

Australia
Telescope
National
Facility

Annual
Report
2001



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Looking back: The hole-in-the-ground antenna at Dover Heights

Photo: © CSIRO, ATNF photo archive B3017

Australia has a long history of innovation and excellence in the design of radio telescopes and their use for radio astronomy. In 1951, staff at the CSIRO Division of Radiophysics excavated a 21.9-metre diameter depression in the sandy soil near the cliff top at Dover Heights, to construct the “hole-in-the-ground” antenna. This antenna was used at a frequency of 160 MHz, with the detection of a strong peak in radio continuum emission detected in the direction of Sagittarius A.

In early 1953 the hole-in-the-ground antenna was extended and upgraded to have a diameter of 24.4 metres. A wooden jig was used to achieve an accurate parabolic surface and this was filled with concrete and lined with wire mesh to provide a reflecting surface. The upgraded antenna was partially steerable, with the position of the antenna aerial adjusted using guy ropes. This image shows construction work in February 1953 on the upgraded hole-in-the-ground antenna. South and North Head of Sydney Harbour can be seen in the background.

The hole-in-the-ground antenna was used with outstanding success to survey radio emission from the Galactic plane at a frequency of 400 MHz. In 1953, this survey provided an accurate position for the centre of our own Galaxy, confirming its location in Sagittarius A, and also provided new detections of discrete Galactic and extra-galactic radio sources.

HIGHLIGHTS

Astronomy highlights

First observations of SNR 1987A at 12 mm (page 19)

One of the principal scientific justifications for the 12-mm upgrade on the Compact Array was to obtain higher resolution images of continuum sources, in particular for the radio remnant of the supernova SN 1987A. In October 2001, the first 12-mm image of SN 1987A was obtained using three Compact Array antennas equipped with interim 12-mm receivers. The data quality shows that the full 12-mm system will be able to produce excellent high-resolution radio continuum images.

HIPASS J0352-6602: a nearby galaxy forming its first stars (page 21)

A massive cloud of neutral hydrogen gas has been discovered from observations taken with the Parkes radio telescope and the Compact Array. The cloud, known as HIPASS J0352-6602, appears to be a very young galaxy that is just beginning to form its first generation of stars.

Polarization in methanol masers (page 22)

The role of magnetic fields in star formation is a matter of heated debate. One way to probe the magnetic fields is to use the polarization properties of masers associated with high-mass star-formation regions. The Compact Array has been used to make the first full polarization observations of methanol maser emission at 6.7 GHz. Four sources were observed with linear polarization detected in all cases.

Searching for neutral hydrogen in groups of galaxies (page 24)

The so-called “high-velocity clouds” are clouds of neutral hydrogen that have higher velocities than expected for sources in our Galaxy. It has been proposed that at least some of the high-velocity clouds are primordial material associated with the formation of the Local Group of galaxies. If so, then other groups of galaxies may also contain similar hydrogen clouds. To test this hypothesis the Parkes radio telescope and multibeam receiver have been used for a sensitive search of neutral hydrogen emission in loose groups of galaxies. For the galaxy group LGG 93, four new detections of hydrogen were made, with hydrogen masses of 10 – 100 million solar masses. For the group LGG 180, three detections were made with slightly higher hydrogen masses.

The magnetic fields of barred spiral galaxies (page 26)

Magnetic fields are believed to play an essential role in determining the large-scale properties of galaxies. Radio observations taken with the Compact Array are being used to produce an atlas showing the magnetic field structures in barred spiral galaxies. The data show that galaxies with strong central bars are associated with a high rate of star formation.

PKS 1257-326: a scintillating quasar (page 28)

Compact Array monitoring observations of the quasar PKS 1257–326 have demonstrated that rapid variability on time scales shorter than a day is a result of interstellar scintillation. The scintillation patterns are produced by focusing and defocusing the radio emission from the quasar, as it passes through patches of turbulence in the interstellar medium. The radio variations follow an annual cycle and this shows unequivocally that the variability is due to scintillation.

On the trail of gamma-ray burst progenitors (page 30)

Gamma-ray bursts provide some of the most luminous events in the Universe but they have not given up their secrets easily. Observations of the gamma-ray burst GRB 011121, taken with the Compact Array and other telescopes, have provided a direct link between gamma-ray bursts and the death throes of massive stars. The optical and radio data for this source are consistent with a supernova explosion of a star that was at least twenty times as massive as the sun, and the birth of a stellar black hole.

Other highlights

Public outreach (page 35)

In 2001, the number of visitors to the Parkes Visitors Centre more than doubled to approximately 125,000. A new Visitors Centre building with upgraded exhibits and audio-visual shows was opened in March 2001.

Public Open Days held at the Parkes Observatory and at Marsfield, Sydney, were hugely successful, attracting several thousand visitors. Feedback from visitors was entirely positive.

MNRF (page 43)

The Major National Research Facilities program funded in 1997 is nearing completion. In 2001 three interim 3- and 12-mm receiver packages were installed on three antennas at the Compact Array. The first of the new array configurations, the EW352 array, was first used in October 2001.

MNRF-2001 (page 53)

On 21 August 2001, the Minister for Industry, Science and Resources announced the allocation of \$23.5M to an ATNF-led proposal put forward by the Australian astronomical community. The MNRF-2001 funding will be used to increase Australia's share in the international Gemini

Telescopes, and to develop technologies for the Square Kilometre Array (SKA).

Square Kilometre Array (page 55)

The ATNF is one of a consortium of major radio astronomy institutions in 11 countries now planning the world's next-generation large radio telescope, the SKA. In collaboration with universities and other CSIRO Divisions the ATNF is contributing to the design of the array in several key areas. In 2001, three types of prototype antenna designs were considered, using Luneburg lenses, cylindrical reflectors and phased array antennas. Other development work involved coherent and incoherent interference mitigation techniques. Site investigations within Australia continued to survey and characterize possible locations for the SKA.

THE ATNF IN BRIEF

The Australia Telescope National Facility (ATNF) supports Australia's research in radio astronomy, one of the major fields of modern astronomy, by operating the Australia Telescope, a set of eight individual radio telescopes.

Mission

- ◆ To operate and develop the Australia Telescope as a national research facility for use by Australian and international researchers.
- ◆ To exploit the telescope's unique southern location and technological advantages to maintain its position as a world-class radio astronomy observatory.
- ◆ To further the advancement of knowledge.

Size and funding

The ATNF employs 135 staff. In 2000 – 2001 the organization's total funding was \$16.3M, of which \$12.4M was direct appropriation from CSIRO.

Status within CSIRO

The ATNF is managed as a National Facility by Australia's largest national research institution, CSIRO. Formerly part of the CSIRO Division of Radiophysics, it became a separate Division in January 1989. The Australia Telescope Steering Committee, appointed by the Minister for Science to advise the ATNF Director, also acts as the Advisory Committee for CSIRO's Radio Astronomy Sector.

Status as a National Facility

The ATNF became a National Facility in April 1990. As a National Facility, the Australia Telescope

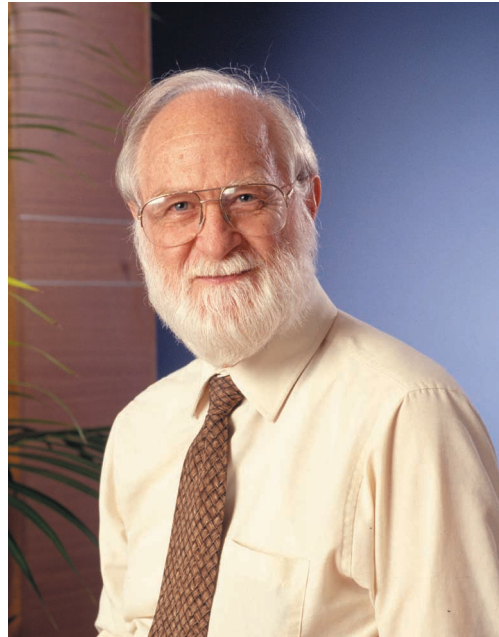


Photo: Kristen Clarke

Professor Ron Ekers, Director of the ATNF

provides world-class observing facilities in radio astronomy for astronomers at Australian and overseas institutions. The Australia Telescope is operated as a National Facility under guidelines originally established by the Australian Science and Technology Council.

Users of ATNF telescopes

Observing time on the ATNF's telescopes is awarded to researchers on the basis of the merits of their proposed research programs by a Time Assignment Committee appointed by the Steering Committee. More than 80% of the telescopes' users come from outside ATNF. In 2001 the telescope proposals allocated time included 115 researchers at the ATNF and other Australian institutions and 240 researchers from 108 institutions in 19 overseas countries.

The ATNF in the Australian context

The ATNF is the largest single astronomical institution in Australia. Approximately 90% of Australian radio astronomy is carried out through the ATNF. The organization has strong links with its primary user base, the university community. The interests of telescope users are represented by the Australia Telescope Users Committee.

The ATNF's Sydney headquarters are co-located with those of the Anglo-Australian Observatory, an independent bi-National Facility that provides world-class optical and infrared facilities. This close association is unique, in world terms, and promotes valuable collaboration between the two organizations.

The ATNF in the global context

Of the fields of modern astronomy—X-ray, ultraviolet, optical, infrared and radio—Australia's most important contribution to the global practice of astronomy is arguably through radio astronomy. This is a result of Australia's early lead in the field, continuous technological advances, and southern hemisphere location. The Australia Telescope is the only major radio telescope of its kind in the southern hemisphere, and thus can view part of the sky which is out of reach of northern hemisphere telescopes. It provides one of the most powerful radio astronomy facilities in the world.

Australian and international observers use the telescope without access charges. This is in accordance with a general practice of the worldwide astronomical community, in which telescope users from different countries gain reciprocal access to facilities on the basis of scientific merit. This allows Australian scientists to use telescopes in other countries and international facilities such as particle accelerators and space-based instruments. Such access provides Australian scientists with a diversity of instruments and leads to a rich network of international collaborations.

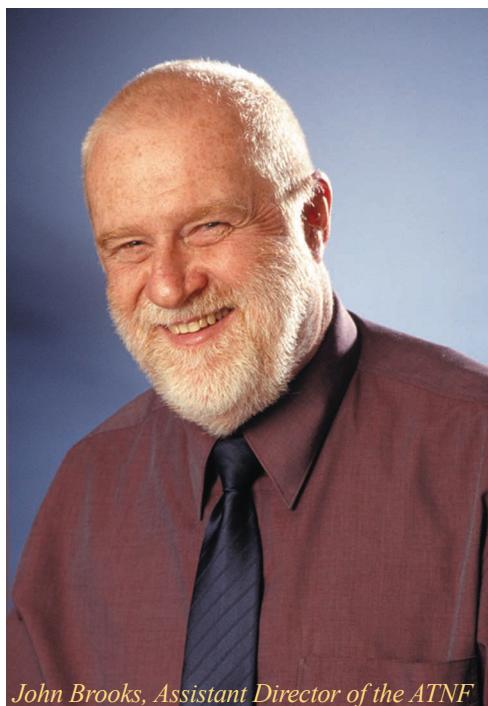


Photo: Kristen Clarke

John Brooks, Assistant Director of the ATNF

The ATNF's observatories

The Australia Telescope consists of eight radio-receiving antennas, located at three sites in New South Wales.

Six of them make up the Australia Telescope Compact Array (ATCA), located at the Paul Wild Observatory near the town of Narrabri. Five of these antennas sit on a 3-km stretch of rail track running east-west; they can be moved to different points along the track to build up detailed images of the sky. A sixth antenna lies 3 km to the west of the main group. Each of these antennas has a reflecting surface 22 metres in diameter. After the radio signals from space are "collected" by the antennas' surfaces they are transformed into electrical signals, brought together at a central location, and then processed. The end result is usually a picture of the object being studied—a picture equivalent to a photograph, but made from radio waves instead of light.

A further 22-m antenna, known as the Mopra telescope, is located near Mopra Rock, in the Warrumbungle Mountains near Coonabarabran, New South Wales.

The other key component of the Australia Telescope is the Parkes 64-m radio telescope, located near the town of Parkes. This telescope has been successfully operated since 1961 and is famous as a national symbol for Australian scientific achievement. Recent upgrades to accommodate a 13-beam focal-plane array have maintained its world-class position as a state-of-the-art instrument.

The eight ATNF telescopes can be used together as a Long Baseline Array (LBA) for a technique known as Very Long Baseline Interferometry (VLBI) which is used to obtain high resolution images of small areas of sky. The LBA is used as part of a larger Australian network of radio telescopes which includes the NASA satellite tracking antennas at Tidbinbilla, near Canberra, and radio antennas in Tasmania, South Australia and Western Australia. The LBA is also regularly used as part of the Asia Pacific Telescope which links radio telescopes in Australia, Japan, China, Hawaii and India, and the VLBI space observatory program (VSOP).

Engineering and technology development

The advance of radio astronomy depends crucially on exploiting the latest technological developments in a range of areas which include electronics,

receiver technology, signal detection and processing, control systems, data processing and information technology. The ATNF provides a platform for the development of cutting-edge technology in Australia.

ATNF Steering Committee

ATNF policy is determined by the ATNF Steering Committee, an independent committee appointed by the Minister for Science and Technology. The Committee helps CSIRO to develop the ATNF's long-term strategy. The inaugural meeting of the ATNF Steering Committee was held in May 1989. Since then it has met at least once a year, to define the broad directions of the ATNF's scientific activities and the development of the Australia Telescope. It is also responsible for promoting the use of the Facility and, indirectly, for allocating observing time.

