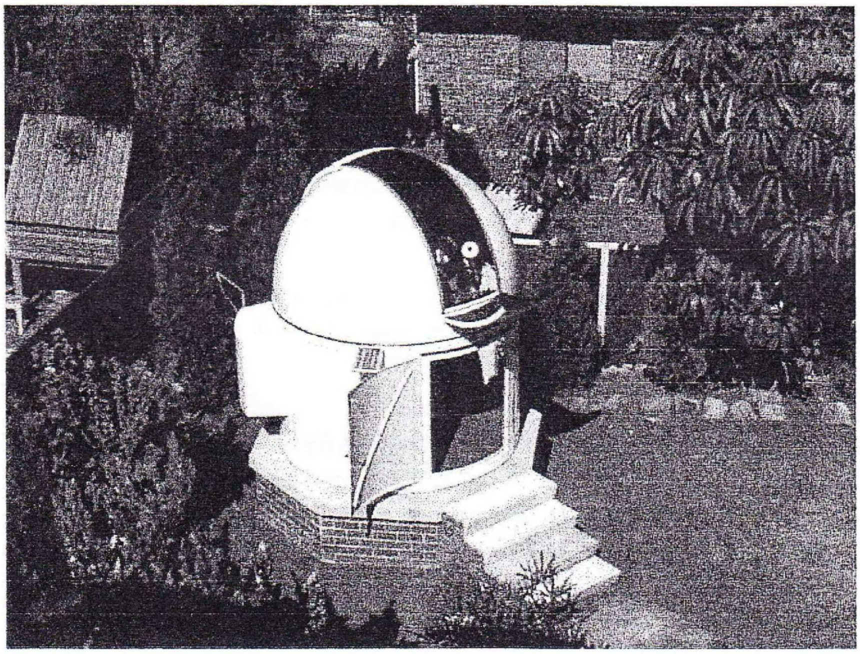

Figure 1. The Southern Sky Observatory.

The CCD chip was binned 2×2 giving an image scale of close to 2"/pixel for our focal length. This meant that the minor planet moved approximately 5 pixels (10") during the integration, but this was rarely visible on the image due to the seeing at our near sea-level observing site. A dark frame was automatically subtracted from all images by the ST8 camera software at the time of acquisition. The photometric reductions were made using the "MIRA" software package, using the synthetic aperture photometry facility. During the reduction process a master flat field was applied to all images before performing the photometry. The master flat was made using multiple night sky images and the 'median combine' method.

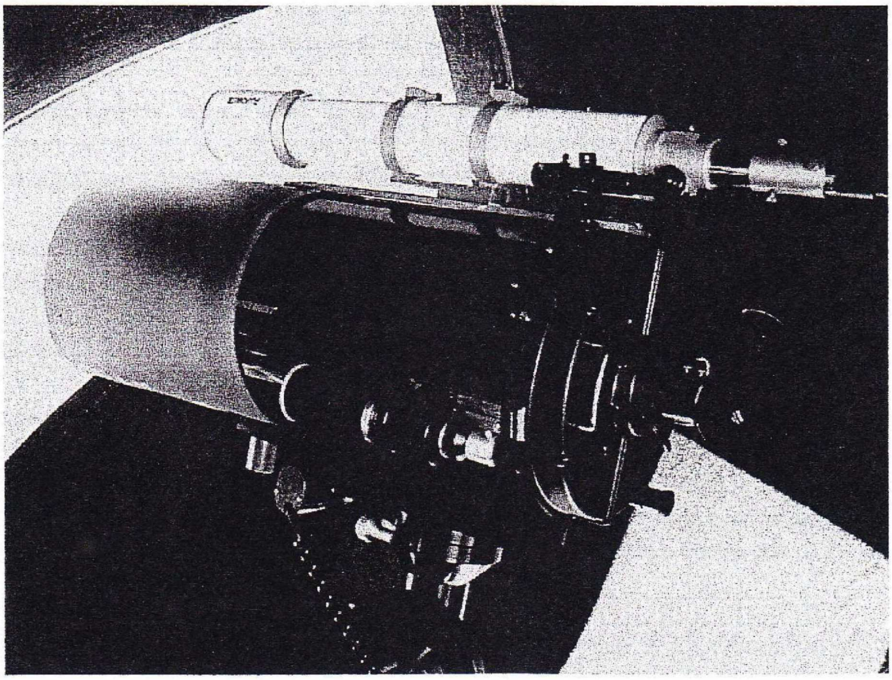

Figure 2. The C14 Schmidt Cassegrain used in these observations.

The non-variability of the comparison and check stars were verified by plotting their instrumental magnitude differences (δ *m*) over time. Although night sky transparency varied considerably throughout the observing period, this difference remained stable (see upper plot in Figure 3). This shows a linear regression fit to the data and from this we can see that the magnitude differences are stable to within ± 0.05 at worst and usually considerably better. Thus we can be confident that if our asteroid varies by more than this we are seeing real variations in light output over time.

For the minor planet the differential instrumental magnitudes were plotted in the sense CUNO minus comparison star (C) and are shown in the lower plot of Figure 3 as 'raw' results. Inspection of these results shows a variation in amplitude of some 0.6 magnitudes – considerably greater than our value of 0.05 above. Thus we have indeed detected variability from our rotating asteroid. Further examination of the plot indicated a possible rotation period of around 3.6 hours. This assumes the maximum near 09.5 UT is the same maximum as that near 13.0 UT. The maximum near 11.5 UT is thus a secondary maximum. In making these assumption we are relying on the fact that minor planets commonly have a light curve showing two unequal maxima and two unequal minima.

The data were phase-folded with this period and a further plot was made and the period refined by visual inspection (Figure 4). This shows one complete rotational cycle – the 0 to 1 on the phase scale

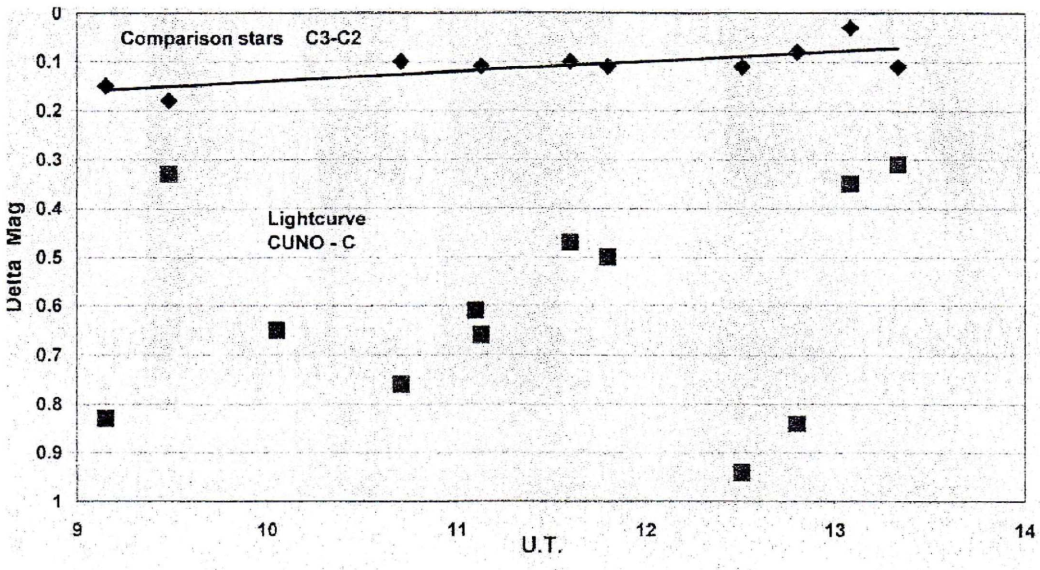

Figure 3. 4183 Cuno light curve 1998 June 19.

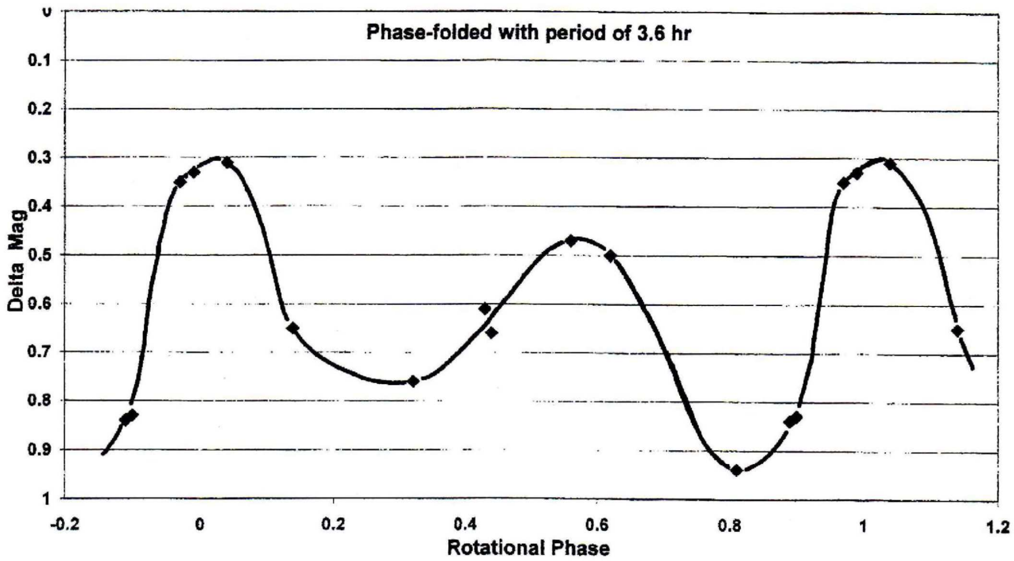

Figure 4. Interpreted light curve of 4183 Cuno.

representing one rotation of 3.6 hours. Zero phase is at 0935 UT on June 19, 1998. The instrumental magnitude variation observed was 0.65 and the light curve shows a classical two maxima and two minima style presented by many minor planets. A synodic period of 3.62 hours is interpreted.

As can be seen from the lower plot of Figure 3 our sampling interval for this minor planet was too large at 20 minutes – being more suited to the rotation period of a 'typical' main belt asteroid. As it turned out a sample interval of 10 minutes or less would have been more appropriate. We were thus extremely lucky to get the results we did – allowing a tentative light curve to be drawn. A case of "Astronomers: 1, Murphy's Law: 1".

4 Discussion

Asteroids vary in apparent brightness due to a number of effects – Solar phase angle, distance from Earth, and rotational-phase reflectivity variations. In this preliminary presentation, these initial results have not been corrected for solar phase-angle differences or Earth-distance effects. Due to the short period of observation, these parameters will have a minimal effect on the light curve presented here.

The resulting light curve is thus largely due to changes of reflectivity during rotation. These changes can have two main causes – differences in the intrinsic albedo of differing parts of the asteroid surface and differences in the cross-sectional area reflecting the light as the asteroid rotates. The latter effect is usually the dominant one except for some 'peculiar' asteroids (e.g. Vesta).

Thus our light curve can be said to be largely the result of the cross-sectional area of the asteroid changing as it spins and reflects the sunlight in our direction. Asteroid shapes are usually modelled by reference to a 'tri-axial ellipsoid', from which a theoretical light curve can be modelled showing two maxima and two minima.

The plot of Figure 4 shows that the two maxima are not of equal magnitude, nor are the two minima. Also, the secondary maximum is not at rotational phase 0.5. All of these features suggest that this asteroid is of complex shape and is not a simple tri-axial ellipsoid. This asteroid may thus have significant albedo variations and/or major topographic features.

Apollo asteroids commonly have rotation rates from 3 to 6 hours. Quite a number are shorter than our proposed period – for example Icarus, Apollo, Sisyphus – and some are similar – for example #4015 Wilson-Harrington at 3.6 h and 1978CA at 3.7 h. The Near-Earth asteroid group have a bi-modal distribution of rotation rates, with a division in the distribution at 15 hours. For rotation periods less than the 15 hours the mean is 4.94 h, not too dissimilar from our proposed period of 3.62 h.

5 Conclusion

These preliminary results yield an interpreted synodic period of 3.62 ±0.03 hours and a maximum variation in magnitude of 0.65 (±0.05). This compares closely with the mean of known Apollo amplitudes of 0.63. Although observations were possible on only one night due to weather constraints, the results derived are consistent with typical Apollo asteroid values. As far as we are aware, this is the first published light curve of this minor planet.

More observations are sorely needed at the next favourable opposition. The next 'good' close approach is in December 2000 when Cuno is within 0.15 AU of Earth – put it on your calendar! At this time Cuno will be slightly brighter at magnitude 13.0, but will be north of the equator, so observational circumstances will not favour southern observers!

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Chasing the shadow: photographing solar eclipses

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Abstract
Chasing solar eclipses is an addictive hobby. After being clouded out near Bombala in 1976, I caught the bug at the 1991 eclipse in Mexico. Since then, I've been to four more eclipses – three cloud free totals, and an annular in Vanuatu. Each has been a unique and wonderful experience.

Photographing a solar eclipse takes dedication and preparation, yet it's hard to get much practice with a phenomenon that occurs for a few minutes every year or two. At each eclipse, I've learnt valuable lessons on planning an eclipse trip, what can go right and wrong, and what equipment you need for good results. The purpose of this paper to pass on these experiences for other amateur astronomers thinking of chasing the moon's shadow.

1 Introduction

Solar eclipses are one of astronomy's most spectacular displays. Yet most people are lucky to see a single total eclipse in their life. Even fewer are privileged enough to be able to travel the world and see more than one. Those who do soon discover that eclipse chasing is an addictive hobby. It is also becoming a popular pastime, judging from the number of travel companies now offering eclipse holiday packages.

Most eclipse chasers are happy to just be there to watch the spectacle, perhaps aided by binoculars. Some also try to photograph the eclipse, even though few will achieve results as good as the professionals. Their reason for trying is simple: they want to capture a memory of a special event.

In this paper, I'd like to share my experiences of photographing solar eclipses. My motivation, like most other amateurs, is to record something of what I saw on the day. I also hope that with each eclipse, the quality of my photographs is improving. Of course, it's difficult for anyone (including professionals) to become an expert at capturing an event that occurs for only a few minutes every year or so.

2 Research

Preparing for an eclipse requires research. Even if you are planning on travelling with a package tour group, you need to choose the right trip. Your choice will be dictated by the primary consideration of all eclipse trips: the chance of obtaining clear skies on the day. Other factors, such as the desirability of the location or the cost of the trip, are secondary ... well, almost.

The recognised expert on predicting eclipse weather prospects is Jay Anderson, who provides the predictions for NASA's eclipse bulletins. There are several sites on the Web where you can obtain this information, including Fred Espenak's site http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html, and the NASA eclipse site http://umbra.nascom.nasa.gov/eclipse.

Apart from the Web, there are several books that you may find useful. Brewer presents an overview of how eclipses occur, with an historical perspective on observations of previous eclipses. Harrington's *Eclipse!* provides interesting information on observing and photographing eclipses, as well as details on the circumstances and locations of the solar and lunar eclipses up to 2017. Pasachoff and Covington (1993) is probably the best reference on eclipse photography, though all of the books provide exposure tables and other general information.

Another important resource, particularly for guidance on photography, is magazines such as *Astronomy* and *Sky & Telescope.* Study the details of their selection of the best eclipse shots sent to them after each event to get good advice on film and equipment choice.

3 Planning

There is one other factor that might influence your choice of location. Most package tours head for the centre line to obtain maximum totality. However, you might like to consider moving closer to the eclipse edge, as it increases the duration of other aspects of the eclipse. For example, the Diamond Rings (see Figure 1) will last for several seconds, you will see Baily's Beads in abundance and get a clear view of the chromosphere. There are a couple of tour groups that specialise in observing from the edge. My shots from the 1994 eclipse clearly show the different type of eclipse you will see.

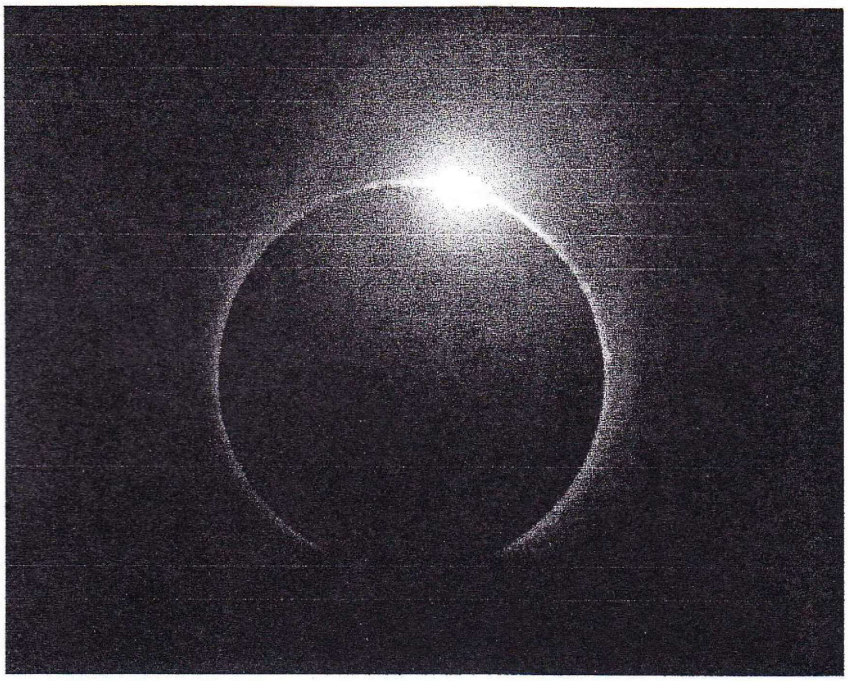

Figure 1. Diamond Ring photographed during the 1994 November total eclipse.

Having chosen your observing location, it's time to decide how to get there. While travelling independently is an option, I recommend you consider teaming up with one of the many eclipse package tour groups. There are too many things that can affect independent travellers: unexpected last-minute price increases, cancellations of hotel or transport bookings (often sold to "higher bidders"), and the difficulty of making arrangements from a distance and with language barriers. Package tours may also be cheaper, since they can negotiate discounts. And in these days of e-mail and credit cards, it is easy to organise a trip with any travel company in the world.

Of my five eclipse trips, four were with astronomer-led groups. Each ran very smoothly, even though some last minute complications often arose. My only independent trip was to Vanuatu in 1998, but I arrived at the site a week ahead of time to ensure I was able to arrange transport. Others who arrived closer to the event found that the car they had booked from Arizona simply didn't exist. Luckily, we were able to share my minibus.

In planning your eclipse trip, you also have to make a choice of a land trip or the increasing popular eclipse cruises. The tradition has been to favour land, since it provides a stable platform for photography. But cruise ships do offer some advantages. They have weather satellite equipment on board and are able to steer towards clear skies prior to the eclipse, while land transport is constrained by the availability of suitable roads along the path, and moving a whole group of people quickly is not easy. A ship can be very stable if the conditions are good – the Black Sea near Romania in 1999 was perfectly flat on eclipse day. However, I wouldn't want to guess what things will be like in the mid-Atlantic in 2001. Lastly, a ship brings all the luxuries of your hotel to the eclipse site, compared to the often difficult conditions on land.

Once you've decided how to get there, you have to decide what to do on the day. There are many things that you could do during an eclipse, and the books mentioned in the previous section will give you plenty of advice. My advice to you is: keep it simple. If you plan to just observe the eclipse, take some binoculars with you, and focus them the night before on some bright stars. But if you plan to photograph or videotape the eclipse, plan on doing *nothing else*. Eclipses run on a special kind of condensed time. Even though you are expecting 2 or 3 minutes of totality, it's all over in what feels like 60 seconds. You *will not* have time to do other things.

Some anecdotes: on my first trip in 1991, I took my camera gear, a telescope, two tripods, a projection screen, filters, and a so-called portable computer to drive the camera. On the day, all I needed was the camera and tripod. In 1998, I decided to try and take some wide-angle shots during mid-totality, so took an extra camera and other gear. The time I took to use this camera would have been better spent checking the framing of my main shots, some of which were cropped as a result.

4 Equipment

There are many options for equipment to photograph eclipses. The camera body doesn't need to be complex, but it does need to have a right-angle viewfinder attachment, motor drive and cable release. A minimum exposure time of 1/2000 seconds is a plus, but not essential. It should be possible to quickly change the exposure without causing too much vibration, since you'll want to cover a wide range of exposures during totality. A mirror lockup facility is not a good idea, as you'll need to watch the drift of the sun through the viewfinder to check for cropping.

Your choice of lens will affect what particular aspects of the eclipse you should concentrate on. A 400-600mm range is good for middle to outer corona shots, and may allow some enlargement if fine grain film is used. For the inner corona and prominences, choose 800-1200 mm. Once you've chosen your focal length, aim to get as fast a system as possible, particularly as you'll probably want to use slow film.

Getting this speed is where things get more difficult. On my first two eclipses, I used a 600mm f/8 mirror lens and an ND5 Thousand Oaks Optical filter. This combination gave me a very dim image of the partial phases through my right angle viewfinder, so achieving a sharp focus was difficult. This made it difficult to take good shots of the first Diamond Ring and small prominences. I was also concerned about touching the focus once the filter was off, as I didn't want to waste any precious seconds of totality. This was a bad move: it is better to lose a couple of shots if the remainder are sharper.

On the next two trips, I used a 500mm lens and 2× teleconverter that resulted in $f/16$. This was simply too slow, though the 1000mm focal length gave a nice image size. Remember that doubling the focal ratio doubles the image size, but quadruples the exposure and increases the effect of motion on image sharpness by the same amount. A shorter exposure can be enlarged to be twice as big but may still end up twice as sharp.

Another factor to consider is that achieving a good focus is more difficult with mirror telephoto lens, since in my experience there seems to be very little range of rotation either side of focus at the infinity position. In comparison, telescopes usually have a smoother focus range at infinity. In either case, replacing the usual prismatic viewfinder with a high contrast matte screen is a good idea.

If your system is slow (greater than $f/10$, for example), consider using an ND4 solar filter instead of the usual ND5. The latter are intended for prolonged visual use, but the brighter image with an ND4 may make focussing on sunspots or the edge of the crescent easier.

It is important that you can rotate the camera body to allow the sun to drift along the long axis of the film. This makes gives you a longer time period before you have to move the camera. As well, in most eclipses the corona tends to bulge out more at the equator than the poles, so it helps to have the equator aligned with the long axis of the frame to avoid cropping. My shots from 1998 were affected by this: the camera body was fixed to the tripod head and couldn't be rotated. As luck would have it, it was 90 degrees out. The outer extents of the corona were cropped as a result, Figure 2.

Having tried various combinations, I've decided that the combination of a Celestron C5 spotting scope with a focal reducer to obtain 800mm f/6.3 is very good. The telescope tube is light weight and compact enough to fit in a carry-on bag. The finder scope is a little small for astronomical use, but more than sufficient to project the sun onto your palm while lining up. Of course, if your budget will stretch to a nice 125 or 150mm aperture apochromatic refractor, then I'd be happy to borrow it.

Equally important is your choice of tripod and head. It is absolutely essential that the tripod be rigid and stable. These days it is possible to buy professional quality tripods (for example, Manfrotto) for little more than the cost of cheap plastic ones. Compared to the cost of a wasted eclipse trip, the extra hundred dollars is an essential investment.

Ideally, the tripod head should allow easy movement to follow the sun during totality, particularly if you are using a long focal length lens. On my first two eclipses, I used a simple 3-axis head that came with the tripod. While this was very rigid when locked, it was difficult to move the camera a small amount when needed. For my later eclipses I switched to a video-style pan/tilt head. Watch out though: these are mainly intended for operating horizontally, and may not work well when the camera is pointed straight up unless you provide some counterbalancing. This adds extra weight to the load on the tripod, so allow for that when choosing the tripod head.

Why not use some form of tracking drive to avoid having to move the camera at all? While you may be able to get reasonable alignment on the day, it's a lot of extra weight to carry, particularly since you'll need a battery as well. I have also found that a lot of tracking drives are designed for mid to high latitudes, and don't work well at low latitudes (as I discovered in Curacao and Vanuatu). And of course, they're a complete waste of time on a cruise ship. A fixed camera can achieve reasonable results if you keep the exposures short enough. Covington suggests that the maximum exposure should be less than ¼ second. This again emphasises the importance of using a fast system.

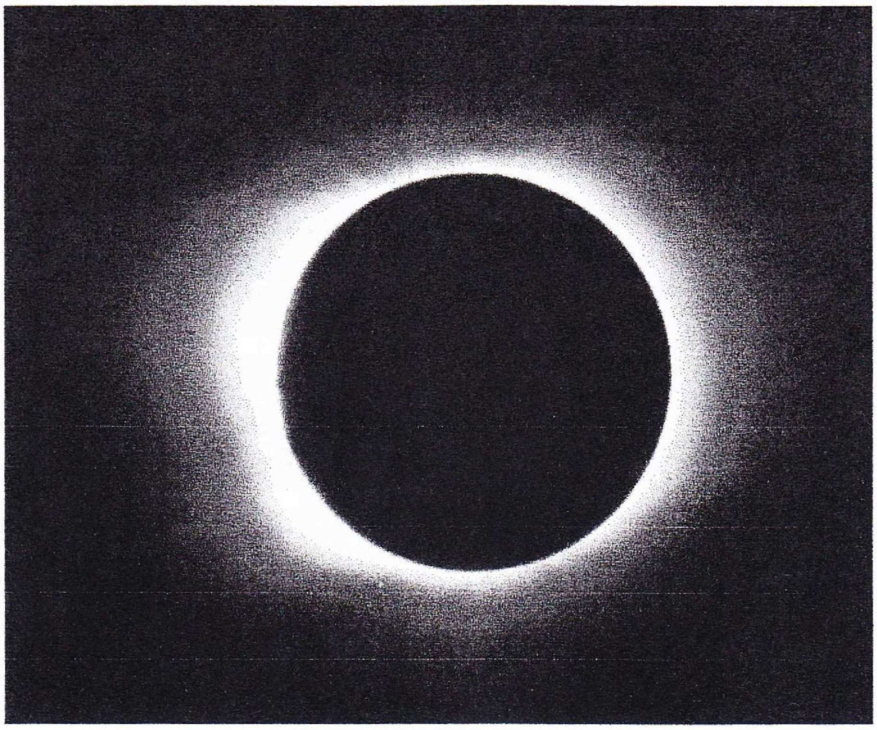

Figure 2. Solar corona at the 1998 February eclipse.

5 Film

Slide or print? It's an old question. Many people will agree that good slide film, such as Kodak Ektachrome or Fuji Velvia/Provia, is the best choice. Many common print films are designed to compensate for a wide range of exposure "mistakes". This is not a good idea for eclipse photography, as you want to take a wide range of exposures and have them faithfully recorded. Personally, I use Provia. Other people like Kodachrome 64, professional Ektachrome, or Ektar 25.

