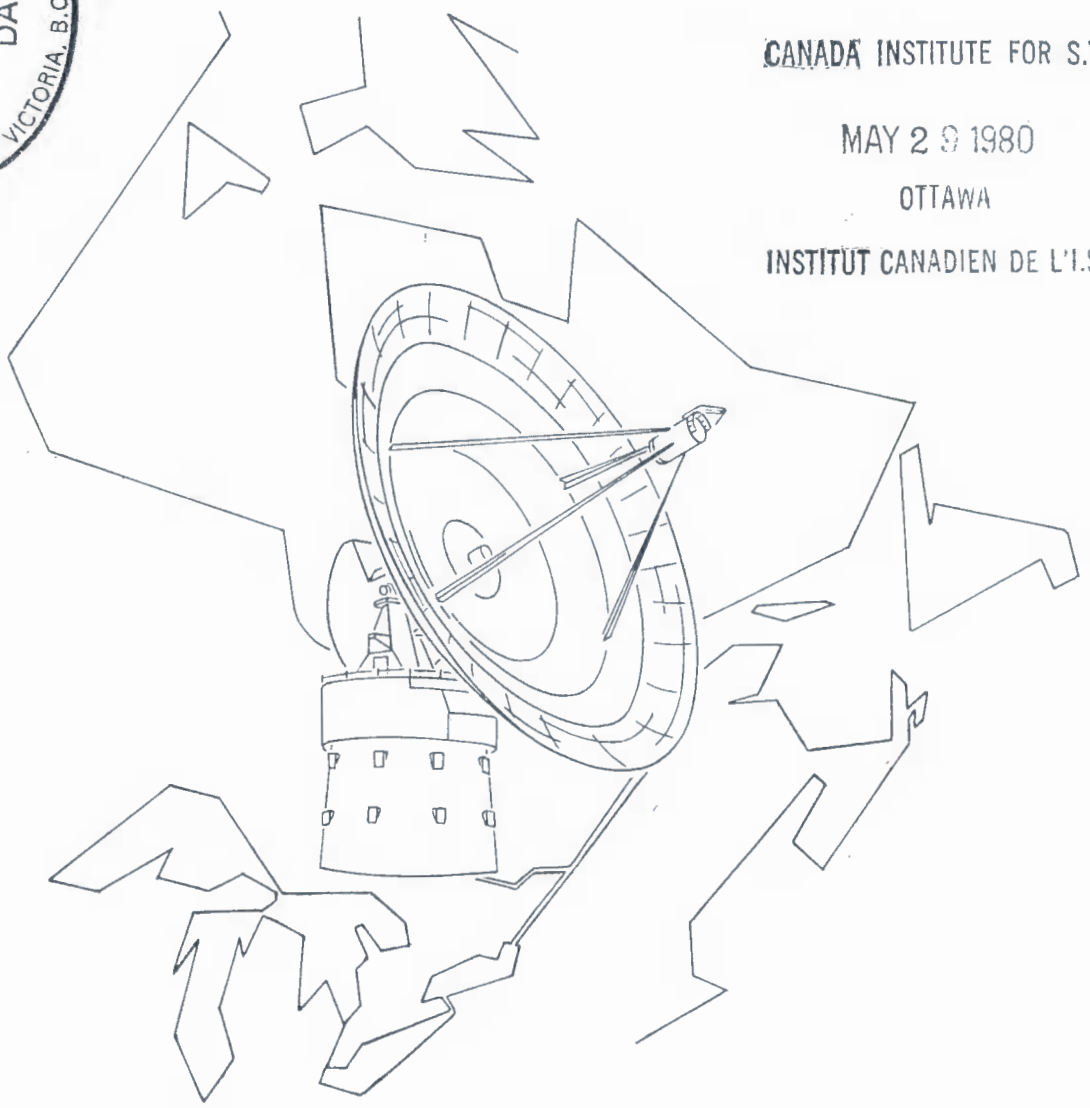
# The A.R.0. observer, issue no. 2

# The A.R.O. OBSERVER









National Research Council Canada
Conseil national de recherches Canada

No. 2
July 1973


## THE KINGSTON MEETINGS: WHO NEEDS THEM?

A Texas Conference on Relativistic Astrophysics has been held in New York City. Perhaps the aura that surrounds Texas makes it possible to accept the idea of a Texas meeting in New York. Although I doubt that the same aura, the same conceit, exists in Kingston, it has become commonplace to refer to the meeting of radio astronomers held in Ottawa on April 26 as the Second Kingston Meeting. There are those who, either through a surfeit of rigour or an undue reliance on NASA terminology, refer to the April meeting as the Ottawa Kingston Meeting. I suppose there are no literal persons who take the obvious step and refer to the next meeting as the Toronto Ottawa Kingston Meeting.

It is perhaps to be regretted that the latter naming system hasn't been adopted. We could then be assured that after a few more meetings the whole system would collapse under the weight of the name. However we manage it, I think we should end the series of Kingston meetings.

I don't believe that we can afford the division into subgroups that follows from these meetings. I think the astronomical community in Canada is too small to sustain a healthy series of C.A.S. meetings and a competing series for Eastern radio astronomers. If the Kingston meetings satisfy the need of the attending astronomers for communication then those same astronomers are much less likely to attend a C.A.S. meeting. I think in the long run we need the C.A.S. meeting a good

deal more than we need the Kingston meeting.

There are other means of communication between people who attend Kingston meetings. The journal you are reading now is one such means. People do meet at ARO and maybe with a little practice they could learn to talk to each other. The ARO Program Committee brings a few people together routinely. Many attend the June Institute in Toronto. There are visits between establishments for a variety of reasons.

At the 2nd Kingston meeting Jack Locke suggested the formation of an ARO User's Committee. There was remarkably little discussion of the suggestion, and I wasn't able to gauge the general reaction. My personal view is that such a committee meeting once a year would be worthwhile. It would permit discussion of the type that occupied some time at both Kingston meetings, but in an environment which could perhaps lead to some constructive change.

Therefore I suggest that we establish an ARO User's Committee to cover one aspect of the Kingston meeting and support two C.A.S. meetings each year. Since the format of the Kingston meetings seems popular, seek a similarly structured period at the CAS meeting. Ask for a two hour period with a keynote speaker and a discussion period - the subject being one of general interest. I believe that such an approach can meet most of the needs which led originally to the establishment of the Kingston meetings.

Lorne Doherty

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## *THIS YEAR, NEXT YEAR, SOMETIMES NEVER*

The toughest part of writing is starting. It doesn't matter what you're writing, a letter, a report, or an article, the hardest part is getting out the paper, clearing yourself a space in time, and putting down those first words. You can think of all manner of reasons for not starting, too much work to do, a meeting to attend, it's only ten minutes to coffee break, you have to mow the lawn or wash the car or mend a fence. Television programmes which would normally be monumentally dull suddenly acquire a new lustre, Merv Griffin sparkles with spontaneous wit, the Leafs play great hockey. At the office you have to tidy your desk, or rearrange your filing system, or go down to the storeroom and pick up some paper clips. You just can't find the time to write. Not today anyway, maybe tomorrow. Or the day after. Maybe.

The trouble with writing is that it makes you think, and thinking hurts. It's not just ordinary everyday thinking - if only I hadn't missed that putt, why doesn't that clown get a haircut, who voted for these idiots anyway - it's organized thinking. Subject, verb, object. Presentation, explanation. Start at the beginning and end at the end. A logical progression. That's what hurts - the discipline. It's bad enough without deadlines.

All of which brings me to my point. A number of you have asked how often the ARO Observer is coming out. The answer is, I don't know. Expect it when you see it.

B.H.A.

*The huge solar flares of last summer gave Newfies a 200 amp charge, blew up a sub-station transformer in B.C., and wrecked a pigeon race in Illinois. The flares could have killed any astronauts unfortunate enough to be on the moon at the time.*

## *THE HOT SUMMER OF '72*

*by*

*Lorne Avery*

Most of us enjoy being surprised - provided, of course, that the unexpected events are pleasant or interesting ones.

Those of us in the field of solar astronomy are occasionally privileged to have our own private star entertain us in an especially unusual or unexpected way. Such was the case last August when old Sol arranged his own particular version of a surprise party and successfully kept the plans a secret until the celebration was underway.

I'm referring, of course, to the series of major solar flares sired by a supposedly over-the-hill Sun, fast approaching that sterile stage of stellar senility euphemistically termed "solar cycle minimum." The only other comparable period of activity recorded occurred in November 1959, during the previous cycle which was characterized by a much higher overall level of activity.

Prior to the events of August, solar astronomers were unanimously agreed that cycle 20, which began in 1964, had been quite disappointing insofar as major flare activity is concerned.

A modest peak of activity had occurred in 1968 and 1969. (The Sun didn't define a nice sharp maximum for us, but rather smeared its most prolific period of flaring over a period of almost 3 years.) By late July 1972 the cycle was obviously petering out with actual minimum slated for 1975.

Against this backdrop of normality, the curtain rose on 02 August on a production of many acts that would take 11 days to unfold.

The active centre in which the flares occurred first developed about 11 July on the disc and disappeared around the west limb without any indication of its history making potential. But, like the impressionist who turns his back to his audience in order to assume a new character, so the Sun contrived to hide its active face from view while it was undergoing significant changes.

Almost from the moment the region appeared on the east limb to begin its second disc passage, it was apparent that its nature had changed.

The first of the series of major flares destined to be spawned by the region occurred on 02 August, 1 day after limb passage.

On 04 August at 06:10 U.T. a flare of importance 3B* began which became, certainly, the greatest flare of solar cycle 20 and, in some respects, the greatest recorded flare of all time.

Again on 07 August, a second

**Flares are classified by the numbers 1, 2, 3, 4 as their H-alpha area increases. The letters F, N and B are used to denote faint, normal, and bright H-alpha intensity levels.*

3B flare exploded (15:09 U.T.) and grew to an optical area some 14 times that of the Earth.

This latter flare was visible in white light as a brightening of the photosphere around the sunspots - a most unusual occurrence that automatically ranks it among the most energetic ever seen. The total energy liberated by this flare alone was equivalent to that produced by two billion 10 Megaton Hydrogen bombs.

Activity continued high for the remaining time of disc passage. On August 11, as the centre moved over the limb, it signalled its departure with a class 2 flare followed by a spectacular surge that kept growing and growing until, like some grotesque solar appendage, it reached heights in excess of half the Sun's radius.

Following the large flare on the 7th, radio communications at many wavelengths were disrupted almost immediately by the intense x-ray and UV bursts which induced widespread changes in the ionosphere. In about 1/2 hour the first energetic particles arrived in the Earth's vicinity, and within 4 hours their numbers had grown sufficiently that a polar cap absorption already in progress from earlier flares was greatly enhanced.