The ATNF's host organization, CSIRO, is composed of 22 business units called Divisions; the ATNF has the status of a Division. These Divisions are grouped into research sectors. The ATNF is the sole member of the Radio Astronomy Sector, and the ATNF Steering Committee acts as

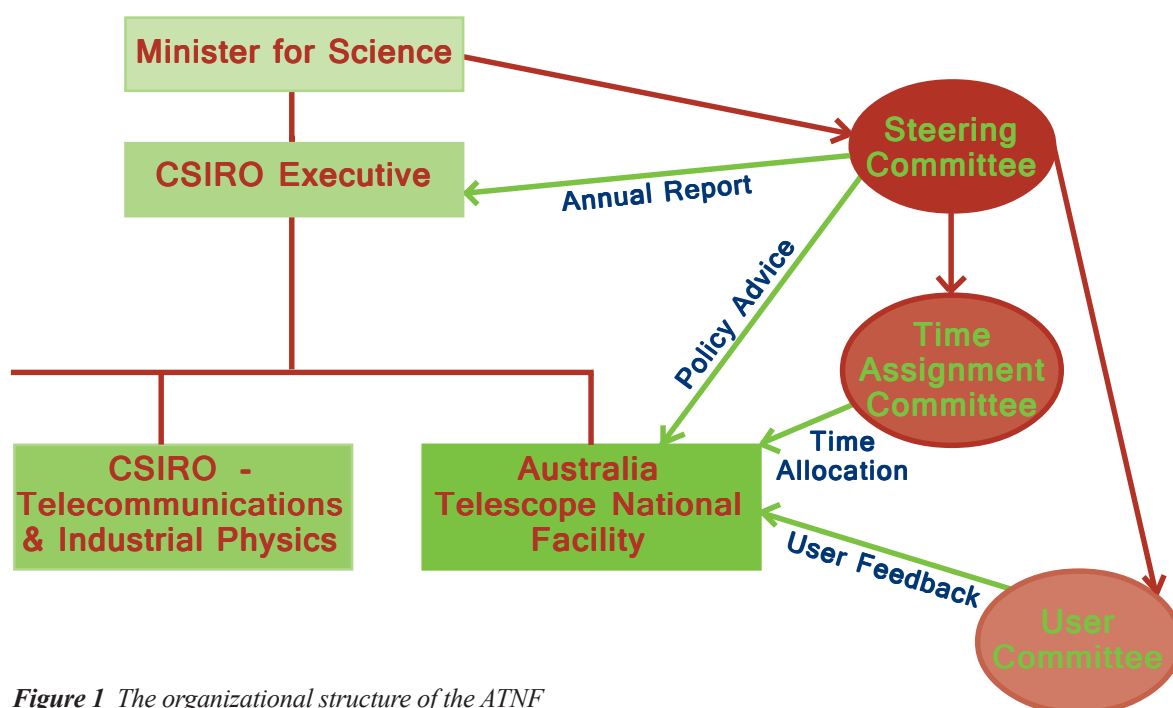


Figure 1 The organizational structure of the ATNF

the CSIRO Sectoral Advisory Committee for radio astronomy.

The Steering Committee appoints an Australia Telescope Users Committee (ATUC) to provide feedback and advice from the user community, and a Time Assignment Committee (TAC) to review proposals and allocate observing time. The committee members for the year 2001 are listed in Appendix C.

Australia Telescope Users Committee

ATUC represents the interests of the Australia Telescope's users. In 2001 it consisted of a total of 19 scientists from the ATNF and institutions around Australia. This committee provides feedback to the ATNF Director, discussing problems with, and suggesting changes to, AT operations; it also discusses and ranks by scientific merit various future development projects. ATUC meetings are a forum for informing AT users of the current status and planned development of ATNF facilities, and recent scientific results. ATUC discussions can be found on the Web at www.atnf.csiro.au/management/atuc.

Time Assignment Committee

The ATNF receives more applications for observing time than it can accommodate: proposals for time on both the Parkes and Narrabri telescopes exceed the time available by a factor of approximately two. The proposals are assessed, and time allocated to them, by the TAC. The TAC meets three times a year and reviews approximately one hundred telescope applications at each meeting.

Strategic objectives

The ATNF is one of the world's leading radio astronomy organizations. The strategic objectives for the ATNF are:

◆ To continue to operate the Australia Telescope in such a way as to maintain a leading international position

The ATNF will provide access to its facilities to satisfy the needs of Australian and overseas users. At least 70% of time on the Parkes and Narrabri telescopes will be used for astronomy. Time lost during scheduled observing periods will be kept to below 5%.

◆ To upgrade the Australia Telescope to maintain its competitiveness in the medium term (3–8 years)

The Narrabri and Mopra telescopes are now being upgraded, under the Major National Research Facilities (MNRF) Program, to work at shorter (millimetre) wavelengths. The upgraded telescopes will use innovative devices for the detection of extremely weak millimetre-wave signals from space. These are being jointly designed by the ATNF and CSIRO Telecommunications and Industrial Physics (CTIP), a project funded by the CSIRO Executive Special Project. The MNRF upgrade will also extend the Australian network of telescopes used for VLBI, which has both astronomical and geodetic applications. The MNRF upgrades will be completed in 2002.

◆ To position the ATNF to participate in major international radio astronomy projects developing over the next decade

The MNRF upgrade will allow the ATNF to maintain a leading position for the next eight to ten years. Beyond that, radio astronomy will be dominated by two major international developments: the Atacama Large Millimetre Array (ALMA) and the Square Kilometre Array (SKA). These instruments will allow astronomers to pursue key questions about the early evolution of the Universe. For Australia to maintain its position in radio astronomy, it needs to have a significant role in at least one of these projects. The SKA is a billion-dollar project, the “next-generation” radio telescope with a collecting area of one square kilometre. Its construction is expected to start around 2012. Australia is well positioned to play a key role in the development

of the SKA. In some respects Australia offers an ideal location for the SKA as it has a number of regions of low population density which are relatively free from radio interference. The technology development required for the SKA will have wide industrial applications and the construction will involve significant industrial contracts.

A preliminary research development program for the SKA, funded by CSIRO, was initiated in 1999, and this has been further expanded in anticipation of the MNRF-2001 funding expected to start in July 2002.

◆ **To conduct an effective outreach program**

The ATNF operates Visitors Centres at the sites of the Parkes and Paul Wild Observatories and has an active public outreach program which has several goals: to raise the national profile of astronomy and related technology in Australia,



Photo: Kristen Clarke

Professor Ray Norris, Deputy Director of the ATNF

to encourage the next generation of scientists by providing educational resources targeted at high school students and their teachers, and to maintain good community relationships.

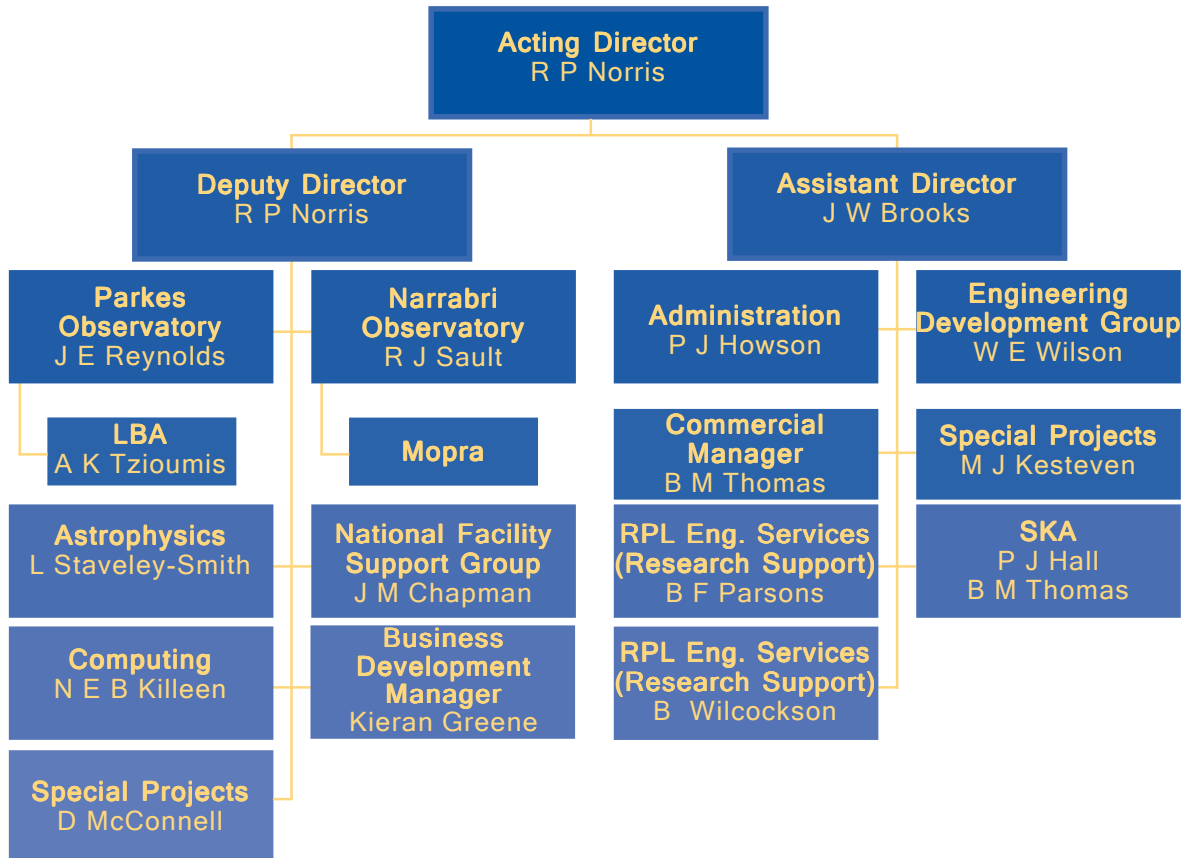


Figure 2 *The management structure of the ATNF in December 2001*

ATNF management changes in 2001

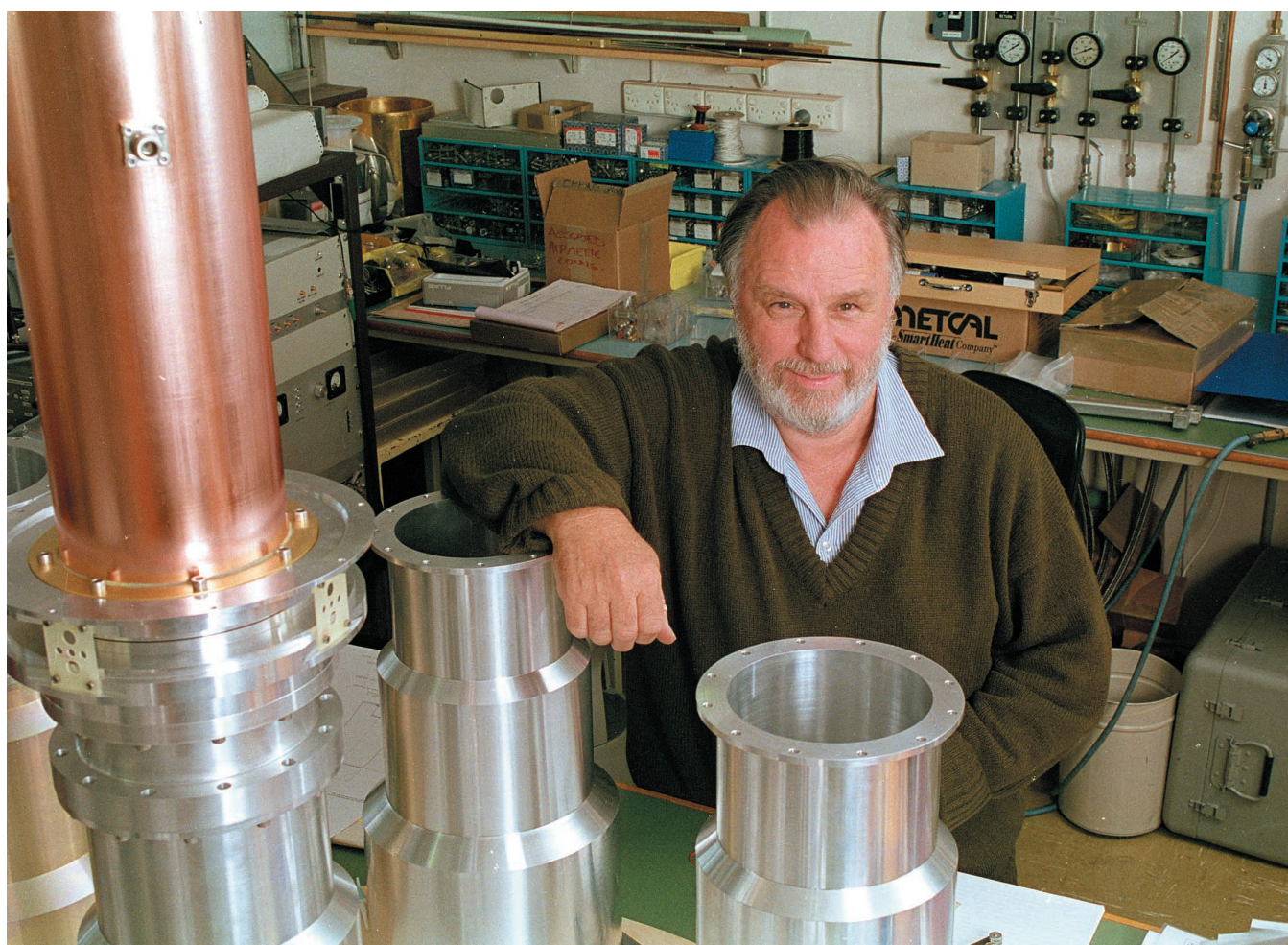
The ATNF Deputy Director, Dr John Whiteoak, retired in February 2001. Following John Whiteoak's retirement, Professor Ray Norris was appointed as the Deputy Director, with overall responsibility for Astrophysics, Computing, National Facility Support and the Parkes and Narrabri Observatories. In other management changes, Dr Lister Staveley-Smith replaced Ray Norris as Head of Astrophysics, Dr Neil Killeen took on extra duties as Head of the Marsfield Astronomical Computing Group, and Dr Jessica Chapman replaced John Whiteoak as the Head of the National Facility Support Group.

In September 2001, Mal Sinclair retired as Head of the Receivers Group after an outstanding career in engineering and science which covered 46 years with the Division of Radiophysics and the ATNF. Mal first joined the Division of Radiophysics in

March 1954 as an apprentice electrical fitter. He became an outstanding microwave engineer and evidence of his skill can be seen at all the ATNF observatories. Mal was an inspirational group leader with a strong sense of history, a deep understanding of the culture of science and a gentlemanly manner. He will be greatly missed for his many contributions to the ATNF.

