Astronomical Society of Edinburgh

Journal

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Delegates from the 2004 Dundee Weekend at the Kirriemuir Camera Obscura.

From the President

As many people are saying: we are living in exciting times astronomically. There is an opportunity for the Society to expand its activities and to reach out to new members including young people.

Your Council are finalising the publication of a Membership recruitment leaflet. We hope, with your help, to make this available to the public in schools, libraries and community centres throughout Edinburgh. If the ASE was to double its membership over the next two or three years we would be in a very good position.

We plan to highlight coming astronomy events and help the public to observe them. There is an eclipse of the sun on Monday 3rd October visible at around 9am in Edinburgh. Here the sun will be partially eclipsed up to about 60 %. Mars comes to opposition (closest approach to the Earth) every two years. There is an opposition on Monday 7th November. Mars will be an attractive bright object at magnitude -2.3 at about 45 degrees above the horizon. Though not as close as the opposition in 2003 the planet is higher in the sky. It will be an easier and better object to observe. As in 2003 we hope to produce an observing guide for the public.

We are very pleased to have the article from Lorna McCalman in this edition of the Journal. The article that you will read is an amended version of an article that is aimed at school children. We hope to publish the full version as a Society pamphlet that can be used schools in Edinburgh.

I think that there is a lot of people, young and old, who would like to observe and appreciate what is going on in the night sky. With the help of all our members the Society can help meet this need. With a little higher public profile I am sure that we can put pressure on the City Council to carry out the necessary refurbishment of the City Observatory and its facilities. It will be expensive but such a historical building must not be allowed to fall into disrepair. It would be a great pity to lose these facilities never mind the modern Centre that ought to be present.

I heard our City leaders saying at a recent conference that Edinburgh likes to be seen as the foremost European city in terms of education / cultural and science facilities. This ought to mean that refurbishing the City Observatory becomes a priority. Let us hope that it will.

Des Loughney

Cooling the Earth

Global warming is one of the most serious problems facing the world today. Certainly the Prime Minister thinks so and the Archbishop of Canterbury fears for the future of the human race. Despite claims that the recent warming is natural, the consensus among climatologists is that the world-wide burning of fossil fuels is largely to blame - increasing emissions of carbon dioxide (CO_2), a major greenhouse gas. An unpleasant climatic change is coming with various dire consequences. Overall, mankind is conducting a dangerous experiment with the world's climate, the damage from which could end up costing at least £130 trillion over the next century.

Will the Kyoto Protocol ameliorate the problem? It seems very unlikely. Considering that climatologists are calling for an immediate cut in CO_2 output of 60 per cent, it is too little and too late. Instead of falling, CO_2 emissions are still rising; since Kyoto in 1997, global traded energy use has risen by 10 per cent and the use of fossil fuels by 10.5 per cent. Moreover, the country that produces the most greenhouse gases (USA) refuses to participate because of the cost. However, even if CO_2 levels are slashed in the 21st century and the level stabilises at between 450 and 1000 ppm, the temperature will continue to rise for centuries and sea level will continue to rise for millennia (1).

What then can be done to avoid catastrophe? Is there a high-tech fix? Technology caused the problem; can technology solve it?

Ignoring proposals that merely slow the increase in the output of greenhouse gases, such as switching all electricity generation to nuclear power and/or renewable energy, the technical fixes fall into two groups: those that try to deal with the increasing CO_2 and those that attempt to cool the Earth. The former include dumping iron filings in the oceans, growing mutant algae in the high seas or attempting to sequestrate all the CO_2 produced by burning fossil fuels, perhaps by burying it in depleted oil fields. The latter include injecting sub-micrometer dust into the stratosphere in shells fired by naval guns, increasing cloud cover by seeding and painting every roof and road white!

An increase in the amount of carbon dioxide is not in itself harmful, except in acidifying the oceans and so harming some sea creatures. Indeed, it could result in an increase in food production as plants absorb more CO_2. What we want to avoid is the consequent rise in temperature; this is what the second group of proposals attempts to address. Because CO_2 contributes only about 70 % of the global warming effect of man-made greenhouse gases, assessments of warming based only on CO_2 rather underestimate it. What is needed is a way of cooling the Earth, regardless of the effects of atmospheric gases.

