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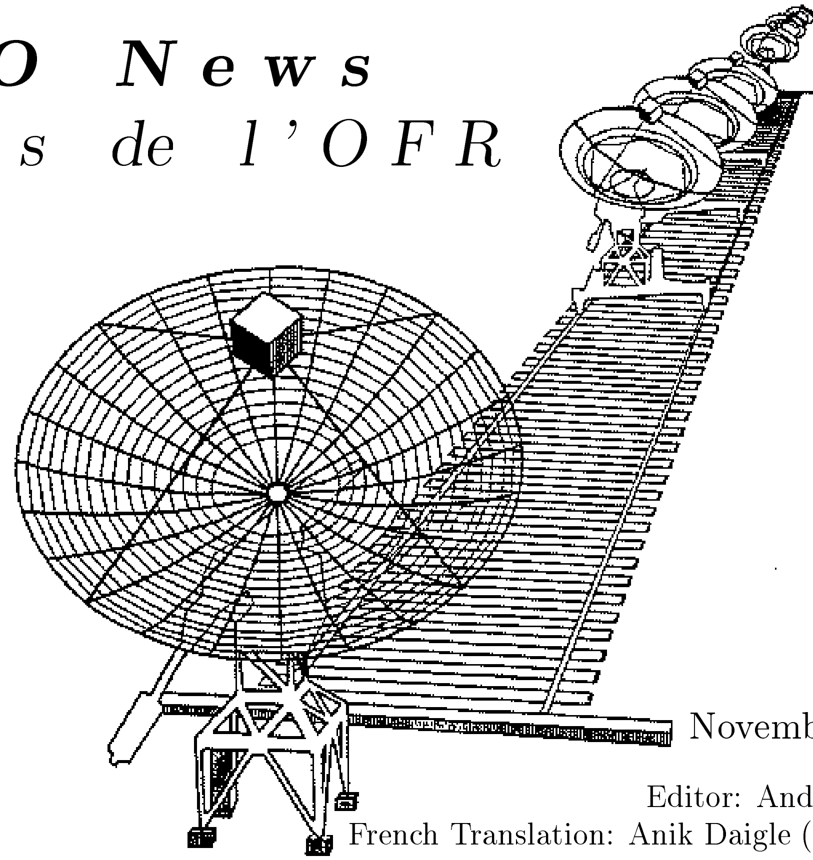


November 2002

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

This has been a rewarding year for DRAO. As funding for Canada's Long Range Plan for Astronomy began to flow, we added a significant number to the group. Looking at the biographical sketches of our new colleagues (see article in this Newsletter) I was impressed by the range and the depth of the talent that we have added. It is particularly gratifying that we have been able to add two young scientists to our contnuing staff. All told, DRAO is now nearly fifty people, including five graduate students and four postdoctoral fellows. It is exciting to work with so much young talent.

Over the summer we moved into our new building. We owe a debt of gratitude to Ron Casorso, who steered the project to completion, on time and on budget, and who organized the move into the new space. There is still much to be done. Ron is currently overseeing the purchase and installation of screened rooms, and the purchase of furniture, as well as the renovation of the original DRAO building, dating from 1959.

The Canadian Galactic Plane Survey (CGPS), as part of the International Galactic Plane Survey, continues to be a major part of scientific life at DRAO and it is a growing success. The total number of papers in refereed journals from the CGPS now exceeds 60. Increasingly these papers are addressing big-picture issues in Interstellar Medium research. 2001 and 2002 were among DRAO's most productive years ever in terms of science publications.

Tom Landecker

Comings and Goings

There have been many additions to our staff in the past year, particularly in the last 6 months or so. The new employees bring with them a diverse range of backgrounds and experience which they will bring to bear on Long Range Plan projects. Some of the following people have been mentioned in previous newsletters, but are included here for completeness:

Dean Chalmers joined the Canadian Large Adaptive Reflector (CLAR) group in March 2002. Dean is a Mechanical Engineer, a graduate of the BC Institute of Technology and U. Waterloo. His experience includes a period with CREO Products in Vancouver, developer and manufacturer of advanced technology for the printing industry. Most recently he has been working at Peerless Page in Penticton, a steel fabricator and manufacturer of tractor trailers.

Peter Cimbaro graduated from Okanagan University College (OUC) in 1990 with a Diploma in Computer Information Systems. He began his career as a programmer, moving gradually towards system administration. From 1994–2002 he was the Systems Project Leader at Western Star Trucks, a manufacturer of heavy-duty transport vehicles employing 600 people in Kelowna. His responsibilities included overseeing computer operations, the Help Desk, and systems services. Peter joined DRAO in April 2002 as part of the computer systems management team.

Dave Del Rizzo took up an appointment as Telescope Operator in April 2002. Dave has a B.Sc. in Physics/Astronomy from York University, and began work at DRAO in 1997 as a Correlator Operator in the Space VLBI Correlator Group. He moved to a temporary position in the DRAO Operations Group in the 2000 to cover for Diane Parchomchuk's year-long leave of absence. When Diane chose to retire, Dave stayed on in that position for a further 6 months while the position was advertised, and was subsequently chosen as Diane's successor.

Sean Dougherty took up his appointment as Research Officer at DRAO in April 2002. He will provide scientific support for the CLAR and will continue to manage the operation of the Space VLBI Correlator. He will also carry on his multi-wavelength research on non-thermal emission from radio stars. Sean received his Ph.D. from U. Calgary in 1993 for work on radio emission from Be stars. He has held postdoctoral appointments at John Moores University, Liverpool, and at DRAO, where he worked on the CGPS.

Dave Fort arrived at DRAO in September 2002 to join the EVLA Correlator team. Dave is a graduate of U. Toronto (Engineering Physics). He earned his Ph.D. at the U. Manchester (Jodrell Bank) in November 1971 in "tape recording interferometry", now called VLBI. He joined the National Research Council in January 1972, and worked in the pioneering Canadian VLBI group on many aspects of signal and image processing. He left Ottawa in 1987 to work for JPL in Pasadena, and since that time has been involved in the application of VLBI technology to deep-space applications.

Richard Hellyer joined the DRAO team in April 2002 as a Mechanical Technologist with responsibilities in the CLAR Group and for the DRAO site and infrastructure. Richard trained as an Airframe Technician with the Royal Canadian Air Force in Calgary, but has followed many lines of work since his return to Penticton, his home town, including work as an arborist and a maintenance contractor at DRAO.

Zhang Heng graduated from Jiaotong University in Shanghai, China, with a degree in Electrical Engineering in 1991. Initially he worked in the R&D department of Anjing, a small company in Tianjin, where he designed analog and digital devices for use in automatic control systems. In 1997 he moved to Singapore, where he worked at the AIWA design centre, developing components for consumer electronics. He has been at DRAO since April 2002, and is part of the EVLA Correlator Group.

Lewis Knee was appointed to the position of Research Officer in September 2001. Lewis earned his Ph.D. from Chalmers Technical University in Sweden in 1991, then worked at the SEST sub-millimetre telescope in Chile. He has published many papers on molecular gas and dust in star-formation regions. As a Research Associate at DRAO for the past few years, Lewis has been working on the Canadian Galactic Plane Survey, lately with responsibility for managing the data reduction effort. He will continue that work, and pursue his research on cold H I in the Galaxy, and the impact of stellar winds on the ISM.