Following Mal Sinclair's retirement, Dr Warwick Wilson was appointed as Head of the Engineering Development Group with responsibility for both electronics and engineering.

The ATNF Director, Professor Ron Ekers, was on leave of absence from July 2001 until April 2002 to take up a Miller Professorship at the University of California Berkeley astronomy department. During his absence, Ray Norris took over as the Acting Director of the ATNF with John Brooks continuing as Assistant Director.



Mal Sinclair, Head of the Receivers Group

Photo: John Masterson

CSIRO changes in 2001 and their implications for the ATNF

Over the last few years, the size and budget of CSIRO have faced increasing funding pressures. When the new Chief Executive for CSIRO, Geoff Garrett, was appointed in December 2000, he embarked on a program to rejuvenate CSIRO. At a CSIRO management meeting in May 2001, the Chiefs of the CSIRO Divisions and the Executive of CSIRO put together a Strategic Action Plan, which is intended to set CSIRO on a new and healthier path. Although the ATNF's budget has not decreased, the ATNF, like all other Divisions of CSIRO, has to respond and take advantage of this changing environment.

The CSIRO Strategic Action Plan can be summarised by six “Key Messages”:

- ◆ **“Look out”** CSIRO will shift its approach to stakeholders and the community, such that CSIRO is responsive and driven by the needs of the Government and the community. The high visibility and high performance of Australian astronomy, the Government support implicit in the MNRF-2001 funding, and the ATNF core role of providing support for the astronomical community, aligns the ATNF well with this message.
- ◆ **“Service from Science”** CSIRO will increase its focus on delivering service from excellent science. There is now an explicit commitment in CSIRO to delivering world-class science, and this has always been a strong focus for the ATNF.
- ◆ **“Focus”** CSIRO is currently spread across many research areas. It will refocus to concentrate greater resources on a smaller number of key research areas. The ATNF already has a strong focus on radio astronomy and associated technology.
- ◆ **“Partner or Perish”** There will be an increased focus on participating in partnerships with other organisations and companies, both within Australia and internationally. The ATNF already does this well.
- ◆ **“One CSIRO”** The “One CSIRO” initiative encourages multi-Divisional projects and teams, presenting a unified face to the world. The ATNF is responding to this message by starting a number of cross-Divisional projects. As an example, the SKA Lunenburg lens project involves four Divisions (page 55).
- ◆ **“Go for Growth”** If CSIRO succeeds in implementing these changes, Australia will benefit and the business and impact of CSIRO will grow. The ATNF has responded with a strategic plan which shows growth in several areas. This plan should be realistic given the MNRF funding and the international support for astronomy over the next few years.

In summary, CSIRO is experiencing a period of rapid change. The ATNF strategic directions, which focus on delivery of world-class science, responsiveness to the stakeholders, and planning for growth over the next few years, are well aligned with those of the new Strategic Action Plan for CSIRO.



A banksia in the ATNF garden at Marsfield

Photo: Stewart Duff



The Kennedy 18-m antenna at Parkes was originally used in Australia at the Fleurs radio astronomy site. It was transferred to the Parkes site in 1963.

Photo: John Sarkissian

PERFORMANCE INDICATORS

The ATNF assesses its performance through key performance indicators, based on those used generally by CSIRO but adapted to be appropriate for a National Facility.

Unless otherwise noted, figures are for calendar year 2001.

1 Scheduled and successfully completed observing time

For the Parkes and Narrabri observatories, the ATNF sets a target that at least 70% of the time available should be allocated for astronomical observations. (The remaining 30% is needed for maintenance and upgrading the facilities.) A second target is that the time lost during scheduled observations from equipment failure should be below 5%.

The following values show the use of time for the year 2001:

	ATCA	Parkes
Time used for scheduled observations	76.1%	82.2%
Downtime during scheduled observations	2.1%	4.1%
Percentage of scheduled observations successfully completed	95.0%	97.2%

The downtime for the Parkes telescope includes time lost for wind stops (1.4%).

2 Response of the ATNF to recommendations by the Users Committee

The ATNF Users Committee (ATUC) meets twice a year, to represent the user community in the ATNF decision-making process. After each meeting the committee presents a list of recommendations to the Director. ATUC considers matters raised by the user community and current operations, and sets priorities for future developments.

Over the last four years, approximately three quarters of ATUC recommendations have been followed-up by the ATNF.

3 Adoption by users and organizations of practices, instruments and processes developed by CSIRO

This list includes a selection of hardware and software developments at the ATNF which are now in use at other organizations:

- ◆ **Karma visualization software** developed at ATNF is used by more than 30 astronomical institutions.
- ◆ **Miriad data reduction software**, jointly written at the ATNF and BIMA, is in routine use at radio astronomy institutions around the world.
- ◆ **ATNF digital correlator hardware and control software** are in use at the Tidbinbilla, Hobart, Ceduna, Hartebeesthoek, Jodrell Bank and SEST Observatories.
- ◆ **Multibeam observing techniques and data management systems** developed for the Parkes Observatory have been adopted by Jodrell Bank.
- ◆ **Components of aips++ software** including visualization routines and fundamental measures, written at ATNF, are being used by several institutions including the Herzberg Institute for Astrophysics (Canada), Jodrell Bank and the Joint Institute for VLBI in Europe (JIVE).
- ◆ **ATNF staff** have provided scientific and technical support for the Taiwanese AMiBA project.
- ◆ **ATNF staff** have assisted software engineers to adopt the ATNF's multibeam software for the Torun telescope in Poland.

4 Time allocation on ATNF facilities

The allocation of time on the ATNF facilities is done on the basis of scientific merit. In 2001 a total of 172 proposals were allocated time on ATNF facilities (each proposal is counted once only per calendar year although some proposals are submitted two or three times). Of these, 112 were for the Australia Telescope Compact Array, 44 were for the Parkes telescope, seven were for the Mopra telescope and nine were for the Long Baseline Array. A summary of the observing programs is given in Appendix D. Figures 3 and 4 show the time allocated to observing teams on the Compact Array and Parkes radio telescope as a percentage of the total allocated time, by affiliation of the team leader.

In 2001 the proposals allocated time on ATNF facilities included a total of at least 353 different authors. Of these, 43 authors were from the ATNF, 71 were from 14 other Australian institutions and 239 were from 108 overseas institutions in 19 countries. Figure 5 shows the total number of authors from each country.

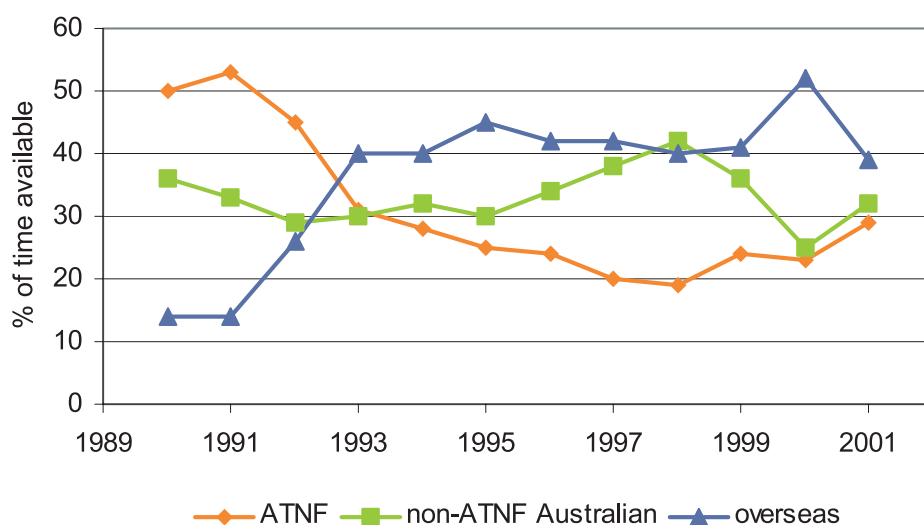


Figure 3 Compact Array time allocation, 1990 – 2001

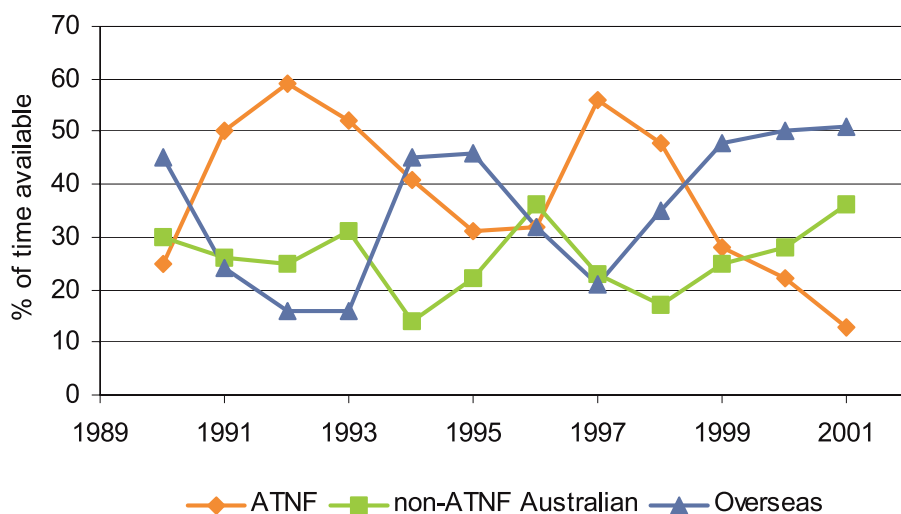


Figure 4 Parkes time allocation, 1990 – 2001

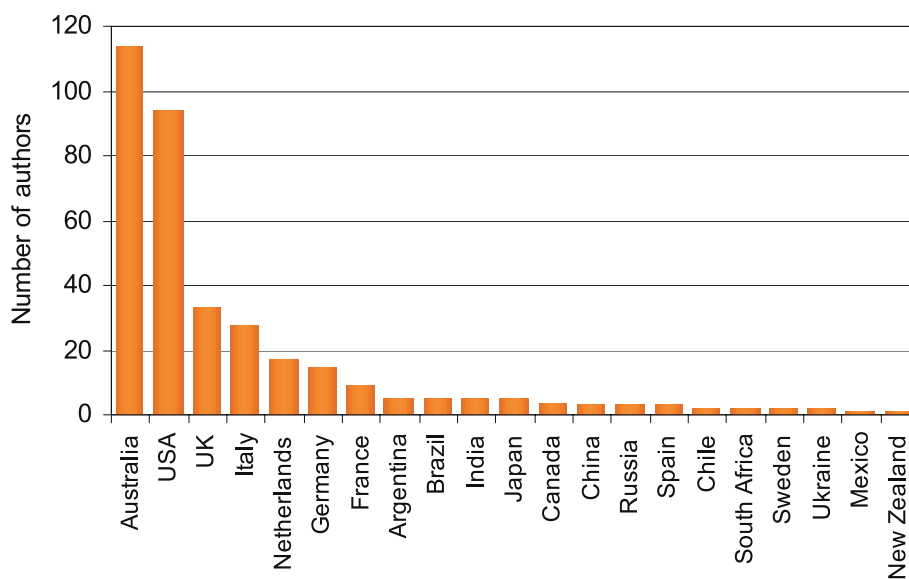


Figure 5 Australian and overseas participation, 2001

5 Teaching, measured by the number of postgraduate students supervised by ATNF staff

In December 2001 the ATNF was co-supervising 25 postgraduate students of which 22 were PhD students and three were Masters degree students (Appendix H).

6 Number of publications

Figure 6 shows the number of publications in refereed journals and conference proceedings, which include data obtained with the Australia Telescope. The publication counts include papers dealing with operations or data reduction but do not include IAU telegrams, abstracts, reports, historical papers, articles for popular magazines, or other papers by ATNF authors. Appendix G lists the 122 papers published in refereed journals and the 30 papers published in conference proceedings in 2001.

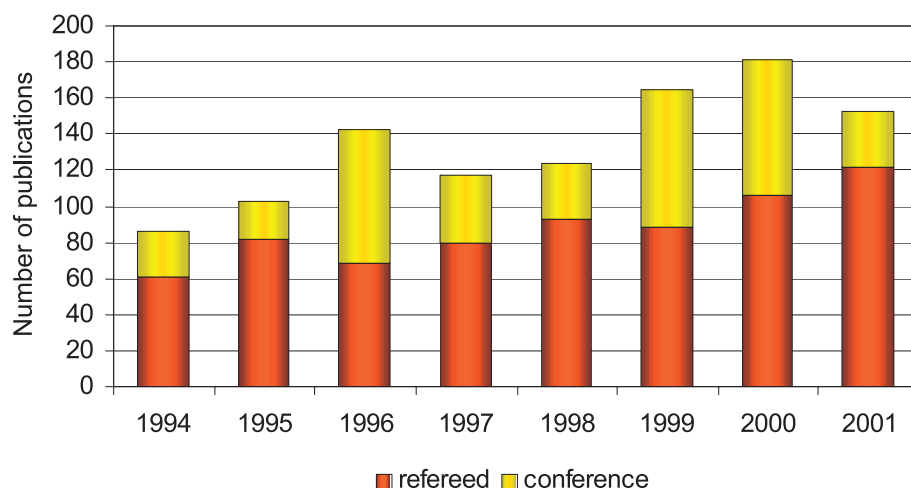


Figure 6 Papers from data obtained with the Australia Telescope, published in refereed journals and conference proceedings

7 Public relations activities

Figure 7 shows public relations activities for the years 1997 to 2001. During the year the ATNF issued nine media releases (Appendix F) and the organization featured in more than 120 press items. ATNF staff gave at least 34 television interviews and 114 radio interviews while approximately 50 talks were given to school, university and community groups.

The numbers shown in Figure 7 have been verified where possible. However, the numbers for media reports (tv, radio, newspapers) for all years and the number of public talks given by ATNF staff in 1997 – 1998 are likely to have been undercounted.

Figure 7 also shows the number of Web hits to the central ATNF Web site. This includes internal use by staff and hits generated by external search engines. The number of Web hits increases from year to year, with 11.65 million hits recorded for 2001.

