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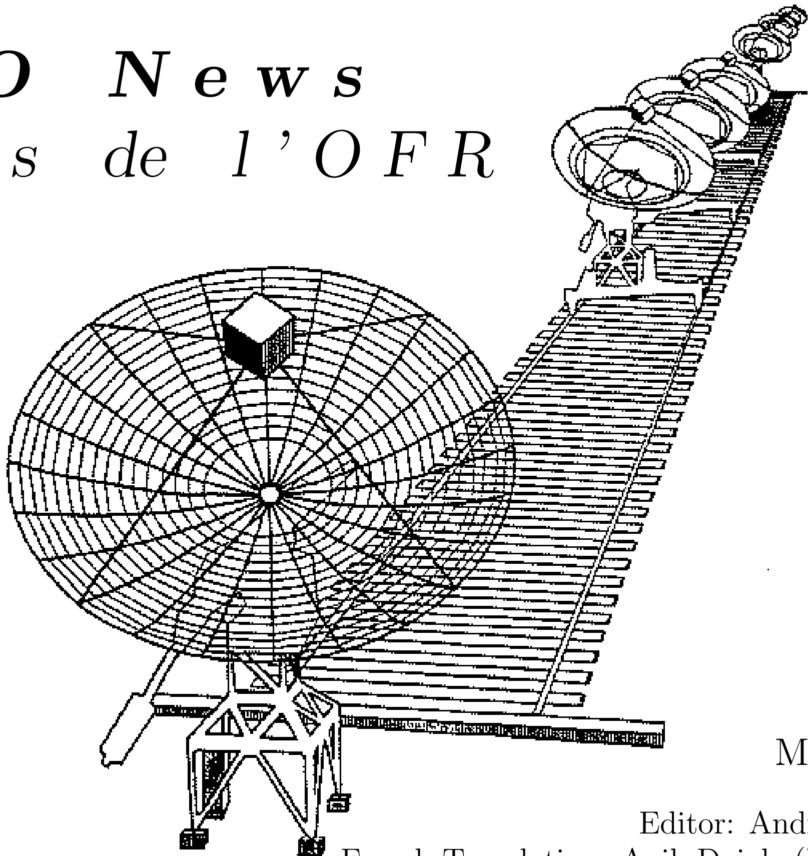
DRAO News
Nouvelles de l'OFR



May 2003

Editor: Andrew Gray
French Translation: Anik Daigle (U. Laval)

Dominion Radio Astrophysical Observatory | *Observatoire fédéral de radioastrophysique*

Herzberg Institute of Astrophysics | *Institut Herzberg d'astrophysique*

CONTENTS

From the Director

ON February 18th, 2003, Canada's Minster of Finance, John Manley, delivered the budget speech. Canada's astronomers listened with anticipation, and were delighted to hear

Budget 2003 also provides ... [funds] ... to the National Research Council to ... secure Canada's participation in leading-edge astronomy projects, including the Extended Very Large Array project in New Mexico and the Atacama Large Millimetre Array project in Chile.

This puts two major radio astronomy projects on a sound footing, and is the outcome of a long process involving the entire astronomy community, which brought Canada's achievements in astronomy to the attention of the nation's leaders. To have astronomy mentioned specifically in the budget speech is a major step forward, and a recognition of the scientific, cultural, and economic significance of our work. At DRAO this announcement has allowed further hiring into the EVLA correlator team, and design work is now proceeding at full speed (see the update on this work elsewhere in this newsletter).

Two DRAO staff members were recognized for their contributions in February 2003. The National Research Council presented Outstanding Achievement Awards to Ken Tapping and Ron Casorso. Ken received his award for the contribution he has made to spectrum management, the process which allocates and protects the radio spectrum that astronomers need for their science. This work demands technical knowledge, diplomacy and persistence. The citation also praised Ken's contribution to public outreach through his newspaper columns. Ron was recognized for his contribution to the design and construction of the new building at DRAO. A fine building was completed on time and for a remarkably reasonable cost. Many features beyond our original expectations were introduced through Ron's creative work.

Inside the new screened room. On the left is the door to the temperature-controlled room for testing electronics.

We are in our new building, but the work of furnishing and equipping it continues. A large screened laboratory space (170 square metres) is nearly complete (see picture). The large area is needed for our correlator projects, but it will also be used for radio-frequency work. As well as general development space, it houses a temperature-controlled room able to test electronic equipment from −20 to +50 degrees Celsius. Our mezzanine library has now been furnished, and the most commonly used books transferred there. The picture shows this pleasant area, which includes ample reading and discussion space. Renovations to the original DRAO building are nearly complete. This will provide at least nine office spaces, and a discussion room.

The mezzanine library

Tom Landecker

Comings and Goings

IN the last issue of this Newsletter (November 2002) we reported 13 new staff members at DRAO. This time we can report two further additions, and expect to introduce two more by the next issue.

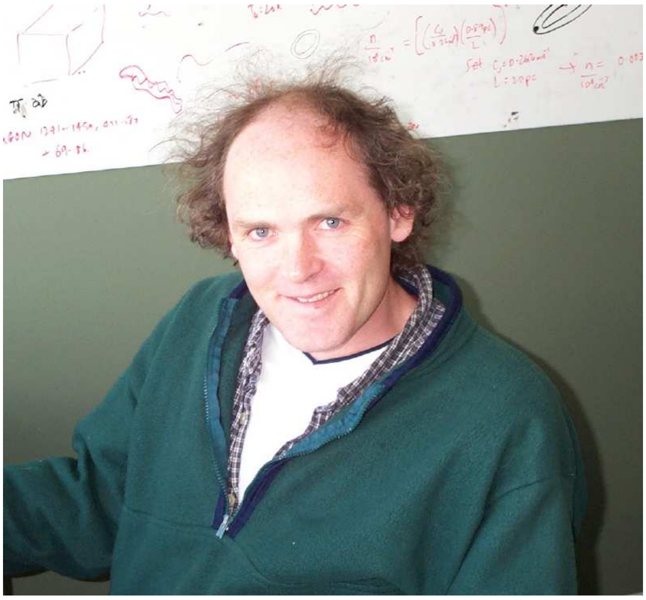
Sonja Vrcic graduated from the University of Sarajevo, Bosnia-Herzegovina, with a degree in Electrical Engineering in 1982. Sonja has more than twenty years of experience in software design and development, mostly for systems that require high reliability and real-time data processing. Since her arrival in Canada, in 1994, Sonja has been working for Nortel Networks and Newbridge Networks in Ottawa. Sonja joined DRAO in April this year as a software engineer on the ELVA correlator.