Zoran Ljusic was appointed as Digital Engineer on the EVLA Correlator project in February 2002. Zoran is a graduate in Electrical Engineering from U. Belgrade. Since his arrival in Canada in 1994 Zoran has been working in Calgary for Nortel and Wi-LAN.

Rob Reid gained the degrees of B.Sc. in Physics from U. Waterloo, and M.Sc. in Astronomy from U. Toronto, where he is now completing his Ph.D. His thesis describes the development of Smear Fitting, a new technique for producing images from irregularly sampled interferometric data. Rob will take up an appointment at DRAO as Postdoctoral Fellow in November 2002, working on the CGPS. He will divide his time between reducing polarization data and research.

Raymond Rusk arrived at DRAO in September 2002 to develop software for ALMA. Raymond has M.Sc. degrees from U. Saskatchewan (mathematical physics) and U. Toronto (instrumentation for optical astronomy), and a Ph.D. in astronomy from U. Toronto. He worked at the Defense Research Establishment (Pacific) in Esquimalt, applying electromagnetic techniques to underwater sensing, before moving into the computer industry as an analyst. Most recently he has been working in the computer group at HIA in Victoria, using his spare time to teach Software Engineering and Computer Science at the University of Victoria and Camosun College.

Ralph Webber joined the ACSIS Group in April 2002. He is a graduate of the BC Institute of Technology, and worked in Vancouver as a communications technologist with the RCMP before spending 4 years at DRAO in the early 1990s, contributing to the development of analog and digital systems for the expansion of the Synthesis Telescope. He returned to Vancouver in 1995 to a position with Glenayre Electronics, a company manufacturing equipment for paging infrastructure, where he worked in the Hardware Design Group.

Glenda Wray is our new librarian. Glenda has a B.A. in Canadian History from UBC, and a Library Technician Diploma from Langara College. Her career has mostly been in the corporate setting, establishing and maintaining libraries and records-management systems for the Aluminum Company of Canada and Trans Mountain Pipeline. Glenda subsequently worked with the library team at the Justice Institute of BC before taking a sabbatical to raise her family. She moved from Vancouver to Kelowna in 2001, and joined DRAO in August 2002.

Graduate students have been important on the DRAO scene for many years. Those working here now are:

Tyler Foster is a graduate of the U. Alberta, with a B.A. in English Literature (1992), a B.Sc. in Theoretical Physics (1998), and an M.Sc. in Astronomy (2000). As an undergraduate, Tyler worked in CCD research with small telescopes, including implementing both software and hardware for the CCD imager on the Devon Astronomical Observatory's 0.5 m telescope, and using the system for photometry of variable stars. Throughout his career he has contributed to public astronomy education. Tyler is currently working on his Ph.D., using data from the CGPS and Devon AO to study the structure of the Milky Way.

Angel Garcia is a graduate in Engineering Physics from U. Alberta (April 2001) and is working towards her M.Sc. She is working with Bruce Veidt in developing low-noise amplifiers for 1420 MHz as part of the effort to reduce the system temperature of the Synthesis Telescope. She is exploiting new low-noise devices developed for the communications industry. These will be directly connected to the wave-guide probes, with no intervening connector, eliminating a source of loss. The techniques developed will be valuable for amplifier development for the CLAR.

Teresia Ng graduated from U. Alberta in Electrical Engineering in April 2001, and is in the M.Sc. program there, doing her thesis research at DRAO. She is working with Tom Landecker on techniques for reducing ground noise picked up by the antennas of the Synthesis Telescope as part of the effort to enhance its sensitivity.

Ed Reid (no relation to Rob Reid above) is a graduate of U. Alberta, earning his B.E. (Electrical) in 1979. Ed worked for many years in the telecommunications industry in Alberta, Ontario, and Colorado, in areas ranging from network engineering to testing of high-capacity fibre optics systems. Feeling that the telecommunications sector no longer offered the opportunities for research and development that he sought, Ed "retired" to pursue graduate studies. His Ph.D. work is in designing antennas to be employed in the phased array feed for the CLAR project.

Maik Wolleben arrived at DRAO in May 2002. Maik did his undergraduate work at the Universities of Hamburg and Bonn, graduating as Dipl. Phys. from Bonn. He is now a Ph.D. student working at the Max-Planck-Institut für Radioastronomie (MPIfR), pursuing research on the Galactic polarized emission. As a collaborative project between MPIfR and DRAO, Maik is making polarization observations at 1420 MHz using the DRAO 26-m Telescope, to complement observations at the same frequency from the Effelsberg 100-m Telescope. Maik brought a polarimeter from Bonn, and has adapted the 26-m front-end to polarimetry. He is also developing calibration and data reduction procedures.

Two people have recently departed from DRAO:

Bülent Uyanıker and **Aylin Yar** left in June 2002. They have returned to the Max-Planck-Institut für Radioastronomie in Bonn, where Bülent is working in the polarization group. At DRAO since October 1999, Bülent developed many data-reduction techniques for polarization data, and produced polarization images for a large area of the CGPS. While at DRAO he published seven papers in the journals from his thesis work and his DRAO work. After arriving in March 2000, Aylin completed her Ph.D. thesis while at DRAO, contributed to the 26-m Telescope H I Survey for Phase 2 of the CGPS, and was involved in several CGPS research projects. We thank them both for their many contributions.

Tom Landecker

The New DRAO Building

The big news about the new building is that construction was finished on time and on budget, and staff moved into their new offices over the summer. The new building offers 10 more offices than the old trailer complex, with most already occupied by new staff, as well as much larger laboratory spaces (both shielded and unshielded), and an area for developing large mechanical structures, which is already seeing use for the LAR project.

The major remaining work to be done inside the building is the construction of a large shielded room on the main floor, which will provide 168 square-metres of space for digital development, including a temperature-controlled chamber for temperature cycling and environmental testing of new equipment.

As for the old buildings, the original 1959 brick building is being renovated to meet current health and safety standards, and once finished will house 4 offices, 2 meeting rooms, the library, and the first aid room. Part of the old trailer complex has been removed, with the remainder seeing continued use by the Space VLBI correlator, or being converted to storage.

Below are some pictures from the new building taken during the summer, while we were still moving in.

Ron Casorso

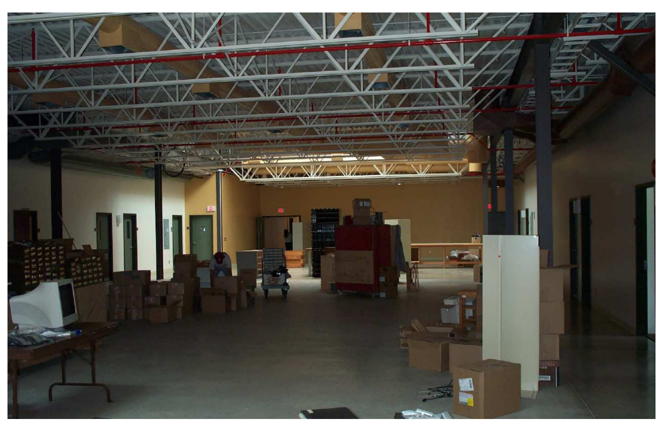
Staff Profile: Charles Kerton, Research Associate

Charles was born in 1970 in Middleton, Nova Scotia, in the heart of the Annapolis Valley, an area known for its fruit, especially apples. Little did he know then that he would move across the country to Penticton, in the heart of the Okanagan Valley, an area known for its fruit . . . including apples!