One way to lower the temperature of the Earth would be to reduce the amount of solar energy reaching it. This could be achieved by placing a shield between the Earth and the Sun so that less solar energy reaches the planet. One geophysicist called this idea 'wild and wacky', although he had no better solution (2).

The idea of placing mirrors in space dates back to Tsiolkovsky and Tsander in the 1920s. That was for propulsion (solar sails), but such a mirror can also reduce the amount of sunlight striking Earth. To work as a solar shield, the mirror must hold itself between the Earth and the Sun for many years. The obvious place for this is at the Earth/Sun L1 Lagrangian point. This is the point between the Earth and the Sun, about 1.5 million km from Earth, where the gravity from the Sun is balanced by that from Earth. Already several artificial satellites have made use of it and the Solar and Heliospheric Observatory Satellite (SOHO) is there now. Because L1 is unstable, the mirror would have to be provided with the means to maintain its position.

Perhaps the first person to suggest using such a shield for this purpose was James Early of the Lawrence Livermore National Laboratory (LLNL) in the USA (3). He proposed a glass shield made from Moon rock that would be launched by mass driver from a manufacturing plant on the Moon. His shield would be 2000 km in diameter and about 10 μm thick, either opaque or transparent in the form of a Fresnel lens, the latter refracting light away from the Earth. In either case, the shield would reduce insolation by about 2 per cent, offsetting the predicted greenhouse trapping expected during this century (based on a doubling of the level of CO_2). The shield would weigh about 100 Mt and cost from $1-10 trillion. However, Early pointed out that the economic impact of global warming might be much greater than this. Indeed, it has been estimated that damage from unmitigated climate change over the next century could cost at least $200 trillion and that cutting emissions to 80 per cent of the 1990 level in the US alone may cost $3.6 trillion, thirty times the cost of the Apollo space missions (4).

About the same time as Early's proposal was published, a letter outlining almost the same idea was published by a Swiss scientist (5). His mirror would be made of aluminium, weighing at least 45 Mt. To compensate for a temperature increase on Earth of 2.5 degrees K, the mirror would need to reduce solar radiation by 3.5 per cent and be about 4.5 million square kilometres in area (or a disc 2393 km in diameter).

Kenneth Roy and Robert Kennedy (4) have also advocated shielding at the Earth/Sun L1, but with a shield only 618 km in diameter. They calculated that this would reduce insolation by 0.25 per cent, resulting in a drop in temperature of 1.5 degrees K, the reduction allegedly experienced during 'the Little Ice Age', the period between the mid-sixteenth and seventeenth centuries when there was an absence of sunspots (the Maunder Minimum). Coincidentally, 1.5 degrees K is the lower limit of the IPCC's estimated increase. Roy suggested that, apart from cooling Earth, the shield could generate electricity that could be beamed to Earth by microwave, so paying for the shield. Because each square kilometre of shield would receive 1.4 GW, even if only 10 per cent of that energy were converted, this would provide the total projected planetary electrical demand for 2050 (9.5 TW), incidentally displacing the burning of fossil fuels for this purpose.

Roy and Kennedy also pointed out that the deployment of such a shield would encourage development of the Solar System, something that we need to do anyway. We need to establish extra-terrestrial colonies, not because the Earth's climate will become uncomfortable, but because there are several major threats to the continuation of civilization on Earth (2). Space exploration has already proved its value in communications and monitoring the Earth's environment. It might provide the only realistic means of bringing global warming under control.

What notice has been taken of this idea? Five years ago, *New Scientist* carried an article that reviewed Early's work (6). It also commented on that of two other scientists at the LLNL, who modelled the effect of such a shield, believing that this would show that the idea would not work (7). To their surprise, the model showed that it would. The *New Scientist* article also noted the interest in this matter by Edward Teller and others (8, 9). Teller founded the LLNL. In the USA, there is no funding or apparent interest in actually solving global warming; all the current work is centred on understanding the problem in more detail.

The idea of using a shield to cool the Earth came to Early after seeing the ideas of Fogg (10) and Freitas (11) who proposed such a method to help cool Venus as part of terraforming.

Steuart Campbell

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See the Sun in a different light

The Sun is something we take very much for granted. It rises in the morning gives us heat and light throughout the day and then drops below our horizon, heralding the cold and darkness of the night. The Sun supplies the power to drive our atmosphere (weather) and is the life support system for the biosphere. The Sun is a dynamic object, constantly changing but at the same time, showing patterns in the way it behaves.