Donna Morgan joined DRAO as an Administrative Assistant in March, 2003. Donna has a Bachelor of Arts in Adult Education from the University College of the Fraser Valley. She has spent the last two years providing community and continuing education programs in the South Okanagan. She has also spent many years providing a variety of administrative support services in the secondary school system. Donna will work mainly with Peter Dewdney and his team.

Tom Landecker

Staff Profile: Chris Brunt, Research Associate

CHRIS was born in 1969 in the town of Buxton, Derbyshire, England. He completed his B.Sc. (1992) at St Andrews, Scotland, where he also met his future wife, Carol (M.A. Philosophy 1992, now a writer of literary fiction). In 1992 Chris and Carol moved to Amherst, Massachusetts, where Chris did his Ph.D. work at the University of Massachusetts, using the Five College Radio Astronomy Observatory (FCRAO). Chris was involved in the FCRAO CO Survey of the Outer Galaxy, which is now incorporated into the Canadian Galactic Plane Survey database.



Chris Brunt

After completing his Ph.D., Chris was offered a Research Associate position with the University of Calgary, based at DRAO, so, in 1999, Chris and his family moved to Penticton. They have grown to enjoy the Canadian outdoors, particularly Vancouver Island, and especially the wildlife—Chris, having previously been exposed only to squirrels and hedgehogs, was amazed to find coyotes howling as he arrived for his first day at DRAO!

Chris now spends his work time calibrating 21 cm and 74 cm aperture synthesis continuum data from the Canadian Galactic Plane Survey. Recently he has also been taking vast quantities of new molecular-line data at FCRAO (via remote observing) in support of Phase II of the CGPS. His main scientific effort focuses on interstellar turbulence, making comparisons between the high spatial dynamic range CGPS data and numerical magnetohydrodynamic simulations.

Andrew Gray

The Overlooked H II Region DA 568

AS part of a project to catalogue extended continuum emission sources in the CGPS Phase I region, I have "rediscovered" the H II region DA 568. Figure 1 shows the 1420 MHz MH2 mosaic which contains two large extended emission features. The larger one is the nearby, optically-visible H II region Sh 2-131, and the smaller one is DA 568.

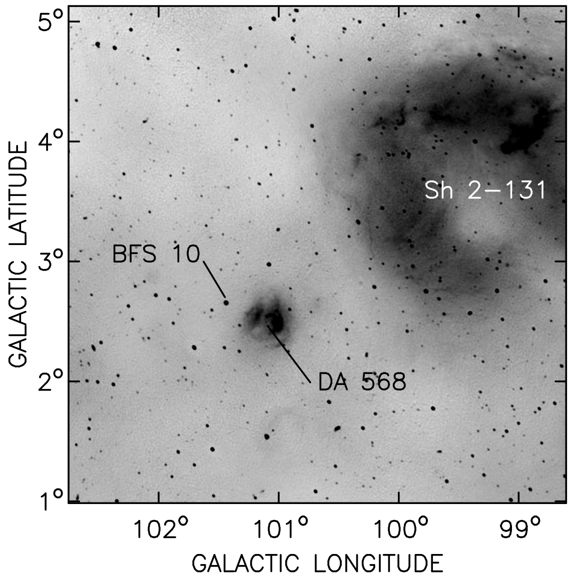


Figure 1: Familiar and unfamiliar H II regions in the MH2 mosaic. Extended 1420 MHz continuum emission in this mosaic is dominated by the nearby (d∼ 0.9 kpc) H II region Sh 2-131. The more distant (d∼ 7 kpc) H II regions DA 568 and BFS 10 are also indicated. DA 568, unlike BFS 10 and Sh 2-131, is not listed in any current catalogues of H II regions in the outer Galaxy.

DA 568 was noted in a 1420 MHz survey of Galt & Kennedy (1968; AJ, 73, 135) made with the 26-m Telescope at DRAO. It was also noted in a Dwingeloo 1417 MHz survey as DW2153+57 (BAN, 19, 201, 1967). Galt & Kennedy classified DA 568 as a point source and, along with a number of other sources, as being "part of HB22". DA 568 has three qualities which then allowed it to disappear from the astronomical literature: it is big, it is thermal, and it is not visible optically. It may be hard to believe, but after the initial two survey papers in 1967 and 1968, DA 568 just drops off the catalogues of radio sources and H II regions in the outer Galaxy. It is easily seen in the contour maps from the various Effelsberg surveys, but the size of the object ($\sim 30'$

diameter) meant that it was not included in the subsequent catalogues, which focused on small diameter or point sources. As there is no obvious optical emission associated with the object, it also does not have an associated Sh 2, LBN, or BFS number. This leads to the strange result that various "complete" catalogues of H II regions in the outer Galaxy do list the optically-visible, 3′ diameter, BFS 10 region, but omit the 30′ diameter DA 568 H II region.

Although this may upset some of our more sensitive readers' sense of completeness and tidiness, it would be of little note except for the fact that DA 568 is clearly a large area of ongoing star-formation in the Perseus arm, and not some old, worn-out, H II region that was overlooked because of its very low surface brightness or because it has been reduced to inconsequential wisps of ionized material.

So what *do* we know about DA 568? From the CGPS 1420 and 408 MHz maps it is clearly a thermal object, and CO maps show that there is associated molecular material. Polarization maps of the region show a large signature from Sh 2-131 but nothing for DA 568, indicating that DA 568 is not a local object. Figure 2 illustrates that there is diffuse 8μm emission at the periphery of the H II region as expected for a photodissociation region. Also, a number of IRAS point sources surround DA 568,

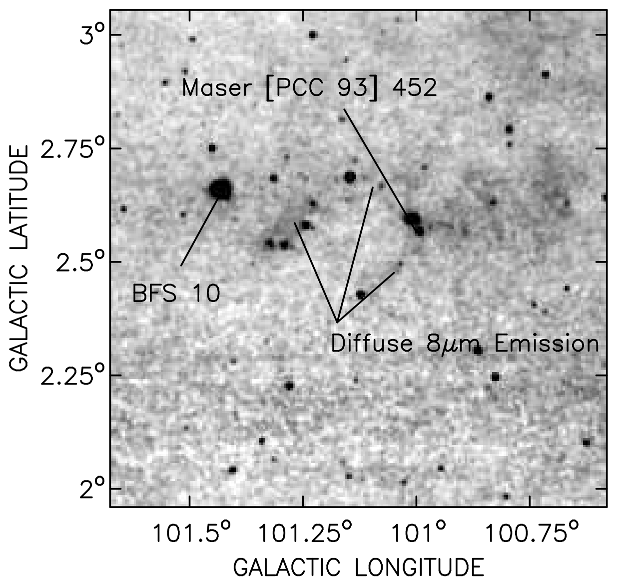


Figure 2: MSX 8.3μm emission around DA 568. The diffuse emission occurs from the interaction of the H II region and surrounding molecular material. Note the position of the maser [PCC 93] 452, which is incorrectly associated with BFS 10 in the literature.