The geomagnetic storm, which typically follows major flares, began 08 August at 23:54 U.T. but was not as large as the storm of 04 August caused by an earlier 2B flare at 19:58 U.T. on 02 August.

The full, detailed list of all effects and events associated with disc passage of McMath Region 331, as it has been labelled in the unfortunately prosaic terminology of science, is much too extensive to consider here. A full account is chronicled in NOAA Technical Memorandum ERL SEL-22 available from the Space Environment Services Center (SESC) in Boulder, Colorado.

The most important flare from a geomagnetic standpoint appears to have been the 2B x-ray flare of 02 August.

Its associated magnetic storm on 04 August induced ground currents in Newfoundland in excess of 200 amps, and dc voltages of 50-60 volts appeared on underground cable between Chicago and Nebraska.

In British Columbia a 230 KV transformer exploded, apparently due to the degrading effects of repeated strong magnetic fluctuations.

Of a potentially more serious nature than tripped circuit breakers and exploding transformers are the energetic particle showers associated with great flares. Judging from SESC figures, had the flares occurred during a manned space flight, the consequences might have been serious indeed.

Over the period 02-12 August, the computed, cumulative radiation doses to an Apollo astronaut range from 358 rems inside the command module (maximum shielding) to 3765 rems for space suit shielding only. This minimum dose would result in vomiting and nausea within 24 hours and eventually 20% fatalities. Doses above 1000 rems are invariably fatal.

The above effects and hazards are well-known to be associated with large flares. Of a much more doubtful and less familiar nature has been the suggestion that solar activity may directly affect the length of our day.

J. Gribbin and S. Plagemann, in a recent edition of Nature, show convincing evidence that the Earth's spin rate was discontinuously slowed on 08 August (a terrestrial glitch in pulsar jargon!) 6 days following the onset of these major flares. A possible mechanism for the change is a large scale effect on the Earth's high atmosphere arising from the radiation and particle fluxes.

Yet another interesting sidelight on flare activity, outlined in the SESC report, relates to bird navigation studies. Biologists believe that one of the navigational aids used by birds is the geomagnetic field.

On 17 June 1972 a large solar induced magnetic storm happened to coincide with a homing pigeon race from Nebraska to Chicago. Usually between 70% and 80% of the pigeons

complete such flights without getting lost, but in this case only 4% managed to return to their home roosts.

The moral seems to be that during solar storms a bird in the hand is worth twenty-five in the bush. Certainly this is the time to commit indiscretions because it's unlikely that your pigeons will be coming home to roost.

At times of major flare activity such as experienced last August, the role of A.R.O. is an especially important one.

At Site 1, the 2800 MHz solar flux is monitored continuously on a daily basis. During the major activity associated with Region 331, two extremely large bursts were recorded by George Dagg, observer at the site.

On 02 August the 2B flare produced a noise burst that peaked at almost 10,000 flux units,and the 3B flare of the 7th gave rise to a burst of 4500 flux units. These great bursts rank among the strongest ever observed in almost 30 years of observation by Covington's solar patrol.


As soon as Mr. Dagg is able to assign a peak flux to large bursts such as these, he reports their time of occurrence and intensity directly by telephone to the SESC world-wide data gathering centre in Boulder, Colo. Apart from their interest to solar physicists, these bursts are important as indicators of several aspects of flare magnitude.

Such impulsive bursts are known to be generated by highly accelerated particles in or near the flare site, and prompt, accurate reporting of their occurrence allows predictions of the severity of communication disruptions and magnetic storms to follow. In addition, the energetic particle hazard can be estimated in advance of the arrival of the particles themselves.

The importance of this advance warning to spacecraft crews or even for high-flying supersonic transports is obvious.

When no spaceflights are in progress, alerts and forecasts are issued by SESC to research centres, power companies, telephone control centres and other interested agencies throughout the world.

It is an indication of the reliability attached to the A.R.O. observations, that on the rare occasions when burst information from Site 1 is not immediately reported, Mr. Dagg is promptly phoned by the Colorado Centre requesting confirmation of burst reports received from other sites.

On relatively quiet days, the 10 cm flux is still sought after as a reliable indicator of solar activity. Site 1 observations are phoned three times each day to a USAF data centre in Colorado Springs and the flux level is included in daily activity reports and predictions issued by SESC.

By way of concluding, the following events, though not related to the August activity, are of interest.

On 29 April of this year, during the course of some LBI observations of 3C84, at Site 3, the record suddenly became extremely noisy and irregular. Efforts to trace the source of the difficulty were unsuccessful and it appeared as though the receiver had packed up.

At length it occurred to Bob Duston to check with Site 1.

A quick call to George Dagg confirmed that a burst was indeed in progress (its peak was 1800 flux units - modest by August proportions) and playing havoc with the big dish observations, even though 3C84 and the Sun were widely separated in the sky.

So, the next time you're observing the Crab Nebula and its flux jumps by a factor of 5 in 10 minutes, don't rush into print to announce the birth of another pulsar.

Give George Dagg a call at Site 1 first - he may have the explanation in terms of another "Tenflare" noise storm.

# In the Feed Bag

with Bill Lawrence

## THE UPS AND DOWNS OF THE SPECTROMETER

When the spectrometer was first put into operation in the vertex room one of the earliest discoveries was the existence of a pronounced ripple in the output. This ripple produced maxima in the spectrometer output at intervals of about 8 MHz, which suggested that some of the received energy was undergoing a path delay equal to about twice the distance between the main reflector and the Gregorian sub-dish.

Subsequent VSWR measurements with a reflectometer verified that multiple reflections were present. These produced a VSWR variation with frequency not only at the above rate but also at about 60 MHz. The latter ripple frequency ties in rather well with the length of the vertex horn.

Various schemes to reduce the reflection from the sub-dish were tried.

One of these consisted of a plate mounted on the end of the feed tube. The position of the latter was then adjusted to produce a second reflected signal which would cancel the reflection from the sub-dish. This procedure had moderate success but was abandoned because any such solution to the problem would interfere with normal prime focus operation.

A more dramatic reduction in the ripple was obtained by using a quarter-wave plate in the hub horn so that only circular polarization was received.

This "cure" went down the drain, however, when it was later found that it produced absolutely no improvement in the operation of the spectrometer. Twenty-twenty hindsight being what it is, it's all too easy to explai this state of affairs.

When the reflectometer is used, the spurious signal undergoes one reflection and comes back circularly polarized in the opposite sense. This is rejected by the quarter wave plate.

When used with the spectrometer, the quarter wave plate accepts the spurious signal because the latter has been reflected twice and shows up with the correct polarization.

At about this time the astronomers transferred their operations to the prime focus where the problem was thought to be not as great.

Reflectometer tests at this location verified that the reflections were indeed smaller but their effect on the spectrometer output could by no means be ignored.

A ten foot diameter cone placed at the vertex reduced the measured reflections. As it also appeared to improve the spectrometer output for some of the observers some of the time it was later replaced by permanent cone with a hole in the middle. The Gregorian feed horn was not obstructed by this device and so the telescope could be used in the Gregorian mode without having to waste time removing the scattering cone.

As with the quarter wave plate in the

hub, the cone produced a much greater improvement when checked with the reflectometer than was indicated by the spectrometer.

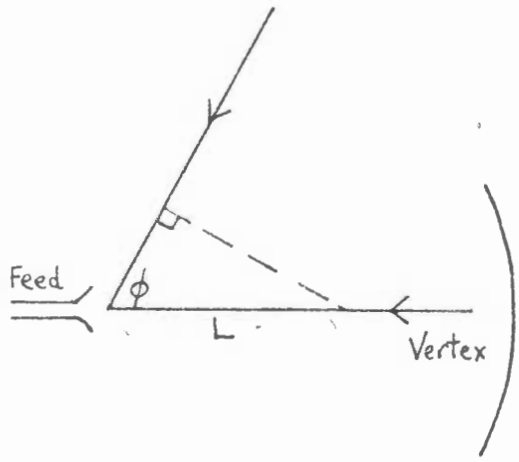
It is thus apparent that the reflection mechanism is not the same for the two modes. As a result of this, the reflectometer has been abandoned and all further sleuthing has been done with the spectrometer.

Early in 1972 an extensive set of data was obtained by measuring the magnitude and "phase" of the ripple for a wide range of feed tube and sub-dish positions. In all cases the telescope was positioned at a zenith angle of zero and five minute integrations were used. Following this, the computer extracted the desired quantities.

Plots of the readings obtained are rather wild but one notable feature is the pseudo-linear relationship between the "phase" of the ripple and the position of the feed tube.

This is also the case for a plot of "phase" against sub-dish position.

If we postulate that one signal comes from the vertex of the main dish- how it got there doesn't concern us for the moment - we can ask what the angle of arrival of a second signal must be to produce the phase feed-position relationship that was obtained experimentally.




A given position of the feed tube produces a peak in the ripple at some point on the display.

If the feed is now moved a distance L, one path is reduced by L and the other by L cos $\phi$ for a net change of L(1-cos $\phi$).

If L is chosen so that the phase shifts 360°, that is, the pattern repeats itself, then

$$L(1-\cos\phi) = \lambda$$

$$\text{or} \quad \cos\phi = 1 - \frac{\lambda}{L}$$

Experiment shows that the distance, L, required to shift the ripple 82 units (channels) is 1.95 inches, with $\lambda$ = 2.84 cm (1.12 inches)

$$\cos\phi = 0.425$$

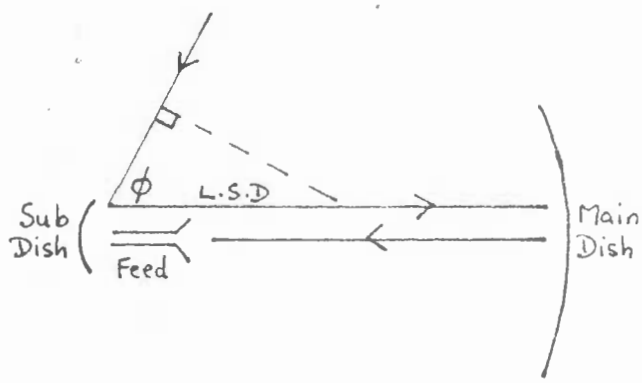
$$\text{and } \phi \simeq 65° \text{ !!}$$

For those not familiar with the telescope, the "!" may be freely translated as "the angle subtended at the feed by the reflector is ± 64°".

In other words, one of the signals is coming in just over the edge of the main dish. As the telescope during these tests was at 0° Z.A., and spill over being what it is, this is not too surprising.