There are several ways of looking at the Sun, but safety is of prime importance. You must never look directly at the Sun, especially with any kind of binocular or telescope unless the instrument is equipped with proper filters which not only block out the glare of the visible light but will also block the damaging UV and infrared rays which we cannot see.

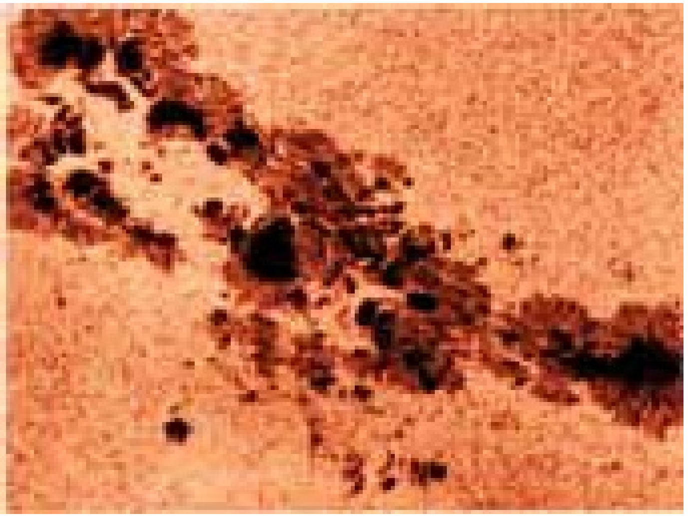
Unless the correct precautions are taken, you will quite literally burn your eye. I remember being shown in school how, if you take a piece of paper and focus sunlight onto it, using a lens or eye glass, the paper will start to smoulder and burn. The same thing happens if you focus unfiltered sunlight onto the retina of the eye. Unlike other parts of the body, the retina doesn't have pain receptors, so there is no way of knowing that you are irreparably burning your eye, until too late.

The main safe methods used by amateur observers to look at the Sun are:

1. Solar Projection
2. Direct viewing through a specialized solar filter
3. Hydrogen alpha telescope

1. Solar projection

This method is good for tracking and measuring the size and position of sunspots and plotting them on a grid. It is a very safe method of observing as the observer stands with his/her back to the Sun and looks at sunspots projected onto a sheet of paper. Accurate plotting of the position of sunspots can be made but no other solar detail is visible by using this method of observing. Sunspots can change in size and shape. There can be lots of them, but sometimes the Sun can be totally blank. However, this does not happen in a random fashion.



US National Solar Observatory, Sacramento Peak

Sunspot activity follows a set pattern with the numbers rising and falling over an 11 year cycle. This is known as the sunspot cycle and plotting the latitude and numbers of sunspots seen against time produces the "Butterfly" diagram. This shows that sunspots do not appear at random over the surface of the Sun but are concentrated in two bands on either side of the equator. These bands first form at mid-latitudes, widen, and then move toward the equator as each cycle progresses.

Early records of sunspots indicate that the Sun went through a period of inactivity in the late 17th century. Very few sunspots were seen on the Sun from about 1645 to 1715. This period of solar inactivity also corresponds to a climatic period called the "Little Ice Age" when rivers that are not normally frozen, did freeze up and snow fields at lower altitudes, did not melt. There is evidence that the Sun has had similar periods of inactivity in the more distant past. The connection between solar activity and terrestrial climate is an area of on-going research. A very topical area for debate. The plotting and observation of sunspots is an interesting study and a useful contribution to our knowledge about the Sun and the possible effects on the Earth. These observations can be made relatively easily and with very modest equipment.

2. Direct viewing

Direct viewing of the Sun can be done by using a metal-coated, purpose made safety filter, usually Mylar or Baader film. The filter is then securely attached to an ordinary optical telescope, the filter covering the full diameter of the instrument which is then used to look directly at the Sun. (Be sure to cover up any finder scope too. It's only too easy through force of habit to unthinkingly use it.) The metal coated solar filter blocks out 99.999 % of the visible light as well as blocking the harmful UV and Infrared rays.