Choosing the right film speed is a little more difficult. In general, slower speeds are finer grain films, though the difference in grain size is not proportional to the film speed. (For example, 400 ISO Provia has a 20% larger grain size than 100 ISO.) But the finer grain may be wasted if the longer exposures are affected more by motion blurring. Keep in mind Covington's advice: the longest exposure that should be used is around ¼ second, depending on your focal length. Choose your film speed to keep your longest corona shots shorter than this.

There is no one exposure that will give the best results, particularly during totality. Most photographers start with short exposures to capture the Diamond Ring, Baily's Beads and prominences, then progress to their longest exposure at mid-totality. This will capture increasing detail of the outer corona. Then, reverse the sequence to be ready for third contact. The books mentioned above all give exposure tables, which I have found to be quite reliable guides.

When taking your shots, make sure you allow the camera and tripod to stop vibrating after the motor drive advances the film and you adjust the exposure. I find myself adopting a rhythm of adjusting the exposure while the motor is running, then pausing for a few seconds before releasing the shutter for the next shot.

6 Before the trip

Before your head off on your trip, make sure you have worked out your observing plan. Type up a schedule of your shots, and take some tape so you can attach this "cheat sheet" to your tripod. Some people have suggested making a cassette tape with announcements at the right times. You then play this tape to yourself, in case you lose track of time. Regardless of how you get your timing, rehearse the sequence of shots several times before the eclipse, so that you can get used to the rhythm of the sequence and be sure that the shots will fit into the available time.

When you come to packing your gear, assemble it completely first. Then disassemble it, packing each piece into your luggage, ready to go. This way you're less likely to end up on the other side of the world with an important part left sitting on the bed back home.

7 On the day

Hopefully, eclipse day will be bright and sunny. You'll probably arrive a few hours ahead of the event, so don't forget you'll get thirsty and sunburnt. Bring plenty of water and a hat. I like to take a towel to drape over my head, like an old style photographer. It makes it easier to see a dim image in the viewfinder while standing in the bright sun. However, don't forget your umbrella. At the 1998 annular eclipse in Vanuatu, it was drizzling lightly during mid eclipse, but we were still able to photograph the event through some thinner cloud. The towel came in handy there, too.

Check your gear well before the eclipse. Equipment can fail at the worst possible time. At the 1999 total eclipse, one of the lenses inside my right-angle viewfinder came loose. I had no backup, and there was no way of repairing it. Luckily, my travelling companion's viewfinder for his Olympus OM-1 was a close enough fit, and this helped me get set up. Of course, he wanted it back during totality, but I found that the straight-through view was comfortable enough if I kneeled on a towel to stop my knees getting sore.

Rehearse your plans in your head prior to the eclipse, and as totality approaches. In the excitement of the moment, you may make the same mistake as one of our party at the 1998 eclipse in Curacao. Post eclipse, he was jubilant that he'd seen his first eclipse. But then he asked: should totality have looked dark through his camera? He'd forgotten to remove his filter. This is why I take my filter off a few minutes ahead of second contact, then refrain from looking through the camera until the Diamond Ring starts. Don't forget to put it back on again after third contact. (If you're lucky, your eclipse expedition leader may make announcements during the eclipse to remind everyone what's happening. If he wasn't planning to, twist his arm. That's one extra chance you won't forget to do something or lose track of time.)

No matter how much planning you have done, things may go wrong on the day. Be prepared to be flexible. My first successful eclipse was in Chile in 1994. I was so awestruck by the view of the approaching shadow and then totality that I simply forget to start taking photos, at least for a few seconds. Leave some slack in your schedule so you have time to pick your jaw up off the ground.

8 Conclusion

Photographing eclipses takes practice, but few of us get very many opportunities. To increase your chance of success, you need to do some careful planning and preparation, and rehearse your photographic sequence till you can do it without thinking. Of course, the more involved in photographing eclipses you become, the less likely you are to ever see an eclipse except through your viewfinder. But that view can be so spectacular that you'll find yourself planning to chase the next moon shadow, just like me.

If you are interested in seeing a selection of photographs from my eclipse trips, please visit my web site at http://users.bigpond.net.au/smr/eclipses.html.

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Astronomy as a self-funding hobby

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Abstract
This paper explores the methods where by amateur astronomers can use their knowledge and equipment to make money. Target markets are identified and the differing ways of working with customers examined. Also discussed is the type of equipment required, and most importantly, how to get your business publicized in the most cost efficient way.

Although there are many ways to approach this topic, the author has based this paper on his own personal experience in bringing astronomy to the public. It is hoped that this will stimulate more amateurs to 'go forth and spread the good word'.

1 Introduction

Astronomy is often considered a solitary hobby with the participants camped out all night in the wilderness viewing tiny patches of light hardly discernible in the night sky. Although that is true for many amateur astronomers, some of us are more inclined to the social aspect of the hobby where sharing the sights with the uninitiated results in mutual excitement. The logical extension of this is for the entrepreneurial types, who have been entertaining friends and relatives through a telescope, to think of the potential for turning this activity in to money-making scheme. This paper explores how this can be done.

2 Identifying your market

My experience has shown that the market is virtually the entire population; however, there are differing segments which can be broken out and targeted in particular ways. (Interestingly, one section of the community which I have found difficult to attract, are other amateur astronomers!). Your target market, however, will be determined on the equipment and facilities you own. It is quite feasible to run an 'astronomy' business without an observatory or permanent viewing site, but this will limit your presentations to taking telescopes etc. to the client's location. On the other hand, having a permanent site with lecture theatre and observatory can provide your customers with a more expansive experience. This, of course, does not preclude you undertaking off site sessions, but it is my experience that moving away from the convenience of your establishment is not very satisfactory.

Below are three target groups, the last one requires a permanent facility.

Target 1. School groups. This has the advantage of immediately providing medium to large numbers (say 40 to 150) which translates into reasonable profits. As a general rule it is easier to take your equipment to the schools and setup on the oval. Try and have a night with a partial moon, at least one planet, say Jupiter or Saturn, a nice double star and an open cluster. With these objects light pollution will not cause too much of a problem. To avoid too much queuing, (remember when you were a child?), you will need one telescope and operator per 10 to 15 viewers. Remember the adults will want to view as well.

Assuming you are going to pay your helpers, a charge of $5 per person is reasonable.

Target 2. Sky parties. In this situation you are offering your telescope and expertise to provide a novel entertainment at a party. This is usually a one-person performance since other activities are also going on. As in the school group situation a partial moon is preferable and one of the 'gee whiz' planets. For a one-hour show for a party of say 30 people, $50 would be reasonable.

Target 3. Viewers at your own observatory. This is the most difficult to generalize for since the operation is dependent upon so many things, such as do you have a lecture room, how many telescopes are there, what is the observatory configuration (i.e. domes, sliding roof, open pad, etc.), how many helpers do you have etc. Another factor is what sort of evening are you going to present? Will it provide an evening's entertainment which goes from 7:30 to 10:30 with refreshments and a talk, or will it be an hour and a half guided look through a telescope and home again?

If the former scenario is the your preference, some expenditure will be needed to make your clients comfortable for the whole show. Seating, white board, water, toilets, a fridge, tea-making facilities, wall charts and heating are just some of your requirements for entertaining your customers. And that has not included the telescopes! The viewer-telescope ratio for this arrangement should, in my opinion, be something like five to one. The suggested charge would be say, $20 for adults and $10 for children.
For the 'quickie' scenario, a viewer-telescope ratio of ten to one may be reasonable with the charges half the above. If your organizational abilities are good, two sessions per night would be possible improving the profitability significantly.

3 Equipment requirements

Since most people who visit an observatory have no idea what they are going to see, amazingly, almost any telescope correctly handled will be impressive! The absolute minimum you will need is a motorized reflecting telescope of at least 4.5 inches (114mm). However to give your clients value for money, I would suggest at least an 8-inch (200mm) SCT or a 4-inch (100mm) quality refractor.

Apart from the telescope, very little else is needed to entertain your customers, however there are some useful tools that can significantly enhance the evening's enjoyment. Firstly, a powerful torch with a focused beam will allow you to point out objects. This arrangement works well on most nights, but with a near full moon, I have found that only a high power spot light is of any use. Planishperes and sky charts can also be of help, but red torches are then essential. Binoculars, of course, are good value and the public can use them with the minimum of supervision. Virtually any binoculars with 50 mm and up aperture are suitable. A computer with an astronomical program can be good fun, especially for identifying the moons around Jupiter and giving additional information on stars etc. The down side of a computer is the light output and the problem of keeping people's busy fingers off it!

Getting back to the most important item, the telescope, and obviously 'bigger is better'. Not only does size impress the pubic, it will allow you to show better images. GOTO type telescopes are particularly good, especially if your sky knowledge is not to good. The number of telescopes will determine the number of viewers and as mentioned earlier, the ratio will vary on the style of presentation.

If your observatory has a lecture theatre or an area where you can address your group before, and/or after their viewing experience, some additional equipment will be needed. At the very least, chairs, a white board and some appropriate posters will be required. Some form of video display with computer interface can significantly improve your presentation. If refreshments are to be offered, an urn, fridge, cups, plates and a preparation area will have to be considered.

4 Presentation

Your presentation of astronomy to the viewers is possibly the single most important aspect of this business. They have to be entertained, informed, and kept interested throughout the evening's 'show'. And this is not easy. Different groups will put different demands on you. The junior school group with lots of small children is one of the most difficult with which to deal. It is challenging to keep their interest going for more than an hour and this is compounded with the problems of their ability to actually see through the telescope. A few good objects such as the Moon, Jupiter, Saturn, a globular cluster and a bright star seem the most they are able to comprehend. This can be complemented by stories of some interesting constellations and looking for satellites.

Older students have their own set of problems, mainly to do with control since they are attending as a class activity and only about 5% will have a real interest in what is going on. Cub, Scout and Guide groups will have widely differing attitudes to your presentation. Their leader,s level of control varies considerably from group to group and you and your team may be called upon to exert your own discipline.

I have found groups of young adults the most satisfying to work with since there are no discipline problems, they are usually very keen, ask lots of questions and can operate the telescopes with a minimum of effort. Older groups are also good to work with, however there can be problems with the focus control and older eyes.

One problem with viewers using telescopes for the first time is ascertaining what they think they are seeing! You must remember that they are seeing for the first time, objects that you have looked at a hundred times, and so they have to be guided through the observing process. Apart from the Moon and Saturn, virtually every other object has to be explained. (It is not uncommon for viewers to 'see' only a single star when looking at Alpha Centauri, even when the telescope is focused. When it is pointed out to them that there are two stars, they are amazed at the sight!)

As a general rule use low magnifications. This gives a clearer image, (although smaller of course) makes focusing easier and gives better eye relief. You can always go to a higher magnification for the planets if seeing conditions are suitable.

Keep the explanations of the objects factual but simple. The distances and sizes of the major objects are all that is normally required to keep most viewers happy. Of course any humorous asides or short anecdotes will always prove popular. The same goes for any talk you may give at other times during the evening. I find it useful to explain briefly about the telescope before hand, emphasizing not to touch the instrument (apart from focusing),. and to run through the major objects on the viewing list. I then do a short 'sky tour' pointing out the planets and interesting constellations using a powerful torch before staring the evenings viewing. If your observatory has seating facilities, the evening can finish with a short talk of an astronomical nature and/or a question and answer session. Depending upon the audience, this can be the best part of the evening. It is good practice to have a number of prepared talks which illustrate some interesting aspect of astronomy such as 'What are Black Holes', (a favorite of the younger groups), 'How Big is Our Universe' and 'Is There Life in Outer Space?'

Any audio-visual aids improve your presentation. Starting from the humble white board though to the full blown Power-Point/video show, your audience will appreciate the visual representation of the various concepts you are putting across.

5 Getting the word out

Getting the customers 'though the door' is usually the most difficult aspect of any business. Luckily because most people want to look through a telescope, the only problem is getting the message out to the public. Since there are numerous ways to waste your time and money publicizing this new venture, I will concentrate on the ways that have proved successful in my instance.

- *Brochures*: These are essential. Although the majority will end up in the bin, you must have something to give to people. They can be quite simple, but should give basic information on the evening including times and dates of operation, and of course any phone numbers and Internet contacts. In these days of desk-top publishing, this is not a difficult or expensive task. Of course the better the brochure looks and 'feels', the more professional you venture will look so it is worthwhile spending a reasonable time on this task.
- *Yellow Pages*: Certainly worthwhile, but restrict the size of the advert since it is very expensive. If someone is going to look your company up under 'Astronomy', there won't be much completion so there is no point of having a big display ad.
- *Unpaid editorial*: This is by far the best exposure you can get since it has the credibility of the media without the huge cost involved in mass distribution. The outlets, of course, are newspapers, TV and radio and it is surprisingly easy to get on to these if you do some homework and present your story correctly. The most important point is that you MUST have an 'angle' that the media can write a story around. Good examples are eclipses, forthcoming astronomy shows, something new in the sky, planetary line-ups, new or novel equipment, etc. Once you have established the suitability of the event, do a short write-up of the 'happening' making sure to emphasize the particular reason it is going to be exciting for the general public. It is then a case of getting on the telephone and contacting the appropriate person in the media outlet and giving an enthusiastic account of the event. This is the difficult part since the people involved are on very strict deadlines and are used to handling world class disasters and so you must have your story succinct and gripping. Once you have achieved that, offer your pre-written account, making sure your observatory or astronomy venture is prominently mentioned, and of course you and your telescope are always available for photographs! Make sure that contact names and direct phone numbers are recorded for future press releases and try to buildup a good personal relationship with that contact. Most importantly, use the contact sparingly since most media outlets are wary of being used for unpaid advertising.

- *Word of mouth*: By far the most cost effective method of getting the message across. However it takes time to build your client base to a point where this gives a significant number of customers.
- *Free passes*: Lots of organizations are after prizes for raffles, quiz shows, etc. You can generally afford to be quite generous with these since the take-up rate is very low, but once again your name is out in front of the public.
- *Cold calling*: If your targets are schools or other children's groups, just front up with a pile of brochures and photographs of your previous shows and tell people what you are offering. Have your pricing structure readily to hand, nothing looks more unprofessional that 'humming and harring' about price. Make sure the photographs are neatly presented and labeled in an album and that plenty of brochures are left for the other staff or group leaders. Never be stingy with brochures. They will not get you business in YOUR top draw!
- *Self promotion*: Tell people what you do and have a business card to hand over if any interest is shown. Most people are fascinated in astronomy and telescopes. Once again, desk-toppublishing programs make printing business cards easy and cheap.

6 Getting the word in

It must be possible for your clients to contact you to make bookings or to alter their arrangements. The telephone is the obvious choice and so a little used or dedicated telephone line should be setup with an answering machine. Web pages and e-mail facilities offer more avenues for contact and bookings. The organization of the bookings is a matter of personal preference and this can be divided into two main systems, computer or index cards. I use the latter since the cards are easily read and updated by anyone anywhere without recourse to accessing programs, often at short notice. Also, the manual system is not subject to viruses and computer malfunctions.

7 Conclusions

Running an astronomical venture is not going to make you rich. However properly run, it can be a very enjoyable way of spending an evening, making new acquaintances and at the same time, generating money to improve your equipment. There are several home truths that should be reiterated if you are going to enter the business of entertaining: 'the show must go on' and 'the customer is always right'. Sometimes very difficult situations arise such as unexpected cloud cover, RA motors failing, part of the group comes late, etc., but you and your team must continue on and entertain the crowd. You have one great advantage over most other 'entertainment', the clients have generally no idea what they are going to experience! This gives you freedom to do just about anything in the way of astronomical showmanship. As long as everyone gets to see through a telescope at some major objects, and they get some interesting facts to talk about, you and your group will go away happy.

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The conquest of Mars

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Abstract
The paper will provide a historical overview of space missions to Mars and discuss the results and findings of those missions. It will also describe missions that have been planned for the near future. Finally, the author will explore the feasibility and timing of a crewed mission to the red planet.

1 Introduction

Mars is very easy to study as it is close to the Earth and has no clouds which obscure its surface. Its generally red appearance led it to being associated with war and when its two tiny moons were discovered they were named Phobos (fear) and Deimos (terror). Through a telescope many surface features are visible on Mars, some of which disappear and re-appear and are grey-green in colour. These gave rise to the theory of large areas of vegetation and deserts. In 1877 the Italian astronomer Schiaparelli reported seeing linear features (Figure 1) which he called 'canali'. This was incorrectly translated as 'canals' leading to the speculation about intelligent life and vast irrigation systems.

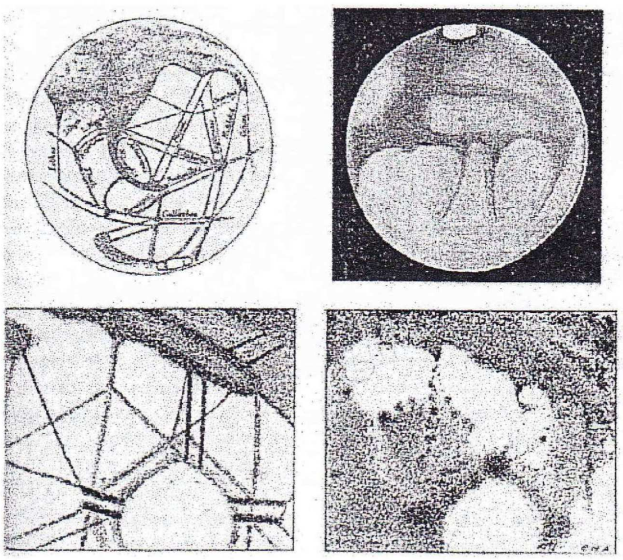

Figure 1. Drawing of canals of Mars

Astronomical observations also showed clouds in the atmosphere and white polar caps which advanced and retreated with the seasons. It was also thought that these polar caps melted to produce carbon-dioxide or water. The atmospheric pressure was estimated at 15% of that of Earth with nitrogen being the most abundant gas, but findings resulting from the exploration by spacecraft, revealed that carbon-dioxide is the principal gas with very little nitrogen or water vapour and no oxygen.

The spin axis and the eccentric orbit cause the southern hemisphere to have short summers and long cold winters whilst the northern hemisphere has less extreme seasons. Launch opportunities to Mars occur every 25 months.

Table 1: Mars landing sites and dates

Name	Location		Date	Notes
Mars-2	47° E	44° S	27-Nov-1971	Impacted
Mars-3	158° W	45° S	02-Dec-1971	Operated for 110 sec
Mars-6	25° W	26° S	12-Mar-1974	Operated for 2 min
Viking-1	48° W	22° N	20-Jul-1976	
Viking-2	134° E	48° N	03-Sep-1976	

2 Mars series

After a number of attempts, the USSR finally succeeded to send a spacecraft to Mars in 1962. This spacecraft, Mars-1, passed the planet at a great distance on 19 June 1963. The spacecraft was to conduct photographic experiments, investigations of cosmic rays and the solar wind as well as the micro-meteorite density.

After a further three attempts the Mars-2 and Mars-3 spacecraft (Figure 2) were launched in the May 1971 window (refer Table 2 for launch dates). Each spacecraft consisted of a lander and an orbiter. The latter carried an infra-red radiometer to construct surface temperature charts, instruments to determine water vapour concentrations by spectral analysis absorption, an instrument to study surface relief by measuring the amount of carbon-dioxide and an instrument to measure the reflectivity of the surface and the atmosphere. The landers carried atmospheric temperature and pressure sensors, a mass spectrometer to determine atmospheric components, a wind velocity meter, instruments to measure chemical and mechanical properties of the soil and a television system to make images of the surface and transmit these back to Earth.

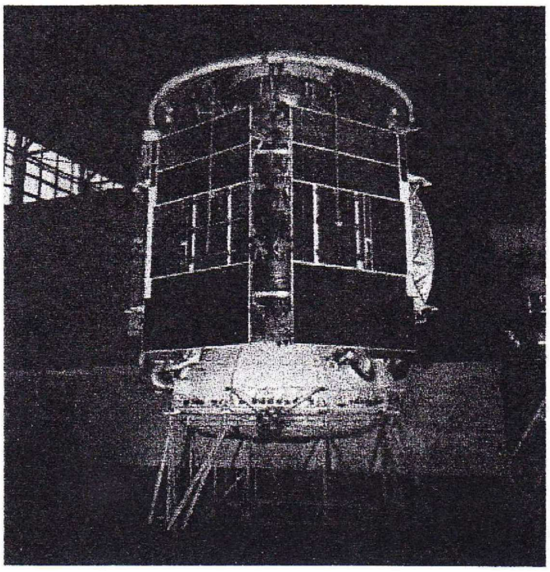

Figure 2. Mars-3

Twenty years later it was revealed that both spacecraft also carried a mini rover each. These vehicles were to move across the surface of Mars being attached to the spacecraft by a 15 m long tether. They carried tiny sensors to measure surface strength and the density of the soil.

The Mars-2 probe went into a 1380 x 25,000 km orbit with an inclination of 48.9° on 27 September 1971, whilst Mars-3 achieved an orbit of 1500 x 190,700 km with an inclination of 48.9° on 2 December 1971. Both spacecraft observed global dust storms which cleared after two months. The ionosphere was found to begin at an altitude of 80 to 100 km and at high altitudes the carbon-dioxide atmosphere was found to separate into carbon-monoxide and oxygen with the sparse water vapour separating into atomic hydrogen and oxygen. A weak magnetic field was detected. The lander on board of Mars-2 impacted on the surface on 27 November 1971 at 44°S, 47°E.

Table 2: Launch dates of Mars series[1]

Name	Launch	Re-entry	Notes
---	10-Oct-1960	---	Failed to orbit
---	14-Oct-1960	---	Failed to orbit
---	24-Oct-1962	29-Oct-1962	Failed to achieve correct orbit
Mars-1	1-Nov-1962		Flew past Mars
---	4-Nov-1962	5-Nov-1962	Failed to achieve correct orbit
---	27-Mar-1969	---	Failed to orbit
---	2-Apr-1969	---	Failed to orbit
Kosmos-419	10-May-1971	12-May-1971	Failed to achieve correct orbit
Mars-2	19-May-1971	27-Nov-1971	Orbited and impacted on Mars
Mars-3	28-May-1971	2-Dec-1971	Landed on Mars
Mars-4	21-Jul-1973		Flew past Mars
Mars-5	25-Jul-1973		In Mars orbit
Mars-6	5-Aug-1973	12-Mar-1974	Landed on Mars
Mars-7	9-Aug-1973		Flew past Mars
Mars-8	16-Nov-1996	17-Nov-1996	Failed to achieve correct orbit

The lander of Mars-3, however, successfully landed on 2 December 1971 at 45°S, 138°W and operated for 110 seconds before it failed. During that period the first 20 seconds of a picture was transmitted. It is believed the rover vehicle may have been blown over by an intense storm. The two orbiters remained operational until 22 August 1972 when they were shut down.

In the July/August 1973 launch window the USSR launched four spacecraft to Mars: Mars-4 and -5 were to orbit the planet whilst Mars-6 and -7 were to release capsules to the surface of Mars. The spacecraft carried plasma traps, multi-channel electrostatic instruments, photographic imaging systems and magnetometers. Mars-6 and -7 also carried a French designed solar study experiment as well as micro-meteorite and cosmic ray sensors.

Mars-4 failed to achieve a Martian orbit, instead it passed the planet within a distance of 2200 km on 10 February 1974. Mars-5, on the other hand, achieved an orbit of 1760 x 32,500 km with an inclination of 35° on 12 February 1974. The two spacecraft provided a total of 60 images of Mars (Figure 3) as well as other data which provided evidence of an atmosphere containing 0.01% ozone and three times as much water vapour as was previously detected on the Mars-3 mission.

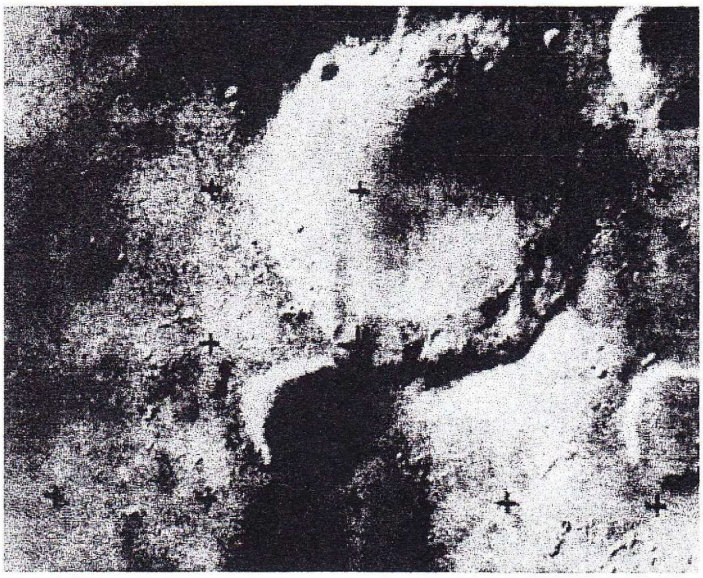

Figure 3. Mars-5 image of Mars

The Mars-7 lander missed the planet by 1300 km on 9 March 1974 although it provided data which indicated a magnetic field near the equator of Mars. The Mars-6 lander touched down at 24°S, 25°W on 12 March 1974 but provided data for only two minutes. During that time, however, the surface pressure was determined at 0.01 Earth atmospheres, with the atmosphere containing 75% carbon-dioxide and 25% inert gases such as argon. The images returned by the spacecraft revealed orange plains, blue mountains, some of which were up to 11 km high, and blue-green craters.

Not until 16 November 1996 did Russia attempt to return to Mars with the Mars-8 spacecraft. Referred to as Mars96 during development, Mars-8 was a 6640 kg spacecraft built by Lavochkin with a three fold purpose to place an orbiter around Mars, place two landers on the surface of Mars and to shoot two penetrators into the surface of Mars. In addition, the spacecraft was to perform scientific investigations during its flight to Mars.

Following its launch the Mars-8 spacecraft (Figure 4) was placed in a low-Earth orbit from where it was intended to boost it into a trans-Martian trajectory which would have seen it arrive at Mars on 12 September 1997. It would then have been placed in a Martian orbit of 300 x 22000 km with an inclination of 101°.1, following which the landers and the penetrators would have been released. The landers would have operated for 700 days, whilst the penetrators would have operated for 350 days.

However, the final stage of the launch vehicle did not fire long enough to place the spacecraft into the desired trajectory. The spacecraft is believed to have re-entered on the third orbit. An upper stage continued to orbit and was initially thought to be the spacecraft when it was given designation 1996 064A. It re-entered off the South American coast near Easter Island on 18 November 1996. The spacecraft itself never received an international designation.