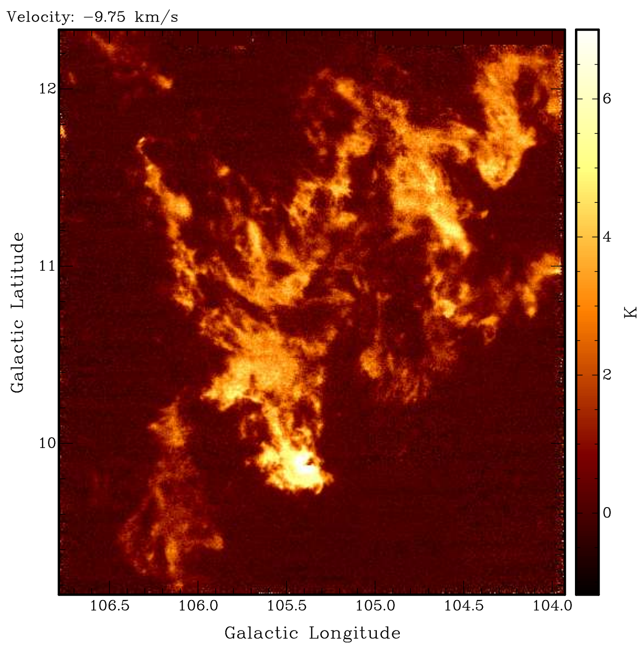
tracing star formation in the associated molecular cloud. DA 568 has a radial velocity of $V_{\rm lsr} = -70\,{\rm km\,s^{-1}}$, based upon the velocity of the associated CO emission and radial velocity measurements made in CS (2-1) and in H_2O maser lines to surrounding IRAS sources. Interestingly, the authors of the various IRAS source studies invariably have listed BFS 10 as the associated H II region, as it is the only nearby H II region listed in catalogues and it has a similar ($-61\,{\rm km\,s^{-1}}$) radial velocity. The radial velocity yields a distance to DA 568 of about 7 kpc [6.5 kpc using the Brand & Blitz 1990 (A&A, 275, 67) velocity field, and 8.0 kpc using a flat rotation curve].

This is truly a substantial H II region. Consider that if we moved DA 568 to the distance of the W3/4/5 region ($\sim$ 2.3 kpc), it would appear three times larger—about 1.5 degrees in diameter, similar in size to the well-known W5 H II region! DA 568 and BFS 10 are possibly related in the sense that they are tracing a region of active star formation occurring in the Perseus arm in this direction, but DA 568 is clearly the more evolved of the two regions. A short paper reintroducing DA 568 to the astronomical community is currently being prepared.

Charles Kerton

Molecular-line Data for Phase II of the CGPS

WE have recently secured a large time allocation at FCRAO to acquire molecular-line data for the high-latitude extension of the Canadian Galactic Plane Survey (Phase II). The extension covers more than 200 square degrees (reaching up to $b \approx 18°$), and will afford high spatial dynamic range, relatively unconfused views in H I, CO, IR, radio continuum, and polarization of many nearby (0.3–1 kpc distance) star forming regions. As well, it provides a probe of disk-halo events in the Perseus Arm.



A sample of the new ^{12}CO data from the region near NGC 7129.

I have been (remotely) observing Nyquist-sampled ^{12}CO (J=1–0) and ^{13}CO (J=1–0) in the high-latitude extension since early February 2003, using the newly developed on-the-fly mapping capability and dual IFs, and we are approximately 25% done. By the end of the Spring season (weather permitting), we should have close to 70 square degrees of new molecular-line data. The entire survey will probably be finished in the Spring 2004 observing season.

The new data have over twice the spatial sampling rate and more than six times the velocity resolution of the FCRAO Outer Galaxy Survey (the main Phase I CGPS molecular line data set). Compared at the same velocity resolution, the new ^{12}CO data are over twice as sensitive as the OGS (and the new ^{13}CO over twice as sensitive as the new ^{12}CO).

Chris Brunt

1.4 GHz Polarimetry with the 26-m Telescope

We are using the DRAO 26-m Telescope to make an extensive survey of continuum polarization at 1.4 GHz. The purpose of the survey is to provide information on the broadest polarization structures to complement observations with the Effelsberg 100-m Radiotelescope and the DRAO Synthesis Telescope. This collaboration is part of the International Galactic Plane Survey.

In May 2002 we began to equip the telescope for polarimetry at 1410 MHz. After receiver changes and software developments, the system was ready for observing by November. The focus equipment was modified to receive both hands of circular polarization, and an analog polarimeter was installed. The polarimeter, brought from Bonn, is of the type used on the Effelsberg Telescope. It operates with an IF of 150 MHz and a bandwidth of 12 MHz.

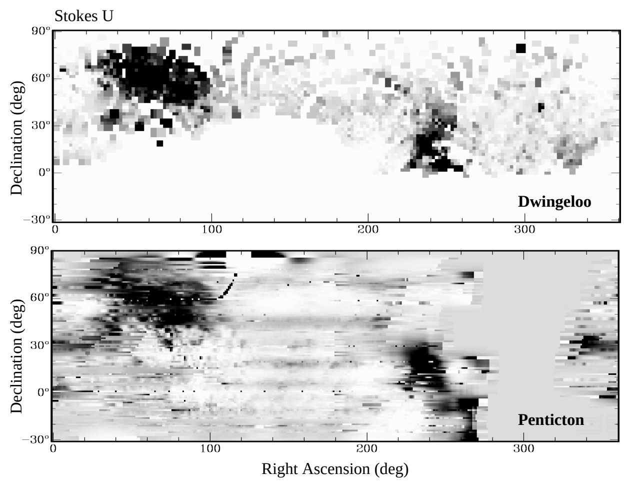
Observations can be made only at night. Polarization angle is strongly affected by ionospheric Faraday rotation in the daytime, and the Sun also contributes a significant signal through the telescope sidelobes, which are strongly polarized. Data are gathered as drift scans with the telescope stationary on the meridian: in this way the contribution from the ground is constant through a scan. We now have data from more than 140 drift scans, using virtually every night, and half the data have been calibrated. Tests show that receiver gain variations are less than 4% over 40 days.