Figure 8 shows the number of visitors to the Narrabri and Parkes Visitors Centres. Approximately 9,000 people visit the Narrabri Visitors Centre each year. Following the release of the film *The Dish* in October 2000 and the opening of the new Visitors Centre building and upgraded facilities in March 2001, in 2001 the number of visitors to the Parkes Visitors Centre more than doubled to approximately 125,000.

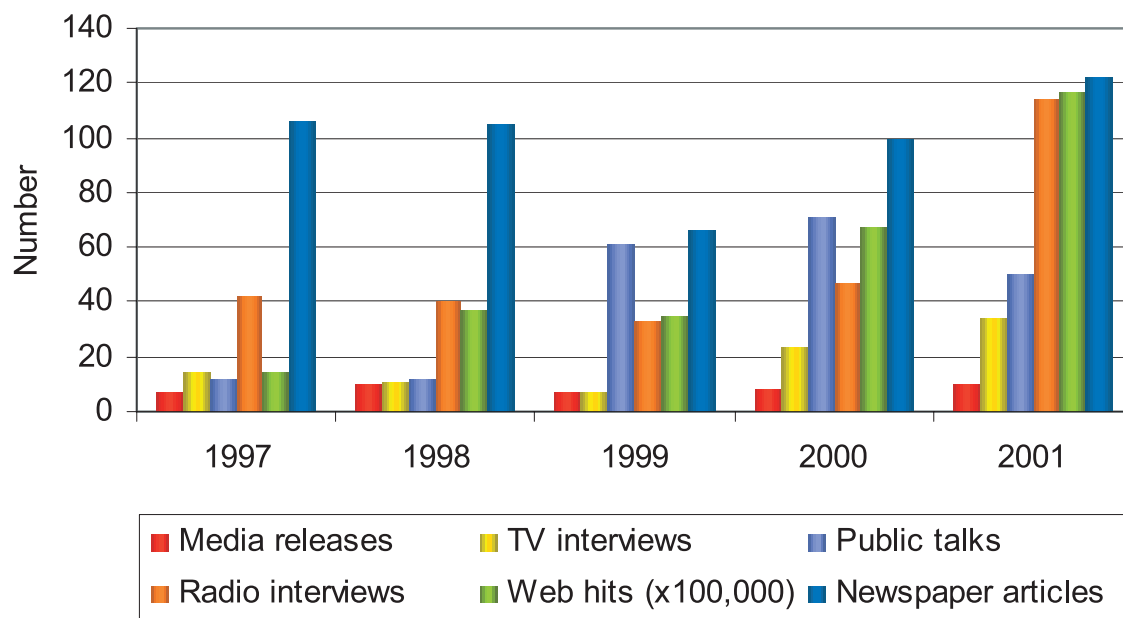


Figure 7 ATNF public relations activities

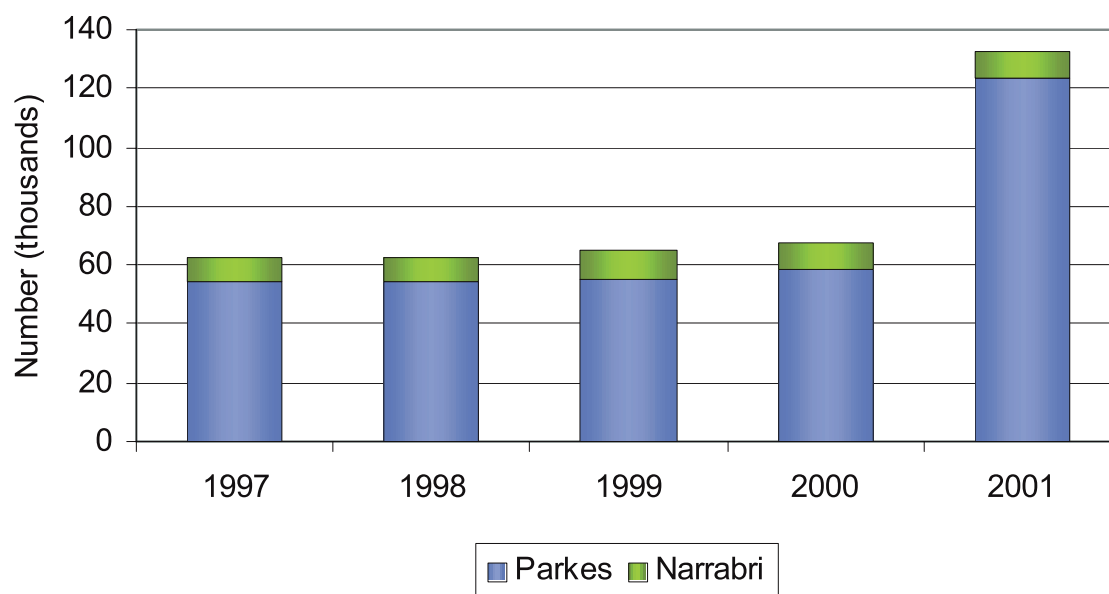


Figure 8 Number of visitors to the Parkes and Narrabri Visitors Centres

8 User feedback at Narrabri and Parkes

Observers at the Narrabri and Parkes Observatories are asked to complete a user feedback questionnaire. Figures 9 and 10 show that the level of satisfaction with facilities provided is generally high. In 2001 the average over all items ranked was 88% for the Narrabri Observatory and 83% for the Parkes Observatory.

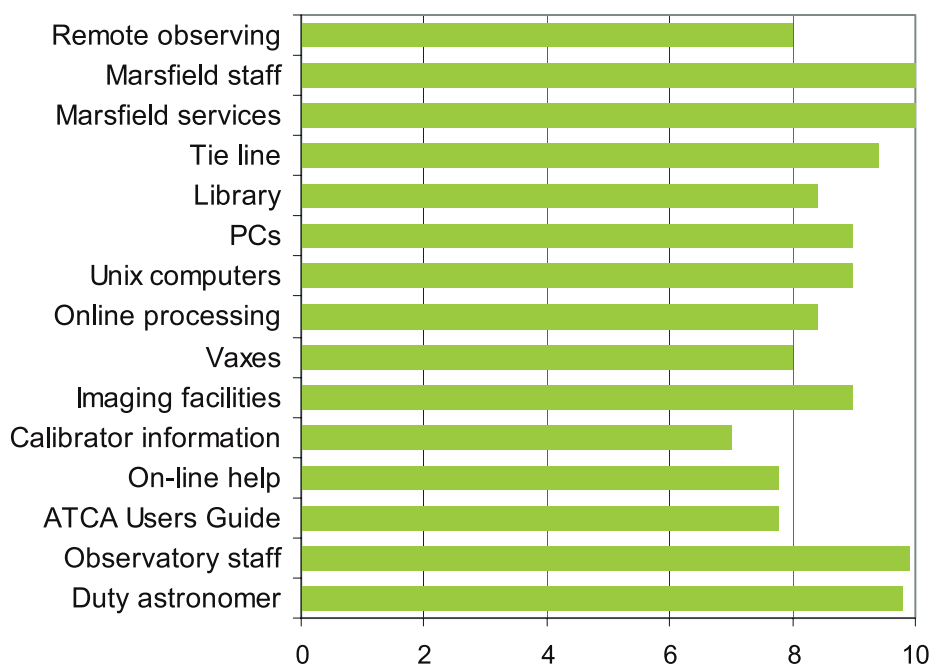


Figure 9 Narrabri user feedback on a scale of 1 – 10 where 1 = poor and 10 = excellent

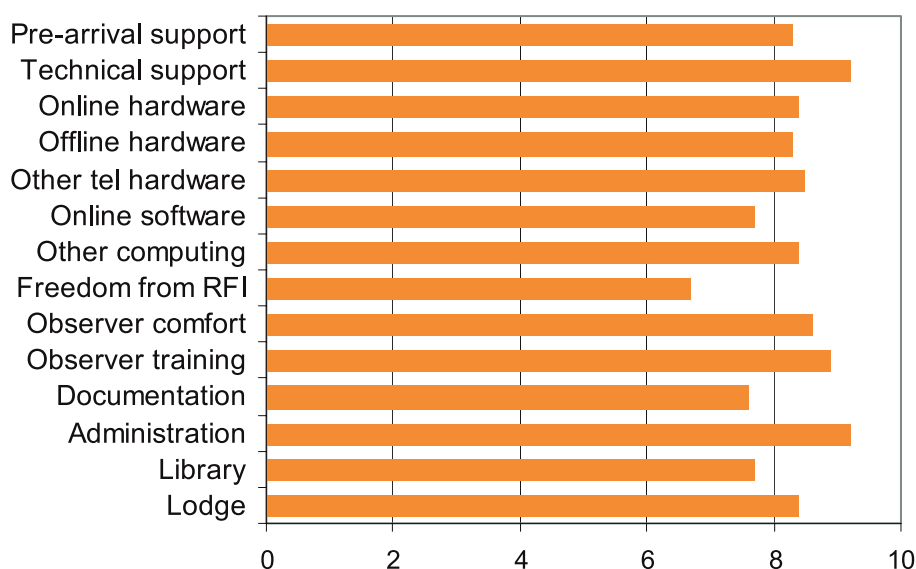


Figure 10 Parkes user feedback on a scale of 1 – 10 where 1 = poor and 10 = excellent

ASTRONOMY REPORTS

First observations of SNR 1987A at 12 mm

One of the principal scientific justifications for the 12-mm system on the Compact Array, part of the 1997 MNRF upgrade project, was to obtain higher resolution images of continuum sources, and of the radio remnant of SN 1987A in particular. SN 1987A, first observed on 23 February 1987, was (and remains) the brightest supernova observed for 400 years. It occurred in the Large Magellanic Cloud, close to the giant nebula 30 Doradus. Optically, the supernova was visible with large telescopes for more than a decade, but the initial burst of radio emission, the “radio supernova”, faded in just a few days. Following this, no radio emission was detected for more than three years. In July 1990, radio emission was again detected with the Molonglo Synthesis Telescope and (for the first time) with the Compact Array. Since then, monitoring observations at both Molonglo and the Compact Array have shown that the emission has increased more or less steadily (Figure 11). This increasing emission signals the birth of a supernova remnant, the first time such an event has been observed.

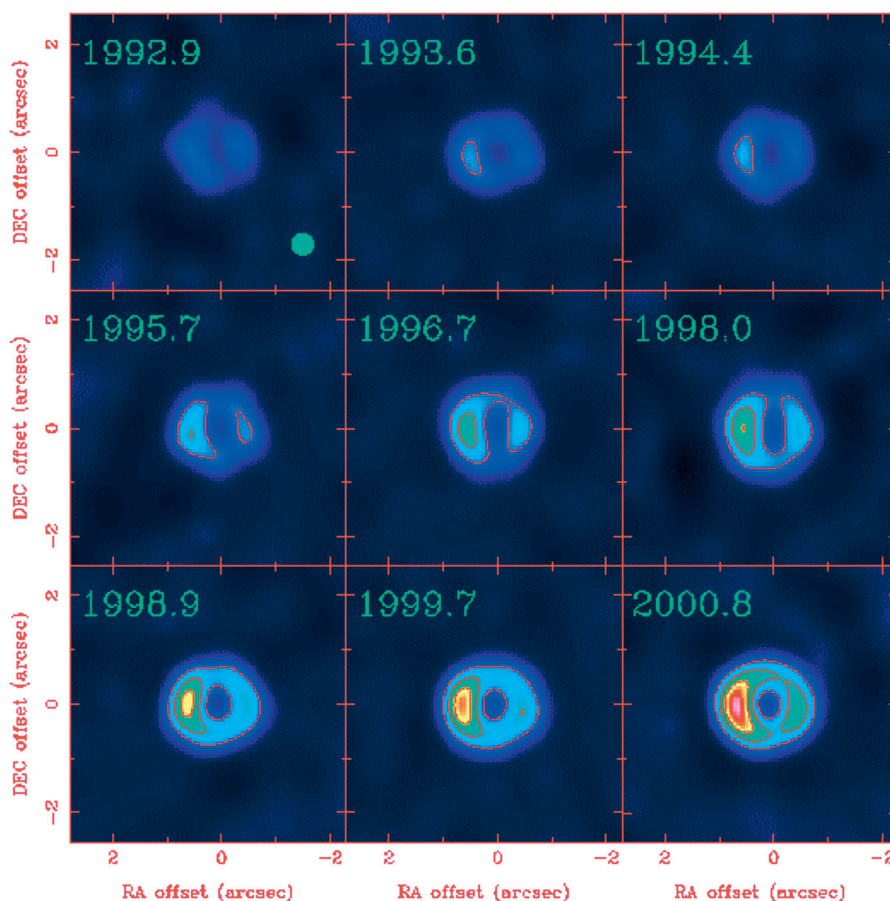


Figure 11 This set of nine images, obtained between 1992 and 2000 with the Australia Telescope Compact Array, shows the radio emission at a wavelength of 3 cm from the expanding supernova remnant SNR 1987A.

Observations with the 6-km Compact Array at 3 cm have a diffraction-limited beam size of slightly less than 1 arcsecond. Currently, the diameter of the remnant, SNR 1987A, is about 1.6 arcseconds, so it is barely resolved. We have been able to apply super-resolution techniques to the data to obtain apparently reliable images with a resolution of 0.5 arcsecond. These show a shell structure, with enhanced emission on the east and west sides, corresponding to the major axis of the projected central ring observed in optical recombination lines and lying within this ring.

At the completion of the MNRF upgrade, expected in the first half of 2003, all six Compact Array antennas will be equipped with 12-mm systems. It is likely that this system will provide the highest-resolution high-dynamic-range continuum images that are possible with the Compact Array. The minimum beam size will be about 0.3 arcsecond, significantly better than the super-resolved 3-cm beam size. It is possible that super-resolution can be applied to the 12-mm images as well, resulting in a resolution comparable to that of the Hubble Space Telescope and exceeding that of the X-ray satellite observatory *Chandra*. This will be of enormous benefit in improving our understanding of the astrophysics of this system.