Sunspots are still the only features observable using this method, but fine detail surrounding the sunspot can be seen, as in the picture. This was taken using a small 80 mm refractor telescope, using a "Thousand Oaks" white light filter. The direct viewing method shows the detail in the sunspots but it's not so easy to plot the positions, whereas the projection method is a convenient way to plot the positions of sunspots on the solar disc but doesn't show the detail.

Neither of these methods shows the Sun's features which are normally hidden from our view by the intense glare. We can only catch a glimpse of them during a solar eclipse. However, the third method of looking at the Sun reveals its hidden treasures.

3. Hydrogen alpha telescope

The Hydrogen alpha telescope allows viewing of the solar disc in a very specific wavelength of light. Seen in hydrogen-alpha light, the Sun appears alive, with rubyred prominences jutting from the limb, dark filaments crossing the disk, and bright flares erupting around sunspots. Viewing the Sun for the first time through a hydrogen-alpha telescope can be every bit as exciting as the first time you saw the rings of Saturn.

H alpha Sun, US National Solar Observatory, *Sacramento Peak*

The Ha telescope looks just like any ordinary optical telescope, except when you look through it you see .... absolutely nothing! So much light is cut out by the filter system within the telescope that, nothing, apart from the Sun produces enough light to penetrate through to the eye. You will also notice that this telescope, for obvious reasons does not have a finderscope. For this reason it can be extremely difficult to locate the Sun. The Sun appears as a large object dominating our sky, but in this case, not large enough! Just try it for yourself and see how long it takes you to find it. (Be careful not to look at the Sun with the naked eye when attempting to aim the telescope ...... it's really tempting, but not worth the risk). Happily, there is a solution to the problem. Hold a piece of white paper behind the telescope so that the shadow of the shape of the instrument falls onto the paper. Move the telescope until you have the shortest possible shadow on the paper, lock out the telescope, look into the eyepiece and the Sun should be in the near vicinity. Use as low powered an eyepiece as you have, to make it easier, a 40 mm eyepiece is a good option.

So what are we looking at when we eventually locate the Sun and what is a Ha telescope? Hydrogen alpha (Ha) is in the red portion of the visible spectrum. The Sun is viewed by isolating the Hydrogen-alpha wavelength at 656.3 nm and rejecting all other wavebands of light.

The brilliant light coming from the photosphere which is the equivalent of the Sun's surface (although a gas ball doesn't really have a surface), washes out all the relatively feeble light of the Sun's delicate outer atmospheres, the chromosphere and the corona. This makes it impossible to see any features because of the glare. Many solar features most prominent in red light get drowned out by the intense yellowwhite light of the photosphere.

If we can isolate the specific narrow band of light and observe the Sun only in this very narrow wavelength, most of the blinding light is eliminated allowing us to observe features which are otherwise not observable in continuous or white light. This reduces the intensity of the sunlight to a safe level. We can now cut out the glare and observe the Sun in red light to best show up the features we are looking for. Observing at this wavelength, we are able to view all the features of the photosphere. These features include prominences, filaments, flares and active regions. The passband around the Ha line must be *extremely* narrow for such details to be visible - typically 0.1 nm. Because of this very tight tolerance, Ha filters and telescopes are very expensive. A few years ago the ASE purchased a Hydrogen alpha telescope to allow members to see the Sun in a different light. It's a fascinating sight and we are really fortunate to have this facility, so why not make use of it? The H alpha telescope waveband can be finely adjusted on the telescope, to show surface detail like bright areas and filaments at the expense of the limb prominences. If on the other hand if we altered the waveband again, we would have a clearer image of the prominences but less detail on the Sun's disc.

It is fascinating to make drawings of the Sun using a combination of all three methods of observing. An incredibly detailed picture can be built up to illustrate the ever changing face of the Sun. Even during solar minimum when there are few sunspots to record, don't assume that the Sun is quiet. There can still be amazing displays of dancing prominences on the limb and long dark filaments snaking across the disc for unimaginable distances. It is also interesting to record bright active areas and look out for solar flares. Make a record of these features and see if you link them to any reported aurora borealis.

Further information on how to observe the Sun can be found on the BAA website at http://www.britastro.org.

If you prefer to read about the Sun rather than make any observations then have a look at the Nasa Spaceweather website at http://www.spaceweather.com. Here you can see daily pictures of the Sun taken in many different wavelengths of light by large telescopes and orbiting satellites. There is also an aurora alert on this web page, so you need never miss the aurora borealis again.