The DRAO polarization observations have not yet been calibrated absolutely. The survey is being tied to the data observed with the Dwingeloo 25-m Telescope by Brouw & Spoelstra (1976; A&AS, 26, 129) at 1411 MHz. The Dwingeloo survey is absolutely calibrated, but samples the sky very sparsely. When the DRAO survey is complete, we will be able to use about 400 points common to both surveys to provide the absolute calibration.

Calibration of raw data involves the following steps: (1) a polarimeter correction to convert the four channels into true cross-correlations (RR, LL, RL, and LR), (2) a Müller matrix correction to remove errors in the feed and hybrid circuit, (3) a calibration of gain and phase from an injected noise signal, and, (4) scaling and rotation to convert RL and LR into Stokes Q and U.

In the first three months of the survey, 200 positions were observed that are also in the Dwingeloo data set. Observations at these points were used to develop the calibration routine. We find a linear correlation between DRAO and Dwingeloo with a scatter in U and Q of 120 mK. The quoted error for the Dwingeloo data is 60 mK, indicating that the DRAO error is currently about 100 mK. Since the thermal noise per data point is about the same for the two surveys, we expect this error to decrease with time as we have more points in common between the two data sets and can refine our calibration.

The image below shows all available Dwingeloo Stokes U data (top panel) and equivalent DRAO data obtained by February 2003 gridded into a map (bottom panel). No sophisticated interpolation has been used to smooth our data. Since we do not observe in the daytime, there is a gap at right ascension 300 degrees. This has since been filled.



A comparison of Dwingeloo Stokes U data (top; Brouw & Spoelstra 1976) and the new DRAO observations.

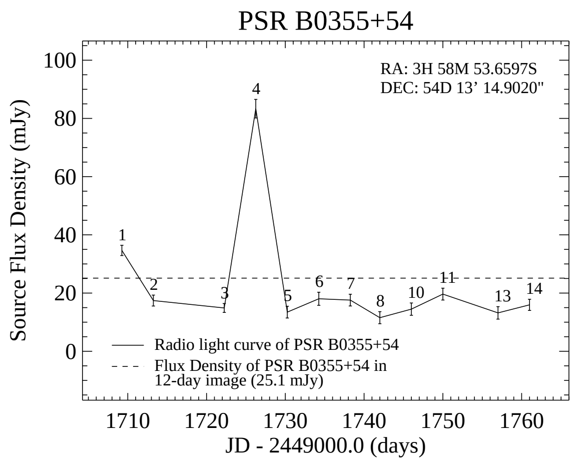
Our ultimate goal is a fully sampled polarization survey of the sky north of declination −30 degrees. With a beam of 36 arcminutes, this will require about 480 drift scans. Currently we have complete sampling at a spacing of 2.5 degrees in declination, with many regions covered at 1 degree intervals. In RA the survey is, of course, fully sampled. Thus, we already have 56,000 data points, in contrast to the 1700 available in the Dwingeloo data set.

Maik Wolleben, Tom Landecker, & Wolfgang Reich

Variable Sources in the CGPS

THE Canadian Galactic Plane Survey (CGPS) comprises 370 overlapping fields observed over an 8 year time span (including both Phase I and II observations), covering over 1000 square-degrees. The data for each field are acquired at 4 day intervals over a span of around 2 months, with overlapping fields that are typically observed at different epochs. The significant sky coverage and time-span of the dataset allowing a systematic search for radio variability on timescales of days to years to be carried out on tens of thousands of compact radio sources in the Galactic Plane.

The search algorithm was originally developed by Sean Dougherty and Russ Taylor, and has been further developed by Dave Del Rizzo at DRAO. A CLEAN-component model of a field is first generated using all daily observations. Model visibilities are then generated for each daily observation and subtracted from the observed visibilities, then images of the residuals are formed for each day. The result is a set of images showing any emission that varies significantly from the mean of that set of observations. If no sources vary then the result is just noise. Automated software locates any sources that do appear and measures the light curve.



A sample light curve for a variable source (in this case, a pulsar) detected using the method described herein.

To date, the new program has been tested extensively on the new CGPS Phase II fields at high Galactic longitude, where there are few major extended emission regions. The results of the tests are encouraging. Variable sources are being detected at a rate of approximately one per field. These include both known variables, verifying the validity of the algorithm, along with some compact sources not previously identified in the literature as being variable.

The goal of this research is to apply the algorithm to all CGPS fields, and to produce a list of variable sources for further investigation. A number of processing challenges still need to be addressed to ensure the robust identification of variables, especially in complex fields.

Special thanks to Andrew Gray for his assistance in this project.

Dave Del Rizzo & Sean Dougherty

Canadian Galactic Plane Survey Update

OBSERVATIONS and data processing in the second phase of the CGPS are continuing, notwithstanding a few minor technical problems which have pushed the observing timetable for the Synthesis Telescope observations back by one month. At present 135 of 177 synthesis fields (76%) have been observed, and we anticipate completing this phase of observations within one year. Data processing is coming along smoothly. Low-order spacing H I observations with the 26-m Telescope have been paused temporarily due to technical issues (now resolved) and because of other demands on that instrument. We hope to restart the 26-m Telescope H I survey and make major progress on it by the end of summer 2003.

As was done for the first phase of the CGPS, HIRES-processed IRAS data in the 12, 25, 60, and 100 μm bands will be produced for Phase II. The processing pipeline system based at CITA has been reconstructed, and current plans are to have the HIRES data ready by the end of summer 2003.

One of the major components of Phase II is a DRAO survey of the local Cepheus Flare cloud complex. To complement this, a ^{12}CO (J=1–0) and ^{13}CO (J=1–0) survey of this region is currently under way using the FCRAO telescope (see *Molecular-line Data for Phase II of the CGPS* in this newsletter). This survey should be complete by spring 2004.

Under the heading of "unfinished business" are the 408 MHz radio continuum mosaics from Phase I, which have now been produced, and should soon be made available. The CGPS technical paper has been accepted and is now in press (Taylor et al., 2003, AJ).

Considerable effort has been made in the last six months to work more closely with the Canadian Astronomy Data Centre (CADC) to improve its ability to provide CGPS data to the worldwide astronomical community. Steady progress is now being made, with an improved search interface and data download procedure currently being put together. Two-dimensional data previewing capabilities are being added, as well as the ability to link into other astronomical catalogues and data bases. Previewing of the three-dimensional data sets from the CGPS is a more challenging proposition, and we are presently exploring ways of providing that capability.

Planning for the continuation of the CGPS beyond the current phase is now heating up, with the goal of submitting a NSERC proposal this Fall. The International Galactic Plane Survey science meeting at Université Laval in Ville de Quebec (May 2003) has enabled us to move quickly towards solidifying the scientific programme and resource requirements for this third phase of the CGPS.