By the age of 4 Charles was already an international traveller, thanks to his father's career in the Canadian

An exterior view of the new building. Note the wire mesh over the windows, to help reduce interference radiated from within.

The upper floor of the new building, looking west. The open area under the skylight will be used for library materials and informal meetings.



The lower floor of the new building, looking east. The large covered area will soon be filled with a shielded room for instrument development work.

The large structure development area, a two-storey space at the east end of the building for working on mechanical aspects of projects such as the LAR. Shown are winch frames for the LAR project.

Armed Forces. Until he was 7, Charles lived in England and Scotland, where he acquired the local accent (which he has since lost). His memories of his time there include having to wear the school tie, and eating the "horrible custard" that was served as part of the school lunches!

Charles Kerton

The remainder of Charles's childhood was spent in Nova Scotia, where he developed a hobby as a backyard astronomer. From 1988–1992 Charles attended Dalhousie University in Halifax and earned a B.Sc. in Physics. It was during this period that he met his wife-to-be, Joanne, while they both worked as summer students at St Mary's University. Charles then went to the University of Toronto and pickled up his M.Sc. in Astronomy. He and Joanne were married in 1994, just in time to fly to Hawaii for an extended honeymoon: after 3 years they returned to Toronto, with Charles's M.Sc. in Geology & Geophysics tucked in their carry-on luggage. While apparently a diversion from his astronomy career, this M.Sc. work was related to the Galileo mission, and Charles now has a better understanding than most of us of the volcanism on Io (Charles also says that he takes perverse pleasure in knowing what is meant by "ferruginous laterite").

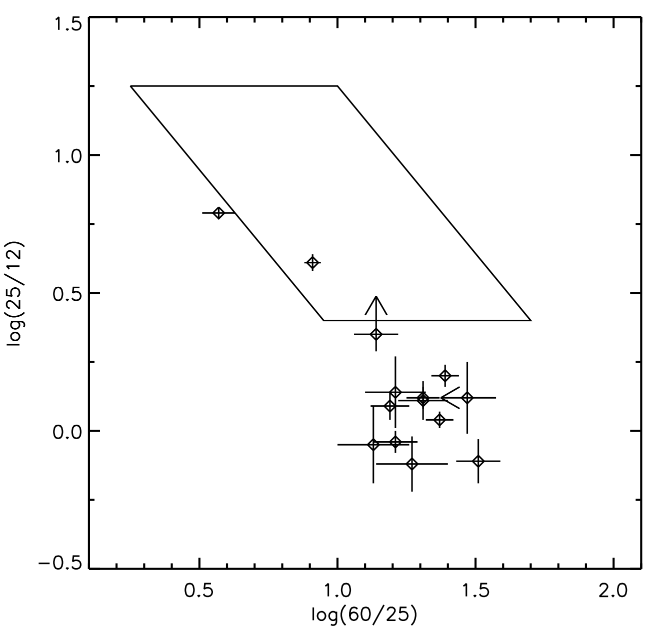
Charles embarked on his Ph.D. at the University of Toronto in 1996, working on the Mid-Infrared Galaxy Atlas (MIGA), the 12 and 25 μm counterpart to the Infrared Galaxy Atlas (IGA) at 60 and 100 μm. In 1997 Charles had the opportunity to work with Lloyd Higgs and Tom Landecker on the Low-Resolution DRAO Survey (LRDS) using the 26-m Telescope at DRAO, supplying short-spacing information for the Canadian Galactic Plane Survey (CGPS) data produced by the Synthesis Telescope. Upon completing his Ph.D. in 1999, Charles returned to DRAO to take up a Research Associateship with the CGPS project, and currently works on reducing the 21-cm H I data from the Synthesis Telescope.

His professional interest in astronomy has not diminished his love of the night sky, and he shares this passion by teaching continuing education courses in astronomy at the Okanagan University College. When not involved in astronomical matters, Charles likes to hike, read, dabble in wood-working, and (a by-product of having two children) try to maintain an indoor freshwater eco-system in which pet fish can live long and happy lives.

Andrew Gray

A Population of Embedded Intermediate-Mass Stars

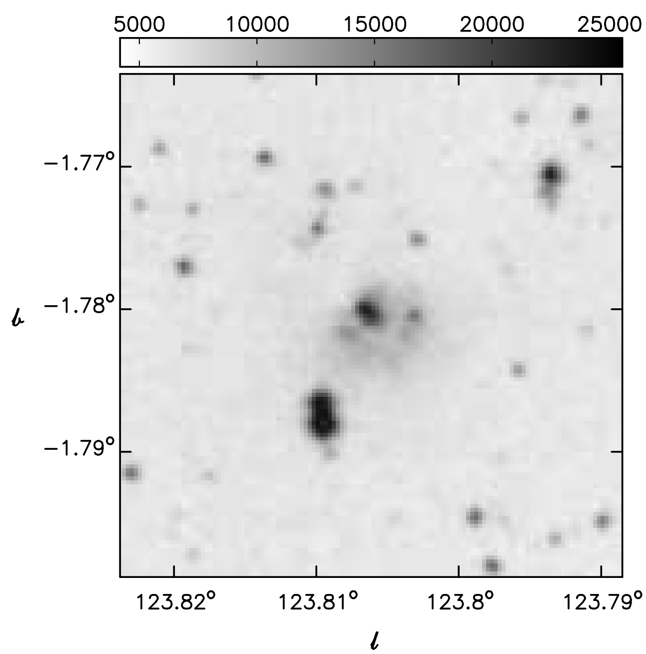
Work has recently been completed on a technique to detect distant young embedded B stars (and possible clusters) from their imprint on the surrounding interstellar medium (ISM). H I 21-cm and ^{12}CO (J=1–0) line data from the Canadian Galactic Plane Survey (CGPS) were combined with mid-infrared images from the Midcourse Space Experiment (MSX) Galactic Plane Survey to detect the photo-dissociation regions (PDRs) and molecular gas associated with embedded intermediate-mass stars (aka dissociating stars).



IRAS colours of embedded stars with detected H I emission. Most H II regions have colours within the solid outline (Hughes & MacLeod 1989).

The technique was applied to a section of the Galaxy covered by the FCRAO Outer Galaxy Survey ($102.^\circ5 < l < 141.^\circ5$; $-3.^\circ0 < b < +5.^\circ4$) and has led to the detection of 15 embedded intermediate-mass stars. PDR models, combined with previous observations of early-type Herbig Ae/Be stars and the non-detection of many of the sources in OH, H_2O and CH_3OH surveys, imply that the objects are $\sim 10^6$ years old. The IRAS colors of the objects form a well-defined group (see Figure) and have been combined with ^{12}CO and MSX observations to identify approximately 100 additional IRAS sources within the survey area as possible embedded intermediate-mass stars.