But what of the other signal? To produce a ripple it has to be coherent with the first and so must come from the same source.

Experiment shows that the position of the sub-dish has a profound effect on the ripple so let us assume that the signal which comes from the vertex got there by bouncing off the sub-dish.



As shown previously, a motion of the feed tube a distance L.F.T. produced a net path change of

$$L.F.T. \ (1 - \cos \phi)$$

From the second sketch it will be seen that an axial motion of the sub-dish a distance L.S.D. will produce a net path change of

$$L.S.D. \ (1 + \cos \phi).$$

Thus for equal shifts of the pattern on the spectrometer display we have

$$L.F.T.(1-\cos \phi) = L.S.D. \ (1+\cos \phi)$$

or $$\frac{L.F.T.}{L.S.D.} = \frac{1+\cos \phi}{1-\cos \phi} = 2.48 \text{ for } \phi = 65°$$

Examination of the best fit straight lines on the phase vs position plots gives a value of 2.68 for this ratio - a discrepancy of 8%.

Not exactly NRC time signal tolerance but it's good enough for me.

It is thus reasonable to assume that part of the problem is caused by energy coming in over the edge of the main dish and getting to the feed by reflection from the two dishes as well as directly.

Various cures have been tried. These include absorber on the sub-dish, a scalar feed to reduce the spill over, a twenty foot diameter cone at the vertex of the main dish, etc., etc.

In all cases some improvement has been noted. However in no case was the reduction of ripple really worth the effort.

The original wobbly phase plot hinted at the existence of more than two paths by which the spurious energy was reaching the feed.

Using the above mentioned cures reduces the signals on only one or some of the paths leaving a still sizable ripple on the display. It can only be guessed that some of these other paths involve the focus cabin and feed legs.

To get rid of the ripple completely all but one of the existing paths will have to be eliminated. Easy to say - difficult to do.

Added on top of all this, there is evidence that ripple with a "period" of about 4 MHz is also present indicating that some of the energy makes two complete round trips.

In actual practice an "off-source" integration subtracted from an "on-source" integration should produce a near perfect cancellation of the ripple caused by the radiation from the ground and the sky.

When a source is included in the "on-source" - a reasonable thing to do - the radiation from the source is bound to produce its own ripple which cannot be cancelled by anything in the "off-source".

This ripple should be proportional to the strength of the source and indeed there is evidence that this is so.

Rumour has it that some observatories have had success in ripple reduction by combining integrations at feed positions which are $\pm\lambda/8$ from the focus.

Some doodling shows that this will work only when the main source of reflection is fixed to and moves with the feed.

As they say in the monthly bulletin, "work is continuing."

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*TWINKLE TWANKLE, LET'S BE SCIENTIFIC ABOUT THIS.*

*Scintillate, scintillate point source of light*
*Like a carbon based crystal refracting at night,*
*Your parallax movements one cannot detect*
*Your flux gives the author cause to reflect.*

*B.H.A.*

# ON THE UNEXPECTED COLLAPSE OF THE EARTH TO A RELATIVELY SMALL SIZE

## An Interdisciplinary Horror Story

by

J.G. Laframboise (CRESS)

It began at the laboratories of the Université du Quebec, Varennes, which was slightly ahead of its competitors in some aspects of laser-induced fusion research.

The experiment was done by Denis Beaupre, a graduate student, and Gilles Marchand, a technician, and involved dropping frozen deuterium pellets inside a vacuum chamber, and striking them from several directions at once with laser pulses, in order to create imploding shock waves inside the pellets, causing fusion to occur.

In this case they were using iron pellets in order to debug their apparatus. Since iron was incapable of releasing energy by fusion, it was unable to resist the pressures of the implosion in the same way as deuterium.

The result was that in the first successful test, about a gram of iron was driven inside its Schwarzchild radius, creating a small black hole.

Since a black hole has mass, it must fall through a gravity field like any other object.

On the other hand, no material vessel can contain it once it is made, since it simply absorbs the material of the vessel, cutting a channel through it in the process, and increasing its own mass. The size of the channel will be much larger than that of the black hole itself, since gravitational stresses near it will fragment the surrounding material.

When it is falling through a material object, it must, however, fall rather slowly (at first anyway) since its own momentum is continuously being spread over a relatively large mass of new absorbed material.

Thus it was that several minutes elapsed before their vacuum chamber suddenly refused to hold a vacuum. Investigation with a leak detector revealed a small hole in the bottom of the chamber, somewhat larger at its lower end.

The fact that the hole continued into the concrete floor under the apparatus went unnoticed.

Shortly afterwards a nitrogen bottle ruptured in the basement below, and shot across the room under the pressure of its released gases. The technician who investigated also discovered water from a broken watermain under the floor, coming up through a hole in the floor about 5 mm in diameter.

In transit through the room the black hole had also swallowed several cubic meters of air, but this had gone unnoticed because the door to the room was open at the time.

No further unusual incidents were observed for another three hours, at which time the building had to be evacuated because of an outburst of volcanic gases and molten rock into the basement, at about the same location as the hole in the floor had been found.

This occurred because the black hole had penetrated by this time to the molten part of the earth, and the diameter of its channel had increased to about 20 meters.

Nothing further was noticed until another twelve hours had elapsed. Then the first global effects began to be felt in the form of a succession of earth tremors of rapidly increasing intensity.

By now the black hole had almost reached the center of the earth and had increased enormously

in size. It had now consumed a mass which was beginning to be a significant fraction of the earth's total.

As a result, the earth's crust now found itself atop a ball of molten material which was shrinking significantly, and it, therefore, began to wrinkle.

Large pieces of crust began to break loose and tilt, and slide under the edges of neighbouring pieces.

The oceans, which now had a diminishing area to cover, began to overflow their boundaries, making enormous clouds of steam as they encountered pools of lava which were coming up through fissures in the crust.

Ultimately, the last remnants of human civilization disappeared under vast waves which crossed and recrossed the disintegrating continents.

The last survivors were three Skylab astronauts, Thomas Smith, Richard Mirkwood and Harold Sims. They slept late that morning because no wake-up call came from mission control.

When they finally looked out, the Earth had disappeared and been replaced by a disk of debris, similar in appearance to Saturn's rings. This had been formed during the final collapse of the Earth, by material thrown off because of its spin.

At the center of the disk was a faint blue glow due to bremsstrahlung emitted by gases still falling into the black hole.

Unwilling to believe their eyes, and running low on oxygen anyway, they finally reboarded and undocked their spacecraft and went through normal de-orbit procedure. Their orbit had not changed substantially during the night, because they were still in the gravity field of the same total amount of mass even though greatly redistributed.

Their maneuver put them into a new orbit which had a lower perigee, but which did not encounter solid material anywhere. There they remained until their oxygen ran out.

They were found several hundred years later by a group of visitors from the Pleiades who were investigating an unusual outburst of gravitational radiation from the Solar system.

## CORRESPONDANCE

Monsieur,

Votre journal, très intéressant et varié, a des articles difficiles à comprendre. Il faut s'y prendre deux fois pour lire et comprendre certains articles.

Les titres ne correspondent pas toujours au contenu de l'article, je dirais plutôt qu'ils sont déroutant par rapport aux articles mais une bonne chose c'est qu'on à la tentation de les lire.

J'aimerais rapporter, ici, quelques idées sur l'histoire de la nomenclature en Astronomie: le titre des constellations et les abréviations.

On peut dire que les noms des constellations ne correspondent pas toujours à la figure des étoiles. Comment prendre "canis Minor", "Aries", et "ursus Minor" pour la vraie figure d'un chien, d'un bélier ou d'un ours, sinon en se référant à l'histoire ou encore au voisinage des constellations plus grandes.

Il y aurait toute une étude à faire avec les signes conventionnels et le nom que l'on donne aux planètes. Pourquoi avoir choisi l'aigle pour Jupiter, ou de Saturne l'avoir associé avec les scythes asiatiques?

Pourquoi ne pas expliquer d'avantage ce qu'on utilise à l'observatoire A.R.O.? Lors d'une visite a l'observatoire, j'avais été surpris du travail de Covington et de ses associés au sujet du soleil.

Pourriez-vous ajouter plus de détails au sujet de l'article de Lavrench, page 20, "The feeds and modification produced in the period from 1966-1972"?.

Je sais que dernièrement l'université de Toronto a fait énormément de travail d'observation sur "Cygnus".

Votre idée de mettre dans un journal un peu de tout pourrait être profitable à l'astronomie et je suis content que plusieurs s'y intéressent.

Bien votre,

Roger Lavoie
Institut d'Astronomie
Université Laurentienne

## FOCUS LOCUS HOCUS POCUS

Most observers know that the position of the focus of the 150 foot telescope is a function of zenith angle.

Even if they don't know it matters little because the drivers automatically keep the focus adjusted. They set it according to a standard curve forever enshrined in plastic in the control room.

The standard curve has, of course, reached its sacred position through ritual use over the years. It was originally just a focus-zenith angle curve which some guy measured once back in the Beginning.

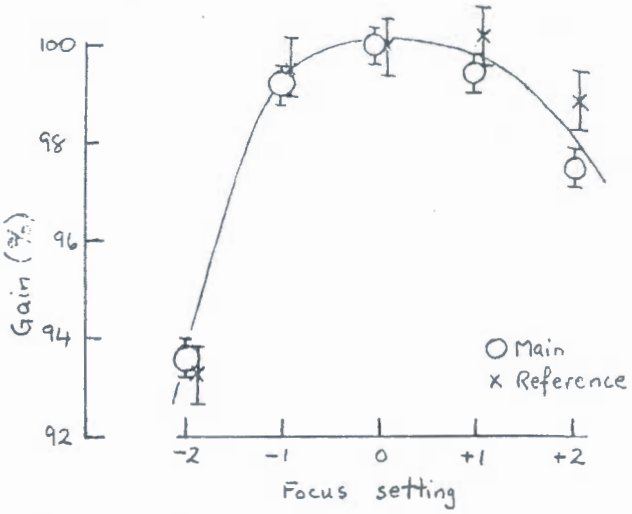
The more astute observers check the accuracy of the focus curve at intervals during their observations. The local dogma has it that any discrepancy from the standard curve can be used as an additive correction for further observations, that the standard curve may change its absolute value but not its relative shape.

That legend must now be accorded the status recently given to the once revered Mr. Christopher, the patron person of travellers.

In June of this year we measured a discrepancy of -0.4 at zenith angle 8°. Fifteen minutes later the discrepancy measured at zenith angle 64° was -2.3.