Most importantly, science production with the CGPS continues to climb: although we are not yet halfway into 2003, there are already more than a dozen refereed papers for this calendar year.

Lewis Knee

News from the S2 VLBI Correlator Centre

THE Space-VLBI project at DRAO is in its final stages. The Canadian Space Agency and the Joint Sub-Committee on Space Astronomy have been advised that we anticipate completion of the project by the end of August 2003.

Over the past year, the mission has concentrated on completing the VSOP Survey project, a project to systematically observe the radio-brightest quasars and AGN, in which Canada plays a leading role: all the data are correlated at DRAO, processed at the University of Calgary, and Canadian scientists play a leading role in the subsequent analysis of the data.

It was hoped that the VSOP Survey would have been completed by the end of August. However, the orbiting radio telescope, HALCA, started to tumble in January and it was not possible to recover its attitude before it entered an eclipse period starting in April. Unfortunately, the eclipse lasts until June 22nd, and it seems unlikely that any subsequent observations could be fully processed before the end of August.

The correlator centre is busy nonetheless. There were a number of key science projects at the heart of the VSOP science programme, one of which was the use of interstellar scattering to "image" pulsars. To fulfill the aims of this experiment, it is necessary to use the full spectral capability of the Penticton Space-VLBI correlator, which restricts correlation to a single baseline at a time. In addition, a number of different "gates" across the pulsed emission profile are being correlated which makes these correlations very, very long—several weeks with the correlator running full-time! There are a few of these experiments to complete, and we anticipate being fully occupied until the late Summer.

The Russian Radioastron space-VLBI mission is now the number one priority position in the Russian space astronomy programme, with a planned launch on March 15, 2006. Since the S2-format recorder system play a major role in Radioastron, we are paying close attention to this rapidly evolving mission.

Sean Dougherty

Progress on the LAR Aerostat Experiment

THERE has been steady progress in many areas on the LAR project since the last newsletter, both with the aerostat experiment and with other aspects of the project.

Aerostat experiment: last Fall the hangar was extended and a curtain-style door was added to provide better protection from wind while the aerostat is in the hangar. This has had the additional benefit of allowing us to lower the helium pressure in between flights, which has greatly reduced the helium consumption rate.

The upgraded hangar. An extra 20-ft section and the curtain-style door were added in Fall 2002.

The bulk of the open-loop flight tests are now complete, with many hours of data collected. A detailed investigation of the GPS reduction software, involving DRAO staff as well as Kyle O'Keefe, the software's author (and U. Calgary Ph.D. student), found several bugs that are now fixed. All of the open-loop GPS test data have been reprocessed, and these data are now being analyzed by Wen Bo working with Meyer Nahon at McGill U.

A limitation of the GPS system is that data logged faster than about 2 Hz become increasingly uncertain. We are now investigating a means of "extrapolating" from the last known position at a higher rate. For this purpose an Inertial Measurement Unit (IMU) is being added to the instrument platform for the next series of flight tests. Milos Jerkovic (U. Victoria co-op student) has just joined the LAR team for the summer and will work on the incorporating the IMU into the data acquisition system.

Preparation for closing the control loop is currently underway. Richard Hellyer has been hard at work assembling the computer-controlled winches, with Jean Bastien responsible for the power wiring. Dean Chalmers attended a course in February at Bosch-Rexroth to learn how to program the winches and has developed a first version of control software for them. All of this came together just in time for the Canadian Square-Kilometre Array Steering Committee meeting on April 30 and May 1, with a demonstration of the winches set up on a 20 m circle and operating in open loop to move the confluence point of the tethers in a circle (see photo).

A new working relationship with the DAO Instrument Group has begun, aimed at development of the control software. Currently they are developing a shell program to pass data from the GPS software to the winch control software. As testing progresses, control algorithms and IMU data feedback will be incorporated into this software. Once the bugs are worked out, the winches will be moved from the test set-up near the hangar to the field, and closed-loop testing with the aerostat will begin.

RF systems: progress is being made on focal-plane arrays for the LAR. Conventional feed arrays (such as the Parkes multibeam system and the FCRAO Sequoia millimetre-wave array) comprise closely-packed feed horns, which cannot Nyquist-sample the focal-plane fields. The LAR must be able to do this, because, unlike conventional radio telescopes, the geometry between the LAR's reflector and feed will be constantly changing. Standard feed horns are not adjustable, making them unsuitable, but with a focal-plane array it is possible to make an electronically-adjustable feed system by combining the signals from the large number of antenna elements in a device known as a beam-former.

A second benefit of the beam-forming method is that the signals from the antenna elements can be split and directed to separate signal processors, the outputs of which produce different *simultaneous* beams on the sky. These beams can be placed so that the sky is Nyquist-sampled, providing a large simultaneous field of view. So far this sort of feed does not exist on any telescope.

Work on this design is being conducted by Ed Reid (U. Alberta Ph.D. student), who is our expert on the Vivaldi antenna elements that are being used for the array. He is currently working on ways to reduce the mass of the array, an important consideration for this project. Angel Garcia is developing a procedure to characterize low-noise transistors and to design highly-integrated, low-noise amplifiers that will form the basis of the receivers. Bruce Veidt is working on wide-band beam-forming design, and some of that work will be presented at conferences in the USA and Australia this summer.

Reflector design: the design for an active reflector that is at the heart of the LAR design is being worked on by AMEC Dynamic Systems of Vancouver. Nathan Loewen, who did work on the surface panelling concept for his Masters project, is working with AMEC, who have a contract to design and construct a section of the reflector. This will be no small object, being a triangular structure 20 m on a side, on which will rest two (of four possible) 10 m triangular panels. Once complete it will be shipped to DRAO and assembled on site. AMEC also has a contract to develop actuators with throws up to 12 m for this structure. Design and implementation of measurement and control systems will follow, allowing the reflector system to be tested.

Dean Chalmers, Bruce Veidt, & Andrew Gray

The New Spectrometer for the JCMT: ACSIS

PRODUCTION of the Auto-Correlation Spectrometer Imaging System (ACSIS) for the JCMT is well underway. Ralph Webber completed the design of the equipment enclosure in December and all of the enclosure equipment has now arrived, with six racks now occupying much of the floor space in the lab area (see picture). Ralph is currently installing the four crates of correlators, developed by Tom Burgess, and will begin installing the cooling equipment and IF system components in the coming weeks. Tom completed the 2 gigasample/s sampler design and has successfully tested the pre-production prototype. Production of the samplers will be contracted out, probably to a Vancouver assembly firm.