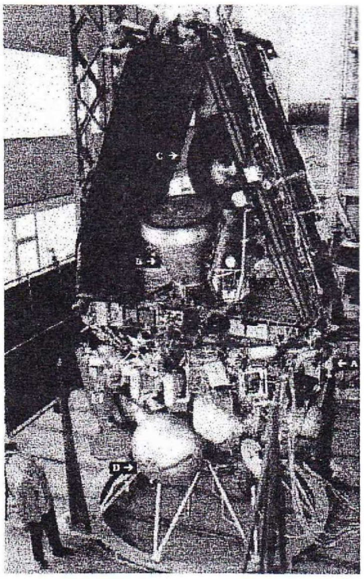

Figure 4. Mars-8

3 Zond series

The Zond series of spacecraft have been used for a variety of interplanetary missions and, in hindsight, it may be more appropriate to consider the spacecraft in this series as technology satellites for interplanetary missions. This is supported not only by a translation of the name Zond, meaning 'probe', but also by the official USSR statement that the flights were development tests.

Zond-2, which was launched on 30 November 1964, was sent towards Mars but communications failed in August 1965 and the spacecraft passed Mars at a distance of 1500 km on 6 August 1965. A plasma jet system was tested between 8 and 18 December 1964.

The next spacecraft in the series, Zond-3 was sent on a trajectory to Mars at a time that there was no suitable launch window for Mars, thereby confirming the developmental nature of the series. Launched on 18 July 1965, it passed the Moon at a distance on 9200 km on 23 July 1965 and took 25 pictures from the far side of the Moon which it returned from deep space nine days later, proving the capability of the communication systems. Subsequent signals by the spacecraft were received from well beyond the orbit of Mars. Other instruments carried by the Zond-3 spacecraft investigated the Earth and interplanetary magnetic fields, solar wind, cosmic rays, micro-meteorites, low-frequency galactic radio emissions and the lunar infra-red and ultraviolet spectra. The spacecraft also tested a plasma engine and conducted various materials experiments.

4 Phobos series

The objective of the Phobos spacecraft was to achieve an orbit around Mars from where extensive observations of the planet were to be made. In addition the spacecraft were to fly past the moon Phobos and release two small landers.

Table 3: Launch dates of Phobos series

Name	Launch	Re-entry	Notes
Phobos-1	7-Jul-1988	---	Contact lost, flew past Mars
Phobos-2	12-Jul-1988	---	Martian orbit

The instrumentation of the spacecraft was supplied by the USSR as well as a number of other countries and the European Space Agency. The spacecraft also were to transmit colour and infra-red images of the Martian surface. The small landers were fitted with television cameras and a number of other scientific instruments and were to be released onto the surface of Phobos. One of the landers was to 'hop' for a distance along the surface.

Contact with the Phobos-1 spacecraft was lost on 2 September 1988 and it may have passed Mars on 23 January 1989. Phobos-2, after achieving an orbit around Mars of 867 x 81,357 km with an inclination of 0°.87 on 30 January 1989, was lost on 29 March 1989 before the first encounter with the moon Phobos, scheduled for April 1989. By then it was in a quasi synchronous orbit with the moon of 6145 x 6409 km with an inclination of 1°.26. Nevertheless, Phobos-2 did return data on the composition of the Martian atmosphere and provided some images of Phobos. The USSR planned to use a back-up model of the Phobos spacecraft as a replacement mission to be launched in 1992, but this mission never eventuated.

5 Future programmes

The political upheaval of the early 1990s, which saw the demise of the USSR, had significant impact on the development of the interplanetary space programme, including missions to Mars.

During the 1994 Mars launch window the USSR intended to launch the Colomb missions to Mars. Experiments on such a mission would have included a television system and a number of scientific experiments, some of which could have been supplied by nations other than the USSR. The mission probably involved an orbiter and the release of French designed balloons which would float through the Martian atmosphere after release from the spacecraft. The orbiters would act as data relay platforms to transmit information back to Earth.

These spacecraft could have been followed by a sample return mission which could have taken place in the 1998 launch window. In the longer term the USSR could have flown an unmanned roving vehicle to Mars in the 2001 launch window and, assuming all robotic missions would have been successful, a crewed mission could have taken place in 2007.

6 Mariner series

The Mariner series of interplanetary spacecraft (see Table 4 for launch dates) consisted of a number of essentially dissimilar spacecraft which explored the inner planets, Mercury, Venus and Mars. Mariner-3 was the first Mars probe launched by the USA, but, like many of its USSR counterparts, it disappeared into deep space. After this initial failure Mariner-4 flew past Mars at a distance of 9789 km on 14 July 1965 and transmitted 21 photos of the Martian surface back to Earth. Unexpectedly, these photos showed many craters a feature which was later proven to be an exception. There was no evidence of volcanic activity or water erosion. No magnetic field or a radiation belt was found whilst a very thin atmosphere, consisting of 95% carbon-dioxide, was detected. Both Mariner-3 and -4 carried a camera with transmission device, a solar plasma probe, an ionisation chamber, a radiation detector, four Geiger-Mueller counters, a helium vector magnetometer, a cosmic ray telescope and two cosmic dust detectors.

Table 4: Launch dates of the Mariner series

Name	Launch	Re-entry	Notes
Mariner-3	5-Nov-1964		Mars probe; in solar orbit
Mariner-4	28-Nov-1964		Flew past Mars
Mariner-6	24-Feb-1969		Flew past Mars
Mariner-7	27-Mar-1969		Flew past Mars
Mariner-H	8-May-1971	—	Mars probe; failed to orbit
Mariner-9	30-May-1971		Mars orbiter

The success of the Mariner-4 mission was followed by Mariner-6 and -7, which passed Mars on respectively 31 July and 5 August 1969 over the southern hemisphere of the planet and the equator at distances of 3400 and 3500 km. They returned, respectively, 74 and 126 photos of the planet. Instruments on board detected carbon-dioxide, carbon-monoxide, and atomic hydrogen, oxygen and carbon in the upper atmosphere. The surface temperature was measured as -50 to 13□C in the daytime and -103 to -52□C at night.

Both spacecraft carried two TV cameras, an infra-red radiometer for thermal mapping, an ultraviolet spectrometer to identify chemical constituents of the upper atmosphere, an infra-red spectrometer to measure the lower atmosphere and the surface composition and a celestial mechanics experiment to determine the mass of Mars and the distance between Earth and Mars.

After the launch failure of Mariner-H, the Mariner-9 spacecraft was placed into an orbit around Mars of 1397 x 17,916 km with an inclination of 64°.3 on 14 November 1971. The mission provided a wealth of data on the planet although initially images gave little detail of the surface because of a prevailing dust storm. It was not until one year later that the spacecraft revealed the true surface of the planet: valleys of enormous size, 4000 m deep, 5000 km long and 150 km wide, and the highest volcano known in the solar system, Nix Olympica, 25 km high and 500 km wide at its baseline. The photos also showed intriguing wind erosion patterns which kept scientist busy for years.

It was apparent that the earlier Mariners had happened to observe very untypical regions of Mars. Now the hemispheres were seen to be very different although the dividing line was not at the equator but at a 50 degree angle to it. The southern hemisphere was found to be very cratered, ancient and inactive and resembling the Moon. The northern hemisphere, on the other hand, appeared geologically active with lava fields, fractures, etc. The spacecraft also made observations of the two moons of Mars and images obtained revealed them to be irregular shaped. The instrumentation of Mariner-9 consisted of an infrared interferometer spectrometer for studies of the planet's surface and composition, its atmospheric constituents, temperature etc., an infra-red radiometer to measure the surface temperature, an ultraviolet spectrometer to study the atmospheric composition, structure and temperature, as well as two television cameras. A total of 7329 pictures were transmitted until the instruments on the spacecraft were closed down on 27 October 1972. Mariner-9 is expected to burn up in the Martian atmosphere in 2025.

6 Viking series

The Viking programme (see Table 5 for launch dates) comprised of two spacecraft, each one consisting of an orbiter, to be placed in a Martian orbit, and a lander to land on the surface of Mars – Figure 5 shows the landing site of Viking 1. The latter provided the most spectacular images of the planets surface following their landings on 20 July 1976 and 3 September 1976. Each lander carried two camera systems, a meteorology boom, a surface sampling instrument, a seismometer, a biology instrument, a gas chromatograph/mass spectrometer and an X-ray fluorescence spectrometer.

Table 5: Launch dates of Viking series

Name	Launch	Re-entry	Notes
Viking Test	11-Feb-1974	---	Failed to orbit
Viking-1	20-Aug-1975	20-Jul-1976	Landed on Mars; orbiter in Mars orbit
Viking-2	9-Sep-1975	3-Sep-1976	Landed on Mars; orbiter in Mars orbit

The three life experiments were based on the assumption that life was carbon based and was probably in the form of microbes or bacteria. In one experiment a sample of soil was incubated in simulated Martian sunlight for up to five days in an atmosphere of carbon-dioxide and carbon-monoxide labelled with a radioactive tracer. The unused tracer was then removed and the sample heated to 625° C to vaporise any organic material, releasing any tracer that had been taken up. As the result fixation of some tracer occurred but the amount was such that it was probably due to chemistry rather than biology. In another experiment a sample of soil was fed liquid nutrients rich in vitamins and amino acids labelled with a radioactive tracer, then incubated at 10° C for up to eleven days. Measurements were then made of any gases resulting from the consumption of the nutrients. An early release of carbon-dioxide was detected probably due to biology rather than chemistry. In the third experiment a sample was put into a liquid nutrient of organic compounds and inorganic salts. It was then incubated for up to twelve days in an atmosphere of helium, krypton and carbon-dioxide. The atmosphere was sampled at intervals for hydrogen, nitrogen, oxygen, methane and carbon-monoxide. It was found that carbon-monoxide and oxygen were expelled which was probably due to chemistry. The overall conclusion of the life science experiments was that the results were very ambiguous and could be explained either by chemical reactions or by very primitive life forms.

Data collected by the landers also showed that the winds were generally less than 20 km/h but that during storms on the southern hemisphere they could exceed 180 km/h. Very little seismic activity was found. The surface is red in colour and has a wide variety of rocks. Analysis of the surface samples gave a 21% silicon content, 13% iron as well as aluminium, magnesium, calcium, sulphur and other elements. It was estimated that 42% of the oxygen is bound up in compounds such as iron oxides, which accounts for the red colour. The two cameras provided images over 350□ from the spacecraft to the horizon. Images were in black/white or colour as well as in three infra-red bands. Stereo images were also produced. Each image took 20 minutes to build up so that a moving object would only be recorded as a line. No lines were found on any of the images.

The orbiters carried two narrow angle television cameras for high resolution imaging, an atmospheric water detector to map the atmosphere of Mars and to detect any water, an infra-red thermal mapper and radio equipment to be used in occultation experiments to provide data on the planet's size, gravity, mass, density and other physical characteristics. The results obtained by the orbiters showed dense carbon-dioxide clouds over the poles during the summer. In the winter these condensed as ice causing a drop in the atmospheric pressure. It was found that the polar caps have water ice as well as the seasonal carbon-dioxide ice. The ice cap extends as far as 50° to 60° latitude in winter. Imagery revealed large surface channels scoured by flooding and many smaller channels apparently caused by water flowing in the past. Huge canyons indicate substantial surface movement. The entire surface of Mars (Figure 6 shows Olympus Mons, the highest peak on Mars) was mapped with resolutions ranging from 200 m to 8 m. The study of the atmosphere revealed that the constituents were the same at high altitude as at the surface, indicating efficient mixing by the winds. No ozone was detected so that the solar ultraviolet radiation reaches the surface, breaking water down into HO and O.

Figure 5. Viking-1 landing site

Both Phobos and Deimos were examined by the orbiters. The moons are probably former asteroids which came near Mars and were captured by the planet. In particular Phobos was mapped with a high resolution. It was found to be very dark and may consist of carbonaceous chondrite with an outer layer of rock.

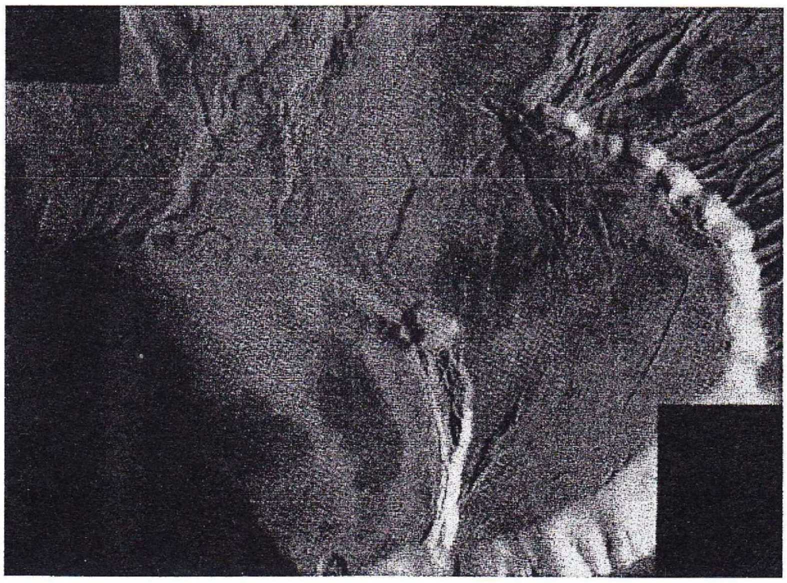

Figure 6. Olympus Mons

Viking-1 attained an orbit of 1500 x 50,600 km with an inclination of 37°.8 on 19 June 1976. The lander separated on 20 July 1976 and landed at 22° 18'N, 48° 0'W. Viking-2's orbit was attained on 7 August 1976 and was 1502 x 35,728 km with an inclination of 55°.6. Its lander separated on 3 September 1978 and landed at 47° 14'N, 135° 18'E.

Although the design life of the Vikings was 3 months, the Viking-1 orbiter was not shut down until August 1980, after an operational life of 49 months. The Viking-2 orbiter remained operational until July 1978 (a period of 22 months) whilst its lander functioned until April 1980 (45 months). The Viking-1 lander was kept operational by public subscription until it ceased to function in November 1982, after 76 months.

7 Mars Observer

On 25 September 1992 the United States launched the Mars Observer, Figure 7. The Mars Observer was a 2487 kg spacecraft which was to be placed in a Martian orbit of 380,000 x 550 km, later to be modified to 375 x 350 km with an inclination of 92°.8. The spacecraft was to undertake a mapping mission of the planet which would have lasted for the duration of a Martian year, that is 687 days. Table 6 lists some other US Mars missions.

Table 6. Other US Mars missions

Name	Launch	Re-entry	Notes
Mars Observer	25-Sep-1992		Orbiter
Mars Global Surveyor	7-Nov-1996		Orbiter
Mars Pathfinder	4-Dec-1996	4-Jul-1997	Lander
Mars Climate Observer	11-Dec-1998	23-Sep-1999	Orbiter; failed to orbit Mars
Mars Polar Lander	3-Jan-1999		Lander

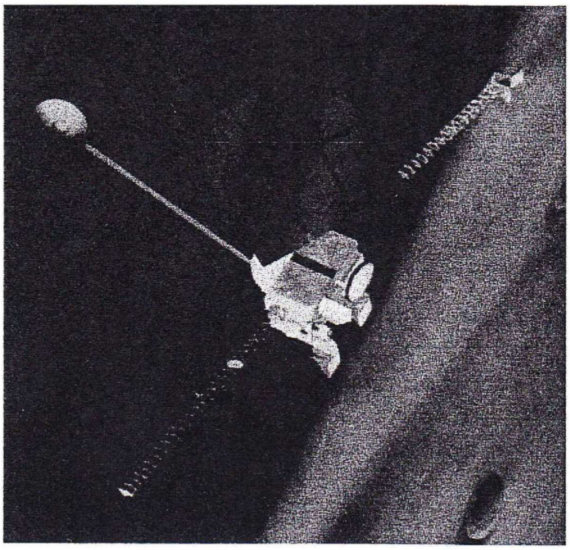

Figure 7. Mars Observer

Contact with the spacecraft was lost prior to Martian orbit insertion which was to take place on 24 August 1993. It is not known if orbit insertion was achieved or if the spacecraft flew past Mars into a solar orbit. The instruments were to study the global elemental and mineralogical character of the surface material, to define the global topography and gravitational field, to establish the nature of the magnetic field, to determine the time and space distribution of particles in the Martian atmosphere and to study circulations in the atmosphere. The instruments consisted of a visual and infra-red mapping spectrometer, a thermal emission spectrometer, a magnetometer, a radio altimeter, a gamma ray spectrometer, a camera system, a pressure modulator infra-red altimeter and a radio science experiment. After reaching Mars after a flight of 11 months, the spacecraft will be placed in a circular polar orbit of 360 km altitude. The mission is expected to end in 1995.

8 Mars Global Surveyor

Launched on 7 November 1996, the Mars Global Surveyor (Figure 8), with a mass of 1060 kg, reached Mars on 11 September 1997 and it was intended that by January 1998 it would have been in a Martian polar orbit of 350 x 410 km, with an inclination of 93°. However, during the aerobraking phase of the spacecraft's flight around Mars, one of the large solar panels experienced too much stress. This solar panel had been damaged shortly after the launch. The aerobraking phase was been amended and the desired orbit was achieved in July 1998.

Through the delay in the areobraking phase the scientific programme was delayed by a year. In July 1998 the alignment of the Sun was incorrect for mapping and it was necessary to wait until March 1999, before mapping could begin – Figure 9 shows a night-time temperature profile returned by the craft.

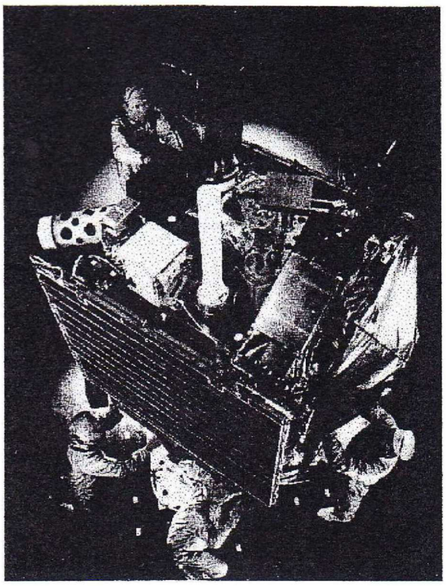

Figure 8. Mars Global Surveyor

Budget restrictions, at this point in time, prevent the extension of the observation programme beyond the one year time-period. However, even if the mapping period would be reduced to only 30 days, 80% of the mission's objectives can be achieved. It is intended that the spacecraft will attempt to observe and image the landing site of Viking-1, Viking-2, and Mars Pathfinder. After an observation programme the satellite will continue to be used as a data relay station for future lander craft.

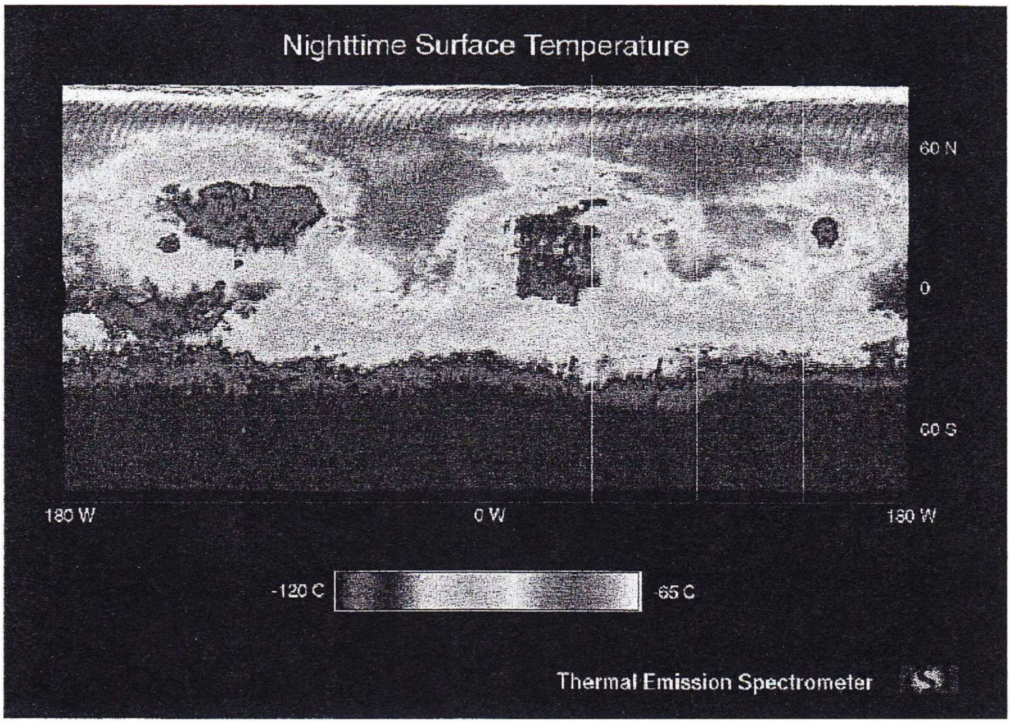

Figure 9. Global night-time temperature profile taken by Mars Global Surveyor (TES)

9 Mars Pathfinder

Launched on 4 December 1996, the Mars Pathfinder was a 890 kg Mars exploration spacecraft consisting of a cruise vehicle, an entry vehicle and a lander. The lander included the Mars Pathfinder Microrover, named Sojourner (Figures 10 & 11), a 11.5 kg vehicle which was 63 cm long, 48 cm wide and 31 cm high.

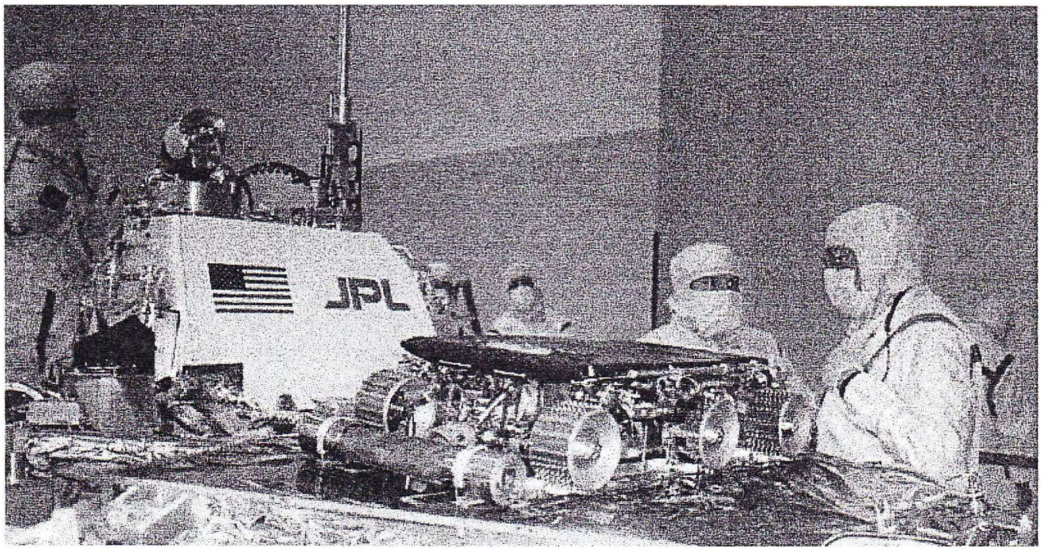

Figure 10. Pre-launch preparation of the Mars Pathfinder

The 890 kg spacecraft made a successful landing on Mars on 4 July 1997. The landing site was at Ares Valles, at app. 19°20'N, 33°55'W, an area which was initially targeted for the landing of Viking-1, which was scheduled 21 years ago for 4 July 1976.

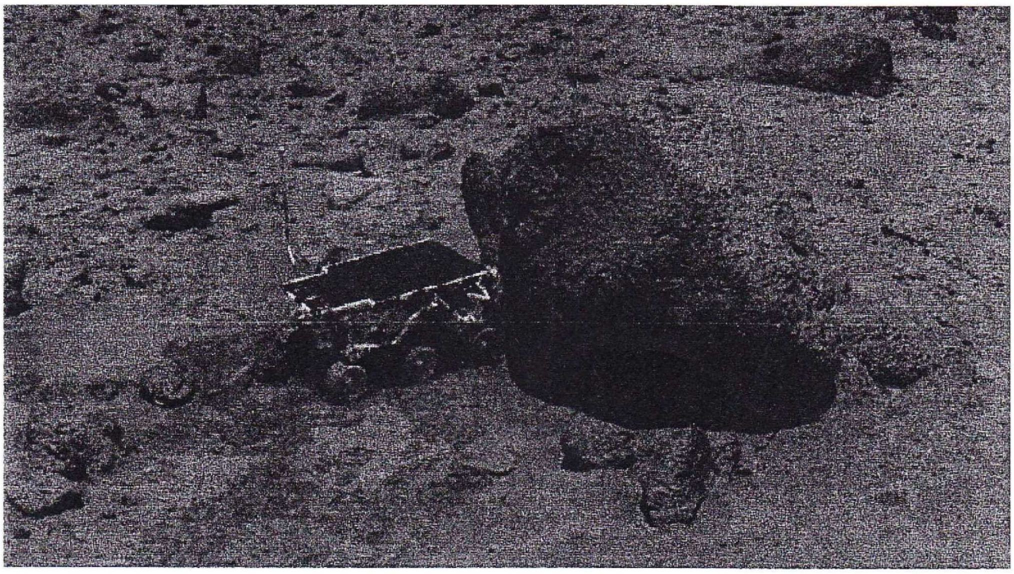

Figure 11Sojourner and the rock Yogi

After the landing the Mars Pathfinder was renamed the Carl Sagan Memorial Station. The next day the Sojourner was released. Although intended to operate only for one week, Sojourner continued to operate until 27 September 1997, when contact was lost. The mission was formally terminated on 4 November 1997.

10 Mars Climate Observer

The Mars Climate Orbiter was launched on 11 December 1998 and was to be placed in an orbit around Mars to observe climatic changes in the Martian atmosphere. The Mars Climate Orbiter, Figure 12, reached Mars on 23 September 1999 and was to achieve an operational orbit of 373 x 437 km and an inclination of 92.9° by 23 November 1999. However, a navigation error brought the spacecraft in at a distance of 60 km and it is believed to have burned up in the Martian atmosphere.

11 Mars Polar Lander

Launched on 3 January 1999, the Mars Polar Lander, Figure 13, was to touch down in the south polar region of Mars between the 75° and 80° South latitudes on 3 December 1999. The 560 kg probe was to land suspended from a parachute, to conduct a primary mission which to last three months. It was to have analysed the soil as well as look for traces of water. In addition two separate probes, identified as Deep Space-2, were to be released before the landing, They would have penetrated the surface up to a distance of 2 m. Although from telemetry data it is clear that the lander did successfully separate from the spacebus, subsequent contact was lost and it is likely that the lander perished during the landing.