In October 2001, three antennas (CA02, 03 and 04) were equipped with interim 12-mm receivers and phase-stable local oscillator systems. Twelve hours of data on SNR 1987A were obtained at two frequencies, 16.96 and 18.88 GHz, within the 12-mm band. The systems were dual polarization and had a bandwidth of 128 MHz at each frequency. Phase stability was excellent for all but the last 2.5 hours. The maximum baseline was 1.1 km, giving a beam size of approximately 2.8 by 1.8 arcseconds. The remnant was clearly detected at both frequencies, with an integrated flux density of 20 millijansky at the lower frequency and 18 millijansky at the higher frequency. These values are slightly higher than those predicted from the cm-band spectrum, but consistent with the prediction within the uncertainties. Figure 12 shows the image obtained by combining data from the two frequencies. The remnant was barely resolved by these observations, giving an image which is similar to the diffraction-limited image at 3 cm.

This is the first image of SNR 1987A at 12 mm. The results were reported in an IAU Circular, the first publication resulting from the MNRF upgrade. They make it clear that the completed 12-mm system will be able to produce superb images of the supernova remnant.

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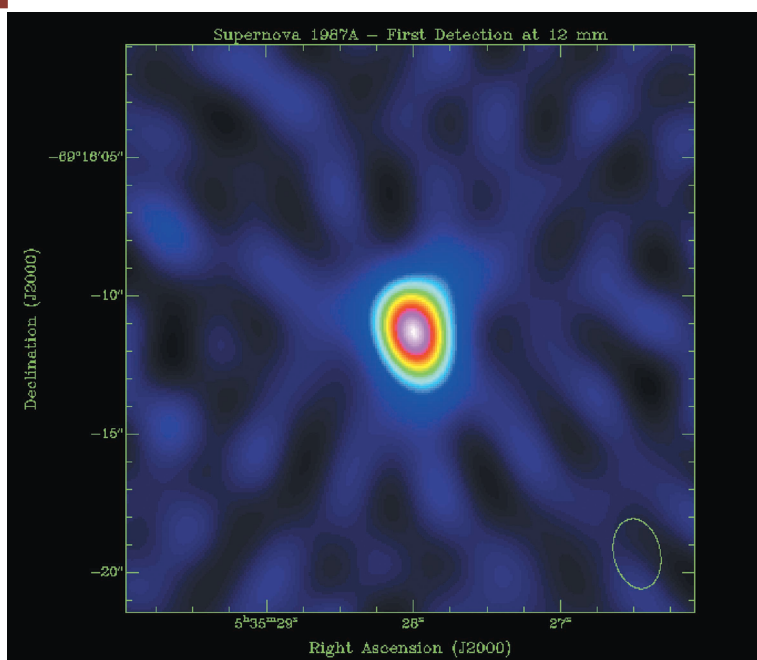


Figure 12 Composite image of SNR 1987A obtained in October 2001, by combining Compact Array data at 17 and 19 GHz. Three Compact Array antennas were used with a maximum baseline of 1.1 km. The ellipse in the lower right corner shows the diffraction-limited beam size.

HIPASS J0352–6602: a nearby galaxy forming its first stars?

We have recently discovered a giant intergalactic cloud of neutral hydrogen gas that challenges many of our ideas about how galaxies form and evolve.

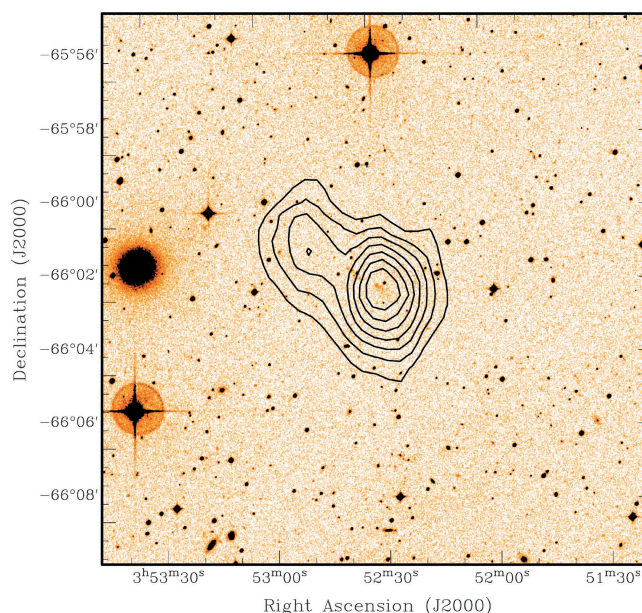
The cloud was discovered in October 2001 from radio images of an elliptical galaxy, NGC 1490, taken with the Australia Telescope Compact Array. This galaxy was targeted because data from the recently completed HI Parkes All Sky Survey (HIPASS) implied that it contained an unusually large amount of neutral hydrogen gas for an elliptical galaxy. Unlike our own Milky Way and other spiral galaxies, giant elliptical galaxies like NGC 1490 undergo a rapid period of star formation in the early universe which uses up almost all the available gas. When neutral gas is seen in these galaxies, it is usually a sign that the elliptical galaxy has recently swallowed a smaller, gas-rich galaxy.

Surprisingly, the Compact Array radio image (Figure 13) showed that although the gas found by HIPASS lies at the same distance as NGC 1490, it is associated with another, previously unknown galaxy which is barely visible to optical telescopes. This gas cloud, now designated HIPASS J0352–6602, is at least as large as our own Milky Way Galaxy, but is apparently only just starting to form its first generation of stars. In contrast, its companion galaxy NGC 1490 turned all its gas into stars very rapidly during a short period in the early Universe. This extreme diversity in star-formation history between members of a galaxy group is quite unexpected, especially since theories of galaxy formation predict that giant neutral hydrogen clouds of this kind should be found only in very isolated environments.

One possibility is that HIPASS J0352–6602 has only just begun to condense out of an intergalactic gas reservoir surrounding the galaxy group of which NGC 1490 is a member. If so, a significant fraction of the baryons in the local Universe may be associated with intergalactic gas clouds rather than with visible galaxies. Further study of HIPASS J0352–6602 is in progress to test these ideas.

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Figure 13 Radio emission at a wavelength of 21 cm from neutral hydrogen is shown here as black contours superimposed on an optical image from the Digitized Sky Survey (UK Schmidt Photographic Atlas). The elliptical galaxy NGC 1490 is seen on the left of the image. The hydrogen cloud is associated with a barely visible and previously unknown galaxy.



Polarization in methanol masers

The strongest class II methanol maser emission is produced by the 6.7 GHz transition, which was discovered in 1991. These methanol masers are only found in high-mass star-formation regions and are often closely associated with main-line OH masers. From the first high resolution observations of class II methanol masers many sources have been found to show a simple spatial and velocity distribution, which contrasts with the complex morphology usually observed in OH masers. Some of the methanol masers have a linear spatial distribution and monotonic velocity gradient, consistent with the maser arising in an edge-on rotating disk (Figure 14). However, to date, this hypothesis has not been conclusively demonstrated for any source. If some methanol masers do originate in disks then they would represent a unique opportunity to study accretion in high-mass star formation at unprecedented resolution.

One aspect of methanol masers that has not previously been investigated in detail is their polarization properties. Polarized emission from masers occurs when the orientation of the molecules producing the maser radiation is not random. Radio-frequency molecular lines are produced between rotational quantum levels and these only arise in molecules that have a dipole moment. Thus magnetic fields are able to align masing molecules, and the degree to which this occurs depends upon the strength of the field and the rate at which collisions and radiation interactions disrupt the alignment process. Methanol is a diamagnetic molecule and the separation of the Zeeman components produced by magnetic fields of 1 – 10 milliGauss (typical of star-formation regions) is much less than the width of the maser line. In these circumstances modest linear polarization can occur, but any circular polarization is expected to be very weak.

The exact role that magnetic fields play in the star-formation process is still a matter of heated debate, and as the polarization properties of masers depend critically upon the magnetic field they are potentially useful probes. In addition, the magnetic field associated with a circumstellar accretion disk is expected to be well ordered, and so if the methanol masers do originate in a disk then the polarization should show

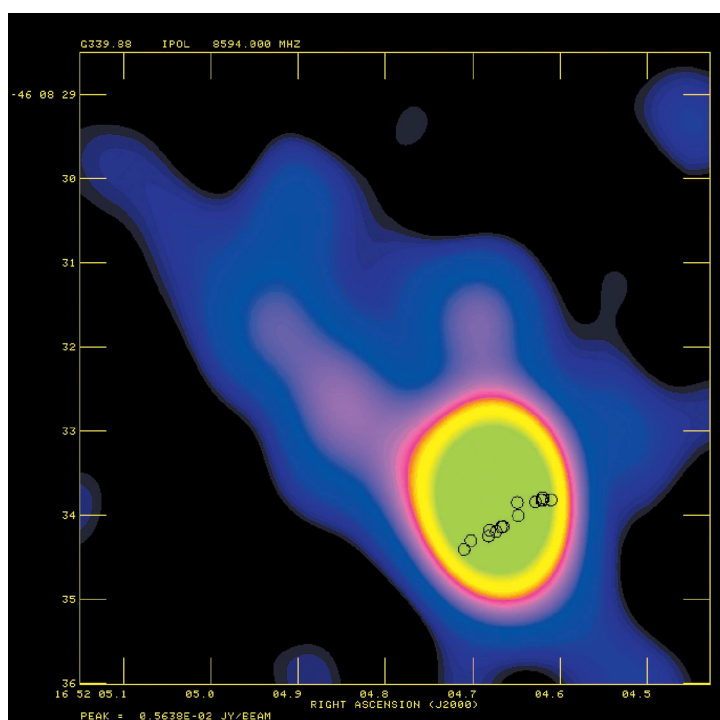


Figure 14 This false colour image shows the radio continuum emission at 8.6 GHz from the ultra-compact HII region G339.88–1.26 (observed with the Australia Telescope Compact Array). The overlaid circles represent the positions of the associated methanol masers at 6.7 and 12.2 GHz.

regular structure. If we naively assume that the magnetic field will be oriented perpendicular to the disk (from an edge-on perspective) then the masers are propagating perpendicular to the magnetic field (Figure 15). In this situation the position angle of the linear polarization will also be perpendicular to the magnetic field (i.e. parallel to the position angle of the disk). This ignores the effects of Faraday rotation, which will not mask the presence of regular structure, but may shift the position angle of the polarization vectors.

The Australia Telescope Compact Array has been used to make the first full polarization observations of 6.7-GHz methanol masers. Four strong sources were observed and linear polarization at levels between a few and 10% were detected towards all sources. None of the sources show circular polarization stronger than 1.5%. The majority of spectral features show linear polarization at levels of 2 – 3%, with a small number of (usually) strong features exhibiting levels of linear polarization of up to 10%.

G339.88–1.26 is one of the best methanol maser disk candidates. The maser emission is coincident with a weak ultra-compact HII region and there is some evidence for an outflow perpendicular to the line traced by the masers (Figure 14). The greatest degree of linear polarization in this source is 10%, which is exhibited by one of the weaker maser features (Figure 16). The position angle shows smooth variation across the velocity range decreasing from near 90 degrees at the lowest velocities to approximately 50 degrees at the highest velocities. For a number of features the position angle changes significantly across the line, perhaps indicating some spectral blending. Polarization VLBI observations which resolve the individual maser spots are required to determine if this is the case. This result is not consistent with a simple model of the maser emission arising in an edge-on disk, as that should produce polarization vectors with a small range of position angles, even if they are not parallel to the disk due to Faraday rotation.

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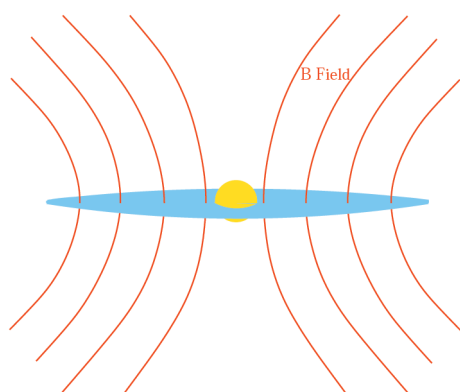


Figure 15 A naive model of the magnetic (B) field associated with a high-mass star still in the process of accretion. In reality the field above and below the disk is likely to be twisted by the rotation of the system, which will also affect the angle of the field as it passes through the disk.

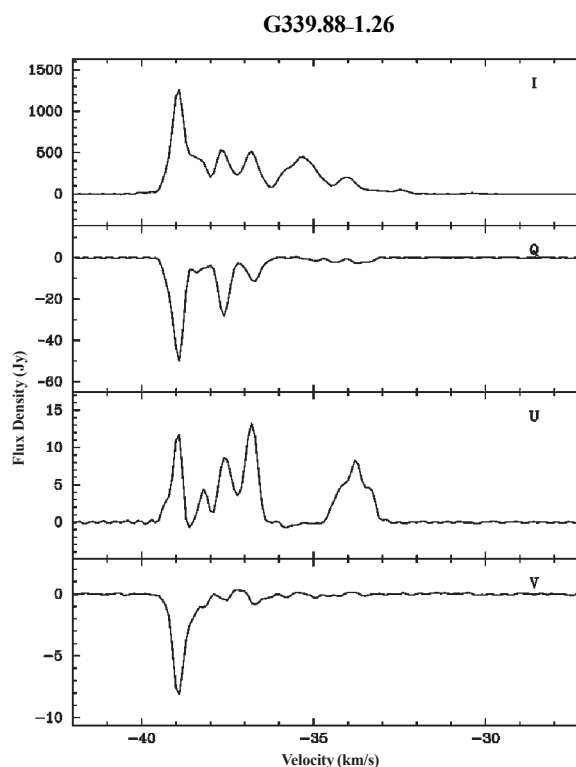


Figure 16 Australia Telescope Compact Array full polarization observations of the 6.7 GHz methanol masers in G339.88–1.26.