Brian Force at the JAC is developing the IF System and has completed the Nasmyth Receiver Switch and the device used to generate test signals for ACSIS. This latter unit, the Built In Test Equipment (BITE), provides ACSIS with an essential self-test capability. The BITE will be useful for in-service diagnostics and aid Lab Integration and commissioning activities. Brian has recently shipped this unit to us, as well as part of the second local oscillator (LO) system, and has begun assembly of the quadrant switch and remaining LO systems.

As reported in the last newsletter, Murandi Communications of Calgary has been contracted to develop the production version of the down-converter module (DCM). Originally developed by Brian at the JAC, this module is a key part of the ACSIS IF system. Murandi successfully completed the detailed design of the DCM, which we reviewed in March. The first prototype should be complete in the next few weeks, and by July we should have five fully tested DCMs to evaluate and use.

The ACSIS reduction system is also nearing completion. The system is being co-developed here by Tony Willis and at the UKATC by John Lightfoot. Tony and John completed version 2.1 of the system in February, which was tested by the project scientist Bill Dent of the UKATC. The system now contains most of the functionality required by ACSIS. Version 2.2 will contain all of the essential functionality and should be complete in the next several weeks. The major effort left is integrating it with the JCMT Observing Control System (OCS).

This work will begin this week with the arrival of Craig Walthers of the JAC, who will be working with Tony for several days.

Gary Hovey

The EVLA Correlator

A major hurdle to the EVLA correlator project has been overcome, with last February's Federal budget making a specific allocation to NRC for the project. Additionally, Treasury Board has now asked for a submission to actually obtain those funds for NRC. This is very good news, and will allow the design and construction of the most flexible and powerful radio astronomy correlator ever envisioned.

At DRAO, the engineering team is making good progress on the various designs in the system. Dave Fort's signal-processing expertise and experience has been invaluable in the design of the Station Board, and, most importantly, the FIR filter that is one of the critical parts of the correlator design. Zoran Ljusic is working on the printed-circuit board design for the Delay Module, which incorporates many features critical to the functioning of the correlator including 0.25 s real-time delay capability, and the ability to seamlessly introduce the +/-0.5 sample tracking delays. It is no small feat to carry out this design using inexpensive but difficult-to-use dynamic RAM running at 256 MHz. Zhang Heng has quickly developed expertise in FPGA design and has become our resident expert in PCI bus design. Brent Carlson has completed a cost and feasibility study of the correlator chip design with the assistance of a major semiconductor manufacturer, and found that the chip is affordable both in terms of cost and power dissipation. The correlator chip forms the second critical part of the correlator design, and largely determines the spectral channel capacity of the system, which is 16,000 channels per baseline for each of several hundred baselines.

The correlator software effort has also begun. Our new software engineer Sonja Vrcic (see *Comings and Goings* section of this newsletter) is steadily learning more about the techniques of radio astronomy and the details of the correlator architecture. This is no small task: it has been estimated that there are more unique configurations possible in the correlator than there are protons in the entire universe! On May 5th, Frances Lau, a computer engineering WES student from the University of Toronto, joined us and started work on writing correlator chip test analysis software, test case generation, and verification. This challenging task is important to ensure that the correlator chip is bug-free before fabrication.

Brent Carlson

Spectrum Management Activities

THE 2003 World Radio Conference (WRC) is in Geneva this summer. There are three issues of particular interest to Canadian radio astronomers:

1. The band-by-band study completed its initial phase at the end of last year, and the results will be tabled at the WRC. The Task Group formed to do this work has now disbanded. It is likely that the work will be expanded to include other bands, and that some sort of on-going study should be maintained. In this case a Task Group will be formed to continue the work.

2. Apart from the band-by-band studies, an important outcome of the work has been some tools for estimating and indicating interference problems in a way that can be quantified. Canada is proposing that key recommendations for the protection of radio astronomy be integrated into single entities. This will make them easier to keep up to date. The risk is that bringing the diverse recommendations into one package will provide a single target for those who wish to oppose them. So far, however, the proposal looks good, and attempts to weaken the protection have been defused or avoided.

3. As we dedicate more of our resources to big, international instruments, we need to have the best assurance that the instruments will be protected from interference so that we will get the intended scientific return on our investment, over at least the planned operating lifetime of the experiment. We would also like to have as much access to radio spectrum as possible. In short, we would like the implementation of "radio quiet zones" around major radio astronomical facilities. Such an idea is new to the International Telecommunications Union, which deals with regulations applying globally. However, these radio quiet zones might be what is needed to protect the cutting edge instrumentation in radio astronomy, and also to address some of the compatibility problems with other services. This year, Canada and the USA, and probably other nations, will be proposing that the ITU commence a study into what we need and how we would work radio quiet zones. This study will use as part of its input the work being done by an OECD forum on large-scale astronomy projects.

Contact `Ken.Tapping@nrc.gc.ca` for more information on the spectrum management activities at DRAO.

Ken Tapping

Synthesis Telescope Observing and Upgrades

OBSERVING with the Synthesis Telescope has suffered from several misfortunes in the recent past. After recovering from the UPS and computer problems reported on in the last newsletter, we went on to experience a problem with the sidereal clock, and the loss of a counter-weight from Antenna 4. The latter incident could have been much worse, but luckily the falling counter-weight did not strike any vulnerable parts of the antenna or its support tower. The counter-weight was quickly reattached and observing resumed. The underlying problem was a bad weld in the mounting strut (which nonetheless held for over 40 years!), and counter-weight mountings on all antennas are now being checked and reinforced. The impact of these incidents on observing for the Canadian Galactic Plane survey has been relatively minor, and it is now expected that completion of observing will be delayed by about one month.

There has been some encouraging results from the work on improving the sensitivity of the Synthesis Telescope at 21 cm. The improvements planned could, combined, achieve a doubling of the sensitivity by reducing the system temperature from the current 60 K to about 30 K. This work, embodied in the M.Sc. projects of Teresia Ng and Angel Garcia (both U. Alberta), has focused on reducing ground-noise picked up by the feeds, and reducing the noise temperature of the receivers.

Teresia's work has seen the inner 2.1 m radius of Antenna 7 receive a temporary solid surface to eliminate ground-noise leaking through the mesh, as described in the last newsletter. This has resulted in a 4 K reduction in system temperature on that antenna. A subsequent project has positioned metal mesh "fences" around Antenna 1 to shield the spillover lobes from the ground, which has realized a 2 K improvement in system temperature. There has also been some work on modifying the feed struts to have triangular cross-section to improve scattering performance (some antennas already had such struts), although the results of this work have been hard to quantify.