There are also many excellent books on the market, one of my favourites being "How to Observe the Sun Safely" by Lee MacDonald ISBN 1-85233-527-0.

With so many resources easily available to us it seems a great shame not to make more use of them. There's no excuse .... well ... apart from the weather!

Lorna McCalman

The 2005 Scottish Astronomy Weekend

Last year's Astronomy Weekend was held in the West Park Centre, Dundee, once again. We are having some difficulties in arranging venues because most of the universities are going over to the new Semester system. The 2004 Weekend had to be held so early (end of August) that it clashed with people's holidays, the Edinburgh Tattoo, Festival and Fringe. Several ASE members could not go.

But with reduced numbers it went ahead. The theme was 'Stars', and we had superb talks from our two main guest speakers Guy Hurst and Dr Nick Hewitt. We also had a nice trip through the Angus countryside to Kirriemuir, to visit the Camera Obscura and the birthplace of Sir J.M. Barrie.

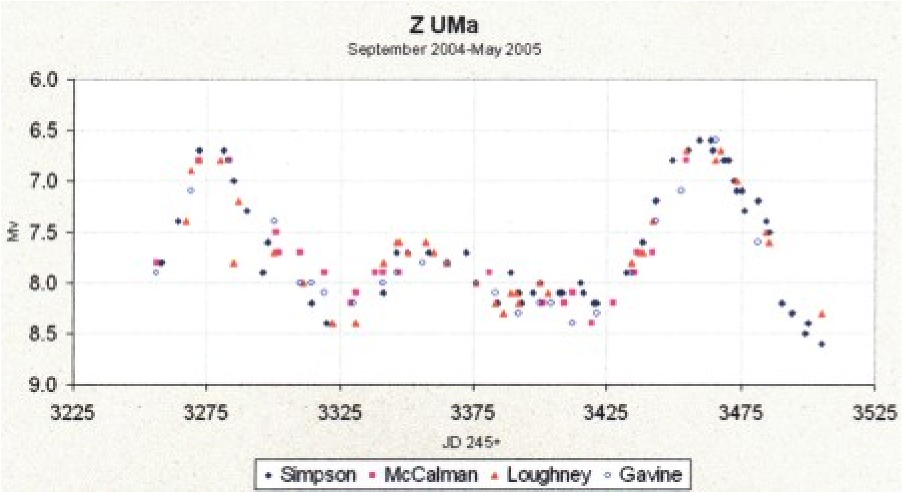
The 2005 Weekend will, for the first time, be held in Inverness at the invitation of the Highland Astronomical Society, on September 23-25. It will be a little different in organisation from the Dundee Weekends. Although the venue will be the magnificent Thistle Hotel, only limited accommodation will be available at the Hotel itself. Most delegates will be expected to arrange their own B & B and evening meals. A buffet lunch will be available at the Thistle. One of the alternative recommended places to stay is the nearby Travel Lodge which is cheaper if you book on line. Please note that Dave Gavine is not the organiser. Booking and other details are obtainable from: Mrs Pat Williams, Liamrig, Upper Myrtlefield, Inverness IV2 5BX.

The programme is one of varying subjects. The main speaker being Storm Dunlop, past President and Secretary of the BAA, well known for his many fine books. His subject will be: "Peculiar and Interesting Stars". Other speakers are Andrew Elliot, Ken Kennedy, Dave Gavine, Maarten de Vries, Pauline Macrae and Mike Reuss-Newlands.