Searching for neutral hydrogen in groups of galaxies

Like people, galaxies have a tendency to gather together. Galaxies have their small towns—groups with only a few galaxies loosely spaced, and their big cities—giant clusters with hundreds or thousands of galaxies tightly bunched while spanning a large area. Roughly two thirds of all galaxies reside in a group of some sort, while the remaining third live in isolation as hermits. These groupings of galaxies are an important building block for structure in the Universe. Not only do the majority of galaxies reside in them, but most of the baryonic (normal) matter in the Universe is likely to be contained in groups as warm and hot gas. While many astronomers have studied the dense clusters and compact groups of galaxies, very few have studied the more diffuse components of structure known as loose groups.

Loose groups of galaxies are collections of a few (typically two or three) large galaxies and tens of smaller galaxies. The large galaxies in these groups are well spaced, with separations of order 100,000 parsecs, and they are spread out over a volume of roughly one cubic Megaparsec. They tend to be dominated by spiral galaxies, but some contain one or two large elliptical galaxies. Our Galaxy, the Milky Way, is part of a loose group known as the Local Group of galaxies. Although we are inside this group, there is much we still do not know about the Local Group and other similar loose groups. In particular, we do not know whether groups of galaxies, and the galaxies in them, are still forming.

Over the past few years, a 30-year old suggestion, that the high-velocity clouds (HVCs), clouds of neutral hydrogen (HI) spread around the sky at velocities inconsistent with the rotation of the Milky Way, are primordial material associated with the formation of the Local Group and its galaxies, has been revived. In 1999, Leo Blitz and collaborators as well as Robert Braun and Butler Burton proposed that at least some of the HVCs may reside at distances of up to a million parsecs from the Milky Way and contain of order 10 million solar masses of HI. For this hypothesis, the HVCs contain primordial material still falling into the Local Group and building up the galaxies in it. In this case, other groups similar to the Local Group should contain analogous HI clouds also lacking stars.

In an attempt to test these predictions we have set out to map HI in a sample of loose groups of galaxies with similar content to the Local Group using the Parkes telescope with its multibeam receiver. Using the narrowband mode, we have mapped the entire regions around four loose groups of galaxies. Two of the groups, LGG 93 and LGG 180, are at a distance of approximately 11 million parsecs, contain only spiral and irregular galaxies, and span 25 square degrees on the sky. The multibeam in its narrowband mode allows for rapid mapping of a large area of the sky down to low mass limits, below one million solar masses of HI at these distances, permitting the detection of possible analogues of HVCs in these two other groups. In addition to searching for HI clouds associated with galaxy formation, we are also making a census of the gas-rich galaxies in these groups and are examining the dynamical structure of the groups. The relative number of small galaxies and the presence of dynamically distinct components in the group (sub-groups) can be used to constrain the various models of galaxy formation and dark matter. Together these datasets will shed a great deal of light on how galaxies and groups form and evolve.

Observations of LGG 93 revealed the six previously known galaxies in the group, plus four new HI detections with HI masses of 10–100 million solar masses. Of the new detections, one is clearly identifiable as a dwarf galaxy, ESO 200-45, while for the other three the poor angular resolution of Parkes makes it impossible to identify a single optical counterpart. An example is shown in Figure 17.

For LGG 180, we detected all 10 group galaxies, plus three new HI detections, all of which have uniquely identifiable optical counterparts (ESO 434-G17, ESO 373-G6, and ESO 434-G8). These objects have slightly higher HI masses (100–1000 million solar masses). The HI detection of ESO 434-G17 is shown in Figure 18. There is still much work to be done to constrain the models of HVCs and galaxy formation.

The detections in both groups should be mapped at higher resolution with the Australia Telescope Compact Array to assure that they are single objects, and accurately identify them with optical counterparts. Optical imaging to place firm limits on the stellar content associated with the hydrogen clouds is also essential. Finally, observations of more loose groups using the Parkes telescope will assure that these groups are not anomalous in their properties.

D. J. Pisano (ATNF); B. Gibson (Swinburne University of Technology); D. Barnes (University of Melbourne); L. Staveley-Smith (ATNF); K. Freeman (Research School of Astronomy and Astrophysics, Australian National University)

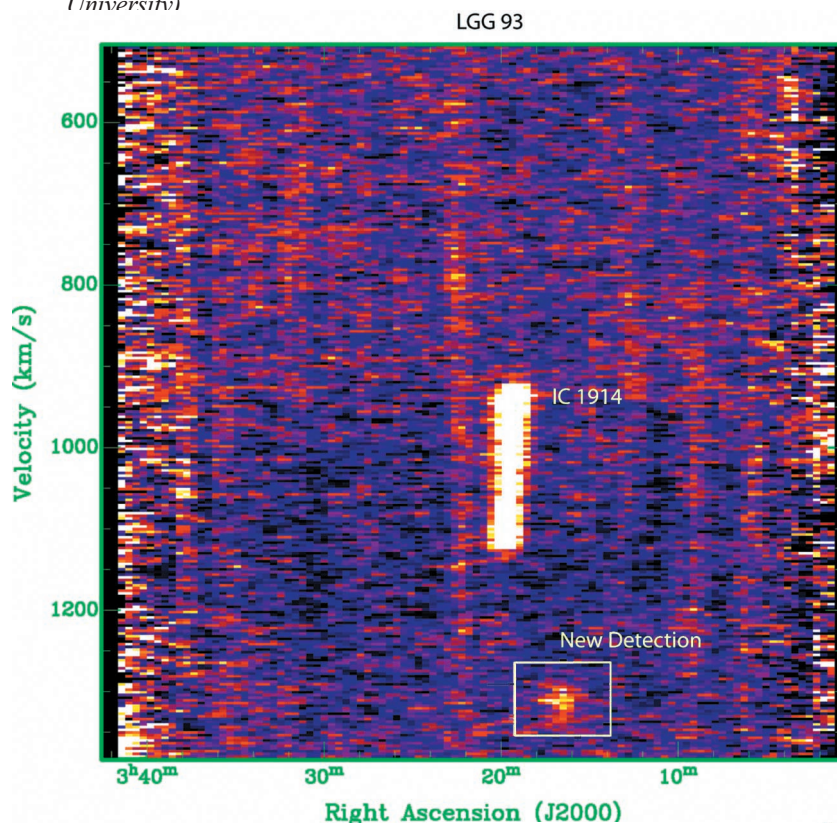
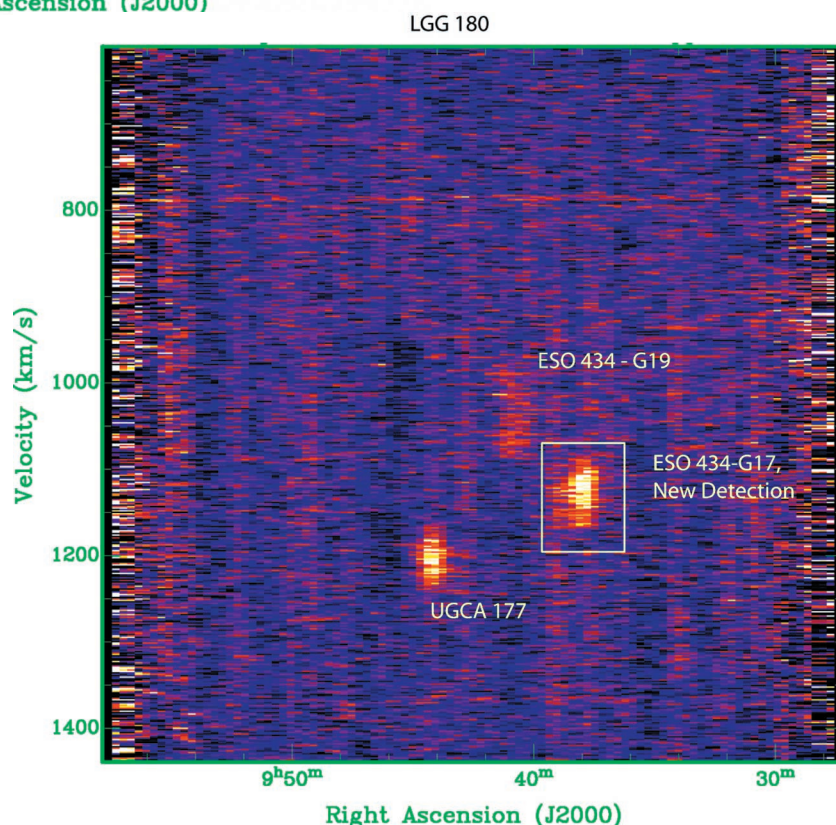


Figure 17 This image, obtained from data taken with the Parkes radio telescope, shows a “position-velocity” diagram for part of the loose group of galaxies known as LGG 93. The previously known galaxy IC 1914 is seen as the bright strip extending over velocities from approximately 900 to 1,100 kilometres per second. The new detection of a cloud of neutral hydrogen shows a much smaller velocity range.

Figure 18 A position-velocity diagram for part of the region around the loose group of galaxies, LGG 180. This shows a new detection of neutral hydrogen emission from the galaxy ESO 434-G17.



The magnetic fields of barred spiral galaxies

We have used the Australia Telescope Compact Array and the Very Large Array (VLA) to study the magnetic fields of barred spiral galaxies. The centrally located bars in these galaxies are believed to cause streaming motions in the surrounding gas which lead to enhanced star formation. The galactic magnetic fields are expected to follow the gas flow.

Until recently there have been few detailed radio polarization observations of barred galaxies and little has been known about how the central bars affect the galactic magnetic fields. To study the magnetic fields of barred spiral galaxies, we selected a sample of 20 barred galaxies with an optical size of at least three arcminutes, from the radio surveys of Whiteoak (1970) and Condon et al. (1998). Ten galaxies were observed with the Compact Array at 6, 13 and 20 cm and 10 galaxies were observed with the VLA. For 17 of the 20 galaxies we detected polarized radio emission, indicating the presence of large-scale regular magnetic fields. The radio data will be published as an atlas of magnetic fields in barred galaxies and are available on the Web at [http://www.mpifr-bonn.mpg.de \(research – archive\)](http://www.mpifr-bonn.mpg.de/research+archive).

As examples, Figures 19 and 20 show the radio emission at a wavelength of 5.8 cm from the southern galaxies NGC 2442 and NGC 7552, overlaid onto optical images from the Digitized Sky Survey. The contours show the total intensity of the radio emission while the dashes indicate the orientation (assuming little Faraday rotation) and strength of the magnetic field.

NGC 2442 (Figure 19) is a member of the Volans Group of galaxies. The optical image has an asymmetric appearance possibly indicating a tidal interaction with another galaxy. Ionized hydrogen emission from the galaxy shows an unresolved central source and a circumnuclear ring of enhanced star formation which has a radius of approximately 600 parsecs. NGC 2442 exhibits strong radio emission from the nucleus and the ends of the bar. Strongly polarized emission is detected from the northern spiral arm, which has a massive dust lane. The magnetic field lines in this arm are aligned, possibly indicating a compression and/or shearing of the magnetic field.

NGC 7552 (Figure 20) is a member of the Grus Quartet of galaxies. This galaxy also has a starburst circumnuclear ring with a radius of approximately 800 parsecs. The galaxy does not have an active nucleus but has a nuclear bar (observed in radio continuum and near-infrared) aligned perpendicular to the main central bar. NGC 7552 shows strong, highly polarized radio emission from the centre of the galaxy, the bar and the inner parts of the spiral arms. The angular resolution of the Compact Array observations was not high enough to resolve the circumnuclear ring. The polarized radio emission from NGC 7552 is strong upstream of the dust lanes and the magnetic field lines are oriented at large angles to the major axis of the central bar.

From this study we find that the radio surface brightness and the rate of star formation in spiral galaxies are highest for galaxies with a high content of molecular gas and with a high quadrupole moment of the bar's gravitational potential. However, galaxies with strong bars do not always have bright radio emission. For barred galaxies with moderate radio brightness, the magnetic fields, traced by the polarized radio emission, are strongest between the optical spiral arms, or have a diffuse distribution. For radio-bright barred galaxies we find that the magnetic fields are often strongest upstream of the bar's shock front which is delineated by massive dust lanes, in conflict with numerical models. The magnetic fields are oriented at a large angle to the bar and curve smoothly towards the bar without an indication of a shock front. We propose that shear in the velocity field around a large bar enhances the magnetic fields in barred galaxies.