New commercial low-noise amplifiers have also been fitted to Antenna 6, reducing the receiver noise by 15 K. Amplifiers being designed by Angel (described in the last newsletter) could see a further reduction of 7 K by integrating the probe and amplifier stages, both reducing amplifier noise and eliminating losses in connectors.

The total of all of the above changes is 28 K, or almost half of the initial system noise. Implementation of these changes on other antennas is expected by Fall; however, not all changes will be implemented on all antennas (for reasons of practicality and cost), and a final system temperature of around 40 K is expected.

Contact `Andrew.Gray@nrc.gc.ca` for further information about the Synthesis Telescope.

Andrew Gray

The 26-m Telescope

THE 26m-Telescope has been busy since the last newsletter. It has seen continuous use by Maik Wolleben, visiting from the Max Plank Institut für Radioastronomie in Bonn to make precision polarization measurements (see *Polarimetry at 1.4 GHz using the 26-m Telescope* in this newsletter). The nature of the observations necessitated modifications to the front-end, and it is a combination of this reason and the lack of a working LO that has kept H I observers waiting. With Maik's project reaching a successful conclusion in May, Tony Hoffmann has put in some effort into implementing a new computer-controlled local oscillator system for the resumption of H I work by June.

Some of the pending H I work includes the completion of the Low-Resolution DRAO Survey for Phase II of the Canadian Galactic Plane Survey. A summer student has now been hired for this purpose, who will begin by removing the polarimeter and restoring the H I system. H I observations will restart by mid-June and will then proceed without interruption until they are complete. The time required to acquire the missing data is about 2 months. The same student will also help with engineering some of the changes designed to reduce ground noise of the Synthesis Telescope (see *The Synthesis Telescope: Observing and Upgrades* in this newsletter).

Contact `Ken.Tapping@nrc.gc.ca` for further information about the 26-m Telescope.

Ken Tapping

The Solar Radio Flux Monitor and the Canadian Geospace Monitoring Programme

THE Solar Radio Monitoring Programme continues to operate as usual, being supported in its routine function by the DRAO Operations Group. The normally reliable system has developed a strange fault in recent months, which was believed to be in one of the antenna position encoders, and was finally tracked down by Jean Bastien. It turned out to be a faulty opto-isolator.

With the growing national and international interest in the science and economic importance of space weather, there is an initiative in progress to integrate the space-weather-related activities in Government agencies and Canadian universities into a single entity—the Canadian Geospace Monitoring Programme (CGSMP). The Solar Radio Monitoring Programme could be a key part of such an entity, since the Sun is the engine driving all aspects of space weather and interference with satellites, power distribution and communication. Watch this space ...

Contact `Ken.Tapping@nrc.gc.ca` for further information about the solar programme at DRAO.

Ken Tapping

Call for Observing Proposals

PROPOSALS are invited for observations to be made with the DRAO Synthesis Telescope and/or the 26-m Telescope. Instructions for applications are given below. Electronic proposal submissions should be emailed to Andrew Gray (`Andrew.Gray@nrc.gc.ca`).

The Synthesis Telescope offers simultaneous, wide-field imaging of radio continuum at 408 and 1420 MHz (the latter with polarization), and H I-line emission (256-channel spectrometry). It is suitable for a wide range of projects, and in the past has been used for everything from solar system to extragalactic studies. We welcome new proposals for telescope time covering any area of radio-astrophysics. Proposals are accepted at any time, and are subjected to external peer review. Proposals granted time are scheduled as soon as possible after receipt.

Cover-sheets and a full description of the Synthesis Telescope and its capabilities are available at `http://www.drao.nrc.ca`, or from the anonymous ftp area at DRAO—just follow this procedure:

```
ftp ftp.drao.nrc.ca
Name:  anonymous
Password:  your e-mail address
cd pub/drao_info
dir
get filename
```

Further information on the Synthesis Telescope is available at `http://www.drao.nrc.ca`, or contact Andrew Gray (`Andrew.Gray@nrc.gc.ca`).

The 26-m Telescope is equipped for spectral-line observing in the approximate frequency range 1300–1700 MHz, wherever man-made transmissions and interference permit. Other kinds of observation may be possible through special arrangements. The instrument is typically used for medium and long-term observing programmes, but short-term ones are also undertaken. Applications should include a description of the programme, scientific relevance, and time needed. Proposals are accepted at any time, and are subjected to internal peer review. Proposals granted time are scheduled as soon as possible after receipt.

Further information on the 26-m Telescope is available at `http://www.drao.nrc.ca`, or contact Ken Tapping (`Ken.Tapping@nrc.gc.ca`).

Recent Papers from DRAO

NAMES of DRAO workers are shown in **bold** in the following. New papers:

Arzoumanian Z., Safi-Harb S., **Kothes R., & Landecker T.** *The Central Engine of the Unusual Remnant DA495.* 2003, American Astronomical Society, HEAD meeting #35, #10.18

Brunt, C. M., Heyer, M. H., Vázquez-Semadeni, E., & Pichardo, B. *Intrinsic, Observed and Retrieved Properties of Interstellar Turbulence.* 2003, ApJ, submitted.

Dougherty, S. M., Pittard, J. M., Coker, R. F., Williams, P. M., **Kasian, L.**, & Lloyd, H. M. *Radio emission models of Colliding-Wind Binary Systems.* 2003, in Winds, Bubbles, and Explosions, eds. S. J. Arthur & W. J. Henney, Revista Mexicana de Astronoma y Astrofsica (Serie de Conferencias), 15, 58.

Dougherty, S. M., Pittard, J. M., **Kasian, L.**, Coker, R. F., Williams, P. M., & Lloyd, H. M. *Radio emission models of Colliding-Wind Binary Systems.* A&A, submitted.

Ehle, M., Harnett, J. I., Beck, R., Haynes, R., & **Gray, A. D.** *Magnetic fields in barred spiral galaxies: NGC 2442 & NGC 7552.* 2002, in Disks of Galaxies: Kinematics, Dynamics and Perturbations, eds. E. Athanassoula & A. Bosma (San Francisco: Astronomical Society of the Pacific), 275, 361.

Galt, J. *Variations in the 1612-MHz OH Line Emission from IRAS 19566+3423.* 2003, JRASC, 97, 15.

Hovey, G. J., Dewdney, P. E., Redman, R. O., **Willis, A. G.**, Kelly, B. D., Gao, X., Lightfoot, J. F., Dent, W. R. F., Rees, N. P., Friberg, P., & Prestage, R. M. *Co-ordinating and Synchronizing Instruments for a Real-time Distributed Reduction System.* 2002, in Astronomical Data Analysis Software and Systems XI, eds. D. A. Bohlender, D. Durand, & T. H. Handley, ASP Conference Proceedings, 281, 355.