The difficulty in directly observing the H I associated with these objects is thought to be due to a combination of observational and astrophysical factors. The observational problems of detecting H I structures within the Galactic plane will be familiar to most readers. Astrophysically stars like this are expected to be quite efficient at clearing out surrounding material on time scales of only 10^6 years (Fuente et al. 1998, 2002). Apparently a "dissociating star" is a particular stage in the early development of an embedded intermediate mass star—the star is old enough that it is no longer associated with a cocoon of very dense gas, but it is young enough that stellar winds and heating due to photo-ionization have not completely disrupted the surrounding molecular material and rendered any H I zone undetectable against the general Galactic H I background (see Figure). The full study can be found in Kerton (2002).



DSS image of IRAS 00556+6048. Many of the embedded stars, such as this one, are visible in the DSS images and have associated optical nebulosity. Gray-scale units are arbitrary data numbers.

References

Fuente, A., Martin-Pintado, J., Bachiller, R., Neri, R., & Palla F. 1998, A&A 334, 253

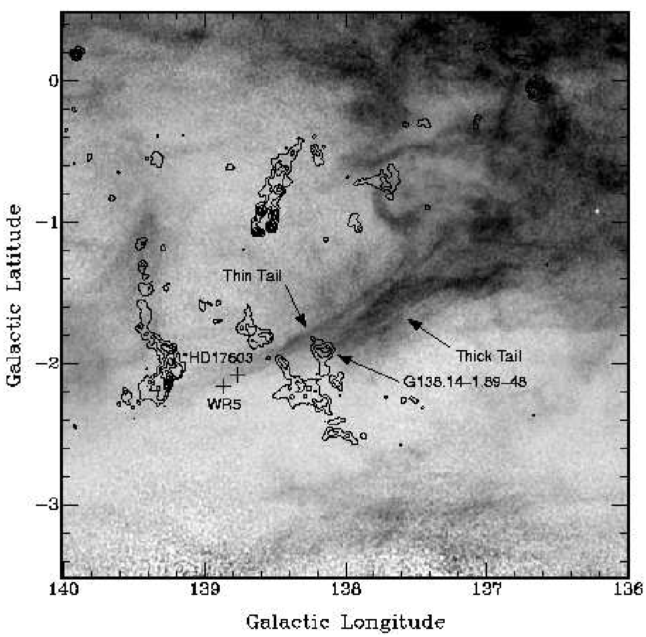
Fuente, A., Martin-Pintado, J., Bachiller, R., Rodriguez-Franco, A., & Palla, F. 2002, A&A, 387, 977

Kerton, C.R. 2002, AJ, 124, in press

Charles Kerton

H I Tails from Molecular Clouds near HD 17603 and WR 5

Using CGPS data, we have discovered a system of long narrow H I tails emanating from molecular clouds located about 2 kpc away in the direction of the Perseus Arm. The main tail appears to stream away from a molecular cloud of mass $400\,M_\odot$ with radial velocities between 5 and $20\,\mathrm{km\,s^{-1}}$. A second very narrow tail lies to the north of and parallel to the main tail. This system of tails points toward the luminous stars HD 17603 (O8If) and the Wolf-Rayet star WR 5 (see Figure). Both



H I tails from CO clouds: H I data (greyscale) showing tails emanating from CO clouds (contours). The thick tail points towards the CO cloud G138.14-1.89-48. Both point towards the stars HD 17603 and WR 5.

stars are thought to be at a distance of about 2 kpc, which agrees with the kinematic distance of the CO clouds. The tails have a well-defined radial velocity gradient in the direction along the tails suggestive of acceleration.

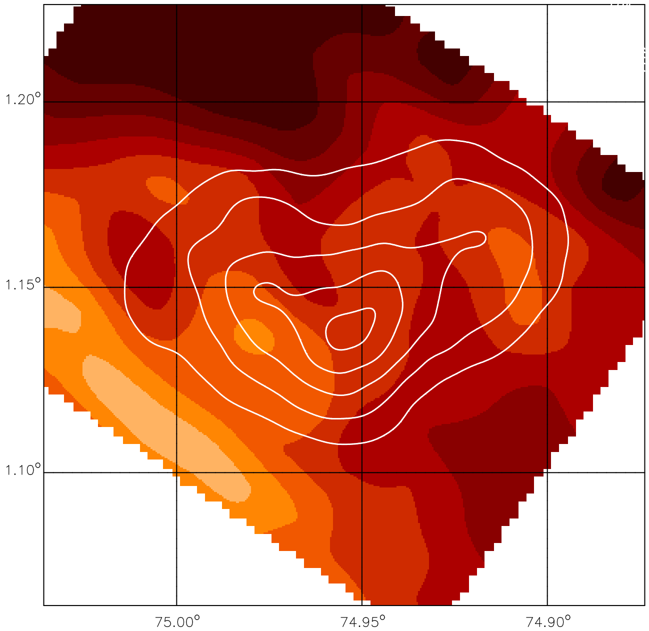
We propose that the H I tails are gas dissociated from the molecular clouds and accelerated away in the wind of one or perhaps both of the stars. The total mass of H I in the tails is $1700\,M_\odot$, roughly 4 times the mass in the molecular clouds. The tails are several tens of parsecs long and the dynamical timescale is a few million years, which is of order the Main sequence lifetime of the massive stars which evolved to become HD 17603 and WR 5. If one or both of these stars have driven the H I tails, this must have occurred while they were on the Main sequence. If the tails are entrained by a stellar wind, it is conceivable that shocks dissociate the gas to produce the H I. Alternatively, the dissociation may be caused by the stellar radiation field(s). There is however no evidence for the effects of photo-ionization in this system. The relative narrowness of the tails suggests that the Mach number in the driving wind is not very large (perhaps at most only mildly supersonic).

The kinematic parameters of the H I flow place tough constraints on the external wind flow. The required momentum flux in the external driving wind implies that a total of $\sim 10^{51}$ erg of available kinetic energy (i.e., not in the form of thermal energy) must have been supplied by the wind over the lifetime of the tails. This is a severe constraint, since in the basic theory of adiabatic stellar wind bubbles, only a tiny fraction ($\sim 1\%$) of the total energy in the wind is in the form of kinetic energy within the shocked stellar wind region which takes up the majority of the volume of the wind bubble. However, mass-loading of an initially supersonic wind from mass sources distributed smoothly throughout the region around the star can reduce the Mach number of the wind without having the wind going through a global shock near the star. If the mass loading is sufficiently heavy, a large fraction of the stellar wind energy (50% or more) will remain in the form of kinetic energy instead of thermal energy. A heavily mass loaded wind can thus in principle account for the very large amount of momentum required in our scenario. Heavy mass loading greatly reduces the mass of the swept-up bubble of ambient gas around the wind bubble, and for HD 17603 and WR 5 we see no evidence for a detectable swept-up shell.