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NGC 2442

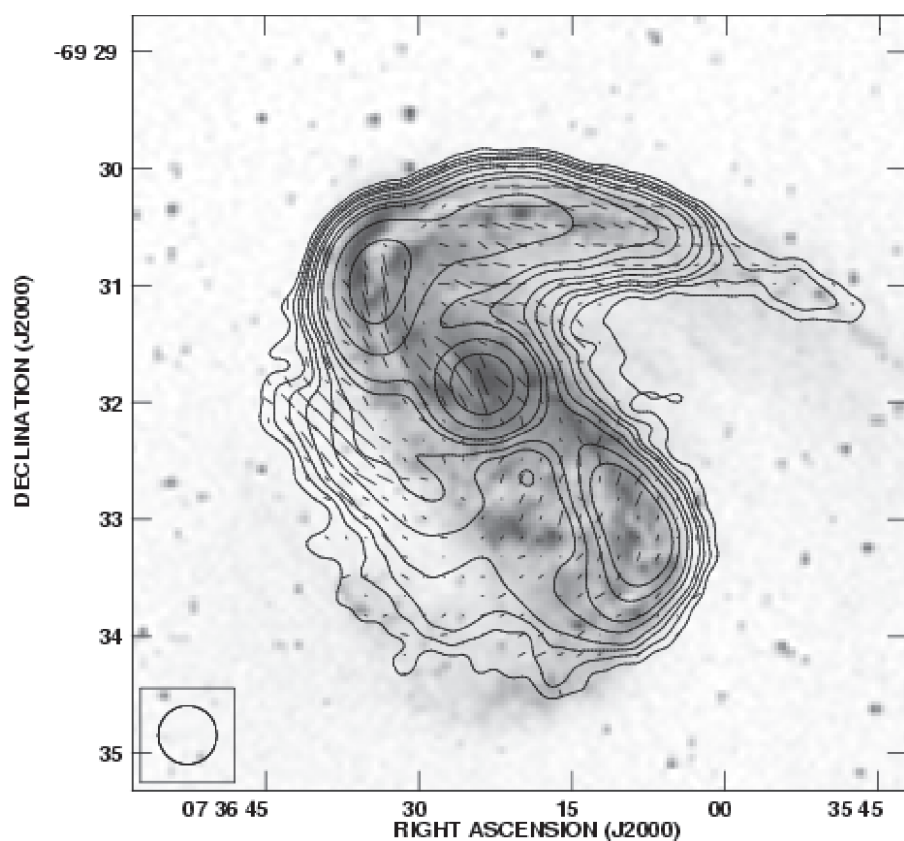
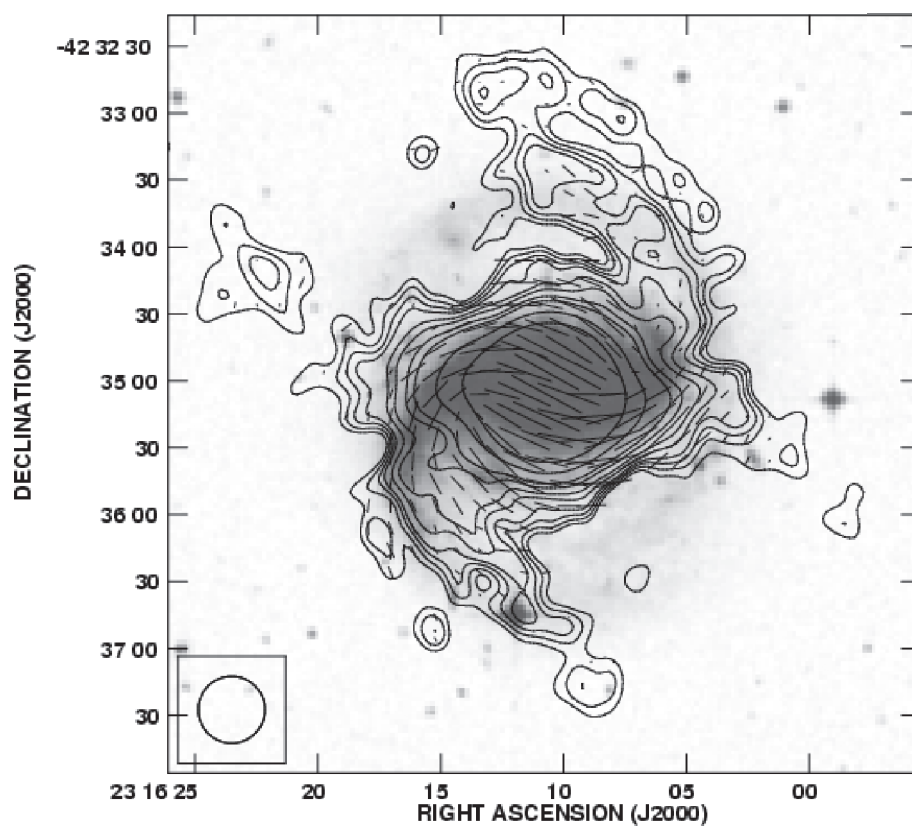


Figure 19 Total intensity contours and magnetic field vectors showing the total and polarized radio emission at a wavelength of 5.8 cm from NGC 2442, overlaid onto an optical image from the Digitized Sky Survey (UK Schmidt Photographic Atlas). The contour levels indicate the strength of the radio continuum emission. The angular resolution of the radio observations is 30 arcseconds. The dashes indicate the strength of the polarized radio emission and the orientation of the galactic magnetic field. A vector of one arcsecond length corresponds to a polarized intensity of 10 microJansky per beam area.

NGC 7552

Figure 20 Total intensity contours and magnetic field vectors showing the total and polarized radio emission at a wavelength of 5.8 cm from NGC 7552, overlaid onto an optical image from the Digitized Sky Survey (UK Schmidt Photographic Atlas). Note that the outer regions of the image show some artefacts caused by incomplete sampling of the data.



PKS 1257-326: a scintillating quasar

Radio variability on time scales shorter than a day has been observed for the past 20 years in a number of compact, extragalactic radio sources. There has been much debate over the origin of this intraday variability (IDV). On the one hand, many radio sources vary at all observed wavelengths, from radio to gamma-ray, and this broad-band variability may thus be explained as being intrinsic to the source. The main problem with very rapid radio variability, if intrinsic, is that it implies a very high source brightness temperature, much higher than allowed by the conventional synchrotron emission mechanism for nonthermal radio emission.

On the other hand, it is known that sources with sufficiently small angular size can be observed to vary as a result of interstellar scintillation, a propagation effect produced in the turbulent, ionized interstellar medium (ISM) of our own Galaxy, which affects only radio wavelengths. An extragalactic radio source small enough to vary on time scales shorter than a day is certainly small enough to scintillate. Interpreting the variability as scintillation generally allows larger source sizes and hence lower source brightness temperatures.

How do we know for sure whether the intraday variability is scintillation, or intrinsic?

Recent Compact Array observations have now confirmed that the principal cause of this radio IDV is interstellar scintillation. Key to this has been the discovery and detailed monitoring of the variability in the recently discovered very rapid variable, PKS 1257–326. This source is one of the three most rapidly variable quasars known. Its flux density has been observed to vary by 40% in 45 minutes.

We have monitored the variability of PKS 1257–326 every six weeks with the Compact Array over the course of the last year, and found an annual cycle in the characteristic time scale of variability, as shown in Figure 21. This annual cycle occurs because the velocity of the interstellar medium, as seen by an observer on Earth, changes due to the Earth's orbital motion. The scintillation pattern is produced by focusing and defocusing the radio emission, as it passes through patches of turbulence in the interstellar medium. The time scale of variability is set by the speed at which this series of patches moves past the observer. For some periods of the year, the relative Earth/ISM velocity can be quite large, so that the scintillation pattern moves rapidly past the observer, and the observed time scale of variability is short. Six months later the ISM and the Earth are moving in much the same direction, so that the scintillation pattern is observed to pass by quite slowly, and the observed time scale of variability is long. The presence of such an annual cycle in PKS 1257–326 shows unequivocally that the IDV in this source is due to interstellar scintillation.

Importantly, this interstellar scintillation can be used as a probe of micro-arcsecond source structure, and of the scale and structure of turbulence in the local ISM. Our data tell us that the angular extent of the scintillating source is at most a few tens of micro-arcseconds. At the distance of PKS 1257–326, 10 micro-arcseconds corresponds to a linear distance of around three light months. We find that the scattering material along the line-of-sight to PKS 1257–326 is likely to be very nearby, less than 100 light years away from the solar system. Modelling the annual cycle also shows strong evidence for a highly anisotropic scintillation pattern.

Thus, with the Compact Array, which has an angular resolution of arcseconds, we can use the ISM and the Earth's orbit to achieve a resolution of tens of micro-arcseconds. That's like extending the Compact Array's railway tracks all the way to the moon!

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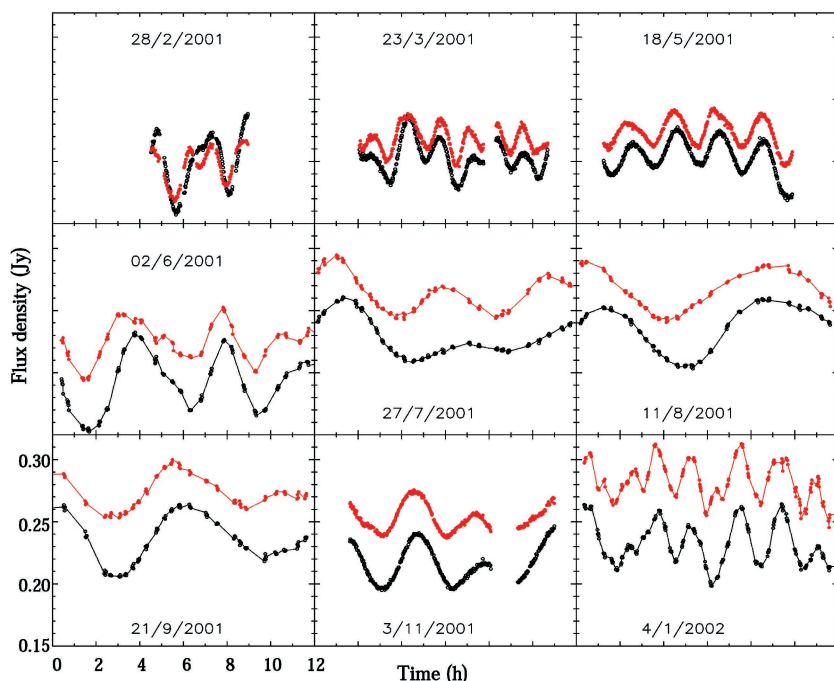


Figure 21 Flux density measurements of PKS 1257–326 over the course of a year, showing the clear annual cycle in variability time scale. From June through September, the rapid variability slows down, then speeds up again towards the end of the year. Six-cm data are plotted in black, and 3-cm data in red. Each box shows one day's data, and represents the same range of values, shown in the bottom left-hand corner.

Figure 22 The characteristic time scale of variability at wavelength 6-cm, defined from autocorrelation functions, measured over 2001. Plotted underneath is the speed, observed from Earth, of a medium moving with the local standard of rest, in the direction of PKS 1257–326. The time scale of variations shows a clear signature of the Earth's orbital motion.

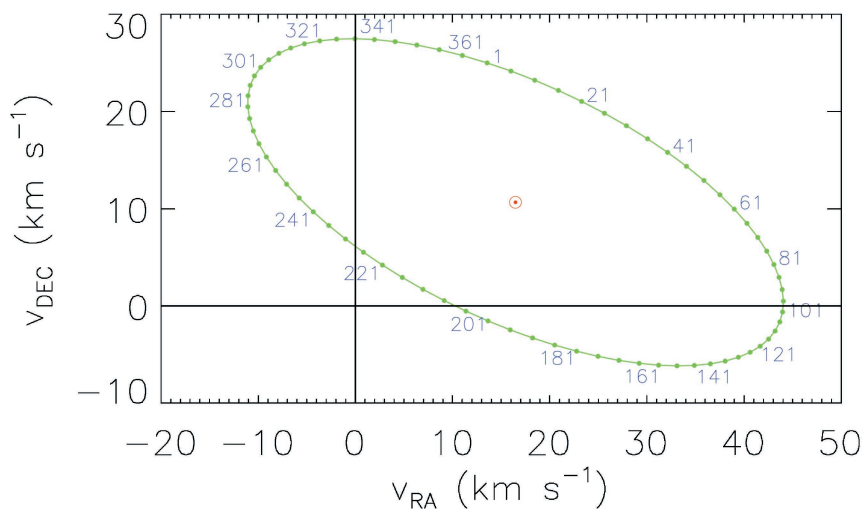
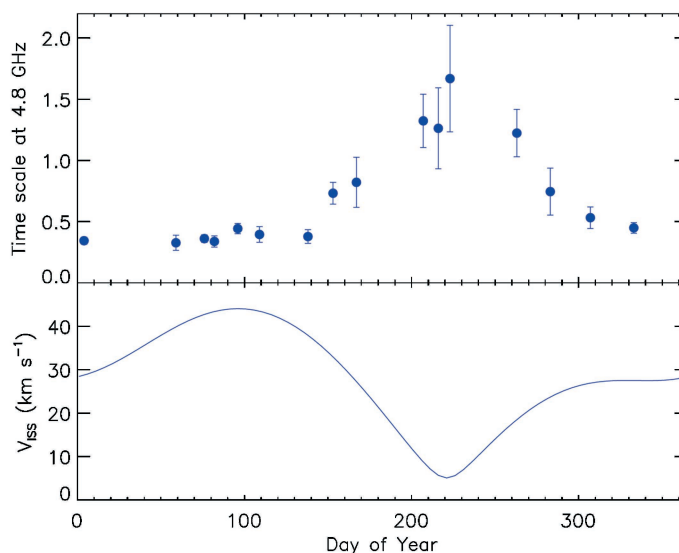


Figure 23 The Earth's velocity with respect to the interstellar medium, for each day of the year, projected onto the plane of the sky. This shows that over the course of a year, there is a large change in the direction of the scintillation speed, which allows us to probe the two-dimensional structure of the scintillation pattern.

On the trail of gamma-ray burst progenitors

Gamma-ray bursts may be the most luminous events in the Universe but they have not given up their secrets easily. For the past several years we have been part of an international effort to unveil these mysterious sources responsible for such explosive events. Now, thanks to observations made at the Australia Telescope Compact Array and elsewhere, we have found a direct link between gamma-ray bursts and the death throes of massive stars.

Any successful gamma-ray burst model must be capable of releasing an enormous amount of energy on a time scale of tens of seconds. One of the more promising candidates has been the collapsar model, in which a massive star, more than 20 times the mass of our own Sun, ends a lifetime of nuclear burning and undergoes core collapse, forming a black hole at its centre. The outer layers of the star are driven outward at speeds of 20,000 to 60,000 kilometres per second in a brilliant supernova explosion. Not to be outdone, the newly formed black hole, powered by infalling material, forms collimated beams of material along its rotation axis at speeds approaching that of light (Figure 24). The interaction of different shocks within the jet is responsible for the gamma-ray emission, while particle acceleration from the ultra-relativistic shock which is driven into the circumburst medium gives rise to long-lived X-ray, optical and radio “afterglow” emission, dwarfing the light from the supernova.