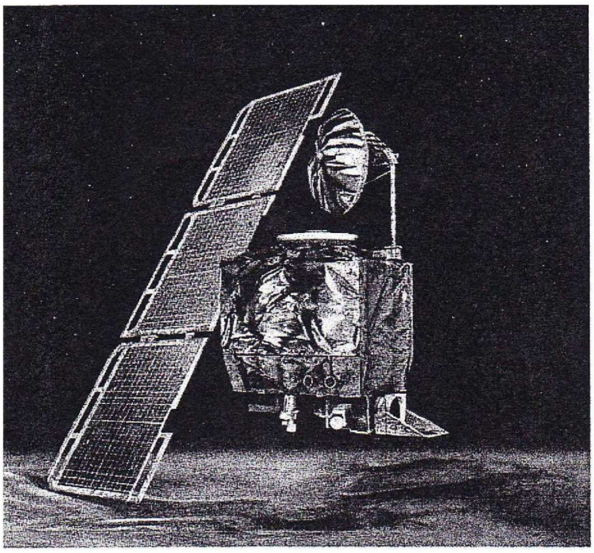

Figure 12. Mars Climate Observer

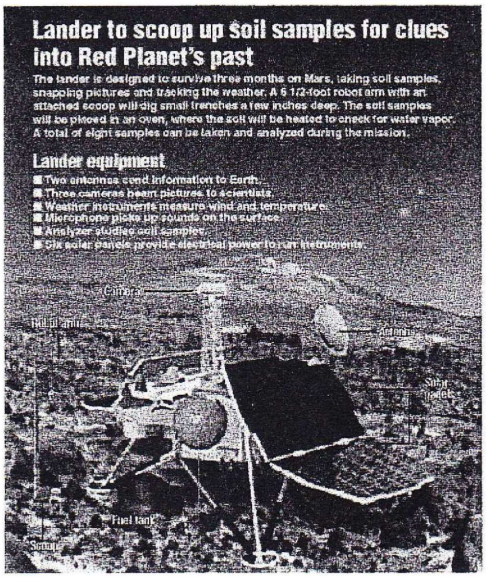

Figure 13. Mars Polar Lander

12 Future United States Missions

The definition of the future missions to Mars are still very preliminary and are very dependent on findings by the current missions. Table t lists future US missions to Mars. Several experiments have already been selected for the two Mars missions planned for 2001. The Mars Surveyor mission will carry the Thermal

Table 7: Future US missions to Mars

Launch	Mission profile
March 2001	Orbiter
March 2001	Lander
May 2003	Lander
May 2003	Lander
July 2005	Sample return

Emission Imaging System which will undertake mineralogy and morphomology of the surface, whilst it will also carry a Gamma Ray Spectrometer. The lander mission planned for that year, will carry an improved rover vehicle which will be capable to operate for a year and can explore a 100 km radius area.

One of the proposals for the 2003 missions includes the Mars Airborne Geophysical Explorer (MAGE). MAGE will be a 9.75 m span aircraft with a hydrazine fuelled propeller engine. It will be released from a Mars landing craft and will then fly for 3 hours through the Valles Marineris. This canyon is 4000 km long, 150 km wide and 10 km deep. The flight would take place in December 2003 and would be named Kitty Hawk for the centenary of the Wright Brothers flight of 1903. If proceeded with, the craft will be developed by the Naval Research Laboratory.

For the 2005 sample return mission, scientists and engineers are studying the feasibility of using resources available on Mars to produce some of the fuel for the return mission. The idea is to incorporate a small plant in the spacecraft which will be able to transform CO2 in the Martian atmosphere into liquid oxygen which, combined with either methane or propane (the components for which must be brought from Earth) will enable the return flight. The methodology has several advantages in that the initial spacecraft will have a lower mass, allowing it to be launched on a Delta or Atlas vehicle rather than a Titan 4. Also the return flight can dispense with the Martian orbit rendezvous and instead fly back to Earth directly and finally, the technique can ultimately be applied to a crewed Mars mission. The 2005 Mars mission will also incorporate a rover vehicle which will collect samples over a period of 583 days.

13 Japan

The only other country launching a Mars mission, has been Japan. The Nozomi spacecraft, Figure 14, also known as Planet B, was launched on 3 July 1998. After launch it was placed in an orbit from which, using gravity assists of the Moon (18 December 1998) and the Earth (20 December 1998), it was sent on a trajectory to Mars. It was to be placed in a Martian orbit of 200 x 27000 km with an inclination of 138°, in October 1999. Over a two year period, it was to investigate the interaction of the atmosphere of Mars with the solar wind. Problems with the propulsion unit in early January 1999, forced the spacecraft to remain in a solar orbit until December 2003 following which it is expected to enter a Mars orbit four years later.

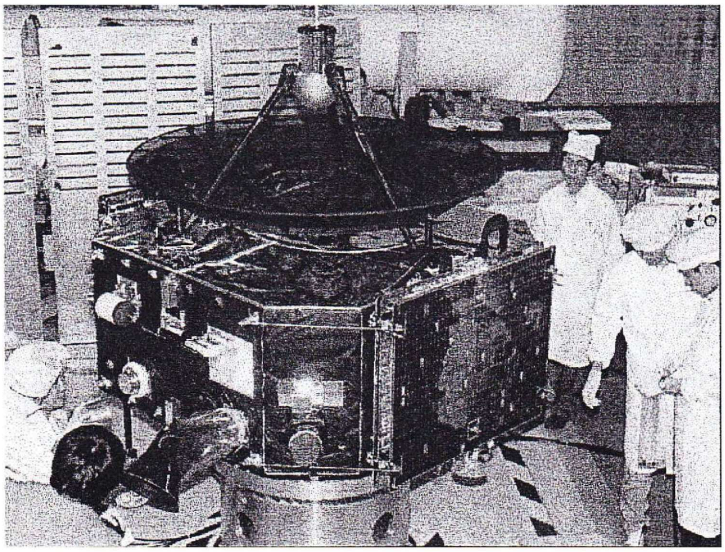

Figure 14. Nozomi

14 European Space Agency

For a launch in June 2003, the European Space Agency is developing the Mars Express (Figure 15) mission. The objective of this mission is to study the surface, subsurface, atmosphere and environment of the planet. The studies currently consider the inclusion of the Beagle 2 (Figure 15), a 60-kg lander which will focus on the geochemistry and exobiology of the Mars surface.

15 Crewed Mars Missions

It is beyond doubt that ultimately crewed missions to Mars will be conducted. However, at this point in time there is no time commitment for such missions by any of the space faring nations. Crewed Mars mission have been considered in the past.

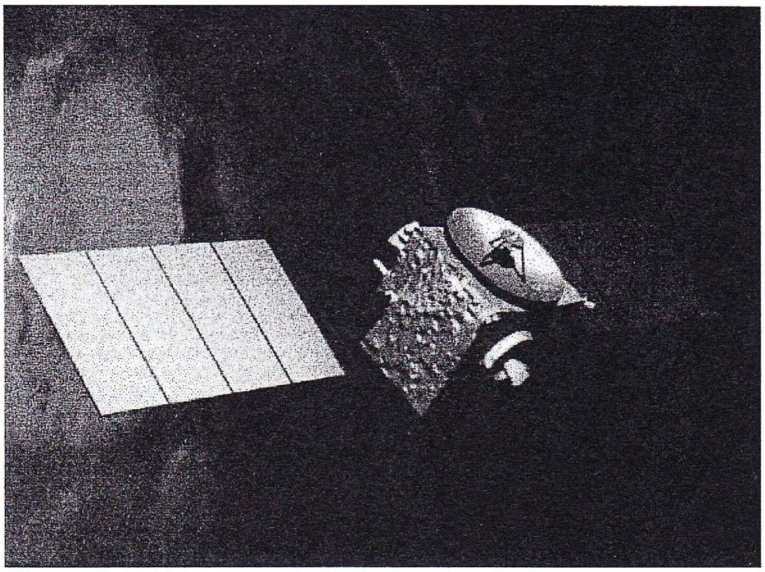

Figure 15. Mars Express

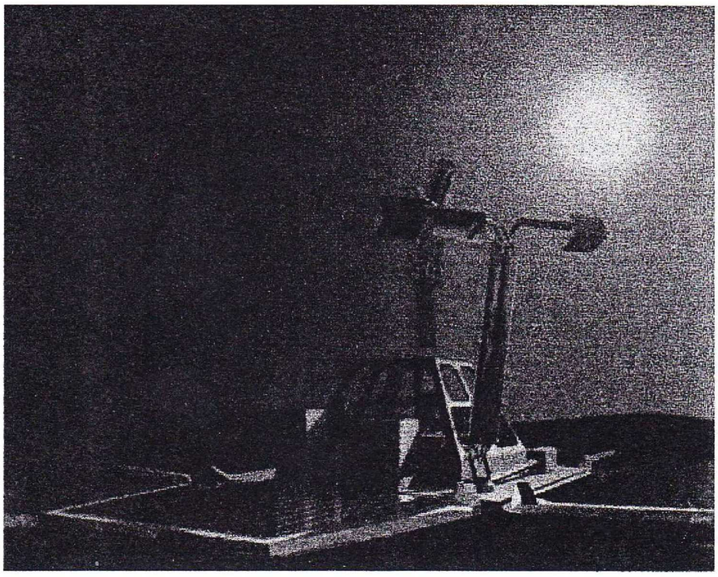

Figure 16. Beagle

15 Crewed Mars Missions

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Even before the first piloted flight by Gagarin on 12 April 1961, the USSR was studying piloted flights to Mars[2]. A section of the Korolyov OKB-1 design bureau studied a Martian Piloted Complex (MPK) which would be assembled in low-Earth orbit, then fly to Mars where a landing craft would descent on the surface Mars. Up to 25 N1 launch vehicles would have been required to complete the 1630 tons vehicle in low-Earth orbit. Of this only 15 tons would eventually have been returned to Earth after a 30 months mission.

It was realised such a large project could never have been approved and accomplished within an acceptable time frame and, as an alternative, a heavy Piloted Interplanetary Spacecraft (TMK-1) was designed by other sections in OKB-1. TMK-1 (Figure 17) would be launched by a N1 launch vehicle and then placed on a free flight trajectory to Mars. After 10.5 months it would be attracted by the

Martian gravity and perform a fly-by which would place the spacecraft into a trajectory for the return flight. During the encounter several remote controlled landers would have been dropped, but, from the information available, the missions would not have put cosmonauts on Mars. The entire voyage, planned for launch in June 1971, would have taken three years.

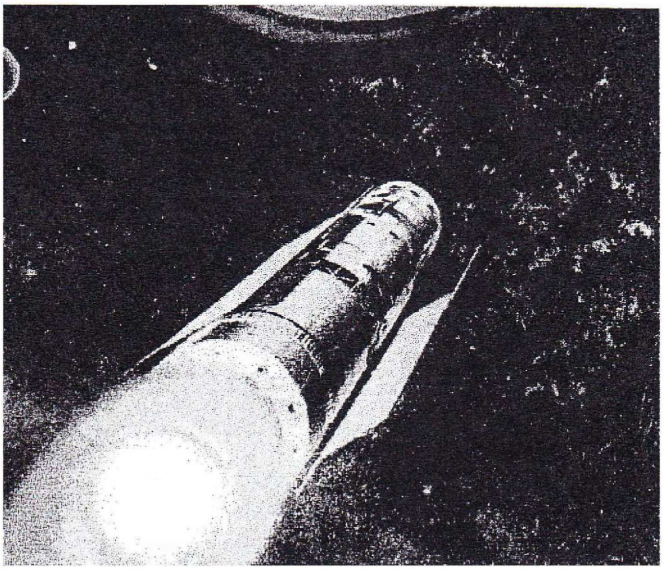

Figure 17. TMK

TMK-1 consisted of a pilot section, a work or equipment section with an EVA hatch, a biological systems compartment that included a closed cycle environmental control system, an aggregate section which housed the Mars probes, a mid-course correction engine and the power units, and a crew re-entry capsule. The project was approved in October 1961 and Valeri Kubasov was selected as the first of three cosmonauts in 1966. Several other studies were but none of the plans seemed to have escaped very far from the drawing boards, if at all.

As for future missions, medical experts in the United States have suggested that a crewed mission to Mars will be at least twenty years away. This is the estimated time that will be needed, at the current rate of space medicine related research undertaken by NASA, to fully understand the potential impact of cosmic rays on astronauts on a 15 months mission. The alternative is for NASA to build a spacecraft with heavy (and hence expensive) radiation shielding.

The technology for a crewed Mars mission is not there and has to be developed. A time frame for that can be expected to stretch over several decades. Success is very dependent on the political stability of the countries that would be involved – any sign of political instability, possibly coupled with economic problems, will delay any effort towards a crewed mission to Mars.

15 Living on Mars

For humans to ultimately live on Mars without the aid of special life supporting technology, it would be necessary to modify the environment of the planet through terra forming. Terra forming is the process whereby a planet is converted to support Earth life-forms. The resources for such an undertaking must be found on that planet itself. A terra formed Mars at some time in the future is depicted in Figure 18.

It is thought that large quantities of carbon dioxide, a basic resource needed to re-develop the environment, are in a frozen state in the Martian poles. A rise in temperature would release this gas. The quantity of oxygen, currently extremely low, could be increased by the use of specially genetically engineered plants although the supply of nitrogen seems to pose a problem.

The temperature could be increased by an artificial greenhouse effect through the releases in the Martian atmosphere of fluorine and chlorine as component gases – just those gases that we do not want here on Earth. The entire process, however, could take 100,000 years before the environment on Mars would have sufficiently altered for it to be fit for Earth life. But, once converted, the environment could sustain itself for millions and millions of years. However, the time span of 100,000 years is the same as that from the emergence of the *homo sapiens* to today.

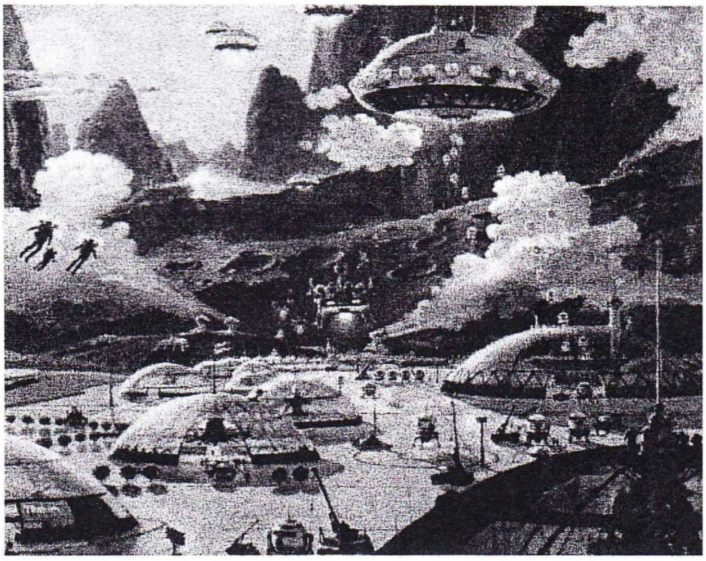

Figure 18. One day humans may terra form Mars to make it habitable (Robert McCall innlustration)

[1] Heyman, J., Spacecraft Tables 1957-1999, Table II.C.2
[2] Wade. M., Encyclopedia Astronautica (Internet site)

Transits of Mercury and Venus

Ian Sullivan
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Abstract
On Tuesday 16 November 1999 the planet Mercury transited the Sun, and the spectacle was seen in the early morning from Australia. The last occurrence of this event was just six years ago in 1993, and we will be treated again in 2003 and 2006. Moreover in 2004, a transit of Venus will occur.

Excepting the Moon, only Mercury and Venus can pass between the Earth and Sun, and so be silhouetted as a tiny black disc, visible from the side of Earth experiencing daytime. The diameter of the disk of Venus while about five times that of Mercury, is only about one thirtieth of the solar diameter. For this reason, these transits cannot be seen except by telescope or projection device, and so have only been observed since the invention of the telescope, and the availability of planetary tables.

The first observations were by amateurs, but in the eighteenth century, professionals became involved using the Venus events to estimate the solar parallax. Some success led to more attempts in the nineteenth century, including those by Australian observatories, but its limitations were realised, and other methods have been employed since.

This paper gives historical background, the basic mechanics of transits, and the prospects for amateurs in observing and photographing them for the next decade.

1 Historical background

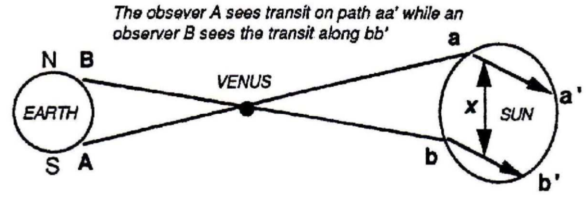
It was a coincidence that Kepler in Central Europe was formulating his famous laws, as the telescope was first put to astronomical use by Galileo in 1609. In 1627 Kepler's Rudolphine Tables were completed, and in 1629 he predicted that Mercury and Venus would both transit the Sun in 1631 in November and December respectively. Kepler did not live to verify this, but Pierre Gassendi in Paris was ready, and observed the last half of the five hour Mercury transit using a projected image of the Sun through a hole in a blackened window, on the wall of a darkened room. At least another three amateurs also observed this transit, but Gassendi , being the only recognised astronomer, took all the credit and estimated a diameter of 20 seconds of arc(nearly twice the actual value). Moreover his planetary image must have been blurred, as he initially thought it was a sunspot.

Gassendi (and everyone else) failed to see the Venus transit a month later, as it occurred during the night in Europe. Jeremiah Horrocks a young amateur in England, later examined and compared Kepler's tables to those of Philips von Lansberg, the Belgian, who, unlike Kepler, predicted a Venus transit in 1639. Horrocks did his own calculations differing from Lansberg, but still placing the planet on the solar disk. Only Horrocks and his friend William Crabtree, a Manchester draper, observed separately (at Hoole and Broughton respectively) projecting images with small telescopes. Both saw the event but only in the hour before sunset on that winter's day - Sunday 4 December 1639 (24 Nov O.S.), with Horrocks observing only as his church commitments allowed. This brilliant young curate was educated at Cambridge, but largely self taught in physical science apart from contact with people like William Gascoigne, inventor of the filar micrometer. Horrocks died in 1641, aged 22, and his friend Crabtree died soon afterwards. Apparently nobody else even attempted to see this transit, and what remains of Horrock's work was published by Dr Wallis in 1672. He reckoned the size of Venus as not exceeding 1' 12" (modern estimate - 1' 3".6)

Since then, transits of Venus have occurred only four times: in 1761 and 1769, then 1874 and 1882. The next pair will be 2004 and 2012. However transits of Mercury are more frequent and a young Englishman William Shakerley travelled to Surat, India to see the 1651 event which was not visible from England. The great Hevelius then saw the transit of 3 May 1661 from Danzig, and estimated a 12 second maximum Mercury diameter. He was followed by Edmond Halley, of comet fame, who was the first ever to see both ingress and egress at the event of the 7 Nov 1677, from St. Helena in the South Atlantic.

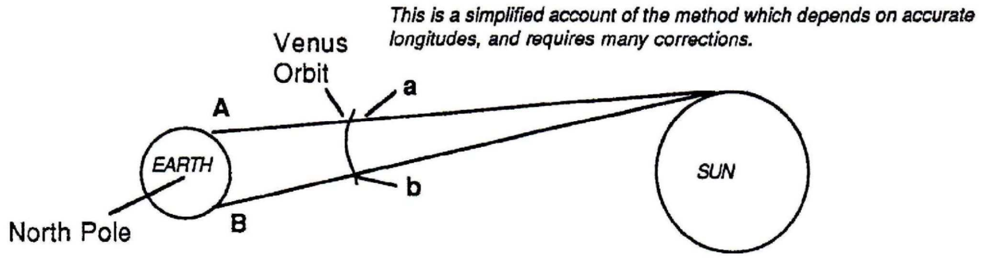
In fact it was Halley who, in a paper written in 1716, proposed using the forthcoming Venus transits to estimate the solar parallax(the mean angle at the Sun subtended by Earth's radius) and hence the Earth-Sun distance. The most accepted value by then was from the Paris Observatory of 1672, when Cassini had observers simultaneously sight Mars from both France and Cayenne, South America, to get a value of 9.5 seconds (yielding an Astronomical Unit of 138,470,350 km). Halley described using a number of observers widely spaced in latitude, with accurate clocks to time the contacts and from the displacement in transit path, calculate the solar parallax. Joseph-Nicolas Delisle, a French academic, who spent 22 years working in Russia, (and later had an assistant named Charles Messier) met with Halley in 1724, but devised a method of his own (see Figure 1). He reasoned that only a single contact local time need be taken at two or more locations, preferably far apart in longitude, allowing sites to be used where the full transit was not visible. The method depends on the precise longitude of the place being known. Even though the observations could all be made from land, carrying pendulum clocks to remote locations, and setting their times by astronomical observations of known 'clock stars' in the days before the event, meant this was not always achieved to the desired accuracy.

HALLEY METHOD



Edmond Halley proposed that if a transit of Venus is observed from 2 widely separated latitudes on Earth, say 10,000 km apart, the separation of an observed position on the solar disk would be about 713 times that or 23,300 km, being about half a minute of arc, or 1160 of solar diameter. This separation (angular and linear - greatly exaggerated in the diagram) could be calculated from the difference in duration between N-S observers. Using mathematics and Kepler's Laws, the solar parallax could be determined.

DELISLE METHOD



An observer at A records a transit begin, as B does a little later. From the distance between A and B, the distance between the two positions a and b of Venus in orbit, can be computed from the ratio of Earth -Venus solar distance. From this and the time difference, the length of the orbit of Venus and her mean distance can be known, and by Kepler's Third Law, the Earth distance, and solar parallax.

Figure 1. The Halley and Delisle methods for determining the Earth-Sun distance from transit of Venus observations.

Nevertheless the Venus transit of 1761 was a grand display of scientific international co-operation, and all the more remarkable for the fact that Britain and France were fighting a war at the time. A total of 120 observations was made from 62 sites from Northern Scandinavia to South Africa. Chappe d'Auteroche, the Frenchman even travelled by horse-drawn sled for five weeks across Russian thawing snow, from St Petersburg to Tobolsk. Neville Maskelyne, later Astronomer Royal, went to St. Helena but was clouded out. La Gentil a Frenchman, was delayed in passage to India by the war, and so arrived too late. Remarkably, he stayed in Asia to observe the 1769 transit, but he too was clouded out. The solar parallax results of 1761 varied from 8".28 to 10".60, partly due to the 'black drop 'effect (Figure 2) which makes timing the internal contacts so difficult. Also it was admitted by Lalande to Maskelyne afterward that the longitude difference between London and Paris was uncertain by 20 seconds of arc!

The transit of 1769 was observed on an even grander scale. At 77 stations, 151 observers from Father Hell in Vardo, Norway, to Captain James Cook at Tahiti tried again. The latter is of particular importance to the history of Australia, as he afterward sailed West from Tahiti to 'discover' New

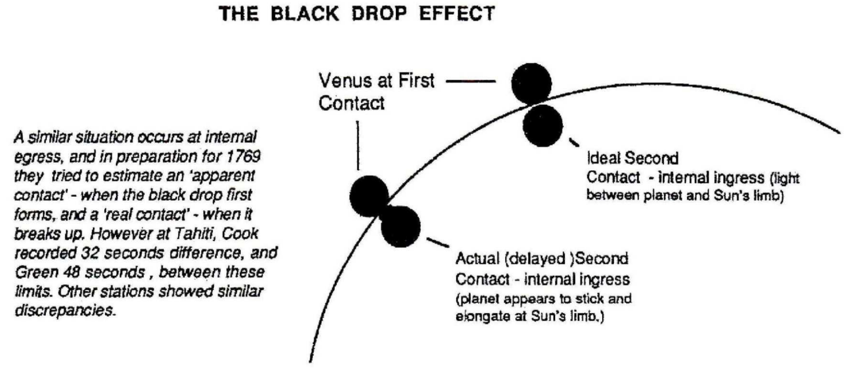


Figure 2. The black drop effect.

Zealand and Australia. Cook and his astronomer Green, each used Gregorian reflectors of 60 cm focal length, and smoked or coloured glass filters for their timings. They did as required, but Green died on the return voyage, as did Chappe and all except one of his French party in Southern California, who succumbed to an epidemic. The overall accuracy was an improvement over 1761, with values from Planmann's 8".43 to Pingre's 8".80. In 1824 the German Encke reworked the results of both transits and calculated 8".5776 which was upheld scientifically until the middle of the century.

For observing the 1874 and 1882. transits the scientific community was not quite so enthusiastic, as they could estimate the solar parallax by observing Mars and minor planets. However they were better placed than the century before, having chronometers for portable timekeeping, continuous recording devices(paper tape or chart), the electric telegraph, and photography. Moreover the positioning of the observing stations was aided by better maps and survey techniques. For 1874 many expeditions were mounted especially by the USA which sent eight parties(with identical 5-inch refractors and heliostats), to sites mostly around the Pacific. The five Southern parties sailed six months before transit, landing in Kerguelen Is., Hobart Tasmania., and Queenstown, New Zealand. As a landing could not be made at Crozet Is. this party went to Campbell Town Tasmania (see Appendix I). There are prominently displayed relics of this visit still at Campbell Town, where only third contact was viewed through thin cloud. The Sydney, Melbourne, and Adelaide Observatories all viewed the event at least partly successfully, and many other parties were sent (Bendigo, Glenrowan, and Mornington Vic. and Woodford, Goulburn, and Eden NSW). A 100mm photoheliograph made by Dallmeyer was employed at Melbourne, and the photos taken by the Director Ellery to London for analysis. The Americans also used long focus photography to obtain over 200 plates - but not all were usable. Calculation of the solar parallax proceeded at the the US Naval Observatory led by Simon Newcomb, who coped with funding difficulties and the publication of rival calculations based on American data. When the 1882 transit presented itself only the end was visible from Eastern Australia., though it was again viewed enthusiastically. Sydney, Melbourne, and Adelaide Observatories sent parties within the country, and more than half were successful. Many professionals were sceptical, but it was visible from USA and parties were again sent. Nearly 1500 photos resulted (7 times the 1874 total). However publication of results was stalled like the previous transit, by funding, and the dismal expectation of results. The difficulty of estimating contact times from photos was likened, by Cambridge Professor Robert Ball, to '*estimating seconds by viewing only the minute hand of a clock*'.

Today transits are of not much concern to professionals, and the solar parallax can be determined from radar echoes from Venus (the current value is 8".794148 - BAA Handbook). Nevertheless Venus transits, being so rare are bound to get some involvement. For amateurs in Australia transits are a great event experience, and we are privileged to have such an array before us in the next twelve years. With the total solar eclipse of 2002 we should make the most of this period.