The difference of 1.9 represents a change in gain of either 6% or 2% depending on the direction of the misadjustment.

B.H.A.




*The dependence of telescope gain on focus adjustment (relative to the optimum setting)*

## NODDER GAIN*

A possible source of error in nodding measurements is the setting of the nodder itself.

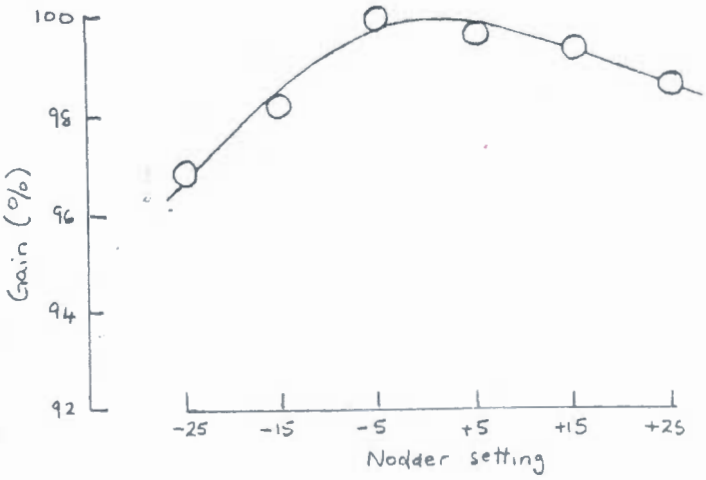
The off-set corresponding to a given setting will remain constant within ±4 arc sec over the whole range of zenith angles. However the setting you measure (in the unlikely event that you ever check the nodder setting) is a function of how you measure it.

You can find one value of the setting by adjusting the dial to find the maximum response from the reference beam. This method gives a different answer from the one you get by scanning through a source with both the main and the reference beams.

The discrepancy is readily explained. The reference beam, being off axis, is asymmetrical, and the so-called peak finding routine in the data system finds not the peak but the centroid of the response.

The discrepancy can be as large as 25 arc secs.

B.H.A.




*The dependence of telescope gain on nodder setting (relative to the optimum setting)*

**A phrase commonly used in expressions such as, "Oh no, nodder gain."*

# Going into Receivership

with Bill Mc Leish
and his Gnomes

## HOW A GOOD AMPLIFIER IS RUINED

The receiver group is ocassionally asked how they can take a 90°K noise temperature amplifier and produce a 160°K noise temperature receiver.

The easy answer of course is that a group of incompetents is unable to appreciate that they are causing the intellectual élite of Canada to spend more time observing than they want to.

The true answer is more shocking - there is a conspiracy afoot to force radio astronomers to accept reality. This is how it works.

To eliminate the bad effects of gain fluctuations in a radiometer either the gain can be held constant to one part in $10^4$ to $10^5$, or Dicke switching can be used. The state of the art in amplifiers produces a gain stability of 1 part in $10^2$ (the manufacturers are obviously not trying - they must be actively opposed to radio astronomy).

Dicke switching requires a Dicke switch. In their private moments the priests of radio astronomy talk about a Dicke switch with 10 GHz bandwidth, zero losses, zero operating time and infinite life.

It is strongly recommended that this switch be used, for in real life the best available are switchable ferrite circulators with 0.25 dB losses.

And, as every one knows, the noise factor of a system is the noise factor of the amplifier times the input line losses (and noise factor converts, indirectly, into noise temperature).

To Dicke switch and get the greatest benefit from it, the off-source antenna temperature at its Dicke switch port should equal the reference noise temperature at its Dicke switch port. This is what you are doing when you balance the receiver, deliberately adding noise to the antenna signal and worsening the system temperature. Pleading ignorance does no good, you pay the penalty all the same.

The reference noise temperature in most of the newest receivers is derived from a flat load at 20°K (the lowest cold station of the helium refrigerator). But this isn't the reference noise temperature seen by the Dicke switch port.

Sybaritic observers insist on working at room temperature and there has to be a connection between the 20°K station and a room temperature connector. If this connection transmits too much heat to the 20°K station the refrigerator stops working properly (another dispute over working conditions - probably the RCEA is the culprit).

A connector with a high impedance to heat (for example a stainless steel coaxial cable) is also lossy, and it usually turns out that the reference noise temperature is between 50 and 60°K at the Dicke port.

(For the doubters who want to check the arithmetic, the losses are around 0.6 dB and uniform temperature distribution is assumed from 20 to 290°K.)

Thus the system temperature at the input to the Dicke switch is the amplifier temperature referred to the input of the Dicke switch plus the reference noise

| Component | Noise Temperature °K | Noise Factor in dB |
|---|---|---|
| a) Amplifier | 30 | 0.42 |
| b) Dicke Switch | | 0.25 |
| c) Dicke Switch + Amplifier | 48.8 | 0.67 |
| d) Estimated Reference Noise | 50 | |
| e) (c + d) | 98.8 | 1.26 |
| f) Calibration Coupler | | .10 |
| g) Polariser and Feed Connection | | .10 |
| h) System = a + b + d + f + g | 117.1 | 1.46 |

temperature.

But this isn't the system temperature in operation.

To inject balance noise and calibrate the system a (lossy) directional coupler is placed before the Dicke switch.

Catering to the observer's idiotsyncracies,* polarisers are placed between the antenna feed and the input to the directional coupler - these have attenuation and the final system temperature is surprisingly high.

A detailed estimate of the new 4.8 cm receiver is given above as an example.

To this system temperature the antenna noise temperature must be added.

Shocking, isn't it? Without the Dicke switch the system temperature comes 53°K plus the antenna noise.

Gnome Evans

**Printed as the author spelled it. A Freudian slip? Or is he trying to tell us something? - Ed.*

---

## INTEGRATE TO BE ALIVE

Most of us are aware of the Jolly Green Giant imprisoned in the receiver room at Site 3, ARO and know that it is a 100 channel 10 MHz wide filter spectrometer.

According to my HP-35 this gives us 100 KHz filters at -3 db points. Because they have triple-tuned circuits they are equivalent in resolution to rectangular filters $\sqrt{\pi}$ times as wide.

In still more obscure language, had we been able to build rectnagular filters, 100 of them would have covered a window 17.7 MHz wide with the same $\Delta T$ as we now have.

Because our filters overlap there is significant correlation between adjacent channels. In fact a monochromatic line centred on a single channel produces a response only 9 db down in the adjacent ones.

The J.G.G. can play one other tune, on filters 10 KHz wide at -3 db. Since these are only single tuned (crystal) filters they are equivalent to rectangular ones $\pi$ times as wide, and the response in adjacent channels to a monochromatic signal is -7 db.

In an effort to extend J.G.G.'s repertoire, a mate is being built for him with filters of 300 and 30 KHz bandwidth. They will be slightly more shapely than the 100 KHz set so resolution should be somewhat improved.

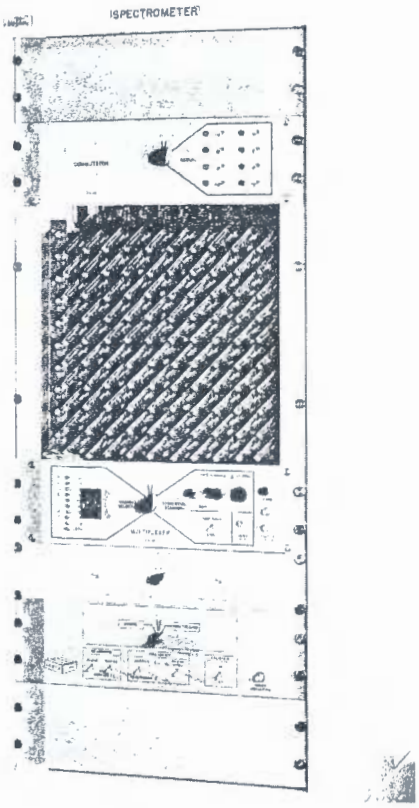
At first users will have a single choice of filter set but if software for the computer can be written it should be possible to call for duets using 10/30, 30/100, 100/300 and eventually 300/900 sets of filters.

With the exception of the 10 KHz and 900 KHz sets the system should work on "total power", and of course any of the new r.f. front ends are compatible with it.

Target date? We'd like to be operating in the first quarter of 1974.

C.W. McL.

Jolly Green
Himself




## FUTURE RECEIVERS

New 1.35 cm and 4.8 cm receivers are being assembled. As is usual with radio astronomy receivers, unusual non standard components are required which have long delivery times. Some components are still awaited for both receivers.

However, most of the components have been received and measured. Nearly all of them have met their specifications.

It is too early to be certain when the receivers will be operational but a late fall (1973) installation of the 1.35 cm system is our first goal.

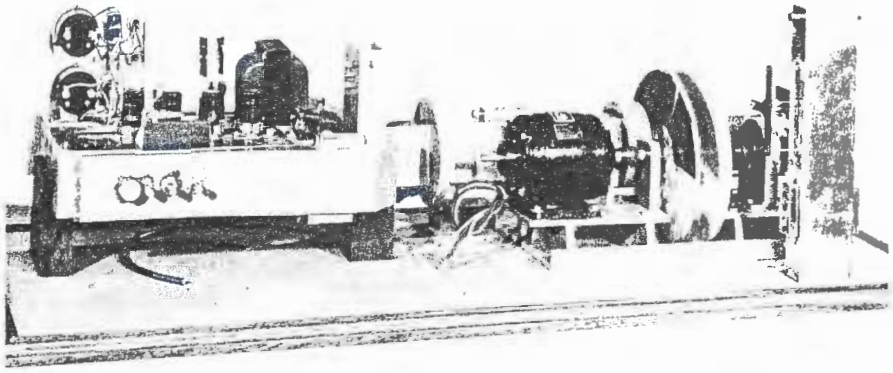
Predicting receiver performance carries a high risk of ovum facialis and is usually avoided.