Israel, F. P., Kloppenburg, M., **Dewdney, P. E.**, & Bally, J. *The peculiar nebula Simeis 57. I. Ionized gas and dust extinction.* 2003, A&A, 398, 1063.

Knee, L. B. G. *The Canadian Galactic Plane Survey.* 2003, in Winds, Bubbles, and Explosions, eds. S. J. Arthur & W. J. Henney, Revista Mexicana de Astronoma y Astrofsica (Serie de Conferencias), 15, 301

Knee, L. B. G., & Wallace, B. J. H I *Tails from Molecular Clouds near HD 17603 and Wolf-Rayet 5.* 2003, in Winds, Bubbles, and Explosions, eds. S. J. Arthur & W. J. Henney, Revista Mexicana de Astronoma y Astrofsica (Serie de Conferencias), 15, 44

Kothes, R. *G107.5-1.5: A New SNR Discovered through its Highly Polarized Radio Emission.* 2003, A&A, submitted.

Kothes, R., & Kerton, C. *Expanding shells of neutral hydrogen around compact* H II *regions.* 2003, in Winds, Bubbles and Explosions, eds. S. J. Arthur & W. J. Henney, Revista Mexicana de Astronomia y Astrofisica (Serie de Conferencias), 15, 163

Kothes, R., Reich, W., Foster, T., & Byun, D.-Y. *The Distance to SNR CTB87 and the Radial Velocity of the*

Perseus Arm towards $l = 75°$ Derived from H I *and CO Observations.* 2003, ApJ, in press

Krawczynski, H., Harris, D., Grossman, B., Lane, W., Kassim, N., & **Willis, A. G.** *Thermal and Non-thermal Plasmas in the Galaxy Cluster 3C129.* 2003, MNRAS, submitted.

Matthews, H. E., **Purton, C. R., Roger, R. S., Dewdney, P. E.**, & Mitchell, G. F. *Neutral Hydrogen associated with NGC7129.* 2003, ApJ, in press.

Molotov, I., Chuprikov, A., Likhachev, S., Salter, C., Ghosh, T., Ghigo, F., **Dougherty, S.M.** *First VLBI Observations with Arecibo in an International S2 Ad-hoc Array.* 2002, in Single-Dish Radio Astronomy: Techniques and Applications, eds. S. Stanimirovic, D. Altschuler, P. Goldsmith, C. Salter, ASP Conference Series, 278, 507

Molotov, I., Kovalenko, A., Samodurov, V., Lipatov, B., Dementiev, A., Antipenko, A., Snegirev, S., Nechaeva, M., Reznikova, V., Altunin, V., Benz, A., Mantovani, F., Stenghellini, C., Tuccari, G., Konovalenko, A., Falkovich, I., Gridin, A., Ananthakrishnan, S., Balasubramanian, V., Sankararaman, M., Hong, X., Huang, X., Shiguang, L., **Dougherty, S., Del Rizzo, D., Fink, A.**, Liu, X., Na, W., Zhang, J., Kus, A., Borkowski, K., Quick, J., Nicolson, G., Shmeld, I., Koyama, Y., Sekido, M., Goroshenkov, Yu., Poperechenko, B., Saurin, V., Ozolins, G., Bezrukov, D., & Zhang, X. *International low-frequency very-long-baseline interferometry network project milestones.* 2003, Astronomical and Astrophysical Transactions, in press.

Molotov, I., Likhachev, S., Chuprikov, A., Lipatov, B., Dementiev, A., Gorshenkov, Yu., Kovalenko, A., Konovalenko, A., Stanghellini, C., Tuccari, G., Hong, X. Y., **Dougherty, S., Shanks, R.**, Liu, X., Zhang, J., Kus, A., Borowski, K., Quick, J., Nicolson, G., Ananthakrishnan, S., Sankararaman, M., Shmeld, I., & Bervalds, E. *Goals and results of the ad-hoc VLBI activity with Russian antennas.* 2002, in 6th European VLBI Network Symposium on New Developments in VLBI Science and Technology, eds. E. Ros, R. W. Porcas, A. P. Lobanov, & J. A. Zensus, Max-Planck-Institut für Radioastronomie, 19

Tapping, K., Cameron, H., & Willis, A. G. *S-Component Sources at 21 cm Wavelength in the Rising Phase of Cycle 23.* 2003, Solar Physics, in press

Updates on papers listed previously as either “submitted” or “in press”:

Brunt, C. M. *Large-scale Turbulence in Molecular Clouds.* 2003, ApJ, 583, 280.

Brunt, C. M. *The Universality of Turbulence in the Molecular Interstellar Medium and its Exploitation as a Distance Estimator.* 2003, ApJ, 584, 239.

Brunt, C.M., Kerton, C.R. & Pomerleau, C. *An outer Galaxy molecular cloud catalog.* 2003, ApJS, 144, 47.

Kerton, C.R. *Detecting embeded intermediate-mass stars using mid-infra-red and 21-cm* H I *emission.* 2003, AJ, 124, 3449.

Kerton, C.R. & Brunt, C.M. *The Association of IRAS Sources and ^{12}CO emission in the outer Galaxy.* A&A, 399, 1083

A.R. Taylor, **T.L. Landecker, & A.G. Willis**, eds. *Seeing Through the Dust: The Detection of* H I *and the Exploration of the ISM in Galaxies.* 2002, ASP Conference Series, 276 (containing many **DRAO** papers)

Taylor, A.R., Gibson, S.J., Peracula, M., Martin, P.G., **Landecker, T.L., Brunt, C.M., Dedwney, P.E., Dougherty, S.M., Gray, A.D., Higgs, L.A., Kerton, C.R., Knee, L.B.G., Kothes, R., Purton, C.R., Uyanıker, B., Wallace, B., Willis, A.G.**, & Durand, D. *The Canadian Galactic Plane Survey.* 2003, AJ, 125, in press.

Uyanıker, B., Landecker, T.L., Gray, A.D., & Kothes, R. *Radio polarization from the Galactic Plane in Cygnus.* 2003, ApJ, 585, 785.

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The winch test described in the text. The "cherry-picker" truck tensions the tethers. The conduit running into and out of the winch enclosures contains the optical fibre used for communications.

The ACSIS enclosures in the lab area at DRAO. The enclosure on the left has been fitted with two of the correlator crates.

The "fences" near Antenna 1. These metal mesh screens shield the spillover lobes from the ground, giving a 2 K improvement in system noise.