2 Frequency of transits

Mercury transits are much more prolific than those of Venus, and no more than thirteen years can pass without one, and sometimes only three years separate these events. They occur in May and November but owing to the eccentricity of the Mercury orbit (See Figure 3), the planet is further from the Sun in

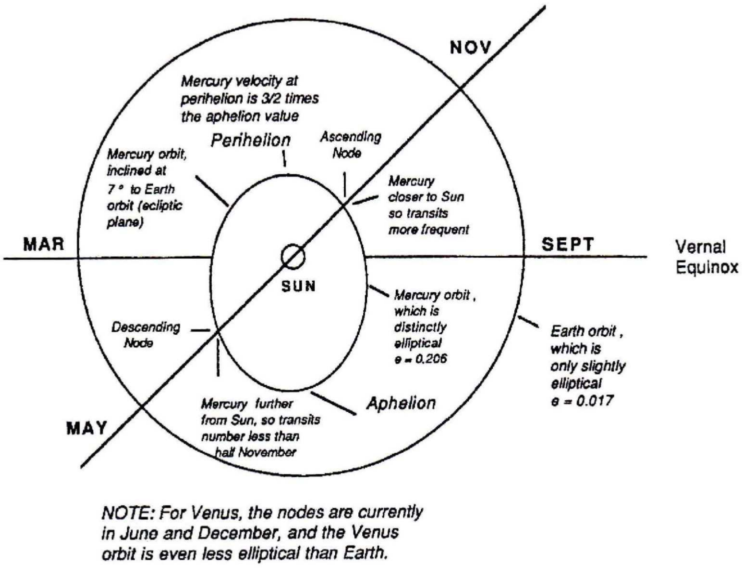


Figure 3.

May creating less tolerance, and less than half the number of transits that occur in November. There is a 46 year series, and the 1999 transit was the last of a series that began in 1171, which explains its 'grazing' contact. A more accurate 217 year series lasts much longer.

Venus transits currently occur in pairs, eight years apart alternately in June and December. The eight year period (which corresponds to 13 Venus years) will disappear, but eventually return. December pairs end in 2854 AD, and June pairs in 3713 AD. Some transits just before the end, will be grazing. These events will also advance slowly in the calendar, so the transit of 5900 will be on 11 July, and be closest to central in alignment for all the years in the interim.

3 COMING TRANSITS (See Figure 4)

For MERCURY, only the first half of the next one in 2003 will be seen from Australia, and the 2006 event will begin less than ten minutes after sunrise in Eastern Australia, making ingress very difficult to observe. Unfortunately the transits of 2016 and 2019 will not be visible from Australia at all; so staying home means waiting until 2032!

For VENUS the long awaited 2004 transit will be curtailed by the winter sunset in Australia, (more so in the East), and in the Southern states, weather expectations are not high in June. In 2012 however, the entire spectacle will be visible from Eastern Australia (WA will miss the start), with the same June weather risk for the South as in 2004. Nobody reading this will need to worry about the transits of 2117 or 2125. (although Dec 2117 looks good for the whole country!)

Coming transits - contact times (AEST approx.)

Contact -	**1**	**2**	**3**	**4**	**1 - 4**	**1 - 2**
Mercury						
2003 Wed. May 7	15.14	15.18	20.28	20.32	5h 18m	4m
2006 Thu. Nov 9	5.13	5.15	10.09	10.11	4h 58m	2m
Venus						
2004 Tue. June 8	15.18	15.38	21.10	21.30	6h 12m	20m
2012 Wed. June 6	8.16	8.34	14.38	14.56	6h 40m	18m

Figure 4. Coming transits – contact times.

4 Observing transits

In preparation you must obviously examine the contact times and also the position angles and contact points(see Figure 5). You must decide how you will view – through a telescope with objective sun filter and low magnification(X 30 – 50),or projected image which is particularly good for a group viewing. For the 1999 Mercury transit, of which Southern Australia saw only first and fourth contacts, I viewed through a magnifier attached to a camera viewfinder. It was adequate for viewing and I saw most of the event, but it did not match the camera, so the photos were not sharp enough to see the planetary disk. For timing contacts you need a radio for VNG (or similar) time signals, and a tape

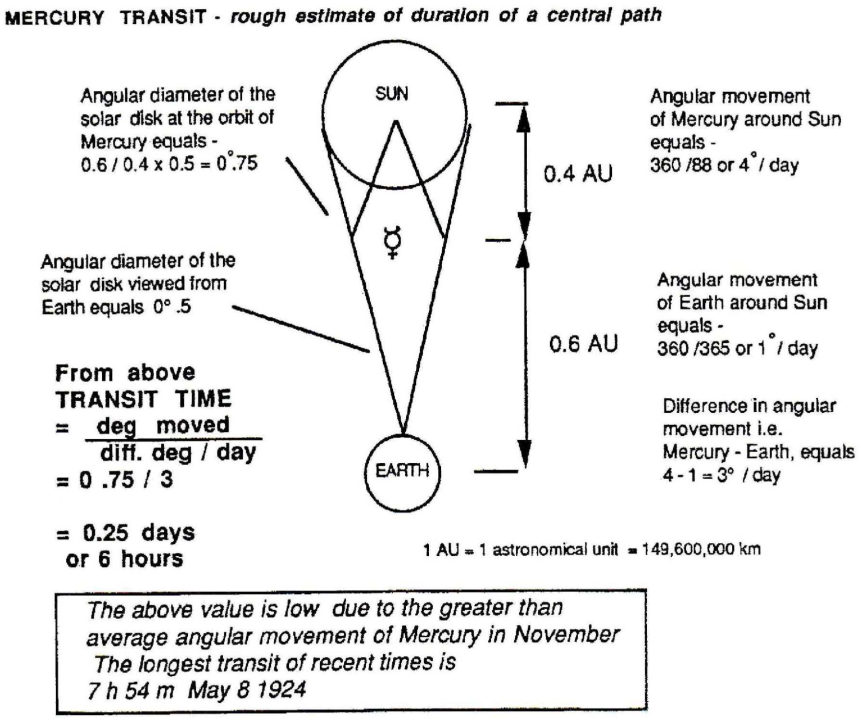


Figure 5. Mercury transit – rough estimate of duration of a central path.

recorder. Good weather is essential, and so you should travel to avoid cloud. (The last two transits in Victoria were seen only in parts of the state with predicted clear weather.) **Also observe all safety precautions for solar viewing, especially if involving others unfamiliar with the dangers.**

5 Transit exercises

To aid understanding you could look at Figure 5 and Figure 6. You could substitute more accurate values(particularly planetary angular motion), to obtain a more accurate estimate of the duration if

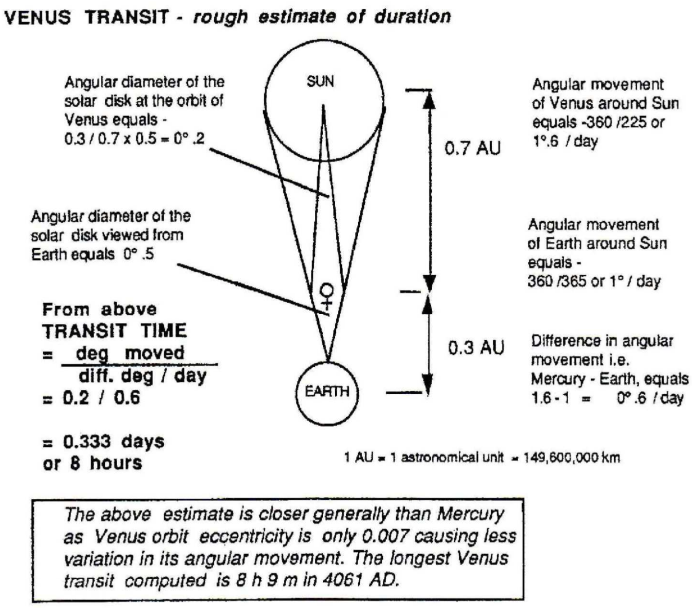


Figure 6. Venus transit – rough estimate of duration.

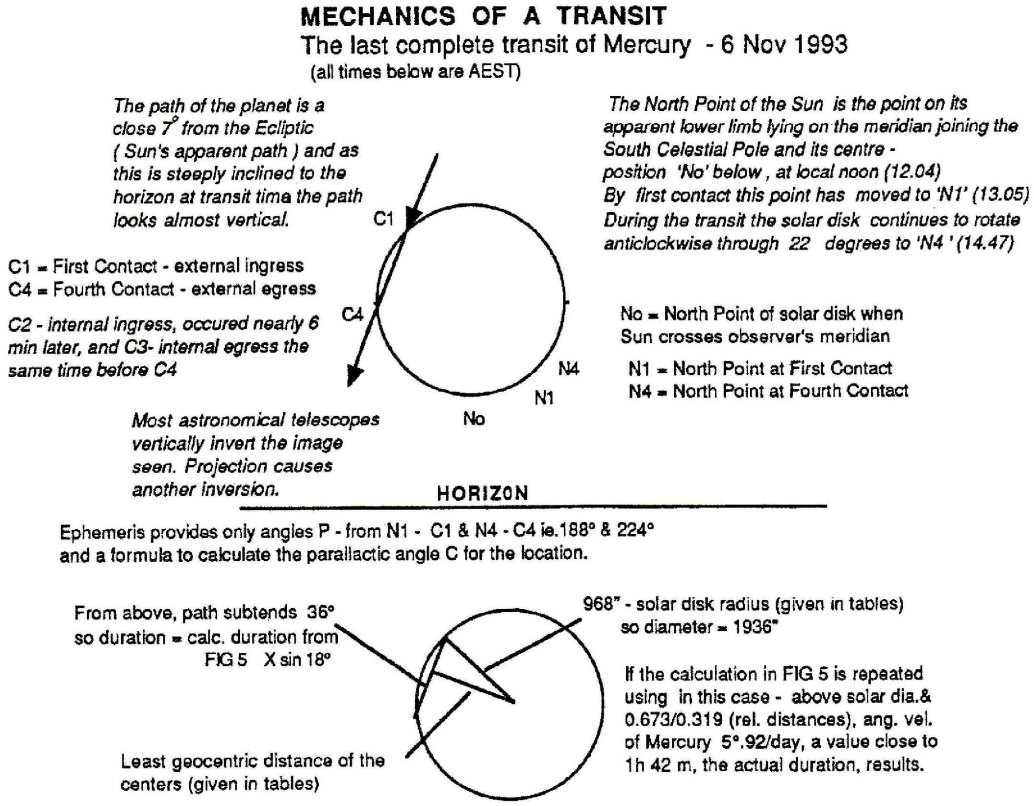


Figure 7. Mechanics of a transit.

transit was centred (see Figure 7). The angular size of the Sun and the separation at mid-transit allows you to calculate by trigonometry the lesser duration over the actual path, and compare this to that given in tables.

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Astronomy online

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Abstract
There are many courses offered Online, or direct from an establishment to the student's computer. Two courses of interest to me are Engineering Computing I from the Monash University and Visual Basic Programming from the Canberra Institute of Technology.

This paper introduces a series of web pages written for the ACT branch of the University of the Third Age (U3A), designed for remote or housebound students and to introduce them to astronomy. The title of the course is Introduction to Astronomy [a student username and password are required] and it includes sufficient information to allow students to observe the night sky with a brief theoretical background for each of the topics.

The paper describes the preparation, presentation and reaction to the course by ten students, all of whom enrolled in October 1999 and went on to completed the course in their own time, most exceeding the nominal 8 week period.

1 Preparation

The course was prepared with the assistance of the University of the Third Age and web page layout by Chirp Design, but all text and images were prepared by the author with Claris Homepage 2.0 on a PowerMacintosh computer. The course consisted of an information page, indexed links to each of the eight topics as well as an interactive forum for use by the students in each week.

All of this information was available online to enable each student to participate in the numerous projects, or questions at the end of each of the eight weeks of the course.

2 The Students

A listing of the students enrolled appears in the table below, with the results of their first project to find individual observing locations in longitude latitude, and elevation. As can be seen in the table, only one student did not provide a personal profile or participate in the course following online registration.

Student	Location	Profile given	Initial Response	Longitude	Latitude	Elevation (m)
Mavis Arnold	Adelaide SA	Yes				
Maria Brandl	Hobart TAS	Yes	11/10/99	142°.3 E	42°.9 S	100 m
Rod Bush	California USA	Yes	12/10/99	–118°.07	33.67 N	
June Chapman	?	No				
Leonard Gabell	Marino Rocks SA	Yes	13/10/99			
James Hannay	Rockhampton QLD	Yes	18/10/99	152.2 E	24.75 S	?
Robert Kelly	Toorak Gardens SA	Yes	1/10/99	1138.50E	34.81S	?
Victo r Macdonald	Gladstone QLD	Yes		151 16 E	23 52S	61 m
John Marshall	Bribie Island QLD	Yes	13/10/99	153.14 E	27.03 S	2 m
Sheila Rowland	?	Yes	18/10/99			
Updated 23-Oct-99						

3 Presentation

This online course was presented as a series of web pages with numerous links to give further information on each of the eight topics, these can be examined without the use of a student password, through my Home Page link, where the course web pages are available with the exception of the forums.

4 Student reaction

The students completed the course and responded favourably to it, although most felt that the details far exceeded their requirements. Sadly one of the senior students died during the course, but a family member advised later that he had thoroughly enjoyed the content of this course.

5 Conclusion

I would encourage those knowledgeable in Astronomy to follow my lead, and where possible encourage other students to pursue an interest in this fascinating subject through other dynamic online courses.

URL http://www.spirit.com.au/~minnah/NACAA2000/ASTRONOMY_ONLINE.html

Proc. XIX Natn Aust. Conv. amat. Astrer. 39-44

An amateur presents innovative ideas as a basis for developments in astronomy beyond 2000

J F Callow

Astronomical Society of Western Australia

Abstract

The classical nineteenth century Newtonian concepts of absolute time and space and an aether at absolute rest as basic concepts in Astronomy that were rejected in the twentieth century. The famous Aether-Drift experiments that are believed to justify this rejection and be correctly explained by Einstein's radical four-dimensional space-time and Special Theory of Relativity. The effect of this Theory on the development of Modern Astronomy and Cosmology.

Measurement of variations in Cosmic Microwave Background Radiation by instruments on NASA's COBE satellite in 1989 are claimed to be experimental evidence of the existence of a preferred reference frame that shows Einstein's Principle of Relativity must be wrong. The innovative alternative explanation of the Michelson-Morley and Kennedy-Thorndike experiments that is consistent with Newton's absolute time and an aether reference frame only relative to which the speed of light is 'c'. This simple explanation that has been overlooked throughout the twentieth century is presented as the basis of developments in Astronomy and Cosmology in the twenty-first century.

Why the measurement of the speed of light relative to Earth can be the crucial experiment that proves which explanation of the Aether-Drift experiments is consistent with reality.

1 Introduction.

Throughout history the desire to understand astronomical observations has been a driving force behind much of the growth in knowledge that enabled some civilisations to flourish while others waned. The ascendancy of Western Civilisation came after Copernicus and Kepler laid the foundations of modern astronomy and Galileo and Newton showed that people of normal intelligence could understand the laws of Nature that caused the Sun, Earth, Moon, Planets and stars to have their observed motions. Newton based his system on the basic concepts of absolute time and absolute space filled with aether at absolute rest. He developed his three Laws of Motion and Law of Gravity on these basic concepts. For over two hundred years progress in science was based on Newton's fundamental concepts. However early in the nineteenth century Newton's idea, that a beam of light consists of extremely small particles or corpuscles, which causes vibrations in the aether, was rejected in favour of light consisting only of transverse waves in the aether. This concept of light gave a more important role to the aether but it did not require any change in Newton's basic concepts of absolute time and space. Later in the century the Scottish physicist Maxwell developed his electromagnetic theory on Newton's concepts and convinced most scientists that electric and magnetic fields had a physical existence in the aether, which had measurable properties of permeability and permittivity. Right to the end of his life Maxwell had no doubt about the existence of the aether and the fundamental role it had in electromagnetic phenomena. When I was a youth in the nineteen thirties technical people concerned with radio generally believed that electric and magnetic fields existed in the aether and that it could be polarised like other dielectric materials. People who took an interest in early radio signals and their propagation around the world generally believed the aether really existed. For ordinary people it was not until after the "Atom Bombs" were dropped on Japan to end World War 11 that Einstein's Theory had any practical significance. Although I started my Professional career as a Mechanical Engineer in 1950 it was not until the late 1960's when I was over fifty years of age that, as a hobby, I made a determined effort to really understand why Einstein's Theory required the rejection of Newton's concepts of absolute time and space and the aether having a role in the laws of physics. I admit that having been taught as a youth that light had a speed 'c' relative to the aether I had great difficulty in understanding how light could have exactly the same speed relative to all inertial reference frames as is required by Einstein's Theory. In August 1969 my practical experience with Newton's Laws of Motion convinced me that although the kinetic energy required to accelerate a particle to the limiting speed 'c' would be infinite, just as Einstein claimed, the mathematics showed this limiting speed **must be 'c' relative to absolute rest.** Einstein developed his whole theory on his belief that absolute rest does not have a role in the laws of physics and he claimed the speed of light was exactly 'c' relative to all inertial observers irrespective of their motion relative to each other. It was this anomaly that first caused me to doubt that Einstein's Special Theory of Relativity was consistent with reality. After further research I became convinced that absolute rest did have a role in physics and I then realised that it naturally followed that absolute time must also have a fundamental role in Nature. How did it come about that most leading physicists and astronomers throughout the twentieth century rejected these essential concepts?

2 The Aether Drift Experiments.

In 1675 the Danish Astronomer Roemer made a measurement of the speed of light by observing the changes in the observed periods of the eclipses of Jupiter's Galilean moons as Earth orbited the Sun. In 1729 the English Astronomer Bradley, after discovering the aberration of starlight, was able to obtain a more accurate value of the speed of light from this phenomenon. It was not until 1849 that Fizeau in France carried out the first experiment to measure the speed of light from a source on Earth. Briefly his method was to determine the time interval required by a pulse of light to make an out and return trip over a measured distance by using a mirror to reflect the light pulse back to the starting point. If D is the distance and T is the time interval required by the pulse of light to make the return trip, the speed of light 'c' was calculated from the simple equation

$$c = 2D/T$$

Although many experiments using improved techniques have since been carried out to obtain a more accurate value, this was still the basic method until 1983 when the speed of light was fixed by International agreement at 299 792 458 metres per second. As the out and return method does not measure the velocity of light, the speed in a particular direction, nineteenth century physicists thought that if Earth was moving through the aether with some speed v, this speed could not be determined from this experiment.

As Earth's speed relative to the aether was unknown, it was thought that neither the true speed of light relative to the aether nor its exact speed relative to Earth could be determined by this method. The speed of light relative to Earth could be $c - v$ in one direction and $c + v$ in the opposite direction. Maxwell, after he had developed his Electromagnetic Theory on the basis of Faraday's electric and magnetic fields having a real existence in the aether, was very interested in what the value of Earth's Aether-Drift 'v' might be. In his article on the "ether" published in the 1879 edition of the Encyclopaedia Britannica he made the following statement: *"If it were possible to determine the velocity of light by observing the time it takes to travel between one station and another on the earth's surface, we might, by comparing the observed velocities in opposite directions, determine the velocity of the ether with respect to those terrestrial stations."*

Physicists did not have the expertise to determine the time light takes to travel one way between one station and another on Earth with sufficient accuracy to carry out Maxwell's suggested experiment. It appeared to require two clocks at a distance from each other to be synchronised with a greater accuracy than could be achieved by any practical method. To this day physicists have not carried out one experiment that accurately measures the **Velocity of Light** relative to Earth.

Albert Michelson a young American physicist who had made an accurate measurement of the speed of light by the out and return method, heard of Maxwell's interest in experiments to measure the "Aether-Drift" and became convinced he could devise a practical alternative method. In 1887 at Cleveland Ohio, with the assistance of Edward Morley he carried out the most famous of all Aether-Drift Experiments. Even if the Sun was at rest relative to the aether, leading physicists believed the experiment had sufficient accuracy to reveal Earth's orbital motion. In Michelson's Interferometer experiment a single beam of light was split into two separate beams by a half silvered mirror. The two beams, after travelling equal distances at right-angles to each other, were reflected back to the half silvered mirror where they were combined in such a way that bright and dark interference bands were produced and could be observed and any displacement of the bands measured very accurately. The apparatus was mounted on a large block of stone that was floated on mercury so that it could be rotated without causing any vibrations that would disturb the interference bands. Because of Earth's motion through the aether physicists believed that there would be a slight difference between the time intervals required by the split light beams to make the return trip over the two arms of the interferometer. By rotating the instrument and changing the orientation of the beams to the direction of the aether drift it was expected that the difference in the time intervals would cause some movement of the interference bands and that by measuring this movement the speed of the aether drift could be calculated. To the surprise of all the leading physicists the experiment gave a null result. There was no consistent shift in the interference bands when the instrument was rotated. Michelson and Morley considered the experiment a failure because it did not measure the Aether-Drift. Although they were unable to explain why it failed, the result of the experiment did not convince them that the aether did not exist.

Independently of each other Fitzgerald and Lorentz suggested that the explanation was that a real change in the dimensions of all bodies naturally occurred with motion through the aether and this contraction cancelled out the expected change in the time intervals. I claim that the true explanation was that these contractions were just those that required no difference at all in the time interval required by light to travel out and back between two fixed points on a body when its orientation to its absolute motion or the speed were changed. Strangely this simple viable explanation, without any dilation of time, has not been developed or accepted by scientists right up to the present time.

In 1905 Albert Einstein put forward his Special Theory of Relativity which not only rejected the aether concept but also Newton's absolute time and space. Einstein's Theory required the dilation of time and the contraction of space itself as well as bodies. The very strange aspect of Einstein's contraction and dilation of time was that they only occurred in a reference frame that was in motion relative to an observer. According to Einstein no change at all occurred in the dimensions of bodies or the rate of flow of time for an observer at rest in the moving reference frame. As physicists were unable to measure the aether drift or the contraction of bodies in an experiment, throughout the twentieth century most scientists have agreed with Einstein that we should accept that they do not occur. I find it is extraordinary that they are quite eager to accept that contractions of bodies and space and a slowing down of clocks must only occur in any other reference frame in motion relative to the observer where it is quite impossible for them to make any direct measurements or observations. For me this is the most illogical aspect of Einstein's theory.

Consider now the claims made by Kennedy and Thorndike about their variation of the Michelson-Morley experiment when they carried out and published their results in 1932. I agree that this experiment was an excellent example of using and developing technology to advance scientific knowledge. However because they published their results under the title "Experimental Establishment of the Relativity of Time" I now believe this experiment will, in the future, become an example to experimenters of how an expensive experiment at the cutting edge of technology, carried out with excellence and giving very accurate results can be completely misinterpreted by someone with preconceived ideas about the results. After reading their conclusions very carefully I claim the results did not justify their title. Their experiment **did not** Establish the Relativity of Time. I have shown this experiment is also fully consistent with Newton's concept of absolute time. Physicists have ignored this important discovery for thirty years. In the future this experiment is more likely to be seen as establishing that absolute time has a fundamental role in physics.

Kennedy and Thorndike begin by correctly pointing out that the Michelson-Morley experiment **does not** provide experimental justification for abandoning Newton's concept of absolute time. They begin their paper by saying; *"None of the fundamental experiments on which the restricted principle of relativity is based requires for their explanation that the classical concept of absolute time be modified; the present experiment was devised to test directly whether time satisfies the requirements of relativity."* I have not heard of any leading physicist contradicting this claim. Kennedy and Thorndike therefore make it obvious that right up to 1932 **there was no experimental justification for Einstein or any other physicist to reject Newton's concept of absolute time.** Later in their paper they say; *"It appears, then, that the theory has needed confirmation, particularly in its most revolutionary aspect; i.e., its denial of the significance of absolute time. Such confirmation has been obtained in the work reported in this paper,.."* I claim there is still no scientific justification for the rejection of the concept of absolute time and their claim that their experiment provides confirmation of the relativity of time is not and cannot be scientifically justified. The simple explanation of the results of the Michelson-Morley and Kennedy-Thorndike experiments that I put forward in 1970 requires Newton's absolute time to have a fundamental role in the laws of physics. This explanation is consistent with the contraction hypothesis put forward by Fitzgerald and Lorentz and the criteria established by Kennedy and Thorndike. They do not look for an explanation of their experiment that is consistent with Newton's absolute time. The contractions of all bodies, transverse as well as parallel to their absolute motion, that I have put forward is the **only possible explanation that does not require any form of time dilation**. Kennedy and Thorndike completely ignore the possible existence of such an explanation. Without showing absolute time is false they accept Einstein's form of time dilation

If the natural changes in the dimensions of all bodies in absolute motion are just those that give a null result in the M-M and K-T experiments, without any dilation of time, all measurements of the speed light by the out and return method in any inertial reference frame are measurements of **the speed of light relative to the aether at absolute rest**. Of course this speed always remains the same. The absolute speed of the reference frame or laboratory in which the experiment is carried out does not affect the result. The contraction of all bodies in absolute motion completely nullifies the effect of the absolute motion those nineteenth century physicists expected to be revealed by Michelson's experiment. The results of all past experiments to determine the speed of light by measuring the time interval required by a pulse of light to travel out and back between two points on Earth's surface would not be affected by Earth's Aether-Drift, irrespective of its magnitude. The experiments would give a constant value for the speed of light, not because the speed of light is the same relative to all inertial reference frames as Einstein claimed, but because the speed of light relative to the aether is always the same in all directions. This is an extraordinary conclusion when it is recalled that throughout the twentieth century physicists have used the null result of these aether-drift experiments as justification for rejecting the concepts of a physical aether and of Newton's concepts of absolute time and absolute rest. I now maintain this discovery, quite unforeseen by Einstein or any of the great physicists of the twentieth century, was one of the most important made in physics in the second half of the twentieth century. I claim this discovery will be a valuable contribution to the development of physics and astronomy in the years beyond 2000. As it requires a return to the concept of a physical aether and Newton's concepts of absolute time and absolute rest having a fundamental role in physics it will seem incredible to most people that it can be true. I say this is an example of truth being stranger than fiction. What twentieth century Science-fiction author would have dared to use such an unlikely idea as the basis for a story about 2000?

The fact is that Einstein did realise that an accurate experiment to measure the speed of light by the out and return method will always give the same result in any inertial reference frame and he called this speed a universal constant. I agree that it is a universal constant and it does have a fundamental role in physics but it should be realised that **it is the speed of light relative to the aether that is 'c' and constant**. Einstein made the extraordinary mistake of thinking that the constant speed of light obtained from these experiments was not the speed of light relative to the aether but was the speed of light relative to any laboratory or reference frame in which the experiment was carried out. The reason he made this error was because he had **previously** come to the conclusion that Newton's absolute time was an expendable concept. Einstein failed to find the explanation that was consistent with Newton's absolute time. I was able to make the discovery that it is always the speed relative to the aether or absolute rest because I had previously come to the conclusion that Newton's concept of absolute time must have an important role in the laws of physics. Einstein was very pleased with the idea that Newton's concepts of absolute time and an aether should be rejected and this would require a revolution in physics.

This explanation about the behaviour of light should be of interest to amateur as well as professional astronomers. It is much easier to understand than is Einstein's theory because it does not require light to behave in a way that is contrary to commonsense, such as having the same speed relative to all inertial observers. Most of you believe the speed of light relative to a laboratory on Earth is exactly 'c' in all directions only because Einstein's Law of Light says so. Your belief is not justified by any experiment. Most people find it impossible to visualise Einstein's Four-dimensional space-time. There is not the same difficulty in visualising three-dimensional space but most people do have some difficulty comprehending the flow or passing of a time, even a time that does not dilate. It is surely more difficult to understand Einstein's Theory because it does require time to dilate in a peculiar way.