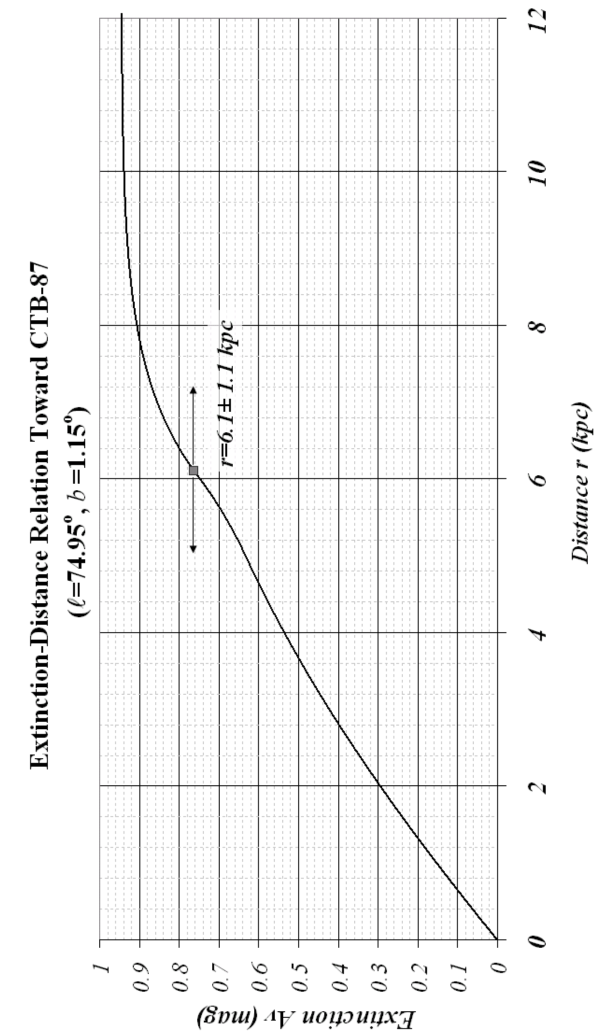
Lewis Knee & Brad Wallace

The SNR CTB87: its environment and distance

An analysis of H I data from the Canadian Galactic Plane Survey (CGPS) and new CO observations in the direction of the supernova remnant CTB87 reveal evidence for a molecular shell surrounding parts of CTB87 at a radial velocity of $-56\,\mathrm{km\,s^{-1}}$ (see Figure). There is no evidence of interacting H I or of the existence of a stellar wind bubble, indicating a supernova explosion of type II and a B2 or later type progenitor star. We established a new distance of 6.1 kpc based on the extinction-distance relation introduced by Foster & Routledge (see Figure), which agrees with a position in the Perseus



CO and CTB87: CO map at a radial velocity of -56 km/s. White contours indicate the radio emission of CTB87 at 1420 MHz taken from the CGPS.



Distance to CTB87: The extinction as a function of distance towards CTB87. The distance to the SNR is indicated.

arm. Our results contrast with previous distance estimates based on H I absorption measurements: using a flat rotation curve gives a distance of about 12 kpc. This discrepancy arises from a significant shift of the radial velocities in the direction of CTB87 because of the spiral shock. The new distance reduces the implied physical size and the luminosity of CTB87 by a factor of two and four, respectively. The properties of this plerionic supernova remnant are then more similar to the other SNRs of its kind except the Crab Nebula, which is an outstandingly luminous object.

Roland Kothes, Wolfgang Reich, Tyler Foster, & Do-Young Byun

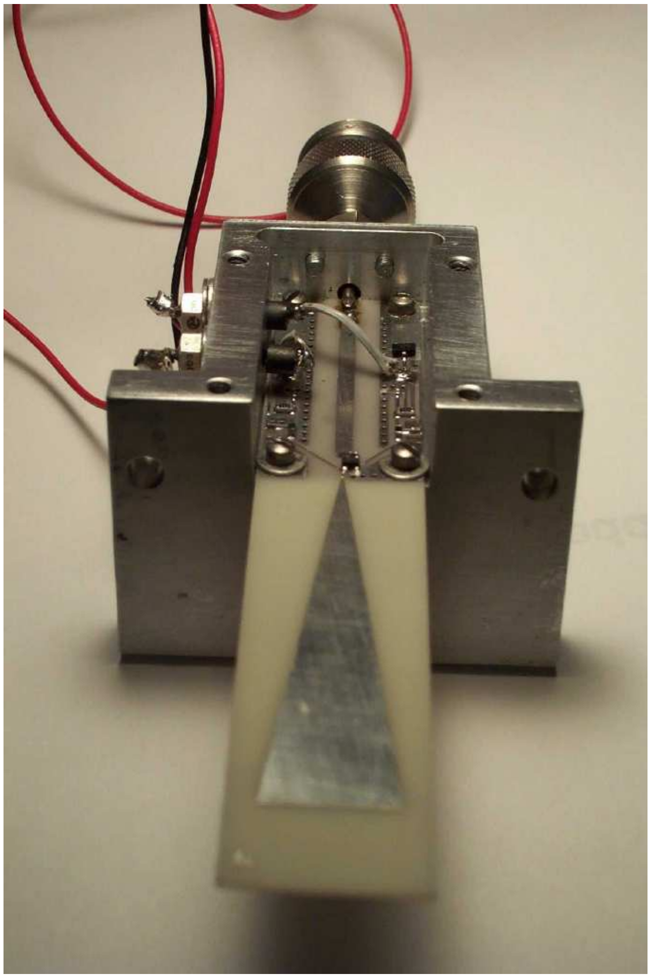
New Low-noise Amplifiers for the Synthesis Telescope

I am working on lowering noise in the front-end receivers as part of the effort to double the sensitivity of the Synthesis Telescope. Front-end receiver noise (34 K) currently forms a significant fraction of the Synthesis Telescope system temperature (59 K). The goal of the project is to produce a low-noise amplifier with at least 14 K less noise than those currently operating in the Synthesis Telescope.

In 2000 Bruce Veidt and Annie-Claude Lachapelle designed and built the Mark 1, a single-stage low-noise amplifier with matched probe. The matched probe eliminates the need for a coaxial cable connection between the waveguide and the amplifier, eliminating a source of loss and alone reducing system temperature by 5 K. The Mark 1 system used an Agilent pseudomorphic high electron mobility transistor (PHEMT; see Figure) and yielded about 10 K less noise than the existing front-end amplifiers.

An inconsistency between the manufacturer's specification for the transistor (specifically the scattering parameters, commonly known as S-parameters) and a software analysis of the amplifier has led us to design and build a test fixture to verify the Agilent PHEMT's S-parameters, and to also test Fujitsu HEMTs. Upon determining the correct the S-parameter values, a final analysis of the noise parameters of the Agilent and Fujitsu transistors can be performed.

A new single-stage amplifier/probe circuit (the Mark 2) will then be designed and built to resolve some problems with the Mark 1. However, it is already known that the single-stage Mark 2 will not be able to produce more than 15–20 dB gain (the Mark 1 had a gain of 15 dB), which is not sufficient for a radio telescope front-end



The Mark 1 single-stage amplifier. The metallic triangular patch at the front is the probe that is inserted into the waveguide. Just the right of the the apex of the triangle is the small, black PHEMT chip. Beyond the chip is the transmission line that carries the signal to the connector at the rear of the device.

receiver. The final step in the project will therefore be the development of a viable multi-stage, low-noise amplifier–the Mark 3.