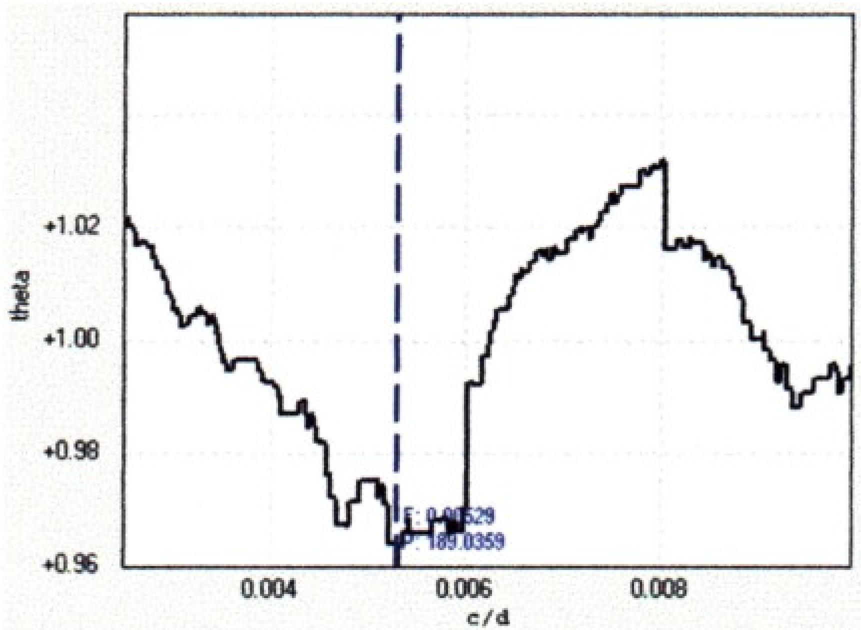
Z Ursae Maioris

Z UMa is what is called a semi-regular variable star. Semi-regular variables are post main sequence cool (red) giant and super giant stars. At various levels within this type of star pulsations are generated which interfere with each other. Complex patterns of variability result as the surface of the star contracts and expands.

Four observers in Scotland (three from the ASE) have been studying this star in recent months. The observations of the four, over a 200 day period, have been combined in the following diagram.



Nearly all these observations have been done with binoculars. The observations illustrate a distinctive light curve which agrees closely with the world wide observations collected by the AAVSO (the American Association of Variable Star Observers). The results are a good example of the valuable work that can still be done by visual amateur astronomers. CCD photometry can be more accurate. Magnitude can be measured to one hundredth of a magnitude compared with one tenth of a magnitude by visual observers. However, CCD photometry would not portray, in this case, a significantly different light curve.



Gary Poyner subjected the results of the 4 observers to an analysis by the Peranso software. This suggests a period of 189 days for the primary pulsation which is quite close to the official period of 195.5 days.

Des Loughney

The Televue Radian eyepiece

At the May meeting of the Society Gary Poyner recommended that anyone wishing to look at faint objects whether they are galaxies or stars should consider purchasing a Radian eyepiece. With this eyepiece, he said, it is possible to see objects of magnitude 14 (with a 200 mm / 8 inch telescope) even in an urban environment.

I wondered if this would be the case. I obtained an 8 mm Radian which gives a magnification of 125 with my 200 mm reflector. Using my old eyepieces, under the best conditions I could see stars of 12.6 mag. Under ordinary conditions 12.2 often seemed to be the limit.

I received the eyepiece in the middle of May. Thus I was not able to test it when the local sky was at its darkest. I, as Gary also recommended, cleaned the primary and secondary mirrors of my reflector. This had not been done for eighteen months but they were not in too bad a condition. I also re-collimated the telescope. When a clear night came along I looked at a group of stars which included one of 10 mag down to one of 14. I was just able to pick out a star of 13.4. I think that after the middle of August I may well be able to see down to 14 (particularly on a moon-less night) though I may have to wear a hood. It is possible that I may have to take steps to ensure that stray light does not get into the telescope by erecting boards to block room lights and street lights. It would also be a good idea to attach a black tube to the end of the reflector.

The Radian has other advantages. I can use it with spectacles. Previously I could only use my 10 mm and 5 mm eyepieces without spectacles. This caused some problems because I have astigmatism. Also the Radian improves all viewing of stars under magnitude 10 because of the quality of the optics and the wide field of view. It is very comfortable to use because even with the drive off it takes a little time for objects to move across the field of view.

For the full specifications see the Televue web site on www.televue.com and look at their section on eyepieces. The cost? Ordering an eyepiece from the UK, at the present time, cost just under £ 200 including VAT and carriage. It is possible to order one from the USA. It seems that you can save about £ 30 minus the carriage cost at current exchange rates.

Des Loughney

The Society at work and the City Observatory

Society members observing the transit of Venus in June 2004 from outside the City Observatory on Calton Hill.
Copyright Edinburgh Evening News.

The City Observatory, at sunset, May 2005.

About the ASE Journal

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