Stephen Hawking, in his article "A Brief History of Relativity" ('Time" special edition 31st December 1999, on The Person of the Century), says Einstein *"solved the speed of light problem once and for all"*. Although I agree Einstein is worthy of being called the "Person of the century" isn't it possible that in 1905, in spite of his genius, he made a genuine mistake about the speed of light? The information we have about light and its behaviour is very much greater today than it was at the beginning of the century. Consider the measurements of the Cosmic Microwave Background Radiation (CMBR) made by NASA's COBE satellite in 1989. Some leading physicists do agree that the measured variation with direction of the CMBR does define a unique inertial frame of reference and have referred to Earth's motion relative to it as "The New Aether Drift". This aether–drift has a magnitude about twelve times greater than Michelson and Morley expected to measure. Throughout Einstein's lifetime there was no such evidence.

It should now be obvious that experiments designed to measure this aether-drift failed because the experiments were of the wrong type. The analysis of the experiments did not take into account the contraction of bodies in absolute motion. Throughout the twentieth century most of the great physicists continued to believe that the M-M experiment failed because Maxwell's aether did not exist or have a role in physics. Some physicists have falsely claimed the experiment proves there is no aether. I claim the truth is this unique reference frame in which the properties of the CMBR are Isotropic is the aether reference frame relative to which nineteenth century physicists believed the speed of light was exactly 'c' in all directions. Physicists have not carried out one experiment that shows this idea is wrong. If this evidence had been available in the early years of this century it would have been most unlikely that physicists would have accepted Einstein's theory or that he would even have put it forward. The facts are that evidence of the existence of a special reference frame was not available to Einstein and as a consequence he made a mistake. The M-M and K-T experiments, when properly understood, show how a simple experiment, carried out in any inertial reference frame, truly measures the speed of light relative to the aether reference frame at absolute rest. In comparison measurement of the speed of light relative to Earth is so difficult that physicists have not yet devised an experiment that does accurately do so.

3 Astronomy in the Future.

What this has got to do with astronomy? If we don't understand the true nature of light and "space" and we too blindly follow physicists in believing that in 1905 Einstein solved the problem of the aether and the speed of light once and for all, we can misunderstand astronomical phenomena that we observe and what is worse, mislead others about the nature of the Universe.

Physicists teach that "A photon has no rest-mass" and that in some experiments a photon behaves as a particle and in others it behaves as a wave in "space-time" that has weird quantum properties. I claim all experiments are consistent with a photon having a rest mass of 7.3726×10^{-51} kilograms and that a myriad of these photons, that have little kinetic energy, exist in the aether and they become visible photons when, in a collision with an electron, they are given kinetic energy that has a mass in the order of 10^{15} times their rest mass. Any photon in the aether can become a radio, infra red, x-ray or gamma ray photon depending on how much kinetic energy is given to it. The waves that accompany such a particle exist in the aether. You might find this difficult to believe but it is consistent with experiments.

We are told the Universe and all its energy as well as space-time itself began in a "Big Bang" and that it has been expanding ever since because a red shift is observed in the light from very distant galaxies. Now we know the experimental evidence is consistent with the aether filling all space, we should reconsider the "Big Bang" theory. If the vacuum of space is filled with a physical aether many phenomena in astronomy and cosmology need to be reconsidered and finding answers could keep many people busy for generations. Astronomers, both amateur and professional, should not be content to accept the claim of physicists that Einstein solved the light problem once and for all. Can we be sure that the observed red-shifts are Doppler shifts? We cannot actually measure the motion of such sources. Some astronomers claim that the observed red shifts are not Doppler shifts, they come about because of the stretching of space itself! What experimental evidence is there to support the idea that "space" can expand or contract? Does the aether expand and contract with "space"? If photons do consist of a particle with a rest mass and kinetic energy their speed 'c' must be relative to absolute rest. I claim that when photons travel through the aether they cause transverse vibrations in it that has a frequency proportional to their momentum. It is quite likely that they would lose some of their energy to the aether when they travel through it for millions of years. If the ICMBR defines a unique aether reference frame at absolute rest the Big Bang theory is in much more trouble than has previously been realised. According to current theory the CMBR is a relic of the Big Bang. The spectrum of this radiation is identical with that of a black body with a temperature of 2.72 K. I suggest this is the temperature of the aether and it is the source of this "black-body" radiation. According to the B-B theory this radiation originated billions of years ago when it had a black body temperature of about 3000 K and the expansion of the Universe has reduced this temperature to that observed today. I claim this is not consistent with the laws of physics. Free expansion into space would not maintain the black body spectrum now observed.

4 Measurement of the Velocity of Light as a Crucial Experiment.

The whole of Modern Physics has been required to conform with Einstein's Special Theory of Relativity and his Principle of Relativity which postulates that light has exactly the same speed relative to all inertial reference frames.

If the speed of light relative to Earth varies with direction by about 700 000 metres per second due to the New Aether-Drift being in the order of 350 000 metres per second, no experiment previously carried out with light would directly measure this variation. If the reality is that the speed of light is exactly 299 792 458 metres per second only relative to a unique aether reference frame that is defined by the Isotropic Cosmic Microwave Background Radiation this would not be consistent with Einstein's Theory of Relativity. The crucial experiment, which could clearly show if Einstein's theory is wrong, is an experiment that would reveal any difference in the speed of light with direction relative to Earth or the Solar System. The obvious experiment is the one suggested by Maxwell in 1879. If there is any difference in the speed of light when travelling in opposite directions between two stations on Earth the speed of light is not a Universal constant of the type claimed by Einstein. I maintain that the technology now exists to carryout an experiment that compares the speed of light travelling in opposite directions relative to Earth with sufficient accuracy to show that they are not always exactly the same. If, in an East-West direction, we have a measured distance D on the surface of Earth I maintain the time interval required for a pulse of light to travel in one direction could be different to that of a pulse travelling in the opposite direction. It should be possible to devise an experiment that can measure the changes in the difference in these time intervals as Earth rotates on its axis. I claim experimental physicists should give priority to carrying out an experiment of this type. Such an experiment should be comparatively simple compared with the experiments now being developed to detect Einstein's predicted Gravity Waves. If this crucial light experiment does not give a null result both of Einstein's Theories of Relativity are wrong and searching for **Einstein's** Gravity Waves will be a waste of time and money.

If Einstein's theories are shown to be wrong they must be abandoned if Scientists, including Astronomers are to retain respect and credibility in the community. If Einstein did not "solve the speed of light problem once and for all" as Professor Stephen Hawking claims and physicists continue to be reluctant to admit publicly that this is possible, it is up to amateur astronomers and all those who believe Science should be a search for truth to take a serious interest in this matter. For thirty years I have been claiming Einstein was wrong about the speed of light. The alternative explanation of the Michelson-Morley and Kennedy-Thorndike experiments that I discovered and put forward as the true solution of the "speed of light problem" have been generally ignored by the scientific establishment. Physicists have not shown it is not a viable explanation of these experiments. I challenge them to do so or publicly admit that they cannot and that they have been wrong in claiming that Einstein solved the speed of light problem once and for all.

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Astronomy as a hobby on a tropical island resort

Ray Johnston
Great Barrier Reef Observatory

The history of astronomy on Hamilton Island really starts in Sydney in the 1970s when a gentleman by the name of Peter Phillips decided to build himself a telescope. Ignoring the commercially-available mirror blanks, Pete purchased a ship's porthole from a marine wrecker, and by the traditional method, ground and polished a mirror. This was a nominal 20 cm in diameter, though it is about as twice as thick as a standard blank. He mounted this in a piece of steel downpipe, again found in a junkyard, and added a commercial front end. All this was mounted on a second-hand surveyor's tripod (God knows where he got that!) and so, the Big Boy telescope came into being. Pete used the telescope in his backyard in suburban Sydney until 1984, when, at the invitation of entrepreneur, Keith Williams, Pete moved to Hamilton Island to set up the first retail outlet in the fledgling resort. The shop was a sell-everything-outlet which he named Trader Pete's. The name has stuck, and today, he is affectionately known on the island as Trader Pete

The Big Boy telescope came too, and it was quickly set up to entertain the resort guests with views of the heavens. So, astronomy came to Hamilton Island. Just prior to the 85/86 appearance of Comet Halley, Trader purchased a motorized equatorial mount to better cater for the increasing number of guests now attending his evening sessions. The facility was then, and still is now, a complimentary activity for guests. It operates as a private concern, receiving no financial input, or other support from the resort management.

Hamilton Island is located 20 km offshore, in the heart of the Whitsundays, and it sits right on the 20 degrees South parallel, placing it on exactly the same latitude south, as Waikiki Beach is to the north. The Observatory is blessed with exceptionally low horizons all round, with extensive sea horizons to the north and east. It sits 83 metres above sea level on a ridge overlooking the Coral Sea, and this makes for a stunning moonrise as the sea is turned into a shimmering carpet of silver. It is at moments like these that earthly views can take over from those of the heavens. It enjoys very dark skies, but it is tempered by a wind that starts somewhere east of Tonga. It is probably the only place in the world where the wind speed can approach that of light! It was to alleviate this problem that a Sidus dome was purchased and erected in 1988. This immediately attracted the attention of NASA, who took over the area for a week. Weird machinery was flown into the island's airport, and strange lights were seen in the sky. It was later revealed that laser experimentation had taken place. There is a story that they were bouncing the lasers from reflectors left on the Moon, but 1 think that this is a local embellishment of the facts, to give importance to the operation and the locality.

In 1990, Cyclone Joy visited the island, and its 200 kph winds blew parts of the Observatory halfway to Ayers Rock. It was repaired, but it languished due to Trader's burgeoning island businesses, and their call upon his time. The telescope was removed and stored under a bed in Trader's home. My wife and I came to the island in 1992, and seeing the deserted observatory, made enquiries, spoke to Trader, and decided to recommission the facility. The telescope was dragged out from under the bed, de-fluffed, re-aluminised, and installed in the dome. Trusting in our limited knowledge of astronomy, we again opened as a complimentary activity for guests. That's eight years and over 20,000 guests ago, and we now operate four instruments, a 30-cm Meade LX 200, the original Big Boy 20-cm reflector, a 15-cm reflector and an 80-mm refractor, plus the usual bagful of binoculars.

So, astronomy as a hobby on a tropical island resort - what's it all about?

Tropical astronomy varies in many ways from that in more southern climes. The weather plays a major part, in that we are unable to operate during what is euphemistically referred to in North Queensland as the "Green Season". It is just a "don't scare the tourists away" expression for the wet season. Rain, high humidity, more rain, masses of cloud, even more rain, a thick roiling atmosphere and additional buckets of rain make viewing almost impossible. This lasts from mid-December until around late-March, early-April. We must also protect our optical surfaces and electronics from the ever-present humidity, as the moulds and fungi have a field day. Add to that the effects of a heavy salt-laden atmosphere, and we have to adopt a comprehensive plan of protection. . We tried kilos of silica gel, but you can almost see the stuff turn from blue to pink as you expose it to the thick, watery atmosphere. We found that by combining two relatively simple procedures, we seem to have the problem beaten, Firstly, we enclose all optics and electronics in vacuum bags, of the kind commonly sold for storage of clothes. We even enclose the whole optical tube and fork mount of the LX200 in a jumbo bag. The judicious application of a vacuum cleaner extracts the air, and the resulting packages are stored in an enclosed cupboard, in which a small light globe burns continuously. This ensures perfectly safe storage over the three months of hell we must endure as a sort of purgatory, before our nine months of heaven.

When the weather clears, we get down to business. Our dome opening procedure would vary somewhat from that in the south. The dome must be approached cautiously, the door tentatively opened, and the light quickly snapped on. An immediate and rapid scan is made of the interior. Why, I hear you ask? Snakes! We have had a number of reptilian visitors over the years, and it still amazes us as to how the hell they get in! My wife opened up one night, stepped inside, and suddenly re-appeared at escape velocity, and in the process, became the fastest pharmacist over fifty metres. A slippery customer was entwined inextricably around the mounting.

Actually they are harmless tree and grass snakes, but we tell people that they are taipans – makes us sound braver! Our next search is for tree frogs, which delight in kipping down in the dome tracks. There is nothing more distressing than to swing the dome and hear a terrible squashing sound – to say nothing of the resulting mess! Then there are the geckos, which regard our dome as the Hamilton Hilton. No matter what you do, they still get in, sometimes even into the tubes of the Newtonians. Their little sticky footprints on the primaries don't go down well, but, at least, they keep the wasps out. Mudballs in your focuser can test your patience.

Outside, a further menace is patrolling. The island is home to some 10,000 flying foxes, whose notorious airborne toilet practices can leave you looking as though you have been hit by a plateful of beetroot. Working near the zenith is always accompanied by a rising sense of panic, but so far our primaries remain pristine. Let me assure you that the hats we wear are not to protect us from moonburn! Another problem we encountered, resulted in us having to convert all our portable scopes to pier mountings, as the low angle of the equatorial mount was causing the counterweight arm to get tangled up with the tripod legs.

Then we must cope with our winter weather. Down jackets, padded pants, furry boots, beanies, gloves, and clutching a hot cocoa or a port in slowly freezing fingers. A vision of our southern cousins perhaps. We tend more to adjust the T shirt and shorts and sip gently on a lightly chilled Chardonnay. We normally work mid-winter in temperatures around 16 - 19 degrees, though wind chill can reduce our apparent temperature, so that we can get into a track suit on really bad nights.

Our skies differ somewhat. We have the Big Dipper filling our northern horizon, with many highlights such as Andromeda and M 31 riding high enough for excellent viewing. On the other side of the coin, we do lose the Cross from our evening sky for around four months of the year. This comes as a disappointment to our many northern hemisphere guests, whose one ambition is to see the Southern Cross. It is surprisingly well known, particularly to the Japanese.

Our guests come from all parts of Australia, with approximately 25% being from overseas. Of the overseas guests, the majority are Japanese, with a fair sprinkling from Europe and the United States. It is an advantage to have some knowledge of celestial objects in varying languages, though English and a lot of arm waving will get you through. Fortunately, I speak Japanese like a native – a native of Zimbabwe! We do communicate quite well, as most Japanese have an understanding of English, and we do have a selection of celestially-oriented, conversational phrases. The Japanese are the funniest people – very shy to start with – but once you open up with some fractured Japanese, they come back in pretty good English, and we get on famously.

Their appreciation of a dark sky is something to behold – and hear. They can become quite uninhibited, and we have even had them in tears. Show them Saturn (in Japanese, Dorsai) through the telescope, and it's like dawn in the chook house! But then, that's the type of audience we all appreciate.

We do play games with them. We focus the telescope on a bright star such as Sirius, and invite the petite honeymoon bride to have a look at it. We then ask if her new husband has bought her a diamond ring like that. She will squeal with delight, and husband takes a look, lets out the typical Japanese HAW! You can't imagine how loud that can get inside a small dome! The whole thing tends to end up in laughter. We try to dispel the commonly-held belief that astronomy is stodgy, and overseen by a lot of bearded super brains. We endeavour to give guests something by which they will remember the experience. By way of example, at the last "Blue Moon", we advertised that you could actually see that the Moon was blue, but the emanation was so subtle that it could only be seen through the telescope. Of course, we had installed a pale blue filter in the eyepiece, and you know, most people bought it! Provided you let them off the hook and don't let them feel that they have been made fools of, you can come up with almost anything, and they do appreciate it. This is evidenced by the comments at the end of the night.

People really are funny. How many times have you heard someone preface their enquiry with ... "*I know this is a dumb question, but ...*" We always reply that a question is a search for knowledge and that we will answer it to the best of our ability. And, boy, are some of them dumb! We had one of our executives, a guy in charge of millions of dollars and hundreds of people, actually ask us whether the planets were inside or outside of our atmosphere!

We involve ourselves in community activities, and one recent event which may be of interest. At sunrise on New Year's Day, we lit a flame using the first sunlight of the new century. This was reflected through one of our telescopes, and ignited a flame in a special bowl. The flame was transferred to a miners lamp, where it will be kept burning until Olympic Day. It will then be used to light a torch, which will be run around the island by our schoolchildren, as part of our Olympic celebrations. We had over a hundred people witness this simple ceremony, and I think it reflects people's fascination in the heavens and space generally.

Astronomy as a hobby on a tropical island resort is a rewarding pastime. We believe that we contribute to the experience of the holiday, and certainly we get as much, if not more, out of it as our guests.

"We may not be at the cutting edge of the science, but the art and heart of astronomy is alive and well on Hamilton Island"

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Current phase of the sunspot cycle

T A Cragg
Astronomical Society of Coonabarabran

Sometime during 2000 it appears that we shall go through a sunspot maximum. Of general interest is how intense will it be and how does it compare with previous cycles.

Perhaps a review of how the numbers defining sunspot activity are determined. A formula derived by Wolf is

$$W = 10g + s$$

where g is the number of groups and s is the number of individual spots. Sunspots form normally in magnetically associated bunches called groups. It was recognized quickly that different instruments, observing conditions, and observer experience could influence such a number greatly. A reduction multiplier rendering the numbers to a common base is required. Therefore the formula used is

$$W = k(10g + s),$$

where k represents a correction factor incorporating the above-mentioned variables, or 'personal' equation. Daily numbers usually form a very sawtooth curve which is smoothed by a monthly mean (see the fine line curve in the lower part of Figure 1 and Figure 2). This is further smoothed with a double 12-month running mean as seen in the heavy line in the third curve in Figure 1. Yearly means of the 12-month running means are depicted by the two curves in Figure 1 which better show the general trends. The data prior to 1840 are largely scattered as it was only after Schwabe's discovery of the 11-year sunspot cycle that daily counts were started as much as possible.

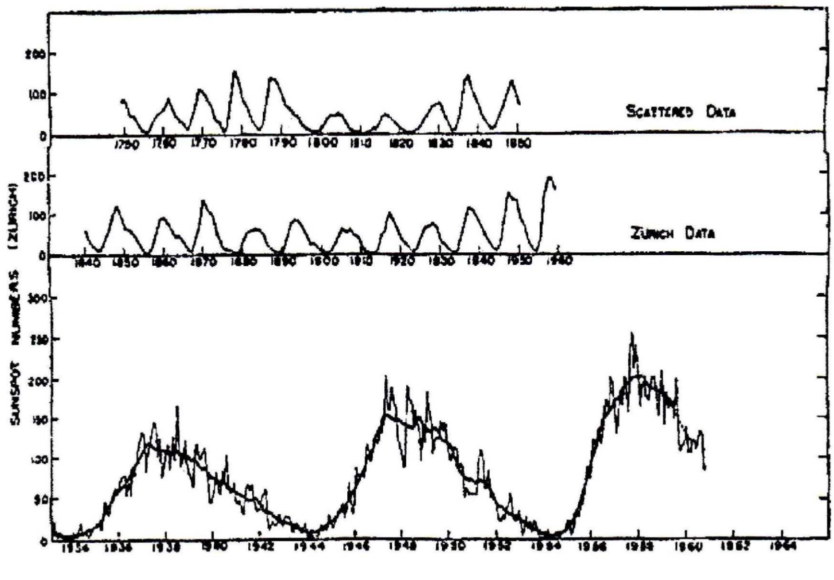

Figure 1. Relative sunspot numbers, which indicate the sunspot activity, are computed by the formula *Sunspot Number = k(n + 10g)*, where *n* is the number of individual sunspot umbrae, *g* is the number of groups, and *k* is a factor depending on the observing conditions. The value of k for Zürich is 0.6. The upper curves give the yearly means of the smoothed monyhly values since 1750; the lower curves the observed monthly mean values (light line) and the smoothed monthly values (heavy line) during recent years. The data are from the *Astronomische Mitteilungen der Eidgenössischen Sternwarte in Zürich.*

Examining the second curve in Figure 1 it is noticed immediately an alternation In the cycle heights. The average of the high points of the 1848 and 1871 cycles is higher than the peak of the intervening 1861 maximum – and so on down the line. One tends to think if a periodic function shows strong evidence for 15 cycles it is reasonably reliable. Note in addition that generally high cycles are more asymmetric than lower ones, that is high cycles are seen to have faster rise rates.

Figure 2 is a plot of the monthly means of the AAVSO Solar Division from 1945 to nearly 2000, and shows the continuing alternation is continuing.

Doubt concerning this 'alternation' came with the 'high' 1937 maximum which should be followed by a 'low' maximum in1948. Note the 1947 maximum was significantly higher than the 1937 one! For the alternation to continue, the 1937 maximum would have to be the highest ever recorded – higher than 1778. Indeed, the 1937 cycle was a record setter, the mean of the 1937 and 1957 cycles barely did exceed the 1947 cycle!

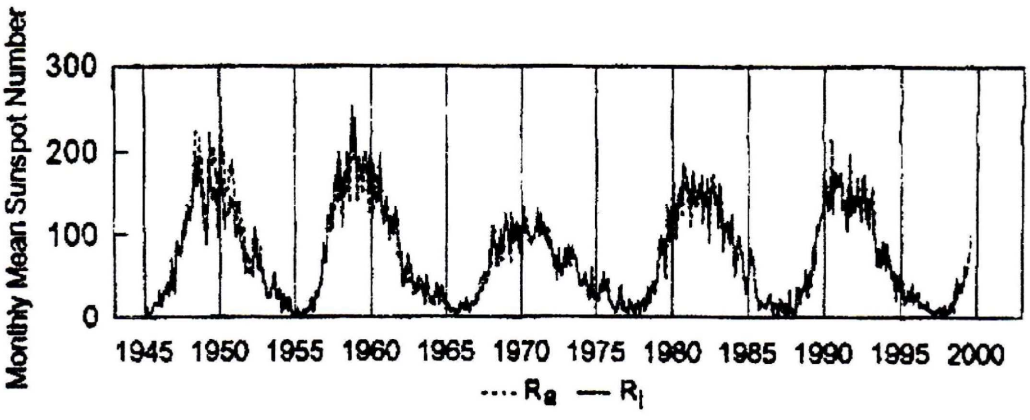

Figure 2.Monthly means of the AAVSO Solar Division from 1945 to 2000.

How does the current cycle fit with the past? Figure 3 shows the current activity as determined by the Sunspot Index Data Center in Brussels, Belgium (the current world data centre). For the alternation to continue, a yearly mean for 2000 would have to exceed well above 150. Note that the current predictions do not show much chance for that to happen. It is clear that unless there is a significant increase in the sunspot activity soon a 150-year alternation will be broken. Let us see what happens in 2000.

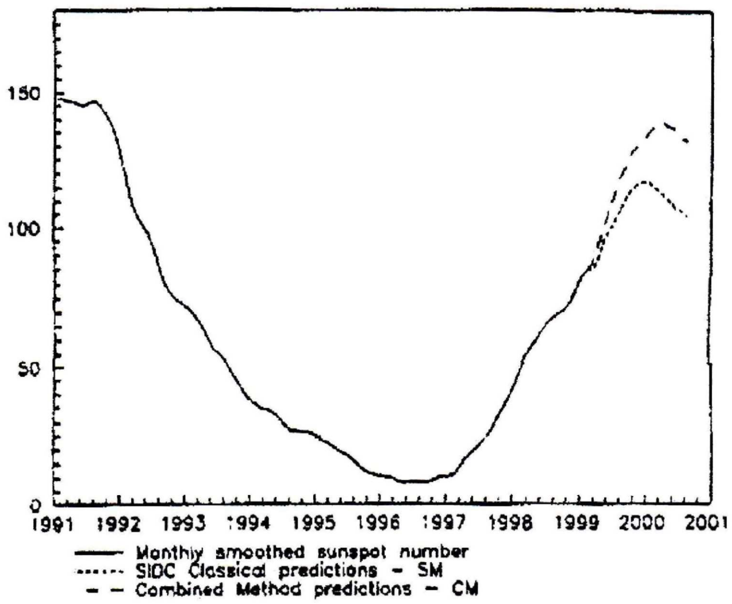

Figure 3. Predictions of the smoothed Sunspot Number using the last provisional value for February 1999 : 84.6 (± 5%).

Craters: meteoritic or volcanic

Dennis Bates
Astronomical Society of Western Australia.

The origin of craters is an argument between specialists as to whether they be categorized as of meteoric impact from outer space, or of volcanic origin in their formation or creation. The stance of Official Science educationally and Museum wise at present is generally that they are of meteoric impact on earth from outer space.

In Arizona in the 1880s prospectors found lumps of iron around the crater known as "Coon Butte". Geologists defined that the iron was an alloy identical to that found in meteorites. many were not convinced craters were meteoric impact. The Arizona crater was about a mile wide and 500 feet deep.

Controversy reigned for many years, early geologists discarded the theory that the land form was created by rock impacts from outer space, it ran counter to all their training. In each case, they found remains of the so called impacting meteorite nearby, which of course volcanic upheavals can also produce. This offers no positive proof that craters are of meteoric impact or of volcanic origins.

The mining engineer Mr Barringer spent $600,000 resolving the question by looking for a huge iron meteorite buried beneath the crater floor. He never found it, because as present science states, it vaporised on impact. however his work established it was indeed a meteorite crater. Walter Bucher, an American geologist attributed the crater in Arizona to some strange kind of volcanism and intense shock as is found in-underground nuclear explosions in Nevada, characteristics which are called cryptovolcanic.

Craters are everywhere in our solar system, by the 1930's geologists came round to accepting the idea of meteorite craters, and at that stage nine were recognized as meteorite craters, which included the Wolf Creek meteorite crater in Western Australia, see Figure 1. Astronomers said it was possible meteorites could collide with earth. Meteorites are known to exist, yet insufficient to cause the craters in general mentioned here classed as meteorite craters, whereas volcanic power moving mountains can be enormous. It is said there are more than 120 impact craters identified at present.

Most meteorites burn up entering earth's atmosphere, they are generally small. Authorities are now adamant craters are of meteorite origin. It is said that Western Australia's Wolf Creek crater was scientifically proven as of meteorite impact origin in 1947, which I consider as inaccurate, and know is untrue, the same can be said of all craters, and in Australia the Henbury, Haast, and Goose Bluff craters, which can be well proven. The Wolf Creek crater was drilled inside to find iron meteorite material without success. It is a whitish sand inside the crater mainly.

It was on the 18th August 1986 that I personally defined the Wolf Creek crater near Halls Creek in Western Australia that this crater was formed from volcanic origin, and definitely not from any so-called meteorite impact from outer space as displayed in Perth's W.A. Museum. It was for this purpose I travelled Australia during 1986, to confirm my experience of land formation origins, etc., on maps (about 600 in all) across the earth's surface, and its volcanic origins form, I had 30 years gold prospecting and mineral or gem experience, as well bushcraft and hiking knowledge. When I first defined Wolf Creek crater as volcanic, I did so even without maps that showed this crater is central between mountain peaks, which should be obvious to most geologists. Maps a little later here only confirmed my views, the land formation volcanic origins I already knew, which I had not yet linked positively to craters even though I was 99.9% sure Wolf Creek crater was not an impact crater before I tried my proven method of mountain peaks, arcs and lines, on local maps. I kept an open mind prior to establishing proof of the crater's volcanic origins. I tried to see the Henbury so called meteorite craters in Central Australia first before I saw Wolf Creek's crater in W.A., however water beat me eight kilometres away twice. I crisscrossed Wolf Creek's crater before I had a detailed map of the area, as my records show.