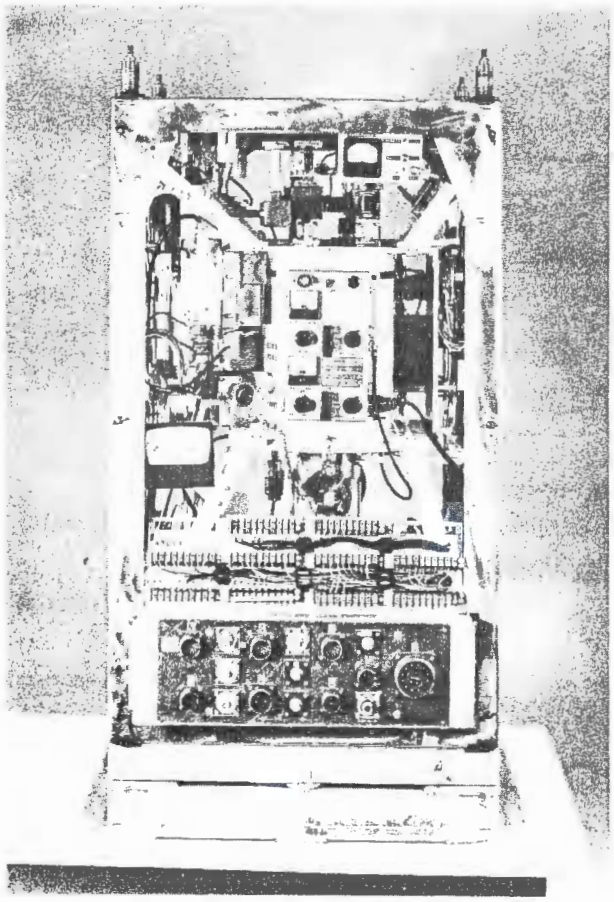
However our present target specifications are listed below with the usual disclaimer that we reserve the right to change the specifications at any time without prior notice.

Both receivers are being built around cryogenically cooled non degenerate parametric amplifiers. In general they will contain the same facilities as are in the new 9.4 cm receiver.

G.E.

| Receiver | Estimated Noise Temp. Dicke Load Switching °K | Estimated Noise Temp. Ideal Total Power °K | Instantaneous Bandwidth MHz | Tuning Range GHz |
|---|---|---|---|---|
| 1.35 cm | 300 | 180 | 300 | 22.235 to 23.0 |
| 4.8 cm | 100 | 50 | 400 | 6.25 to 6.5 |





*The old and the new are contrasted in these two photographs. (The Observer has discovered that the Xerox machine does know how to reproduce photographs.) The upper shows the very first radio astronomy receiver ever built in Canada, Art Covington's 2800 MHz receiver for solar observations. Below it is the best receiver we have, the 10.7 MHz cryogenically cooled parametric amplifier.*

# GOODBYE COPERNICUS

by

Gary O'Neill*

My contribution to radio astronomy can best be described as "second order" and "transitory". "Second order" because I was not doing astronomy per se but providing a service for astronomers, and "transitory" because my contribution will last only as long as the ARO computer system survives.

However I did work on the three major systems at ARO, namely, the data acquisition system, LBI, and the line receiver, and I suppose I can claim some small credit for scientific advances proceeding from the use of these.

If my effect on radio astronomy was minimal, radio astronomy's effect on me will require consideration at some greater length. In any endeavour one has likes and dislikes. However in my case the likes were happily numerous and the dislikes few.

The most salient feature in my "like" profile would have to be "people".

The people at NRC and from the universities with whom I worked and with whom I was acquainted were a joy and a blessing. This applies to the support and service personnel, secretarial staff and even by and large to the radio astronomers.

The latter group, being somewhat more diverse and demanding, posed certain problems at times in establishing a viable relationship. However even very few of this rare breed could be classified as "vexatious to the spirit."

Another large plus factor was the freedom I enjoyed in carrying out my duties.

With frequent weekend trips to ARO a part of the normal routine, working hours were pretty well a matter for one's own conscience. Coupling this with a project oriented approach to work tasks,it afforded one an atmosphere of freedom and responsibility which encouraged a level of achievement superior to that of a more restrictive and over-supervised environment.

This "adult" approach expected by so many scientists was particularly cherished by me. I had previously worked for an organization which insisted on an inflexible system of working hours, and I hated it hugely.

Certainly I'll miss Fred's cooking. The affable chef in the wilderness made the frequent trips to ARO more palatable.

An army marches on its stomach, and to some extent the same is true of the operation of a radio observatory, such as ARO. As one who has availed himself of Fred's culinary services frequently and I might add heartily and with

* *Gary O'Neill was a computer programmer (and a damn good one) with the Radio Astronomy Section of NRC from 1967 to 1970. He left us to take up law, and enrolled at the University of Ottawa, from which he graduated with distinction this year, coming second in his class and picking up several prizes and honours on the way.*

*His departure from NRC was more of a gradual Chesire cat withdrawal than an abrupt disappearance. He has returned here every year as a summer student, and has put in occasional winter weekends at ARO, which means that actually we have seen about as much of him as we see of the Chief.*

*I asked him to tell us why he left science, and what his thoughts are on looking back at it. — Ed.*

thorough enjoyment, I must think that he deserves a large measure of the credit for the smooth functioning of ARO.

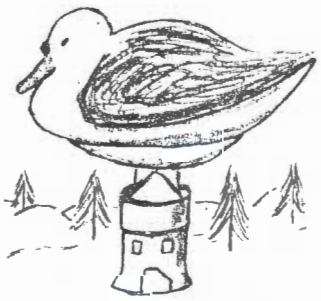
On the other hand I will not miss my trying experiences with the bathroom scales which inevitably followed trips to the observatory.

The disruption thrust into one's life by the necessity of working at ARO was probably the number one dislike on my list, though working the midnight shift was a close rival.

A somewhat distant and annoying third were the omnipresent blackflies and mosquitoes.

An inquisitive reader at this stage might wonder what caused me to leave at all seeing that I seem to have liked more than disliked.

The best explanation I can give is that I was faced with an increasing lack of interest in things scientific generally and in things computer specifically. Although the peripheral aspects of my work were quite satisfactory, I was coming to view computing more and more as a sterile activity.



Faced with waning interest in my work with computers I decided to leave the scientific field and enter another which I felt was more compatible with my interests. My subsequent three years at law school have happily proved that my decision was the correct one.

It is difficult to pinpoint the cause of this diminishing interest.

I don't think I was greatly influenced by the current anti-scientific tack of public opinion. Probably my initial reasons for entering science were superficial. My assessment of my abilities, inclinations and talents was influenced too strongly by my desire to enter the realm of the scientist and engineer.

Though I had several peaks of interest subsequently, I never had the solid sustained interest which one should have to spend a lifetime at a particular endeavour.

The question arises whether or not my astronomy background has prepared me in any way for my new profession.

Certain acquired skills are indispensable to a practicing lawyer.

Firstly, the mechanical skills of reading, writing and spelling are essential. In this area my radio-astronomy experience has been tested and found wanting. After working with mnemonics for so long I have acquired a great facility for producing sentences like "NABL DRTY CLON CLOF OOPS SPEC!" However I am hesitant to claim that such consummate skill will be an asset in a legal career. Despite the fact that the man in the street probably thinks legalese is every bit as unintelligible as the afore-written sentence (and probably conveys less information) I have a deep foreboding that the legal community, conservative as it is, would be slow to recognize such a talent.

Radio Astronomy, you get a minus rating here, but things get better.

Analysis. Law professors continually drive home to their students that the single most important tool of any lawyer is the ability to analyse, analyse, analyse.

Well I certainly won't hesitate to say that my former career has stood me in good stead in this area. In fact with all modesty I can say that I'm strong on analysis.

Let me give you a typical example: the problem of whether to go to ARO on a Sunday afternoon and miss the football game on CTV, or to go up on Sunday night and miss Fred's steak dinner.

It takes little imagination to realize that a mind honed sharp on analytical problems of such proportions would regard the analysis of the element of mens rea* in specific intent offences as mere child's play.

Communication is of the essence in a legal practice. Here again I feel my past experience will serve me well. Once one has had any success at all communicating with the TSS terminal, any communication of the man to man variety becomes trivial.

* *Rea, the plural of the Latin reum, or room. Thus mens rea, or mens rooms, the site of many of the types of offences considered above. - Ed.*

My experience has probably left me weak in directing secretaries' activities but using the services of 1/32 of a secretary is better than no experience at all.

The final areas where expertise is needed are office management and accounting.

In the former case I have relatively little experience. At NRC the first problem was to find an office and the second to keep it. Little time was left for managing it.

However, at one point I did have the opportunity to requisition a clock and supervise its installation.

As for accounting, my experience consisted almost solely of attendance sheets and travel expense forms. In filling out expense forms I acquired especially valuable experience in juggling figures. It's probably only a small step from there to the corporate balance sheet.

On reflection, it is quite remarkable how my experience in radio astronomy has prepared me for the legal profession. Astronomy has indeed been good to me.

However I certainly hope that I haven't precipitated a mad rush of astronomers and like personnel to the law schools, leaving the astronomical ranks decimated.

There's always that danger in writing a revealing article such as this.

## NEW GADGETRY

John Zelle announces the installation of a new pointing corrector in the 150' telescope control system. This analogue device is installed in the error detector circuitry. It can put in offsets of up to 30 arc secs in both zenith angle and azimuth angle. These offsets can be used to counteract any small misalignments of the feed horn.

At the moment the range is limited by the linearity of the error detector field. It is hoped to extend this range in the future.

There are plans to install a similar device in the Master Equatorial unit. All four components of the pointing error curve could then be readily corrected. However any changes in the quantities with hour angle or zenith angle would still be present, because the devices apply only a constant offset.

There also remain uncompensated and uncomprehended those mysterious changes which are at the moment attributed to telescope deformations caused by changes in the weather.

The alt-azimuth device has been tested by Chris Purton to his apparent satisfaction (mutterings of 1 arc sec were heard). Chris is fussy about his pointing. If he is satisfied, everyone up to, but excluding, Norm Broten should be satisfied.

B.H.A.

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*I want to make this perfectly clear...*

Subject to conditions on his length of stay.....an individual can travel from Sydney to Vancouver for less than $100 more than a group of 15 or more. *CAS Newsletter no. 3.*

- whereas by the regular flight you have to travel for more than $100 more than a group of 15 or more. Moreover you could probably travel for much more than $100 less than a regular fare and more than $100 less than a group of 15 or more if you travelled in a group of much more than 15. Nevertheless it would probably be more convenient and less difficult to form a group of 15 or more, in which case you could travel for more or less the same as any other group of 15 or more.

Now for the journey from Vancouver to Sydney the situation is more complex .....

B.H.A.

# TRYING OUT COMPUTER CONTROL

by

Lostina Fogg*

As far as I know, the only astronomers, or would-be astronomers, who have used the control system (apart from Lloyd Higgs) are Chris Purton, Don Retallack, and myself. Don has had many hours of successful observing with the system, mostly for mapping, but the efforts of Chris and myself have been largely unsuccessful and somewhat frustrating. I'd like to record my impressions, even though many of the errors were my own, and most (or all) of the bugs have been fixed in the May '73 system.