Angel Garcia

Reducing Ground Radiation Pick-up by the Synthesis Telescope

The two main sources of system noise on the Synthesis Telescope are ground noise and receiver noise. My project is to examine the mechanisms by which ground radiation enters the antenna and perform experimental modifications on the antenna to lower the ground noise. Together with the project aimed at reducing the receiver noise (see article by Garcia above), the total antenna noise of the DRAO Synthesis Telescope will be halved and the sensitivity at 1420 MHz will be doubled.

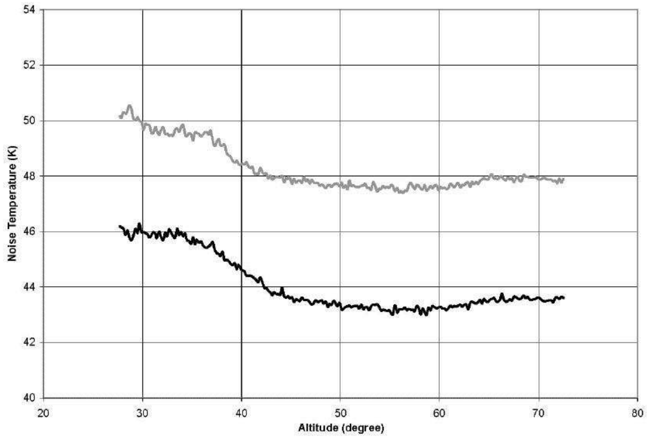
The main contributions to ground noise are leakage through the mesh, spillover noise, strut scattering, and edge diffraction. The leakage of ground radiation through the mesh accounts for 5.9 K. Ground radiation in the spillover region (from the edge of the reflector to the horizon) is not intercepted by the reflector and thus enters the feed directly, contributing 8.1 K. The support struts scatter the plane wave from the main reflector, and produce large conical sidelobes known as scatter cones. Parts of these scatter cones illuminate the ground and pick up thermal radiation, contributing approximately 5.8 K. Diffraction of ground radiation around the reflector rim into the feed contributes another 0.6 K. Summing all the contributions, the total ground noise is 20.4 K. (These numbers apply to antenna 7, one of the noisiest anetnnas.)

In an experiment to reduce the leakage through the mesh, the center portion of the reflector of Antenna 7 was covered with aluminum auto-body tape (see Figure). Since the feed illumination tapers off at the edge

Antenna 7 of the Synthesis Telescope at DRAO, showing the aluminum tape covering the central portion, as described in the text.

of the reflector dish, the effect of mesh leakage is far more prominent in the dish center, so shielding only the center portion of the reflector is sufficient.

After covering the inner 2 m radius of the 9 m reflector, the noise temperature was successfully reduced by 4 K at all elevations (see Figure). The auto-body tape is self-adhesive, and was applied directly onto the



The system noise temperature on Antenna 7 as a function of elevation. The grey line shows the noise temperature measured before the reflector was shielded. The black line shows the noise temperature measured after a 2 m radius was covered with aluminum tape.

reflector mesh for this experiment. We are now looking at ways to reduce mesh leakage that we can leave on the dish permanently. Other experiments are also in progress, including modification of the shape of the struts and reduction of the spillover contribution by the use of shields and fences on the ground.

Teresia Ng

Absolute Polarimetry at 1.4 GHz using the 26-m Telescope

The 26-m Telescope is currently being prepared for absolute polarization measurements at 1.4 GHz. Maik Wolleben brought an IF-polarimeter from MPIfR and has incorporated it into the receiver. The polarimeter requires circular polarization as input, but the receiver produces orthogonal linear polarization, so a quadrature hybrid was installed ahead of the polarimeter. The hybrid does introduce cross-talk and non-linearities, so extensive calibration measurements need to be done to derive the required correction terms. The data processing software is written in `glish`, a scripting language used in the `aips++` project.

The planned observations will provide data to improve the absolute polarization calibration of the Effelsberg 1.4 GHz Medium Galactic Latitude Survey. The data from that survey will be incorporated with the CGPS 1.4 GHz polarization data from the Synthesis Telescope. Until now the absolute calibration of the Effelsberg measurements have relied on data obtained with the Dwingeloo 25-m telescope in the 1960s and 1970s. However, the Dwingeloo measurements are severely undersampled and are of limited sensitivity (60 mK compared to 8 mK of the Effelsberg measurements). There are large areas of sky in which the polarized intensity drops below 100 mK, leading to problems when trying to use the Dwingeloo data for calibration.

We plan to observe almost the entire sky visible to the 26-m Telescope in drift scan mode. The data will have significantly higher sensitivity than the Dwingeloo data, allowing improved calibration accuracy. Each night the telescope will be set at a fixed elevation on the meridian and drift scans will be measured for a certain declination. This method keeps the ground radiation constant for each scan, allowing it to be determined and subtracted. Additional elevation scans will help to check ground radiation differences between the scans. A sampling interval between 2° and 5° in declination is believed to be sufficient to calibrate the Effelsberg polarization survey.

The receiver modifications have now been done and the software development is complete, and observations began in November 2002.

Maik Wolleben, Tom Landecker, & Wolfgang Reich

Progress on the Canadian Galactic Plane Survey

As mentioned in the previous Newsletter, all 36 H I mosaics from the first phase of the Canadian Galactic Plane Survey have been completed and released to the CGPS Consortium members. Since then, these H I mosaics have been publicly released through the Canadian Astronomy Data Centre. In addition, all 21 cm continuum (C21) mosaics have also been publicly released. As this Newsletter goes to press, we are beginning the creation of the complete set of 74 cm continuum (C74) mosaics.

Data processing for the second phase of the CGPS is now well under way. Thus far, 71 fields (of a total of 177 in Phase 2) have been reduced in H I, 51 in C21, and 13 in C74 (109 of 177 fields have been observed to date). Once the second Low Resolution DRAO Survey (LRDS II) of H I with the 26-m Telescope is complete, we will have the low-order spacings data required to produce out first Phase 2 H I mosaics.

The Canadian Astronomy Data Centre (CADC) has launched into further development of the CGPS data server system which currently exists at CADC. It is intended to provide improved data search tools as well as the ability to do some visualization of the data sets before download. A central part of this development will be the utilization of the Aladin system provided by the Centre de Donnees astronomiques de Strasbourg (CDS), which can be used to display data, overlay contours and/or plot objects from other data sets. We hope to announce the availability of the enhanced CADC-CGPS server system in the next Newsletter. Until then, the old system is still in place, with all of the H I, C21, CO, and HIRES IRAS (12, 25, 60, 100 μm) data for Phase 1 available for download by registered users of the CADC (register at `http://cadcwww.hia.nrc.ca/cadc/register.html` or http://cadcwww.hia.nrc.ca/cadc/register_fr.html). Enquiries about the data should be addressed to Lewis.Knee@nrc.ca.

Processing of 21 cm polarization data has been in hiatus following the departure of Bülent Uyanıker. This autumn a new post-doctoral fellow, Robert Reid (U. Toronto) will join the team at DRAO and get polarization data processing restarted.