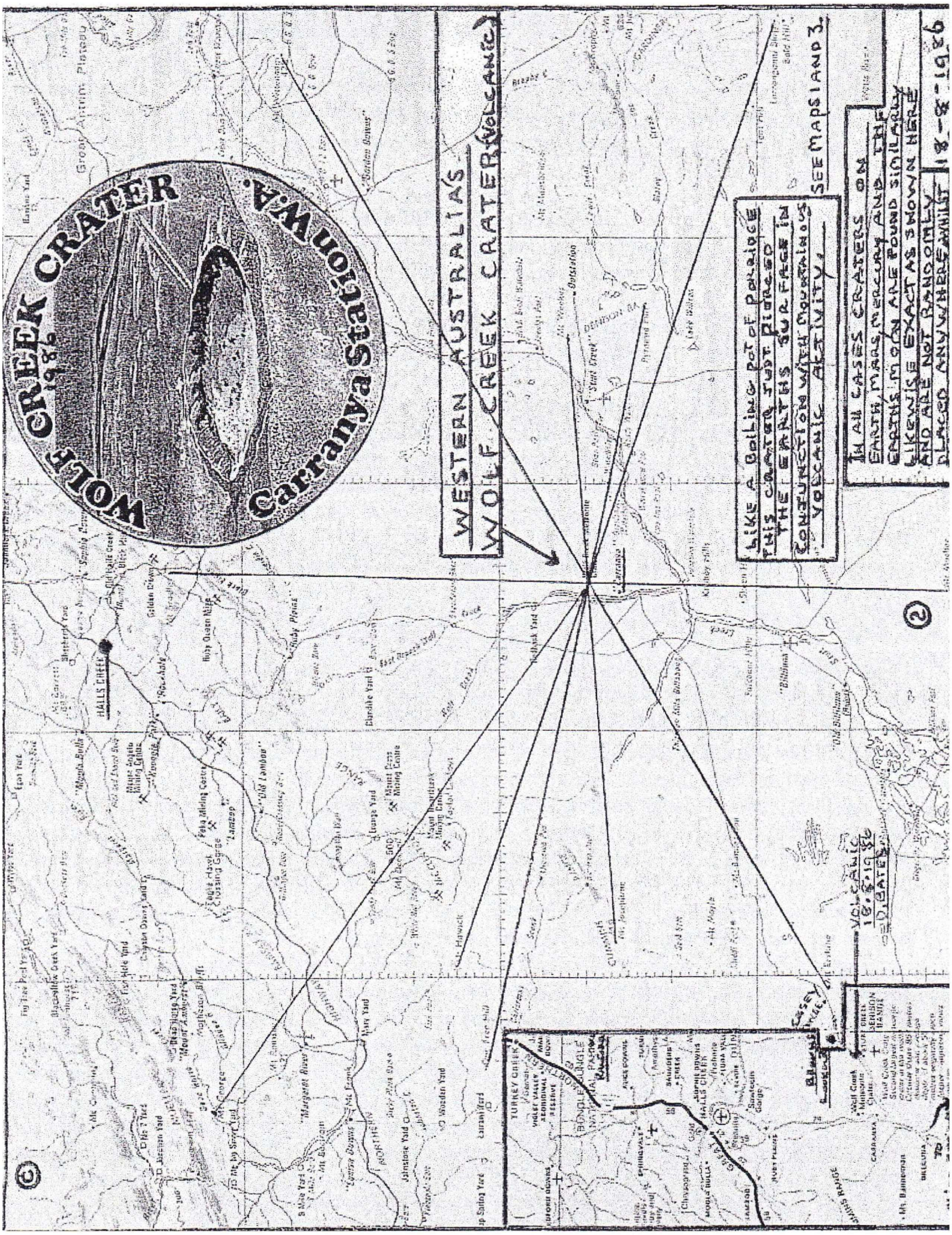

Figure 1. The Wolf Creek Crater.

Having lived at the beginning of the space age race, so called metalliferous meteorites are definitely not space junk that cause craters, which are such small scale as to be near negligible. Knowing is more exciting than guessing, however the illusion is sometimes more exciting than the truth. We all seek the truth, the absence of error. Surely, common sense and logic should tell us meteorites that are supposed to form craters could not be so exact between mountain peaks or other significa with so called random entry in every case. Surely they can't say impacts push up mountains many miles away. As well surely science can't say craters found exactly between peaks as shown on my map enclosed here of Wolf Creek's crater position to mountain peaks, is exact in position whilst the earth is rotating and revolving in so many cases, for outer space impacts on earth.

The Wolf Creek crater is unique in appearance and of great geological interest. Figure 1 shows that it is centrally situated in a straight line on extremely detailed good maps between more than thirty mountain peaks nearest to the crater, some over large distances, it is similar over the global earth, moons, and planets. It appears evident craters are volcanic unless there be better evidence to the contrary. The Wolf Creek crater has just pierced the earth's surface crust, similar to like a pot of boiling porridge, the sunken central portion of the crater loose enough to sink as a trench hole normally does. In this case it has a total rim on its perimeter, whereas many crater's rims are destroyed on their rims by volcanic action in the vicinity and water in many cases. How one epicentre affects another becomes clearer as shown on map examples, and experience with sound reasoning, a classic example of this is found about nature's window, near Kalbarri in Western Australia, as well among ocean waters and land charts.

I have been working and researching Ether 40 years, I won't go into all the details, however it is evident the planets and earth's moon were in existence at the time of Wolf Creek's crater formation, said to be 3,500 million years old. It certainly is the same age as the surrounding mountains over several hundred kilometres which includes the argyle diamond volcanic region with its volcanic plugs.

The chemistry of craters and their mineral content is a long story. In short nickel is the main ingredient of so called metallic meteorites, after iron. The earth is of one age, rock classifications imply since the last change or fault, volcanic upheaval, quake, or the like. In so called metallic meteorites the average density of iron and nickel combined with their respective proportions is close to 7.9 classing water as one density. Strong magnetic materials such as iron and nickel have both traverse and longitudinal waves of various lengths causing random orientation in places, iron is a stronger magnetic element than nickel, their combinations tend to resist corrosion. Iron oxide forms the cementing material of ferruginous sandstones such as quartzite found at Wolf Creek crater, quartz itself is an oxide of silicon. Iron and nickel's energies flow conductively diamagnetically, and turn paramagnetic (align) at certain temperatures. Iron and nickel when heated absorb increasing energy vibrations of ion molecules and atoms which expand and change the energy level wave vibrations from right angles to alignment where the particles possess a less restricted motion, and the attractive forces of the particles are overcome by fusing or melting, displaying differences of heating, one part alloyed or fused, whilst another part shows cubic or rectangular crystal formation about the edges as seen in volcanic meteorite material. Most all crystals particles in solid state are homogenous whose boundary surfaces have planes arranged at definite angles to one another.

Wolf Creek crater clearly depicts an upward thrust according to what was visible to me in certain places, which any competent person should pick up, among rock inclinations. etc., and rim rock strata which indicates upward thrusts which in one case has turned outward at the top from the vertical. The energy flow of iron at 90.5% and nickel at 8.6% metallic so called meteorite material is diamagnetic (at right angles), in the transfer of energy by wave motion. Metals have 1, 2, or 3 electrons in their outer shells, iron is a monatomic molecule, that is one atom per molecule.

Honeycombed so called meteorites have holes about the edges associated with gas vents blown out on heating. In most cases when metal is heated, in air or oxygen, it burns, and chemical changes occur in meteorite or volcanic metals. Oxidation is the addition of oxygen, and removal of hydrogen. Oxidation increases the valency of the cation when ferrous iron oxide FeO burns in air to form Fe_2O_3, which involves the removal of one electron. Igneous (formed by fusion) rocks comprise 95% of earth's crust. Metallic compounds with non-metals are covalently equally shared in general 'nearby, having positive and negative ions of the non-metal which are electrically charged. Currents produced by volcanic crater formation are physical actions, the chemical changes are due to energy level changes among the materials. Rapid cooling form small crystals, slow cooling larger crystals.

Volcanic earth's Tektites (Australites) have differing structural arrangements, many have cooled quickly amongst water, where atoms have had insufficient time to arrange in crystal formation homogenously perfect, some are well waterworn, and others cooled in earth's atmosphere. Tektites are heterogenous (a mixture of constituents not uniform, they may be in any proportion), they are isomers, as the quartz family.

It is important to keep records of events, such as times and places accurately, of nature's cataclysms. Volcanically linked eruptions cause metal formation by particle transfer in suitable rock country, which is patterned to many rich areas of mineralization. Earth rotates true north, not its magnetic axis. Volcanic or earthquake eruptions are linked to ether, and to time. The element iridium is found in igneous rocks as those which have been heated or molten, found in so called meteorite metallic materials. Iridium belongs to the platinum group of metals. Our sea basins on our moon are solidified lava of volcanic origin, they have no water. In any area of craters or mountains all that is needed is a good map with topographic information, an old compass, ruler, and pencil, it doesn't take long to get a little experience in any localized area on a map.

Volcanoes and earthquakes have been proven to be linked with ether mathematically, as well they and craters do have an etherized outer space origin, however "not from impact" from outer space. Earth's moon and many other planets positions are linked to quakes times exact to the second. Thus the difference is noted between meteorite impact and outer space origins for craters. Craters such as Wolf Creek are linked to much more than a tremor or formation, indeed the far off surrounding mountains were massive eruptions, but at Wolf Creek crater having just pierced the surface here. Craters are volcanic from their own entity and not from meteorite impact, their origin is outer space caused by the effect of one or more bodies affecting another, via the medium of ether to earth, as for the Wolf Creek crater. Earth's moon appears to be the most major source followed by planet Mars for upheavals on earth.

Underground water is thrown up with volcanicity. Iron sulphide is produced with acid reaction, it is insoluble in water, but soluble in acids. Pyrites (FeS_2), a sulphide of iron, changes to iron oxide above water level. The production of electrons by iron involves the dissolution of the iron by oxidation. Iron oxide combined with water produces chemical changes, as a hydroxide (contains no oxygen). Water is acidic in character and can act as both an acid and a base. Acids are proton donors. Metals have a negative excess of electrons, and positive deficiency, they can act as electron donors easily, forming positive ions by loss of electrons. Non-metals are electron acceptors, having vacancies in their outer shell. A substance accepting electrons is an oxidiser (removal of electrons), and a substance donating electrons is a reducer (addition of electrons). The melting point of iron is 1536°C, and nickel 1453°C. So called meteorite metallic materials of iron and nickel from outer space should have melted or fused on the outer boundary, many specimens still show about the edges crystallisation. Electrons drift to impurities such as the brittle iron sulphide where less electrons are produced, giving rise to jarosite on decomposition (basic sulphate of iron and potash). Carbon, water and metallic volcanic materials are good conductors, iron as the carbonate and the sulphide. Carbonates react with acids, iron sulphide is acidic and a proton donor of an ion or molecule. Metals form base oxides, in general the oxide ion 0^{2-} acts as a strong base and good proton acceptor. Chemical changes involve regrouping of atoms. Etherized rays ionize gases, knocking out electrons causing energy level changes and forming positive ions by loss of electrons and current, excess energy illuminates as light and heat in heated solids, allowing electrons to move more freely. The Greeks and Romans framed mythology dealing with volcanic origins, science must be built upon truth, not folklore stories. It is the unknown which fascinates man, causing him to challenge man's thinking in attempts to find answers among nature and himself which results in civilization, much of which lies outside the field of his immediate experience. Thus another point of view with respect to crater origins, which in my opinion are volcanic and not from meteorite impact.

A straight line from Henbury crater in Australia's Northern Territory to Haasts Bluff crater cuts Goose Bluff crater, just as a straight line from the Olga's to Mt Grundy cuts Mt Connor and Ayers Rock, all of which are volcanic in origin, of which I have detailed proven maps. A map with examples of Wolf Creek crater is shown in Figure 1.

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Australian amateur astronomical conventions: a history of NACAA

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Abstract
Following a visit to Mt. Stromlo Observatory in 1965 October and a preliminary get-together during Easter in the following year at Katoomba, the first Convention was held in Canberra during Easter 1967. Conventions followed annually until 1970 after which they have been held at Easter biennially with a new name – National Australian Convention of Amateur Astronomers – which has remained to the present day. A short preliminary history of the Conventions held during the past thirty years is presented as much material is still to be found, it is either unavailable or has been lost either physically or in the memory.

1 Introduction

The visit of the James Cook Astronomers Club (JCAC)[1] and the Canberra Astronomical Society (CAS)[2] to the Mt. Stromlo Observatory in October 1965 resulted in Elaine Polglase of the JCAC and Joe Kawalski of the CAS sending a letter (Figure 1) to all Australian amateur astronomical societies advising them of a preliminary meeting at Katoomba during Easter in the following year prior to the first convention. Interest by the societies was mixed and it was noticeable that the smaller, particularly non-capital city, ones showed greater enthusiasm for the concept, although they may not have attended.

Whilst the results of the Katoomba Meeting are known, there appears to be no records and amateurs who were around at the time have either passed on, cannot recall events of over thirty years ago, have lost all interest in the science, or are not interested in trying to help put together a record of these conventions for posterity. The meeting confirmed the idea of a gathering in Canberra in 1967 which would be organized by the JCAC and the Pacific Astronomical Society (PAS)[3] and held at Easter, note that neither of these organizations were located in Canberra nor in the Australian Capital Territory (ACT), a logistical nightmare. In all nineteen conventions have been held in each of the Australian States and one Territory. Table 1 lists the locations and hosting organizations of these conventions, the exact names of the first four will be found in the text.

Dear Sir,

In 1965 October the Canberra Astronomical Society and the James Cook Astronomy Club enjoyed a wonderful visit to Mt. Stromlo Observatory.

During the meeting that followed the clubs decided to suggest to all amateur astronomy clubs throughout Australia the possibility of holding a convention in Canberra, Easter, 1967.

In order to ensure the success of this venture, it was further proposed a preliminary meeting be held in Katoomba, Easter, 1966. One of the functions of this meeting will be to appoint a committee to organise the National Convention.

We have chosen Katoomba, as it provides a variety of tourist attractions for the non-astronomy enthusiasts in the family, and accommodation to suit those who wish to camp, caravan, flat or board. Also we sincerely hope, that by making the venue a holiday resort, all of us will have the chance to meet in a relaxed environment.

Whilst we realise that interstate clubs may not be able to be represented at Katoomba in 1966, there may be one of your members in Sydney at the time able to attend. We would certainly appreciate your club's support and look forward to any suggestions you may care to make in regard to the general programme.

In order to assess the response and commence the preliminary arrangements as soon as possible, it would be appreciated if your replies could be forwarded to the secretary, P.O. Box 31, Sutherland, N.S.W.

Hoping to receive your full co-operation.

We are, yours sincerely,
Elaine E. Polglase, for JCAC
J. Kowalski, for CAS

Figure 1. Letter sent to Australian amateur astronomical societies in 1965.

Table 1. Australian amateur astronomical conventions, 1967-2000.

No.	Year	City	Host(s)
1	1967	Canberra	James Cook Astronomers Club Pacific Astronomical Society
2	1968	Port Macquarie	Port Macquarie Astronomical Association
3	1969	Ballarat	Ballaarat Astronomical Society
4	1970	Wollongong	Illawarra Astronomical Society
5	1972	Melbourne	Astronomical Society of Victoria
6	1974	Bridgewater	Astronomical Society of South Australia
7	1976	Sydney	Astronomical Society of New South Wales
8	1978	Canberra	Canberra Astronomical Society
9	1980	Geelong	Astronomical Society of Geelong
10	1982	Brisbane	Astronomical Association of Queensland
11	1984	Perth	Astronomical Society of Western Australia
12	1986	Hobart	Astronomical Society of Tasmania
13	1988	Sydney	Astronomical Society of New South Wales British Astronomical Association (NSW Branch) Sutherland Astronomical Society
14	1990	Frankston	Astronomical Society of Frankston Astronomical Society of Victoria
15	1992	Adelaide	Astronomical Society of South Australia
16	1994	Canberra	Canberra Astronomical Society
17	1996	Brisbane	Astronomical Association of Queensland Southern Astronomical Society Brisbane Astronomical Society Southeast Queensland Astronomical Society
18	1998	Sutherland	Sutherland Astronomical Society
19	2000	Perth	Astronomy WA

2 Early conventions 1967-1970

The success of the First National Convention of Australian Amateur Astronomers is even more remarkable because it was organized by the JCAC and PAS from a distance without a local organization to back them up and so making quick visits to the ACT necessary. Another problem was that there was no seed funding and donations from the Societies were slow in arriving. The number of amateurs proposing to attend was not clear until late in the arrangements which was another complication for the Committee who had no precedent upon which to call. The venue was the upper level of the Australian National University Students' Union Building. There were eleven clubs from four states represented at the Convention:

James Cook Astronomy Club
Pacific Astronomical Society
Port Macquarie Astronomical Association
Astronomical Society of New South Wales
Illawarra Astronomical Society
Goulburn Astronomers Club
British Astronomical Association NSW Branch
Bundaberg Astronomical Society
Moreton Bay Astronomers Club
Ballaarat Astronomical Society
Astronomical Society of South Australia,

some of the names of clubs appear differently in different accounts.

Friday, 1967 March 24 would have seen motor cars arriving in Canberra from the four states and by eight o'clock some fifty amateur astronomers had registered and gathered in the lecture hall to hear the first address (perhaps a pot-pourri) given to an Australian Convention of amateur astronomers by Ralph Sangster of South Australia when he spoke about an automatic grinding and polishing machine, a recently-found meteorite, and bonded lenses. The night also allowed registrants to view telescopes and accessories brought down for display. In all seven talks (see Appendix I, authors with year of first paper as 1967) were given by representatives from six clubs. During Saturday morning a photograph of as many as could be rounded up was taken by Ralph Sangster, Figure 2.

The official delegates were in the meantime holding a meeting as has been done at each convention since. The locations of the next three conventions were decided, and a set of guiding principles were established for host societies of subsequent conventions. This latter point was achieved after long and sometimes heated debate to avoid the word constitution and thus the formation of an over-riding body. The conventions were to be held biennially; however, for special reasons the next would be held in 1968 at Port Macquarie, and to avoid a New South Wales (NSW) monopoly the following ones to be in Ballarat, then Adelaide.

Figure 2. Amateurs attending the 1967 Convention in Canberra. Photograph by Ralph Sangster.

Saturday saw the only possible disappointing aspect of the convention when the group visited Mt. Stromlo Observatory; however, it was due to the last minute actions of Alex Rodgers in organizing an illustrated address by Don Mattewson that the visit was not the disaster feared upon arrival. It should be pointed out that the organizing committee commenced its operations and finished them during the change of Directors at Mt. Stromlo. "Bok was the first Mount Stromlo director to take seriously the role of public relations in the life of the observatory. ...Bok's successor ... was Olin Jeuck Eggen ... one of Eggen's first changes was to discontinue the Visitor's Nights." (Haynes *et al.*, 1996:176-179). Those of us who visited the Observatory in the 1960s can endorse these comments and sympathize with the organizers when the group was treated no better that tourists despite many efforts to secure a night visit to Mt. Stromlo. Don Gray, Deputy Station Master of Tidbinbilla filled in the evening with a talk on the functions of the deep space station.

As a further act of atonement, the near-full Moon put on a spectacular display on Easter Sunday. "Sunday morning at 9 o'clock the caravan assembled in Queanbeyen for the trip to the Hills Cross [*sic*]. The mile long silvery structure presented an imposing sight as it glittered in the moonlight on the dry bown [*sic*] plain." (Klingen, 1967). The Molonglo visit of two hours was followed by a picnic lunch at Cotter Dam on the way to Tidbinbilla, "... where we were received with open arms and accorded the kind of V.I.P. treatment we would have liked to experience at Mt. Stromlo" (Elwell, 1967). This was obviously one of the highlights of the weekend.

The final part of the convention was the dinner on Sunday evening accompanied by the usual speeches and parting discussions. The organizing committee was pleased to announce that the accounts (Table 2) balanced and that no further donations from clubs would be needed. The total amount passing through the account differs slightly from a current NACAA when many thousand of dollars pass through the treasurer's hands.

The outstanding success of this first convention, ignored by Australia's largest amateur society, set a standard for others with "a hard act to follow". Within a year it would all be on again on the mid-north coast of NSW at Port Macquarie, to coincide with its sequicentenary. The report of the organizing committee presented a Conclusion which appears in Appendix II.

During the intervening year between the conventions, Norm Webb of the Port Macquarie Astronomical Association (PMAA) travelled far and wide giving talks to astronomical clubs urging them to send representatives to the 1968 Convention, and it was due to his untiring efforts and exuberant enthusiasm for the event that it was a success. He wrote letters to all parts of the world advising particulars of the convention and requesting support, something which is not done today. Some of the results of his efforts were made manifest when messages were read out on the first morning,

Table 2. Financial statement for First National Convention of Australian Amateur Astronomers, Easter 1967

		Receipts			Expenditure	
1966		Donations		1966/67		
	9/6	Port Macquarie	$10.00		Stamps	$6.12
	1/7	Far North Queensland	10.00		Stationery	2.24
	5/9	Pacific Astr. Club	10.00		Telephone costs	15.65
	15/9	James Cook Astr. Club	10.00		Telegrams	0.95
	1/12	South Australia	10.00		Canberra visit	8.52
	14/12	Bundaberg	10.00		Tape	3.30
1967	23/1	Astr. Soc. of N.S.W.	10.00		Cheques	0.50
	30/1	Illawarra	10.00		Hall	80.00
	20/2	Ballarat	10.00		Sat. party	17.50
	26/02	B.A.A. of N.S.W.	10.00		Sun. dinner	127.50
	27/2	Moreton Bay	5.00		extra seats	6.00
		Dinners:				
		James Cook Astr. Club	45.00			
		Pacific Astr. Soc.	24.00			
		Ballarat	24.00			
		South Australia	6.10			
		Astr, Soc. of N.S.W.	3.00			
		Goulburn Astr. Club	9.00			
		Port Macquarie	6.00			
		Bundaberg	6.00			
		Illawarra	30.00			
		Registration	10.18			
			$268.28			$268.28

"... messages of goodwill were received from the Astronomer Royal – Sir Richard Wolley, Patrick Moore, Major General R.C.A. Edge – Director General of the Royal Ordnance Survey – Amateur Astronomers & etc. in Brazil, U.S.A., England, Germany, Austria, Mexico, South Africa the Vatican Astronomer & New Zealand – also from Astronomical Societies & persons in several parts of Australia." (Webb, 1968).

A Civic Welcome was extended by the Mayor of Port Macquarie, Alderman C C Adams and the Convention was officially opened by Harley Wood, NSW Government Astronomer, who also gave an address in which he conveyed valuable advice to the young men and women whose intention was to graduate as astronomers or allied professionals. Tidbinbilla was again present with Deputy Director, W A L Forsyth, giving the next talk on The Review of the Surveyor Program

Some seventeen talks were given by amateurs from far and near. It was pleasing to see that three metropolitan Melbourne amateurs gave talks, but they were not there as official representatives of the Astronomical Society of Victoria (ASV). Two of these were under twenty years of age and Michael Silver, aged 15, got support from Rotary to attend. Another supported attendee was David Harlos of Orlando, Florida, who read the announcement of the Convention in *Sky and Telescope*. David had distinguished himself in science and was prominent in his High School Astronomical Club, who made him its delegate to the Convention. Cars were washed, cakes were sold, raffles run, etc. and with the interest of the local newspaper two-thirds of his fare was raised. This qualified him for Government assistance and he flew to Australia to be the first amateur from America to attend an Australian convention.

About fifty people attended the Port Macquarie Convention and most may be seen outside the Observatory in Figure 3. The Convention was voted a success and it was noted the great amount of effort which had been put into making it so by the Organizing Committee and particularly Norm Webb.

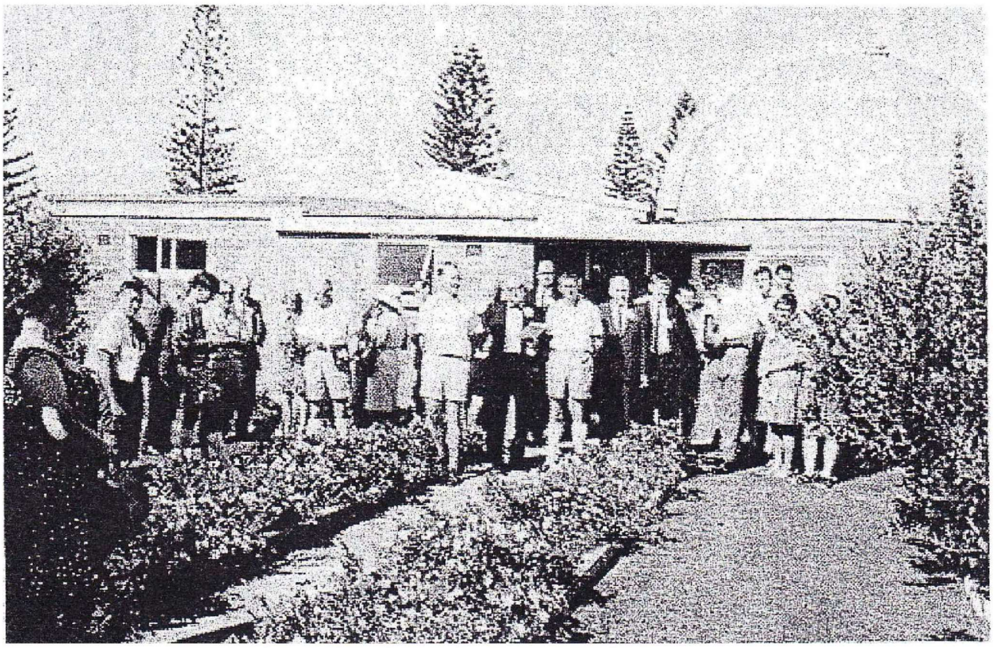

Figure 3. The 1968 Convention group outside the Port Macquarie Observatory.

The resolutions passed at the Delegates' Meetings are only there to be ignored, for the biennial concept was thrown out the window with Sygmunt (Joe) Czynski inviting all and sundry to Ballarat in twelve months time and in the following year, 1970, the gathering would take place in Adelaide. Again a regional centre had put its hand up to host the gathering, still the big Societies were shunning the conventions.