First, I've found that control works pretty much as advertised - the computer does control the telescope and focus (polarizer I haven't tried - N/A for the 2.8 low-loss feed anyway). It just can't be beaten for slewing to a new source - there's no waiting while the driver studies his chart to decide which way to drive the ME and telescope. It also tells you instantly if the source is in a limit.


Slewing motion is faster than under desk control, so as soon as you type or push NEXT or enter coordinates, it rushes off at top speed, via the shortest route, to the source. It rushes right into the scan as well when it gets there, maybe before you were ready, but I understand SW2 up will now prevent this, at least for time scans.

For a long series of scans it's slower than using the autoscan facility of the old system, because it seems to do more checking when turning around.

The ability to work in 1950 coordinates, corrected for pointing errors, is very nice (particularly for map-makers) and though I haven't tried the galactic coordinates, I'm sure this feature would benefit the same people.

It does take some practice to get used to it, since the computer needs to know a bit more from you than before in order to control things. It's a bit like asking the driver to move off source for a minute and having him ask, "What direction? How fast? How far?". The annoying part is that many mistakes are fatal, i.e. you lose control and can't get it back without the driver's help.

Locking in sometimes doesn't work. There appears to be some problem with the amplifiers in the tower, which need to be balanced pretty finely, or it stays in ED course. The control group types are quite happy to balance them if there is any difficulty with this problem.

A new set of pre-sampling filters has been installed. The switches also control what the computer thinks the delay is, and of course the whole thing will work incorrectly if the delay is incorrectly known. Unfortunately, the code is different for the new and old systems, so there's a switch at the back of the panel which changes the code sent to the computer.

Check with the driver or a member of the receiver group about the setting of this switch, or better yet, have them do it.

What hasn't worked well is the user's software, i.e. the AQ subroutines. These were written for the old system, and many will require a few changes to be compatible with the new system. Lloyd Higgs has modified the most frequently used routines (scan averaging, source finding, nodding, etc.) to work with the new system. Others may work, but should

**Lostina Fogg is the pen name of Andy Woodsworth of Queen's University. Andy is one of the first to have a crack at the new computer control system, and he records his impressions here. Andy is a well known try-anything-once-er. Last summer, it is rumoured, he tried alligator wrestling. I'm sure we all owe a great debt of gratitude to Andy, who wrote this article with a pen held between his teeth. - Ed.*

be used with caution until it's clear they're working properly.

Unfortunately, with the release of more than one version of the new system, the continued existence of the old system, and the installation of new filters and switches, there is a confusing variety of modules, library tapes, and paper tapes at ARO and it's extremely difficult to find out which ones are the correct ones. This will hopefully be tidied up shortly.

I suggest that working source finding and nodding modules be specially marked "Welcome to the ARO control system", and documented clearly for people to get started.

I suggest particularly that people do get started, i.e. try out the new system. The system can't be debugged unless people try it to discover what, if any, bugs are still left.

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## CONTROL INFUSION

by

Don Retallack, Queen's University

Want to use control but don't know how to get started or whether it's worth it yet? Good, at least you're interested and may even have gone so far as to read the notes on the new system; if you haven't, *do so now*, I'll wait.

Understand them? Well, neither did I at first, but I've successfully used the system for all my observing during the last eight months and will reveal all (almost!).

First, rumours of bugs have mostly been true but the system has worked well since December and the latest (May '73) is great and can do all those wonderful things like source finding, nodding, etc., and more (can any driver scan in galactic coordinates?). Remaining problems are related to software as the new system is incompatible with existing modules and some AQ subroutines.

As a start then, here's a list of AQ routines that I *know* do work (have I ever lied to you before?):

| | | |
|---|---|---|
| QLLYNC | *AACAVM | *QLNSRC |
| QLRCVR | *QLNOIS | *AACVIM |
| AAPASS | *QLAZND | *QLSTA5 |
| QLRCRD | *QLSONF | *QLSTA6 |
| AAPANG | *QLNODC | |

The ones with a * are new or changed routines and are documented at ARO and/or in a memo from L.A. Higgs dated March 5, 1973. These (the ones with a *) *must* be loaded from paper tape at module generation time *before* the system tape is searched, and can be provided by the computer group.

And here's a list of modules with some notes (more detailed notes and sample runs are at ARO - ask the computer group for appropriate system tapes):

APTG (L.A. Higgs)
Source finding with scan averaging in 1950.0 equatorial coordinates and catalogue mode. Basically similar to previous source finding modules.

SRC1 (D.S. Retallack)
Same as APTG except different status routine.

RECT (L.A. Higgs)
Receiver testing module, similar to old RXTS except does test at A.Z. = 90° and Z.A. = 45°.

NODR (L.A. Higgs)
Z.A. Nodding in 1950.0 coordinates and catalogue mode. Provides 3 minute nod with 1/2 second sample interval and

defaults to 50 samples per element. ES.1 gives short RA50 scan. Basically similar to previous nodding modules (e.g. NOD3).

AZND (L.A. Higgs)
New module which nods (wags?) in longitude (e.g. RA50) but does not do main-reference changing. This module is useful for on-off measurements and is written for 1950.0 and catalogue mode. ES.1 is a short RA50 scan (which must be first element of a scan pattern), ES.2 is on-off, and ES.3 is calibration.

MAP1 (D.S. Retallack)
Mapping module (no scan avg.) in 1950.0 coordinates and non-catalogue mode. ES.1 is RA50, ES.2 is DC50 but both have empty event schedules (fill in your own STRT, STOP, ORTH, and STEP events in absolute units). ES.3 is calibration.

MAP2 (D.S. Retallack)
Same as MAP1 but 600 point scan averaging included.

SRC2 (D.S. Retallack)
This one does source finding (with scan avg.) in 1950.0 coordinates and catalogue mode similar to APTG or SRC1 and does on-off scans similar to AZND (hence it's nicknamed superscan). To use it, use ES.1 for source finding, changing the P coordinate to DC50 to do DC50 scans (the module loads in RA50). Then use ES.2 for on-off scans at found source position and ES.3 for calibration.

MAP3 (D.S. Retallack)
Will do 10 BW square map around a source in 1950.0 coordinates and catalogue mode. Resultant data is compatible with L.A. Higgs' contour mapping program (but remember to use a data tape). Module provides the options of scanning in RA50 or DC50 and of using reference scans. It will take about two hours to acquire data for the map.

All of the above modules are sufficiently complete that a novice can easily use them and sufficiently general that an experienced user can easily modify them for special tasks. However, I recommend that before using them, you talk to someone who has.

A few words now about actually observing. Obviously, space doesn't allow a complete users' guide here so I'll briefly record hints, reminders and suggestions that I've found useful and have noted in my copy of the notes on the new system.

Note that you can't even *get* control if the driver doesn't cooperate (no, Don, that long piece of aluminum rod over by the barometer is *not* to be used even if the driver *is* asleep). You will probably make mistakes which abort control but don't be discouraged, you'll learn sooner or later (I hereby claim the record for longest continuous control - 8 hours, and I only aborted because it was breakfast time!).

The teletype (like all teletypes) occasionally mis-reads the paper tape and aborts control so be prepared to stick around (or come back to find that the telescope has just been sitting throughout the hockey game!).

When setting up, get the ARO staff to turn on the new observer's console, set the filter identification code switches and balance the lock-in amplifiers. Also make sure that you get a May '73 system tape. The drivers don't know what you're doing under control* and therefore can't keep a log so make sure that your module has a status routine and keep switch 23 up or you won't know later what you've done.

To execute a scan, the event schedule must tell the computer what you would (or should) have told the driver previously - polarizer position, scan rate and orthogonal coordinate (or tracking mode and dish position for time and polarizer scans). 1950.0 and Galactic coordinates can only be used if independent day numbers have been loaded (if not, RA50 and DC50 default to R.A. and DEC. but GALL and GALB are useless).

If the polarizer position is not specified (or specified with a negative argument) the polarizer stays fixed

**That will make two of you - Ed.*

wherever it happens to be (in Altaz system). This is handy for the low-loss feed at 2.8 cm but if you want a particular polarizer setting with other feeds, you must say so to the computer. Note that the driver's desk indicator shows only the Altaz polarizer position even though the Equatorial light is on.

The catalogue mode is extremely useful (probably the best new system addition) but takes some careful reading to fully comprehend. In the catalogue mode (YCAT), all events are relative to the source position and, further, in the beamwidth mode (BW) all offsets are relative to the source position *and* are in beamwidths (don't forget which modes you are in or the telescope may go screaming off).

Keep your eyes on the console lights indicating YCAT and BW and check that the event schedule is set up the way you want it. Note that when loading a source catalogue, the source name must be 8 characters long (padded with blanks if necessary) and the source must be recalled from the catalogue with exactly the same name, including blanks.

The first source coordinate is assumed to be in hrs., mins., secs., if /LDSC and /SORC are used, and in deg., min., sec. if /LDSC1 and /SORC1 are used. When a scan is enabled, absolute event positions are copied by CPES; at all other times only the relative positions are copied.

In the BW mode, event displacements and scan rate are cos $\delta$ corrected so modules can be not only receiver independent but source position independent as well.

Not all commands are legal paper tape commands - illegal ones abort control - so check the notes on the system.

Check with the computer group at ARO for the procedure for loading subroutines when generating a new module (libraries are no longer on system tapes but Gord and Mike can get around that!).

Don't be put off by all those beautiful new lights, do make comments and suggestions to the appropriate people, and don't be afraid to call for help - I'll talk to you even if it is 3 a.m.* Good luck!

**But what will you say?*

---

## W A N T E D

250 reels of missing magnetic tape

300' reels in the ARAxxx series
300' on 600' reels in the ARCxxx series
600' reels in the ARExxx series
1200' reels in the ARGxxx series
1200' on 2400' reels in the ARJxxx series
2400' reels in the ARLxxx series
1200' reels in the ARNxxx series

The ARNxxx series are thought to have strayed south of the border. Note also the following long lost strays.

| | | | |
|---|---|---|---|
| ARA | 016 | ARG | 084 |
| ARC | 002 | | 088 |
| ARE | 030 | | 091 |
| | 033 | | 092 |
| | 039 | | 098 |
| ARG | 002 | | 100 |
| | 007 | | 101 |
| | 009 | | 109 |
| | 028 | ARJ | 001 |
| | 041 | | 003 |
| | 042 | | 007 |
| | 050 | | 009 |
| | 052 | | 010 |
| | 054 | ARL | 002 |
| | 062 | | 007 |
| | 074 | | 010 |
| | 075 | | 012 |
| | 076 | | 013 |
| | 080 | | 021 |
| | 083 | | 923? |

Tape no. ARL 013 has been returned from the Computation Centre, with the only external marks Scratch Tape #1, file #1 DRX Noise Test file #2 DRWS Test 4.5 Hz Filter, #3 DR.NSW.Test 4.5 Hz Filter, #4 RAW.AVSP,93,94,95,96 Point 16.