Lewis Knee

News from the Space-VLBI Correlator Centre

The orbiting radio telescope, HALCA, the centre-piece of the Japanese-led VSOP mission, continues observations of high brightness temperature objects well into its 6th year of operation. Indeed, apart from a few minor attitude adjustments, HALCA has performed flawlessly over the past two years.

Since February 2002, when NASA participation in the mission ceased, the mission has concentrated on completing the VSOP Survey project, a project to systematically observe the radio-brightest quasars and AGN. Canada plays a major role in the Survey project, through correlation of almost all the survey data at the S2 correlation centre at DRAO, and the VSOP data analysis centre at the University of Calgary.

Now that we are correlating almost all the observations made by VSOP, the action has been fast and furious, with a total of 36 experiments completely correlated and shipped off to the data analysis centre since May, for an average rate of 6 experiments/month.

The Canadian Space Agency and the Joint Sub-Committee on Space Astronomy have been advised that we anticipate completion of the Survey project in August 2003. This will require an increase in the data-processing rate to approximately 8 experiments/month, a challenge the correlator centre staff are excited to meet!

Recently the Russian space agency, ROSAVIACOSMOS, and the Russian Academy of Science announced that the Russian Radioastron space VLBI mission has been given the number one priority position in the Russian space astronomy programme. The launch of the 10-m diameter antenna is scheduled for March 15, 2006, placing the spacecraft in an orbit with an apogee altitude near 340,000 km and a perigee altitude near 10,000 km. It is expected to concentrate its scientific efforts to observations at 22 GHz, offering unprecedented angular resolution.

Of great interest to the S2 Correlator Centre, the bandwidth of the observations will be 128 Mbit/s, and it is planned that the global S2 network will play a major role in the observations and correlation. The Space-VLBI project was originally started in Canada to support the Radioastron mission, but the launch date was continually pushed back. However, the situation appears to be very different today, and the various international participants in the VSOP mission, including us here at DRAO, are now paying close attention to the rapidly developing situation of Radioastron in Russia.

Sean Dougherty

Progress on the LAR Aerostat Experiment

Much has happened in the LAR Aerostat Experiment since the last issue of *DRAO News*. Several new people began working on the project: Richard Hellyer and Dean Chalmers were hired in April, Richard as a mechanical technologist, and Dean as a mechanical engineer. Both have been invaluable in completing work for the field trials of the aerostat system. Dean is also involved in design work for mechanical systems that will be needed for future stages of the project, including winch and feed platforms, and reflector support and actuation. He has been working with people at AMEC in Vancouver on some of these projects. We also have Matthieu Passard, a mechanical engineering student from France, working with us until January.

In the field, work on the instrument platform and launch trailer was completed in March, with helium inflation taking place late in that month. Low-altitude tests in which the aerostat was constrained by the ground-handling lines were conducted during April to familiarize the flying crew with procedures for launching and retrieving the aerostat and to verify that the equipment worked properly. During this phase it was found that modifications to the main winch were needed to increase its capacity. Full altitude tests then began in May, initially without the instrumentation package, but with full instrumentation by the end of the month.

In this early testing it quickly became obvious that learning to cope with the wind was our biggest challenge. It does not take much of a breeze for the "sail area" of the aerostat to pose real problems for ground-handling operations. The rotating boom which allows the aerostat to weather-vane when tied down to the launch trailer has proved to be invaluable. Records from the site weather station showed that the calmest time of day during the summer months is between about 10pm and 10am, so launches were undertaken before dawn, with the aerostat being retrieved once winds reached a speed of about $4\,\mathrm{m\,s^{-1}}$ (14 kmh).

Winds have also been a problem when the aerostat is stored in the hangar. The present, open-ended design allows a considerable amount of wind to enter the hanger and buffet the aerostat, which is not good for long-term durability. In order to alleviate this problem, a 6 m extension to the length of the hangar and a curtain-style door are being installed to provide better protection for the aerostat.

Other challenges that we have faced so far have ranged from problems with the instrumentation and data acqui-

The aerostat in flight over the White Lake basin in May. Note one of the peripheral tethers rising from the foreground. The point at which the three peripheral tethers meet is approximately 200 m above the ground. The aerostat flies on a single tether above this point, with the length of that tether being one of the variables under test. At the time of this photo the tether length was 20 m. Experience quickly showed that longer is better, and the length now used is 150 m

sition systems to workmanship issues with the construction of the aerostat. These have now all been overcome, but at the cost of delaying the data acquisition phase of the project by several months. Nonetheless, several sets of good quality data for use in verifying models of the system performance have been obtained. These data are being sent to Meyer Nahon at McGill University, who developed the models, for analysis. Initial results look promising, with motion of the platform seeming to be dominated by slow, large-scale motions.

To date, tests have used three fixed-length tethers attached to concrete anchors, with the length of each tether determining the azimuth and zenith angle being tested. We are now preparing for the next phase of the project, in which winches will be deployed in place of the concrete blocks to provide dynamic control of the instrument platform's position. Winches and mounting frames have been delivered and are being readied for use. The design of a control system has begun, and will draw on the analysis of results of existing flight tests. Initially we will be using 3 winches, but will ultimately use 6 winches to provide better zenith angle coverage.

Andrew Gray

The New Spectrometer for the JCMT: ACSIS

Since the last newsletter there have been a number of developments concerning the Auto-Correlation Spectrometer Imaging System (ACSIS) being developed for the JCMT. The correlator hardware, developed by Tom Burgess, is now complete and four crates of hardware have been built. Tom is now working on the final production of the samplers, that will turn the sixteen signals from the 345-GHz HARP receiver into digital data. The data rate from the samplers is extremely high. In total they present 64 giga-samples per second to the correlators. Several racks of equipment are needed to house, cool and interconnect the ACSIS IF, correlator and reduction hardware. Ralph Webber joined the ACSIS team in April and is developing this infrastructure to do this.

An essential part of ACSIS is the IF system. Much of this hardware is in the process of being built by Brian Force at the JAC. A key component of this system, the Down-Converter Module, is being built by Murnadi Communications of Calgary. After reviewing the design last February they were awarded a contract in August to make several key modifications to the DCM and build prototype and production units. We recently attended a system design review of their work and are happy to report that it is thorough, well underway and on track. Prototype assembly and testing is planned to begin in January, while delivery of prototypes is scheduled for April. The production units will be delivered in batches beginning in June and ending in July.

The third key part of ACSIS is the reduction system. This system produces calibrated spectra, at a 20 Hz dump rate, that can be gridded and displayed in real-time. The software runs on an array of Linux computers and is being developed using Glish and aips++. The system will be capable processing up to 10 MB of data per second, something few telescope systems can match. To handle these speeds ACSIS will likely run on an array of sixteen dual-processor Linux-computers, which will be purchased in the second quarter of 2003. In total the system will have 16 GB of memory and over 2 TB of disk storage. An initial version of the reduction software was completed in September and was recently tested by the project scientist, Bill Dent (UKATC). The final version of the software should be complete by July, with final integration and commissioning of ACSIS in the fourth quarter of 2003.