There is something about the intimacy of rural towns and cities which make for special gatherings where it is not too far to anything nor too far to the homes of local amateurs who want to welcome you to them. Although a large provincial city Ballarat was cosy to be in with the locals. Joe Czynski of the Ballaarat Astronomical Society (BASv) was nearly as hard-working as Norm Webb and wrote innumerable letters to all parts of the world, including Buckingham Palace. Note the spelling of the Society's name where the old official spelling is used and is still used today by its civic authorities, although Ballarat is used for the spelling of the shire. The home of the BASv is the Municipal Observatory at Mount Pleasant, a suburb of the City of Ballarat, where the third National Convention of Amateur Astronomers was held, the only municipal observatory in Australia.

The Third Convention was the whetting show for many Victorian amateurs who were supported by the ASV having appointed an official delegate, Hans Eisink, a former resident of Ballarat. Some of them are present in Perth thirty-one years on and still presenting papers after giving their first convention paper at Ballarat. There were ten papers delivered of which five were by ASV members with the others from various states. Included among the speakers was the first lady speaker at an Australian Convention of Amateur Astronomers, Norma Breen (JCAC) read a paper on Planetary Atmospheres. All the papers were presented on the Saturday in three sessions and after the evening session many went up to Mt. Pleasant to observe through the 26-inch reflector and the 8-inch refractor.

The Delegates' Meeting was attended by most with the voting being restricted to one delegate from each state. After a lengthy debate, it was resolved that the conventions be held annually and that the next would be in Wollongong at Easter 1970. Norm Webb brought up the idea of an Australian society with a proper constitution, a grand lodge for the running of national conventions. Following another long discussion, John Perdrix suggested that the meeting appoint Tom Richards to carry out a feasibility study and give him the power to pick the necessary people to help. Tom Richards accepted the appointment providing he could expect help from the Victorian society, – it should be pointed out that Richards had recently arrived from New Zealand. This help was assured by the ASV President and the motion was passed which provided for a progress report being given in 1970. Although not recorded in the Minutes of the Delegates' Meeting, it was decided that delegates be sent by Australian societies to the next conference of the International Union of Amateur Astronomers. The convention was closed by Councillor Bill Roff, a former Mayor of Ballarat and President of the BASv. Bill Roff will be remembered by those who attended the dinner following the re-opening of the Municipal Observatory in 1958 when Bill told us that the 26-inch mirror had been re-silvered at Mt. Stromboli.

The last of the early conventions was hosted by the Illawarra Astronomical Society (IAS) and held in the regional city of Wollongong in the Lecture Hall of the Arts, Commerce and Science Section at the Wollongong University College. The hard-working organizing committee was headed by Laurie Brown ably assisted by Bill Ede who produced a short report on the Fourth National Amateur Astronomer's [*sic*] Convention, Easter 1970, also designated elsewhere as the Fourth Australian National Convention of Amateur Astronomers. The convention was a social, environs, and financial success; however, the authors of the report were critical of the small number (8) of papers offered, very poor response by societies to correspondence (nothing has changed), the last minute cancellation of the Mars Symposium, and the report of the Feasibility Study Group (Richards, 1970) presented by John Perdrix, a member of the group. This report recommended that no national body be set up for the present, Laurie Brown was an enthusiastic supporter of a national body instead a group of amateur societies having little, if any, contact with each other.

Easter Sunday morning contained two talks and the Delegates' Meeting which decided that the conventions should be held biennially (believe it or not, after a change at each Delegates' Meeting, this was the last change) with the 1972 Convention to be hosted by the ASV and held in Melbourne. Following a talk on The Dapto Radio Astronomy Station, attendees visited the station some fifteen kilometres south of Wollongong, Figure 4.

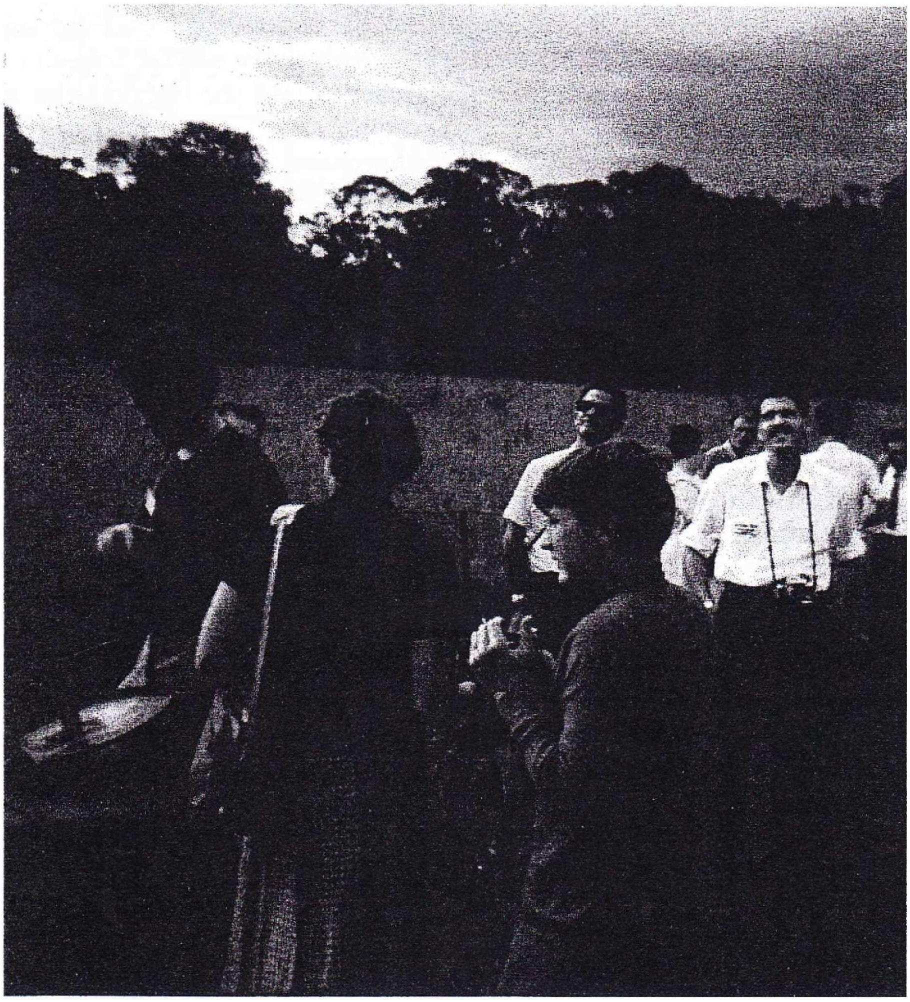

Figure 4. Fourth Convention members at Dapto Radio Station.

Easter Day came to an end when we all assembled at the El-Jaye Motel for a pleasant evening repast, a few, well-chosen, short speeches, and then to the IAS club-house for viewing and a look at the Apollo 11 film. Monday was an opportunity for registrants to gather again at the Wollongong University College to 'chew the fat' with a Recapitulation and Discussion period. It was a successful convention and a credit to the organizing committee headed by Brown and Ede. This time there was to be a gap of two years allowing time for better organization and recruitment of paper presenters.

3 NACAA is born

Depending upon when and where you lived, the arrival of a comet was considered the harbinger of either good or bad news. The 1972 Convention was destined to be a success for Bill Bradfield had just discovered another comet, a NACAA comet. After a break of two years, this convention got a new name which has remained until the present time. The name needed to have a catchy acronym, like APEC or ASEAN, and this was forthcoming when Perdrix rearranged pieces of cardboard each with the letter of a suitable word. It took a few hours with new words and finally there it was the National Australian Convention of Amateur Astronomers – NACAA – and you will be knackered if you forget it. The 1972 Convention was the first to be held at a venue which offered accommodation as well as conference facilities. It was also fortunate that a few on the organizing committee had had experience in their professional careers with running conferences. The fifth convention saw the first issue of a *Proceedings* of the convention a feature which has continued to the present day. So NACAA saw the beginning of a number of innovative features, all of which have become part of our biennial get-together. The obligatory convention satchel was introduced and supplied by Monty Ash of Astro Optical Supplies, so the first NACAA saw a revolutionary change from the previous ones and the start of many excellent ones to come.

The opening address was given by Perdrix, who spoke on The Amateur in Science, in which he discussed the scientific approach and the role played by several amateurs in the discipline of astronomy. The official opening was performed by the Rt Hon. A A Calwell, former leader of the Federal Opposition. Not only did he fulfill this function, but he also instructed and entertained the participants as only he could in his own inimitable manner. Figure 5 shows the official opening after which Bruce Tregaskis responded on behalf of the host society, the ASV.

Eighteen papers were presented during the two and a half days by members of six societies, with members the host society giving ten papers. On the Saturday evening, we all caught a tram into the city and spent time at a private showing in the H V McKay Planetarium with Ron Cavill and Dave Marshall

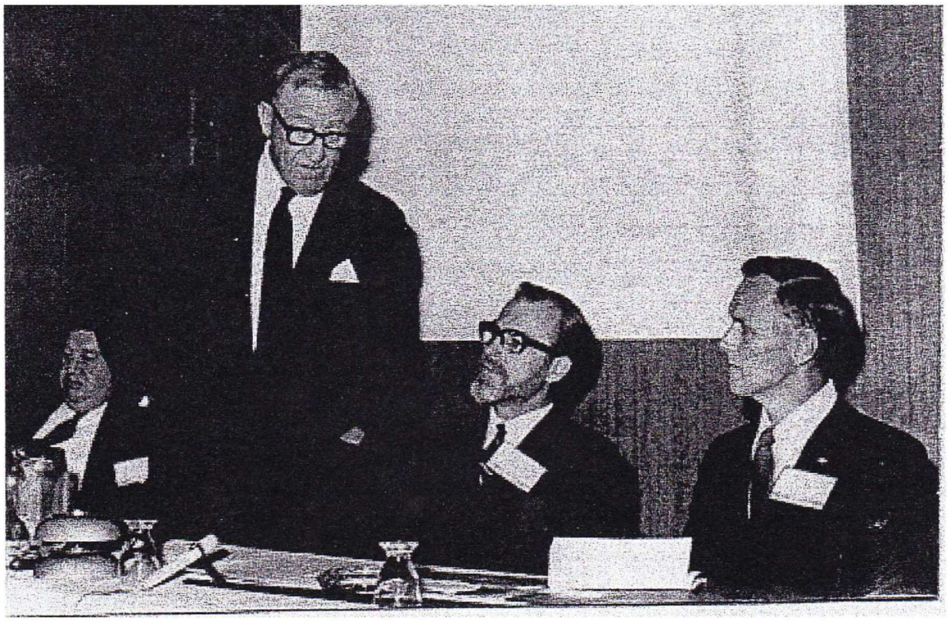

Figure 5. Rt Hon. Arthur A Calwell (standing) opening the 5th NACAA with left to right S D Chivers, J L Perdrix, and T B Tregaskis.

operating the Goto projector. Although hard to believe, it was a fine evening in Melbourne, so a number of 'Nacaarians' hopped on a tram and went to the Old Melbourne Observatory site and made use of the ASV's 310-mm reflector and 80-mm refractor as well as the Museum's 200-mm refractor originally purchased for the 1874 transit of Venus. The social event of the Easter gathering was the Convention Dinner on the Sunday evening when sixty participants and guests enjoyed sumptuous meal, good company, and fellowship. By midday Monday it was all over for another two years with "See you in Adelaide in '74." An enlargement of the 1972 Convention photograph was displayed at the 1998 NACAA in Sutherland to try and find out the names of those present; however, our memories are getting shorter for only about three-quarters could be named.

The Delegates' Meeting was not as spirited as some earlier ones with the ideas of a constitution, federation, and time interval between conventions not discussed. Ten societies were present with a representative from Western Australia for the first time and a further ten years before another was present. There was still the ideas of co-operation between societies with the exchange of library holdings, rapid transmission of astronomical discoveries, honorary membership to visiting amateurs from interstate while they were holidaying. Suggestions were made for the next NACAA when the Astronomical Society of South Australia (ASSA) offered to host the event in 1974.

In the intervening years, The Berenice Page medal was inaugurated by the Astronomical Society of Australia (ASA) in 1972 in memory of Mrs Berenice Page, a foundation member of the Society. The award recognizes excellence in original work in amateur astronomy in Australia and its territories. The assessment committee looks for scientific contributions which have served to advance astronomy. In particular, the award is not made in recognition of organizational services, for popularization, or solely for proficiency in established techniques.

The award, consisting of a bronze medal, is made by the ASA Council at intervals of approximately two years. The medal is usually presented by a member of the ASA Council at the biennial National Australian Convention of Amateur Astronomers (NACAA). Table 3 lists the recipients of the Berenice Page Medal.

Table 3. List of Berenice Page Medal Winners

Year	Recipient	Astronomical work for award
1973	Sydney Elwin	For photometric observations of the occultation of β Scorpii by Jupiter
1975	David Herald	For observations of Baily Beads in the solar eclipse of 1974 June 20
1978	no award	
1980	no award	
1982	Bill Bradfield	For the discovery, up to that time, of eleven comets
1984	Byron Soulsby	For work on the oblateness of the umbral shadow
1986	Robert Evans	For visual discoveries of supernovae
1988	Robert McNaught	For photographic nova and supernova observations and discoveries
1990	Barry Adcock	For telescope design work and planetary observations
1992	Mal Wilkinson	For the design and construction of a radio-telescope and subsequent observations of the Io-Jupiter system and for his development of a model for the emissions
1994	Paul Camilleri	For discoveries of novae and Mira variables and the development of simple photographic techniques for nova
1996	Peter Williams	For his extensive on-going visual observations of variable stars, especially the R Coronae Borealis variables searches
1998	Gordon Garradd	For significant contributions in the observation of asteroids, comets, novae and supernovae

The ASSA took up the suggestion of the 1972 Delegates' Meeting to make the theme of the VI NACAA Astronomy and Education and what better establishment could they have chosen than Raywood, the In-service Conference Centre of the Education Department of South Australia at Bridgewater, a south-eastern Adelaide suburb. With the pattern set in Melbourne, the convention went along without any hitches after the opening by the Hon. Hugh Hudson, Minister for Education in South Australia, who referred to the part played by astronomical knowledge in guiding the fast clipper ships with their cargoes of wheat and wool which contributed so much to the growth of Australia.

The proportion of papers presented by members of the host society grew from 55% in Melbourne to 75 % in Adelaide, and only two-thirds as many papers. There were plenty of activities to educate and entertain the visitors who went to the ASSA Observatory, the Zeiss Planetarium of the South Australian

Institute of Technology at The Levels, and individual observatories belonging to members of ASSA. An Open Forum session was held, as suggested at the last Delegates' Meeting, which proved very popular. The attendance was, unfortunately, restricted to fifty, the maximum capacity of Raywood and this was not conveyed to the organizers until it was too late to change the venue.

The Delegates' Meeting accepted the offer of the Astronomical Society of New South Wales (ASNSW) to host the VII NACAA, whilst the ASV would host a seminar following the 1976 October total solar eclipse. There was still the hope by some delegates that more co-operation and possible federation could take place between societies. It was at Wollongong in 1970 that Bill Ede and Laurie Brown were so disappointed with the Richards (1970) report, delivered by Perdrix, stating that union was not on for the present; however, Ede was still promoting the idea of a Secretariat to facilitate the transfer of information between societies. The IAS took over the running of same for the next two years.

The lack of documentation of some of the next NACAAs and the lack of answers from the societies who hosted or co-hosted conventions makes it very difficult to complete this history accurately, so it shall remain to be completed when the author can travel to the Eastern States to try and find journals, bulletins, newsletters, and correspondence in some societies. Table 1 lists the remaining locations for the conventions.

Discussion

It can be seen from the very first convention that for some twenty years there were constant moves to promote co-operation and some sort of federation to share resources amongst the amateur clubs of Australia and perhaps New Zealand. The mixed membership of the RASNZ with both professionals and amateurs together with the affiliation of most amateur societies with the RASNZ showed what could be done across the Tasman and that there was not a great need for them to be involved in an Australasian organization. The Feasibility Study carried out in 1969-1970 by Richards, Whitby, and Perdrix effectively put paid to the idea of the formation of an Australia-wide astronomical body (Richards, 1970). The possible formation of a federation – like the Astronomical League in the US or the Federation of Astronomical Societies in he UK – favoured by some amateurs was never accepted by the larger societies who were afraid of loosing their independence and dominance.

It should be pointed out that NACAA does not exist, it is solely an acronym used to designate a biennial get-together. Whilst it is not suggested that the above idea be resurrected, it is felt that NACAA needs a home. A repository where one can find copies of the Minutes of previous Delegates' Meetings, Programme and Abstracts booklets, convention photographs, and all the other bits and pieces which would have made the task of scribing this preliminary history a lot easier. All that is needed is a cupboard or locker in a permanent place.

Another award was introduced in 1986 by Astral Press, publishers of the *Australian Journal of Astronomy*, for the best paper presentation at each NACAA. It started as a clock mounted on a piece of polished West Australian iron oxide and became a silver medallion in 1990 and has continued since. Table 4 lists the recipients of the Astral Award. One of the sponsors of the 1988 NACAA offered a prize for the best paper, so that year the Astral Award was an encouragement award.

Table 4. Recipients of the Astral Award 1986-1998

Year	Recipient	Title of Paper
1986	Tom Cragg	CV Aquarii
1988	Peter Jones	Computer star maps
1990	Peter Nelson (speaker), JL Blanksby & AW Kruijshoop	Recent planetary and lunar occultation observations by the Occultation of the ASV
1992	Peter Nelson (speaker) and Jim Park	Observing mutual phenomena of Jupiter's moons 1991
1994	Fraser Farrell	The recruitment and supervision of amateur variable star observers
1996	Zac Pujic	The Cookbook CB245 CCD camera: evaluation of performance
1998	Vello Tabur	Computer-aided comet hunting

Conclusion

The amateur astronomical community of Australia owes a lot to the endeavours of Elaine Polglase and Joe Kawalski whose idea these conventions were, together with John McGregor and L G Klingen who did the majority of the hard work in getting the first one up and going without a precedent. This started the sequence of our conventions to which we all look forward. If it may be permitted, the following are some thoughts which it is felt would improve the concept of NACAA.

- The Convention Dinner should revert to the Sunday evening to allow one member of each society present to express in a few words his thoughts on the convention, and to add that final touch to a successful and happy weekend for the Monday is often a lost day.
- The Delegates' Meeting be held on either late Saturday afternoon or early Sunday morning. This will permit Delegates to lobby for their pet idea and allow them to enjoy the Friday evening reception to the full with everyone else.
- That the host society write a report of the convention which should be sent to all other societies, but in particular be deposited in a repository which I hope will eventual following NACAA 2000.
- That a NACAA satchel with all its goodies be deposited in this repository together with a copy of the group photograph and any other memorabilia which could help future historians.

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Notes

1 The James Cook Astronomers Club was formed in 1961 and for want of a better term at present amalgamated with the Pacific Astronomical Society and ultimately became the Sutherland Astronomical Society.

2 The Canberra Astronomical Society referred to in the 1965 letter was the second so-named society and the present one, the third, was formed in 1969.

3 The Pacific Astronomical Society was formed in 1961 under similar circumstances to the JCAC as breakaway groups from the Sydney Amateur Astronomers which in turn was a breakaway from the BAA NSW Branch. Early in1972 it was amalgamated with the JCAC.

Appendix I. Paper authors, number written, and year of first paper presented during 1967-1998.

Author	No. of Papers	Year of 1st paper	Author	No. of Papers	Year of 1st paper
Adcock, Barry	14	1969	Heyman, Jos	1	1984
Alexander, Cass	1	1968	Holmes, Kerry	1	1994
Allison, Andrew	2	1972	Hudson, Gordon	1	1998
Anderson, Peter	1	1996	Ibbetson, Kent	1	1998
Archer,	1	1967	Irvine, Chris	1	1968
Ashe, Ron	1	1984	Irving, C	1	1970
Austin, Rod	1	1970	Jackson, Ken	1	1982
Ball, Lindsay	1	1982	James, Andrew	5	1970
Barclay, Jim	2	1982	Kellock, Gerry	1	1982
Bembrick, Col	6	1982	Lanigan-O'Keeffe, Robert	5	1969
Benjamin, Thomas	1	1976	Lawrence, Reg	1	1984
Bhathal, Ragbir	1	1996	Le Marquand, Arthur	1	1976
Bisdee, Colin	1	1972	Leach, Tim	1	1996
Bland, A A	1	1990	Lee, Steve	2	1980
Blanksby, James	1	1990	Leiba, Marion	2	1990
Blow, Graham	1	1982	Loveday, Nick	3	1978
Bobroff, Peter	1	1994	Lowe, Peter	1	1994
Bosher, James	1	1974	Lukaszyk, Igor	1	1996
Bradfield, Bill	8	1972	Lumley, Ted	3	1972
Brakel, Albert	1	1994	MacDonald, Alistair	2	1968
Breen, Norma	1	1969	Manietta, Siegfried	1	1996
Bridge, B J	1	1982	Marshall, Dave	1	1968
Briggs, G	1	1972	Mathers, S W	1	1972
Bryan, James	1	1990	Mattingly, Ross	1	1968
Cable, Ron	1	1968	May, Ed	1	1984
Caldwell, Peter	1	1994	Moy, Mike	1	1996
Callow, John	1	1984	Mazur, F	1	1972
Carroll, Bruce	1	1998	McMillan, Brett	1	1992
Chatfield, Clive	1	1972	McNamara, Geoff	1	1988
Clark, Barry	3	1969	McNaught, Rob	1	1998
Clarke, Rod	1	1978	McQuistan, Gavin	1	1974
Cook, J L	1	1970	Miller, David	2	1992
Cook, Keith	1	1967	Morel, Mati	1	1990
Coombs, Arthur	1	1972	Morland, John	1	1994
Cooper, Kevin	1	1976	Moser, W	2	1968
Cragg, Tom	3	1980	Moy, Daniel	1	1994
Crook, Brian	2	1996	Naughton, Merv	1	1980
Crump, D	1	1980	Nelson, Peter	3	1990
Czynski, Joe	1	1968	Nooriafshar, Mehryar	1	1996
Daggar, Dave	2	1982	Norman, Peter	6	1976
Davies, Geoff	2	1984	Orchiston, Wayne	7	1982
Davies, Graham	1	1998	Page, Arthur	5	1980
Dodd, Luke	1	1996	Park, Jim	5	1984
Doran, Bernie	1	1982	Pattie, Steve	2	1986
Dunn, John	1	1968	Perdrix, John	14	1969
Dyke, Norm	1	1984	Piazza, Alan	1	1970
Edelman, Howard	3	1972	Poppleton, Bruce	1	1984
Elwell, P	1	1967	Potter, Dennis	1	1969
Elwin, Syd	3	1968	Price, Robert	1	1978
Evans, Robert	3	1986	Pujic, Zac	2	1996
Farrell, Fraser	1	1994	Purcell, Patrick	1	1996
Fielding, G	1	1967	Purvinskis, Rob	1	1998
Forbes, Keith	1	1988	Reich, M	1	1972
Gardner, John	1	1976	Reimers, Chris	2	1994
Genet, Russell	1	1982	Richards, Tom	3	1969
George, Martin	1	1986	Ring, Steven	1	1996
Goodman, Dennis	1	1982	Rochford, Kevin	1	1969
Halpin, Terry	1	1982	Rost, Fred	1	1998
Hardy, Stephen	1	1980	Royer, Ronald	1	1990
Harlos, David	1	1968	Rumbelow, Dennis	1	1974
Harries-Harris, Eric	1	1974	Russell, Steve	3	1978
Harrison, Ken	3	1986	Ryder, Jeff	1	1982
Herald, David	12	1976	Sallur, Brian	1	1984
Herbert, Wayne	1	1984	Sangster, Ralph	1	1967

Paper authors, number written, and year of first paper presented during 1967-1998 (concluded).

Author	No. of Papers	Year of 1st paper	Author	No. of Papers	Year of 1st paper
Selby, Keith	1	1976	Trainor, Jim	3	1976
Silver, Michael	1	1968	Tregaskis, Bruce	7	1972
Simmonds, Ed	2	1976	Tregear, Bert	1	1972
Skilton, Peter	1	1994	Turner, Lincoln	1	1998
Smith, Trent	1	1984	Walker, Stan	2	1994
Soulsby, Byron	11	1976	Walters, Brian	1	1992
Sprott, Graham	2	1972	Ward, Keith	1	1996
Stockdale, Chris	2	1992	Webb, Norm	1	1969
Sullivan, Ian	1	1998	Whitby, Len	1	1970
Sumner, Bruce	2	1972	Wilkinson, Mal	3	1984
Sved, J	1	1972	Williams, Nick	1	1996
Tabur, Vello	2	1996	Wilson, Ian	1	1996
Taylor, Mark	2	1976	Wolf, Mick	4	1974
Thompson, Gregg	4	1980	Yates, Alan	1	1976
Thornhill, Wal	2	1988	York, Albert	2	1967
Trainor, D C	1	1968			

Appendix II

Conclusion from Klingen (1967)

We may safely say that the convention was a success and that this was due to the pleasant manner and co-operation of every member who attended. It furthermore has achieved the main objectives:

(a) exchange of information among members;
(b) determining the times and place of three successive conventions;
(c) in accepting a set of principles to serve as "Rules of the game" for future conventions;
(d) in widening our horizons and promoting the cause of amateur astronomy.

From the organising point of view we would like to make following comments.

(1) It would be helpful if clubs could send in their donations as early as possible after the organising club has sent a budget statement of expected costs.. In our case contributions and donations were received 8 months after we sent the first letter and 3 months before the function, so that all preparations had to be-made in a hurry.

(2) We frequently found that delegates who were to keep the members of their clubs posted on the developments of the convention had omitted to do so. There were instances where frustrated members tried to contact the organising committee direct because they had not seen one of the five circulars that were sent to each club.

(3) Although this is left to the discretion of every club, we feel that the organising committee, which is duly appointed by and responsible to the host club, should at least be made up of the following people:

(a) a chairman who shall president the meetings of the committee:
(b) a secretary-treasurer to keep records of funds and handle the correspondence;
(c) a program-convenor who shall be responsible for organising the program, contact lecturers, etc.
(d) a secretary to type and duplicate all letters.

Most of the burden of this convention was borne by John McGregor, myself and last but not least my wife Tineke, who handled all the correspondence and kept check of the accounts. This was strenuous at times and other club members then came to the rescue.

(4) It would be an advantage if people who want to present papers and films would submit to the organising committee several months in advance the contents and exact duration of their presentation. This will enable the program-convenor to compile an interesting set of lectures. If possible copies of the talks could be distributed to the clubs beforehand so that they have ample time to prepare questions.

(5) We estimate the total amount of work involved at about 600 manhours - this includes everything - writing letters - contacting people, etc. This is equivalent to having 4 people work Saturday morning for one year.

(6) Lastly we think that Easter may after all be the time when most people have least commitments.

We would like to end this report by thanking all the members once more and the Australian National University Union staff for their efforts in helping to make this convention a success.

for The Organising committee (sgd) L.G. Klingen.