If you are concerned about Scratch Tape #1 data or can shed any light on the whereabouts or use of the above strays please contact June Burrell, Radio Astronomy Section, M-50, NRC.

She promises a reward.

# TWO DATA ACQUISITION MODULES

Details are given below of two programs I've written for ARO.

The background correction calculation has been used frequently by me, and to some extent by Chris Purton, and performs as advertised. It reduces to zero the amount of tedious scaling from the chart records and calculations previously required. Of course, it will only be useful to people who like to grovel about in the noise.

The spectrum tape routine is very simple, and definitely works, but its usefulness remains to be demonstrated. The weighted scan averaging routine (AVSP) probably holds the most promise. To do this, one would have to make sure that the event schedules of the scans being averaged "line up" to better than a sample interval.

Andy Woodsworth

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IDENTIFICATION: Background Correction Calculation

NAME: QLBKGD

AUTHOR: A. Woodsworth

LANGUAGE: FORTRAN

SUBROUTINES REQUIRED: IOCS, FLOAT, SQRT, H$22, M$22, D$22, A$22, S$22, FPIN, FPOP

PURPOSE: This subroutine will calculate the slope of a least squares linear fit to receiver output, with standard error. It may use the output from a scan averaging routine. After each zenith angle scan the background correction in flux units and standard error are typed out. There is no limit to the number of samples taken.

USE: ES.3 must contain a calibration of the usual type (QLLYNC). After the calibration the operators flag is set to 21 -- i.e. type /FLAG 21. When ES.1 or ES.2 are enabled, the routine will request the following information, which must be entered in exactly the format specified, padded out with trailing zeros if necessary.

ENTER CAL STEP & S.E. OF CAL JUST COMPLETED
FORMAT XXX.XX,XX.XX

ENTER PEAK FLUX DENSITY OF STANDARD SOURCE IN F.U.
FORMAT XX.XX

ENTER MEAN/CAL AND P.E. FOR STANDARD SOURCE
FORMAT XXX.XX,XX.XX

ENTER BEAM SEPARATION IN ARCSECONDS

If any of these are not known at the time, a value which will facilitate later scaling should be entered, i.e. 10.00

When the scan is completed, the message below is typed out.

SLOPE = XXXXX.XXXXXX SIGMA = XXXXX.XXXXXX

BGCORR = XXXXX.XXXXXX SE = XXXXX.XXXXXX

SLOPE is the slope of the least-squares linear fit, and SIGMA the standard error in SLOPE in units of 2mV/arcsecond. BGCORR is the correction which must be added to any nodding result, and SE the standard error in BGCORR, in flux units.

NB Once the correct parameters have been entered, any number of scans may be done. New parameters will only be requested when the flag is set to 21.

METHOD:

$$\text{SLOPE} = \frac{(n\Sigma x_i y_i - \Sigma x_i \Sigma y_i)}{0.1545\,(n\Sigma x_i^2 - (\Sigma x_i)^2)}$$

$$\text{VAR} = \frac{\Sigma y_i^2 - \frac{1}{n}(\Sigma y_i)^2 - (\text{SLOPE})^2\left[\Sigma x_i^2 - \frac{1}{n}(\Sigma x_i)^2\right]}{0.1545\,(n-2)\left[\Sigma x_i^2 - \frac{1}{n}(\Sigma x_i)^2\right]}$$

$$\text{SIGMA} = \sqrt{|\text{VAR}|}$$

where the factor 0.1545 converts from computer arc units (binary fraction of a circle) to arcseconds

$y_i$ = $i^{th}$ sample of receiver output

$x_i$ = $i^{th}$ sample of zenith angle

n = number of samples (unlimited, since samples not stored)

$$\text{BGCORR} = -\frac{\text{SLOPE} \times \text{SSFD} \times \text{SEP}}{\text{CALL} \times \text{MEANC}}$$

$$\text{SE} = |\text{BGCORR}| \times \left(\left(\frac{\text{SIGMA}}{\text{SLOPE}}\right)^2 + \left(\frac{\text{SEL}}{\text{CALL}}\right)^2 + \left(\frac{\text{PE}}{\text{MEANC} \times 0.6745}\right)^2\right)^{1/2}$$

SSFD = standard source flux density
SEP = beam separation
CALL = calibration step
SEL = standard error in CALL
PE = probable error in MEANC
MEANC = mean/cal for standard source
0.6745 converts from p.e. to s.e.

Notes: A module (ANDY) using this routine is on my tape. It contains scan averaging, but I tend not to average scans. The most efficient method I've found is:

1) Do a calibration (ES.3),then type /FLAG 21

2) Enable ES.1 and enter required parameters

3) Drive the telescope in zenith angle at 5°/minute from the zenith to the horizon, taking a series of 4° scans (all in the same direction) clearing the arrays and event schedule between scans. The sequence of push button commands is:

STRT 4° scan, say 1°-5°, 6°-10°, etc
STOP
NABL
ABRT clears data area in scan averaging if SW 16 up
CLAN removes event schedule and enables

4) At bottom (80°) reverse and go back up, as in step 3

5) Average the two sets of results, omitting obvious anomalies. It will take about 40 minutes to do all of this, and for consistent weather, the results will be reasonably consistent from day to day.

QLBKGD is not on any magnetic tape libraries at the moment, but I can mail a copy of the paper tape to anyone wishing to generate their own module.

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IDENTIFICATION: "Spectrum" Tape from Scan Averaging

NAME: QLLINE

AUTHOR: A. Woodsworth

LANGUAGE: Assembler

SUBROUTINES REQUIRED: FLOAT, IOCS

CORE: $63_8$ + Subroutines

PURPOSE: This program will output the averaged data from a 100 point scan averaging routine in the format of a line receiver spectrum tape.

USE: If SW 15 is up, the "spectrum" tape is punched at the end of the scan. The tape may be loaded by the line receiver software later, for weighted averaging, baseline smoothing, display or plotting, using /AVSP or /LDSP commands.

METHOD: The 100 (or less) points in the summed data area are floated and dumped (in floating point format) starting at location '43715. Since this is normally in the background, background programs can not be run in this part of core while the tape is being punched. They may run at all other times, however.

Notes: A working module (KRIS) exists on my tape. It has a pointing scan initialization of 6 BW, but one can expand the scan to 10 BW -- any longer will cause an array overflow.
The module also contains source finding, and a status report if SW 23 is on. Anyone wishing to generate his own module will have to obtain the paper tape from me, and at the moment one patch will be required.

## THERE'S A TIME AND A PLACE

Once upon a TIME there lived, in the far off woods, a big ogre and a family of lesser ogres who were, however, just as evil. This ogre existed on that most ethereal of quantities - TIME. (Pardon me, Einstein, but the question of relativity of this story depends on your frame of reference.)

The poor mortals who came in contact with these ogres were often reduced to blathering idiots and were seen frequently whispering into the sympathetic ears of their Friendly Programme Committee. (One of these mortals suffered so consistently from the ravages of these ogres that it was rumoured that a little black cloud hovered over his head.)

The Friendly Programme Committee did what little they could to placate these overwrought mortals by assuring them that it was only a matter of TIME before the solution to their problems could be found.

Now there lived in a nearby castle a knight errant (or should it be errant knight) and the usual cortege of squires, footmen, pages, servants and cooks. This knight struggled with the ogres in vain for the big ogre had grown strong from his bountiful supply of TIME.

In desperation this knight appealed to the chieftain of a far-off kingdom for assistance. This chieftain then appointed his most valiant of knights to gird himself in his armour and take up the struggle with the giant ogre. The knight immediately became airborne, and lo, the giant ogre began to get weak from loss of his sustenance - TIME.

The knight of the castle, with his squires, footmen, pages, and servants, fought valiantly with the lesser ogres and one by one reduced them to mere skeletons of their former selves.

Norm Broten

### 150' TELESCOPE, DOWNTIME, MAY 1971-APRIL 1973

| | Telescope Breakdown | Computer Breakdown | RCVRS Breakdown | Total Telescope Systems | Misc. * Breakdown | Total Overall Downtime |
|---|---|---|---|---|---|---|
| May 1971 | 3.18% | 0.36% | 2.86% | 6.4% | 5.25% | 11.65% |
| June | 2.37% | 0 | 5.41% | 7.78% | 9.00% | 16.78% |
| July | 0.05% | 1.54% | 11.31% | 12.90% | 2.50% | 15.40% |
| Aug. | 1.35% | 0.22% | 6.66% | 8.23% | 11.50% | 19.73% |
| Sept. | 0.24% | 0 | 9.40% | 9.64% | 2.25% | 11.89% |
| Oct. | 1.29% | 0.36% | 1.15% | 2.80% | 2.50% | 5.30% |
| Nov. | 0.70% | 0.61% | 4.91% | 6.22% | 1.23% | 7.45% |
| Dec. | 3.51% | 0 | 5.40% | 8.91% | 3.51% | 12.42% |
| Jan. 1972 | 2.25% | 0.18% | 3.67% | 6.10% | 4.15% | 10.25% |
| Feb. | 3.14% | 0 | 1.22% | 4.36% | 2.18% | 6.54% |
| Mar. | 1.37% | 0.53% | 0.26% | 2.16% | 4.38% | 6.54% |
| Apr. | 0.74% | 0.79% | 4.46% | 5.99% | 2.23% | 8.22% |
| Average: | 1.68% | 0.38% | 4.73% | 6.79% | 4.19% | 11.01% |

**i.e. acts of God, snow, wind, rain, LBI equipment not working, etc.*

| | Telescope Breakdown | Computer Breakdown | RCVRS Breakdown | Total Telescope Systems | Misc. Breakdown | Total Overall Downtime |
|---|---|---|---|---|---|---|
| May 1972 | 0.44% | 0.40% | 2.35% | 3.19% | 9.75% | 12.94% |
| June | 1.84% | 0.17% | 6.87% | 8.88% | 1.21% | 10.09% |
| July | 0.49% | 0.53% | 2.72% | 3.74% | 1.11% | 4.85% |
| Aug. | 5.78% | 0 | 0.86% | 6.64% | 8.95% | 15.59% |
| Sept. | 1.14% | 4.89% | 0 | 6.03% | 4.47% | 10.50% |
| Oct. | 2.21% | 4.58% | 0.87% | 7.66% | 11.68% | 19.34% |
| Nov. | 2.97% | 0.54% | 0.83% | 4.34% | 5.12% | 9.46% |
| Dec. | 1.96% | 0.10% | 2.49% | 4.55% | 10.82% | 15.37% |
| Jan. 1973 | 0.36% | 0 | 0.17% | 0.53% | 9.43% | 9.96% |
| Feb. | 0 | 0 | 10.48% | 10.48% | 15.27% | 25.76% |
| Mar. | 0.75% | 0.96% | 3.96% | 5.67% | 2.75% | 8.42% |
| Apr. | 0.19% | 0.10% | 1.83% | 2.12% | 13.02% | 15.14% |
| Average: | 1.52% | 1.02% | 2.79% | 5.32% | 7.80% | 13.12% |

All Downtime expressed as a percentage of actual program hours on duty.