Gary Hovey

Spectrum Management Activities

As the 2003 World Radio Conference approaches, there is increasing pressure to get the important issues in radio astronomy protection addressed. The three main areas of activity are: (i) the ongoing work at evaluating the interference threats and protection needs for each individual band allocated to radio astronomy, (ii) the perfection of tools for use by operators of services posing potential threats to radio astronomy in estimating what problems they will cause, and to whom, and (iii) producing documents containing information needed for (i) and (ii). The misunderstandings out there have to be heard to be believed. This year, Ken has attended meetings in Washington and Geneva to work on the studies and the tools, attended two meetings with Industry Canada in Ottawa. With help by DRAO staff, we have produced a document describing the nature of radio astronomical observations and the protection needs, and persuaded Industry Canada to propose this formally in Geneva.

This is slow work, sometimes terrifying and other times tedious. However, clear windows in the radio spectrum are as important to radio astronomers as the radio telescopes that look through them. Contact Ken.Tapping@nrc.ca for more information on the spectrum management activities at DRAO.

Ken Tapping

The Synthesis Telescope

Observing with the Synthesis Telescope has generally gone well in the past 6 months, with the exception of a failure of the main uninterruptible power supply in the Blockhouse. One battery shorted out, causing all of the batteries to fail. It is likely that a power spike associated with this incident prompted the hard-drive in the main observing computer to also fail. To cut a long story short, it was more than 2 weeks before everything was up and running again. While such delays are frustrating, this incident will not significantly delay completion of observing for Phase 2 of the Canadian Galactic Plane Survey, which remains on track to finish in early 2004.

Experiments are on-going to increase the sensitivity of the Synthesis Telescope at 21 cm. This work includes investigating new amplifiers and ways of reducing the amount of ground noise being picked up by the antennas. Reports on this work are contained elsewhere in this newsletter.

Andrew Gray

The 26-m Telescope

Observing time on the 26-m Telescope has been at a premium lately. Over the past summer a significant amount of observing time was allocated to Heather Cameron (U. Toronto graduate student) for a study of the feasibility of using the Telescope to measure absorption of linear polarization in the H I spectral-line as a means of determining distances to polarized emission regions. The Telescope is now being used by Maik Wolleben (U. Bonn) for continuum polarization measurements that will be used to supplement polarization measurements made at Effelsberg. In between these actvitities, the Telescope continues to survey the Phase 2 region of the Canadian Galactic Plane Survey to provide short-spacing information for the Synthesis Telescope observations.

Longer-term, experimental projects of the type described above are ideal for the 26-m Telescope, and provide a valuable opportunity for students to obtain hands-on experience with radio-astronomy equipment. Applications for observations using the 26-m Telescope in this way may be made at any time, and are scheduled on a priority basis. Contact Ken.Tapping@nrc.ca for more details.

Ken Tapping

The Solar Radio Flux Monitor and the Canadian Geospace Monitoring Programme

Over the years, the NRC's solar radio flux data, known internationally as the 10.7 cm Solar Flux, has become more widely used in the space science, environmental, and industrial areas than in the mainstream of astronomy. To move the programme more into the space area, we made a proposal to the Canadian Space Agency to come in as a partner to manage and operate the programme. Tom Landecker and Ken Tapping made presentations to the CSA in St Hubert, and Ken has attended two more meetings since. We obviously touched the right spot. Our ideas are now part of a proposal for a Canadian Geospace Monitoring Programme, which is a partnership of the CSA, NRC, and Canadian universities, to bring together the different geospace monitoring programmes and space science activities into a single consortium, with better scientific and industrial connections.

Over the next year we expect to start an upgrade of the solar radio facilities at DRAO, and the incorporation of our data into a common Canadian data site. We will continue building our scientific partnerships, and of course, attend more meetings.

In the age where Space Weather and the environment are important issues, and there is need for focussed guidance in Canada's increasing activities in space, the CGMP has the potential to be considerably more than the sum of its parts.

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. In both cases, electronic proposal submissions should be emailed to Andrew Gray (Andrew.Gray@nrc.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
```

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.ca`).

Recent Papers from DRAO

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

Belostotski, L., Landecker, T.L., & Routledge, D. A technique for microwave ranging and remote phase synchronization, Trans. IEEE, IM-51, 551

Brunt, C.M. 2003, Large-scale Turbulence in Molecular Clouds, ApJ, in press.

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

Brunt, C.M., Kerton, C.R. & Pomerleau, C. 2003, An outer Galaxy molecular cloud catalog, ApJS, in press.

Kerton, C.R. 2002, Detecting embeded intermediate-mass stars using mid-infra-red and 21-cm H I emission, AJ, in press.

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

Kerton, C.R., Brunt, C.M., & Pomerleau, C. 2002, A new outer Galaxy molecular cloud catalog, 199th AAS Meeting, BAAS, 33, 1390

Kerton, C.R., Knee, L.B.G. & Higgs, L. Positive intermediate velocity H I in the CGPS, in Seeing Through the Dust: The Detection of H I and the Exploration of the ISM in Galaxies, eds. A.R. Taylor, T.L. Landecker, & A.G. Willis (San Francisco: ASP), v.276, in press

Landecker, T.L., Uyanıker, B., & Kothes, R. 2002, Polarization imaging of the Galactic emission at 1420 MHz: The Canadian Galactic Plane Survey, in Astrophysical Polarized Backgrounds, eds. S. Cecchini, S. Cortiglioni, R. Sault, & C. Sbarra, AIP Conf. Proc., 609, 9

Taylor, A.R., **Landecker, T.L., & Willis, A.G.** 2002, eds, Seeing Through the Dust: The Detection of H I and the Exploration of the ISM in Galaxies, ASP Conf. Ser., 276

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. AJ, submitted.

Uyanıker, B., & Landecker, T.L. 2002, Counter-intuitive polarization structures, in Astrophysical Polarized Backgrounds, eds. S. Cecchini, S. Cortiglioni, R. Sault, & C. Sbarra, AIP Conf. Proc., 609, 15

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

Uyanıker, B., Reich, W., **Yar, A., Kothes, R.**, Fürst, E. 2002, Is the Cygnus Loop two supernova remnants?, A&A, 389, L61

Zhang, X.Z., Qian, S.J., **Higgs, L.A., Landecker, T.L.**, & Wu, X.J. 2002, Radio observations at 232 MHz and multifrequency spectral studies of SNR HB21, Ap&SS, 279, 355

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

Kothes, R., & Kerton, C.R. 2002, Expanding shells of shocked neutral hydrogen around compact H II regions, A&A, 390, 337

Kothes, R., Uyanıker, B., & Pineault, S. 2002, The SNR G106.3+2.7 and its pulsar wind nebula, in Neutron Stars in Supernova Remnants, eds. P. O. Slane & B. M. Gaensler, ASP Conf. Ser., 271, 205

Kothes, R., & Uyanıker, B., & Yar, A. 2002, The distance to the SNR CTB109 deduced from its environment, ApJ, 576, 169

Uyanıker, B., & Kothes, R. 2002, A Large Atomic Hydrogen Shell in the Outer Galaxy: SNR or Stellar Wind Bubble?, ApJ, 547, 805

Uyanıker, B., & Landecker, T. L. 2002, A Highly Ordered Faraday-Rotation Structure in the Interstellar Medium, ApJ, 575, 225

Observatory Contact Information

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