J. Zelle

---

*Sorry about that, Bud the Spud (Stomp)*

Rene St. Denis accosted me the other day.

"What," he demanded, "happened to P.E.I."

I stared blankly. P.E.I. has never been more than a trifling with the fringe of my consciousness. I was unaware of any reason that I should be regarded as a source of expertise on the subject.

"The cover of the ARO Observer", he repeated, "whatever happened to P.E.I.?"

I shuffled the papers on my desk and found a copy of the last edition. Sure enough, P.E.I. was missing from the map on the cover.

"Look", I said, "we've got Anticosti Island and Newfoundland. What are you, some kind of island freak?"

"I'm going there this summer", he replied sorrowfully, "I looked for it, and it wasn't there."

I hope his landing is not as wet as he seems to be anticipating. In the meantime I can only apologise to P.E. Islanders. If you survive Rene's visit, I'll try and get you back in Confederation in time for the next issue.

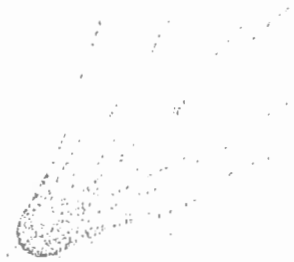
B.H.A.

## C O N T E S T

The editor is pleased to announce the ARO Observer's Most Atrocious Pun Contest. The only rule of the contest is that the pun must appear in the heading or text of a contribution to the Observer. Leading contenders so far are Chris Purton's 'Much Ado About Nodding' (Observer No 1) and Bill McLeish's 'Integrate to be Alive' (this edition).

First prize is a mouth-sized piece of adhesive tape.

# The Comet's Tail



## IN DEFENCE OF THE FLAT EARTH SOCIETY

The most valuable thing I learned in four years at Cambridge was that to be a success in life it is not necessary to know a great deal. It is sufficient to sound as though you do.

I was raised in Glasgow, a dour city of sceptics and scoffers and bellicose disputations. I learned early that you had better be sure you knew what you were talking about before you opened your mouth. If your friends ever caught you in a mistake it would be years before they would ever again pay any heed to anything you said.

I remember one unfortunate who ventured the opinion that Acker Bilk, a jazz musician popular at that time, was a Dutchman and a graduate of the Dutch Swing College. When some later research on the sleeve of a record revealed that the self same Bilk was a former R.A.F. corporal from Somerset (Acker, it seems, is Somerset for mate, or friend) my friend's fate was sealed.

For the rest of our time at Glasgow University, his every statement would be put down by someone with a sour "Aye, an' you're the bloke who thought Acker Bilk was a Dutchman."

It was thus that my arrival in Cambridge occasioned me some considerable surprise. (I cannot say what kind of trauma I engendered in the Cambridge system). That beautiful city, I found, and in particular its university, was filled with beardless striplings who proclaimed loudly and at length on a wide variety of subjects and with such complete self assurance that I, uncouth hayseed that I was, was convinced of their omniscience.

This conviction was reinforced by my observation that none of their proclamations was ever seriously challenged. Indeed the protagonists in a discussion would treat each other with a civility which implied mutual congratulations on their inherent wisdom.

I immediately developed a giant inferiority complex under which I laboured throughout my years there. Not wishing to reveal my ignorance, I kept my own counsel and avoided all serious discussion outside of a small circle of very close friends. True, I occasionally noticed a puzzling discrepancy between fact and opinion, but I continued in a state of awe until the end of my time there.

It was several years after leaving that I came to the opinion I now hold, that many of the young gentlemen of Cambridge are full of beer and sandwiches, and that the rest of the world knows a thing or two as well.

Glasgow and Cambridge are a long way from Fredericton, New Brunswick, but the subject that I have just rambled through and around is not far removed from the Flat Earth Society of Canada. The F.E.S.C., you may remember, was described by their President, Leo Ferrari, in the last issue of the ARO Observer.

The first reaction of most of you on hearing of the Flat Earth Society was

probably one of scorn, disdain and disbelief. "Cranks." That was my own initial reaction on first encountering the Flat Earth Society through the medium of the television programme 'Take Thirty'. It was some ten minutes into the programme that I began to feel that I was being put on.

I have little doubt that it is just such a conditioned reflex which most delights the members of the Flat Earth Society. I can only suggest, however, that if you persisted in your initial contempt towards them, then you did not read in the article what was actually said but what you expected to see.

Most of you, I expect, eventually decided that they were a bunch of looney jokers indulging in some relatively harmless fun. Well, they're certainly all of that. But there is more to it.

There is an undercurrent of seriousness to their purpose which deserves consideration. Let me quote once again from their (highly articulate) literature: "A man should always question the strongest convictions of his age, for these convictions are invariably too strong (Chesterton).....We of the Flat Earth Society have *elected* to dispute the one thing which our culture regards as indisputable." The italics are mine.

They point out elsewhere that although everyone accepts without question that the Earth is round, not one person in twenty could have given you, before the age of Apollo, one single cogent reason that it should be so.

Yet despite the fact that their everyday common sense must have told most people that the Earth was flat, they continued to believe implicitly that it was round. They believed it because it had been told to them time after time and with confidence.

This surely is an appalling condemnation, not only of our own failure as scientists to explain ourselves, but of the unthinking gullibility of man. A fact becomes truth not because of its demonstrability but because of repetition and lazy-minded acceptance. If you say something often enough and assertively enough, eventually what you say will be believed without question.

We live in an age of overwhelming technological and sociological change, an age when knowledge outreaches understanding and efficiency overrides compassion.

Children are bussed from primary school to middle school to high school, or are moved from town to town as their father works his way up the business ladder. There is never a chance to develop the roots from which grow that inner stability and sense of worth which lead to sound judgment.

Experts, self-anointed or CBC appointed, continually offer us facile answers to complex questions. We are told that all we need is universal Love, the abolition of the motor car, health food, communes, and a moustache. Jesus saves. Jesus, alas, has not saved me from the mosquitoes since DDT was banned.

We are told that all we need are price and wage controls, no strikes, law and order, everybody working, and short hair. Simon Pure's simple cure.

Abortion on demand is touted, yet abortion on demand is basically a denial of one's accountability for the foreseeable consequences of one's own actions.

The Flat Earth Society, by adopting a heretical position, is forcing people to think in order to refute it. Most people feel guilty about questioning 'authority'. The Flat Earth Society stands as an example to them. It blasphemes and is unrepentent, yet it is not struck down.

In its own quixotic way it is saying, "I believe in myself. I believe in what my senses tell me. And if some damn bureaucrat or theorist or psychiatrist or social planner thinks he knows better than I do what is good for me, then he'd better be prepared to prove it."

And that is an attitude we can surely all support.

B.H.A.

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*The editor would like to thank the many people who offered to contribute to this issue of the Observer. He would especially like to thank the much smaller number who actually did contribute.*

*Turn the page, we're not finished yet.*

# THE MAPLE LEAFS FOREFER

At a recent Canadian Astronomical Society meeting we were treated to an entertaining, informative, and in many ways worrisome after dinner speech by Mel Hurtig, the Chairman of the Committee for an Independent Canada. Canadian independence, it seemed clear from his impressive array of statistics, is very much an endangered species.

Inspired by his talk. I wrote to him asking if he would summarise it in print for the readers of the Observer. Partly for patriotic reasons and partly as a come-on, I offered to spread around any membership application forms he might care to send me.

He was understandably unable to find time to write the piece, but consummate politician that he is, he did not neglect to send me a charming letter into which were stuffed the aforementioned application forms. I later received another bundle from the Ottawa branch of the C.I.C.

I found that they were as easy to get rid of as a burr in a lambswool sweater.

"Are you interested in joining the Committee for an Independent Canada?" I would ask.

There is an ungrammatical conspiracy afoot in this land to reply to that question, "Independent from what?"

"Ho, ho, ho", I chortled the first time, with Clausian gusto. Why discourage an attempt at humour? There's little enough of it. After the fourth or fifth time I couldn't even raise a feeble "Ha!". I had discovered that the humour was unintended. The question arose out of real puzzlement.

That attitude of bewilderment betokens perhaps a much stronger spirit of independence than the C.I.C. is aware exists. Among natives of a truly sovereign country there is a confidence so complete that it never occurs to them to question their own sense of identity.

On the other hand it could reflect the inertia, the ignorance and the easy virtue which the C.I.C. feels it has to struggle against.

At any rate I am sufficiently discouraged that I am resolved to confine my struggle for Canadianism to my private life. I'll leave the public battle to the hardier souls such as Mel Hurtig.

Myself, I'll watch hockey on television, and go to a few Canadian football games. I'll eat with my fork in my right hand and use my finger as a pea pusher. I'll save for a summer cottage beside a crowded lake. I'll set off fireworks on Victoria Day and stubbornly persist in referring to Canada Day as Dominion Day. I'll skate on the Rideau Canal. I'll wait for Groundhog Day and celebrate the sound of running water in Spring.

I'll continue to watch Front Page Challenge and Susan Keller and CBC television, and to eschew cablevision. I'll even keep up my subscription to MacLean's, though I prefer the New Yorker, because they've convinced me that it is my patriotic duty to do so. I'll certainly renew my subscription to Saturday Night (It's May issue arrived this June at about the same time as the July issue of Esquire. Now *that's* Canadian.) I may even get around to learning the words of "Oh Canada" one of these days.

But there is one thing I will not do. I will never, under any circumstances, drink Canadian wine. There are some sacrifices that no man should be asked to make for his country.

B.H.A.

P.S. If you want an application form for the Committee for an Independent Canada, just let me know.

The ARO Observer is produced by the Astrophysics Branch of the National Research Council to serve as a forum for the Canadian astronomical community, and in particular for those members of it who use the Algonquin Radio Observatory. The views expressed in these pages are those of the individual writers. They do not in any way represent the official opinions or policies of either the Astrophysics Branch or the National Research Council.

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Nous sollicitons des articles, en anglais et en francais, s'adressant aux personnes qui s'intéressent à l'astronomie.