For some time now evidence has been slowly accumulating in favour of the collapsar model. All well-localised gamma-ray bursts occur in host galaxies which are actively undergoing star formation, sometimes at a rate of several hundred solar masses per year. Likewise, the radial distribution of gamma-ray bursts closely follows the (stellar) UV light from their host galaxies. Substantial gas and dust along the line-of-sight to gamma-ray bursts has also been inferred from the absorption of low-energy X-rays and extinction of optical afterglows. In many cases the dust extinction is large enough to produce optically

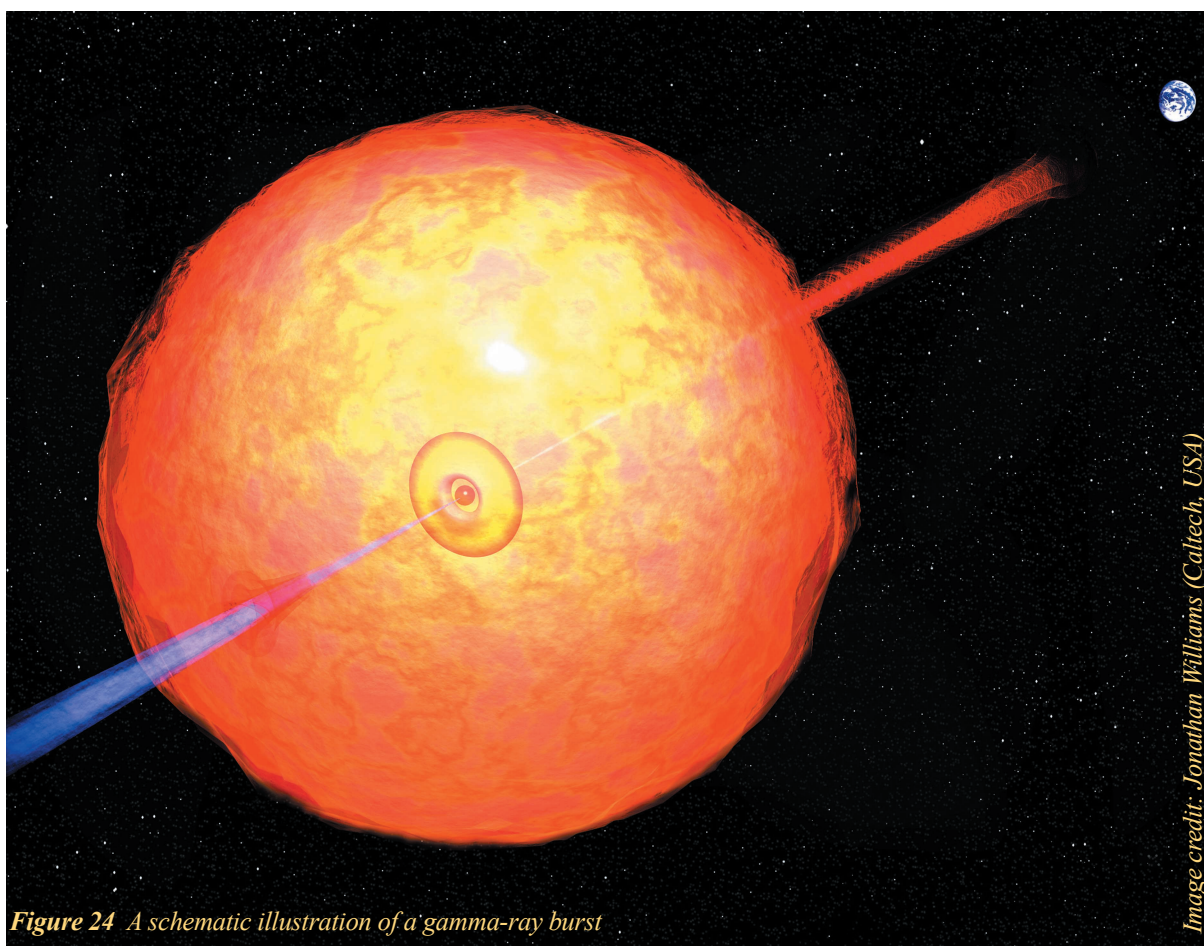


Figure 24 A schematic illustration of a gamma-ray burst

Image credit: Jonathan Williams (Caltech, USA)

“dark” gamma-ray bursts which are visible only in the radio and X-ray bands. While these indirect indicators have been telling us that gamma-ray bursts originate in the same dusty, gas-rich environments as massive stars, the decisive evidence in favour of the collapsar model has remained elusive.

Fortunately, the collapsar model provides two powerful observational tests. The massive star progenitor undergoes prodigious mass loss prior to collapse, shedding nearly all of its hydrogen envelope. The relativistic shock driven outward must propagate through this gas and hence we expect to see the mass-loss density profile imprinted on the spectral and temporal evolution of the afterglow emission. Observations at radio wavelengths are especially important in detecting the wind signature since they probe the rise and fall of the afterglow emission as the shock propagates through this density gradient.

Another inevitable consequence of the collapsar model is that a supernova explosion will occur simultaneously with the gamma-ray burst. The light from the afterglow and the supernova can be distinguished from each other since the former undergoes a pure power-law decay, while the latter exhibits a rise to maximum several weeks after the burst, followed by an exponential decay. Similarly, the optical spectrum of the afterglow is a featureless (synchrotron) continuum, whereas the supernova spectrum has characteristic red colours. Detecting the weak supernova signal in the presence of the afterglow and the host galaxy is not an easy task. Prior claims of late-time red “bumps” and stellar wind signatures have been made but not together and not with a high degree of confidence. With the gamma-ray burst of 21 November 2001 (also known as GRB 011121) we had our long-awaited opportunity to search for both.

GRB 011121 began innocuously enough. It was detected as a 30-second long burst at 18:47 UT by the Dutch/Italian satellite *BeppoSAX*, and the subsequent ground-based response by our group and others quickly identified the optical and radio afterglows. A pleasant surprise awaited us when an optical spectrum, taken at the Baade 6.5-m telescope, showed that the redshift of this burst was $z = 0.36$, making GRB 011121 the nearest cosmological gamma-ray burst known to date. By contrast, most of the two dozen bursts with distance determinations lie at redshifts between one and two. Since nearby gamma-ray bursts are ideal for carrying out tests of the collapsar model we immediately began a large observing campaign on GRB 011121.

Broadband optical observations were undertaken at the Anglo-Australian Telescope (AAT) with the newly commissioned IRIS2 instrument, and the du Pont 2.5-m and Baade 6.5-m telescopes at Las Campanas Observatory. These observations enabled us to determine the spectrum and the power-law decline of the optical afterglow at early times. When the light curves were extrapolated to a time between 15 and 75 days after the burst we found that our Hubble Space Telescope measurements taken at this time were an order of magnitude brighter than expected. Both the light curve of this flux excess and its observed spectral shape were consistent with the expectations for a supernova of type Ib or Ic.

Meanwhile at the Compact Array we had made seven epochs of observations of the afterglow at 4.8 and 8.7 GHz, spanning from one day after the burst to 70 days later. By comparing the early evolution of the optical afterglow with that of the radio afterglow, we were able to eliminate all other potential afterglow models, including an isotropic or highly collimated outflow expanding into a constant density medium. Taken together the optical and radio data are consistent with a gamma-ray burst exploding into a wind-blown circumburst medium. Moreover, careful modelling of these data tell us that the mass loss of this pre-supernova star was 10^{-7} solar masses per year, typical of evolved stars.

If all long-duration gamma-ray bursts are due to the core collapse of massive stars, as these observations certainly suggest, then we are likely witnessing the birth of a stellar black hole. Looking ahead, this raises the exciting possibility that in the future gamma-ray bursts could be used to trace star formation when the Universe was very young. The extreme luminosity of gamma-ray bursts and their accompanying afterglows means that in principle they could be detected out to redshifts of 10 or higher, at a time when the first stars were still being formed.

D. A. Frail (National Radio Astronomy Observatory, USA/Caltech University, USA); P. A. Price (Research School of Astronomy and Astrophysics/Caltech University, USA); E. Berger (Caltech, USA); M. Wieringa, R. Subrahmanyam, R. Wark (ATNF)



The Australia Telescope Compact Array

Photo: David Smyth

OPERATIONS

National Facility Support

The AT National Facility Support Group, located in Marsfield, provides support for public relations activities, communications, educational programs and time assignment processes.

Staff changes

In February 2001, Dr John Whiteoak retired from the ATNF after a highly distinguished career. He first joined the CSIRO Division of Radiophysics in 1965 and was the Project Secretary during the construction of the Australia Telescope. From 1989 until his retirement in 2001 he was the Deputy Director of the Australia Telescope. John's many contributions include three years as Officer-in-Charge at Narrabri, an immense scientific output, many former students who have gone on to become professional astronomers, and an outstanding role with the International Telecommunication Union. To honour his career a scientific symposium was held at the ATNF in Marsfield on 7 February 2001.

Photo: John Masterson



Dr John Whiteoak

Higher-degree students

Education is one of the ATNF's key performance indicators. ATNF staff members participate in a long-standing program to co-supervise higher-degree (Masters and PhD) students. This arrangement gives students access to world-class observing facilities and the chance to interact with a range of practising astronomers. At the end of 2001, 25 students were taking part in the program: their projects are listed in Appendix H. Four students completed their PhDs during the year: their theses are listed in Appendix G.

Most of the higher-degree students undertake studies in astronomy, but the ATNF also offers higher-degree projects in areas of engineering such as microwaves, digital and electronics, and in computer-related topics.

Summer vacation program

For more than a decade the ATNF has coordinated a program each summer for undergraduates in science, mathematics, computing and engineering who have completed at least three years of their degree. The students work on individual research projects under the supervision of research scientists for 10 to 12 weeks. During this time they experience the working environment of a major research facility. A number of former vacation students have later returned to the ATNF, either as employees or to do a co-supervised higher degree.

For the 2001/2002 program there were 234 applications for 22 positions, 10 with the ATNF (two of these at the Narrabri Observatory) and 12 with CTIP. The program included a series of introductory lectures, tours of the CSIRO Marsfield and Lindfield laboratories, and a weekly session where a staff member talked on a research topic.



2001/2002 ATNF summer vacation students

Photo: Shaun Amy

A highlight of the program was an observatory trip where the students visited either the Parkes radio telescope (with Naomi McClure-Griffiths) or the Australia Telescope Compact Array (with Bob Sault) and worked in small teams to take observations with the radio telescopes. A one-day symposium, organized by the vacation students, was held at the end of the program with a presentation given on each of the research projects.

Work experience students

Each year, typically 30 school students do a week of work experience at either the Parkes Observatory or at the Compact Array. The students are assigned to staff members, and help visitors with observing or work in the Visitors Centres.

ATNF photoarchive

The ATNF historic photographic archive dates from 1939 and comprises over 100,000 individual negatives or slides, and associated prints. The collection includes photographic records of the people involved in Australian radio astronomy, key events, radio telescopes and field stations, space missions, engineering achievements and commercial work.

In 2001, a thorough assessment was made of the contents of the collection. This involved the careful examination of many thousands of images to determine which images are worth retaining. Approximately 50% of the images were identified as being of significant historical interest.

As part of the collection has been deteriorating, in October 2001 it was relocated to a purpose-built room in Marsfield, where the temperature and relative humidity are maintained at suitable levels



This photograph taken in 1952 shows the World War II Georges Height radar antenna installed at the CSIRO Potts Hill field station. In 1951 this antenna was used for the first Australian observations of neutral hydrogen.

for ongoing conservation. As the next stage of the project, in 2002 the most historically significant photographic negatives and prints will be scanned so that the images are available as a digital image-library database. The archive is being developed as a resource for those researching the history of Australian astronomy and for exhibitions, education and public relations.

Public outreach

The ATNF supports a wide range of public outreach activities. Some statistics relating to the public relations activities are shown in Figures 7 and 8 (page 17). Here we describe some of the major public relations events that took place during the year.

ATNF Open Day at Marsfield

The ATNF, in conjunction with CTIP, held an Open Day at the Marsfield site on 24 November 2001. The day was a great success with well over a thousand members of the public wandering through the laboratories, admiring our displays and chatting to astronomers and engineers.

In feedback, visitors revealed that they greatly enjoyed themselves and considered that they learnt a great deal about the ATNF and CTIP, and also about CSIRO in general. In particular, the tours of the ATNF receiver laboratories and the Square

Kilometre Array exhibit were big hits with the Open Day visitors. Other exhibits featured remote observing with the ATCA, an “astronomer’s corridor”, the history of the Parkes radio telescope and an area where visitors could ask an astronomer questions about astronomy.

Parkes 40th Birthday

On 1 November 2001 the Observatory commemorated 40 years of unbroken scientific achievement with a half-day symposium “Parkes: 40 years of scientific excellence”, held at the Visitors Centre. Over a hundred ATNF staff, retirees and invited guests heard a program covering the entire life of the telescope, from recollections of the early days to signposts for future directions, but with particular emphasis on recent scientific highlights in HI and pulsar work. The wide-ranging program was reflected in the span of ages and diversity of presentation styles of the six invited speakers. There was unanimous agreement from all who attended that the symposium was an outstanding success.

At the conclusion of the symposium, special guest of honour Lettie Bolton, widow of the Observatory’s first Director, took part in a small ceremony officially naming the tree-lined avenue from the telescope to the Observers’ Quarters as the John Bolton Avenue.



Photo: Shaun Amy

Roopesh Ojha, a postdoctoral fellow at the ATNF, talking to a visitor at the ATNF Marsfield Open Day



Photo: John Sarkissian

Mrs Lettie Bolton (left) with ATNF Bolton fellow Naomi McClure-Griffiths (right)

In recognition of the important role played by the Observatory in the local community over the last four decades, the Mayor of Parkes, Cr Robert Wilson, presented the Observatory with a fine engraved clock. All then adjourned for an excellent dinner in a marquee set up adjacent to the Visitors Centre. Informal presentations from Peter Churchill and Mike Dinn, the current and former Directors respectively of Tidbinbilla, and recollections from many older members of the party, including Bruce Slee and Lettie Bolton, concluded a most memorable and enjoyable day.

Parkes Observatory Open Weekend

On 3 – 4 November 2001, the Observatory held an Open Weekend. Several special activities were provided to entertain and educate interested members of the public on the history and important continuing research work of the Observatory. Foremost among these were the telescope tours, proving just as popular as they did on the last Open Weekend in October 1998. Some 1,800 people were conducted through the tower over the two days, a figure which is evidently close to the physical limit, given the genuine curiosity and wonder shown by the public in the details of the telescope and consequently their reluctance to be rushed through too quickly! Special thanks go to Professor Matthew Bailes, Haydon Knight and Jamie Stevens for not only attempting stoically to

maintain normal observing throughout both days, but explaining their work so clearly and patiently to the endless procession of visitors.

Astronomy lectures and the “meet an astronomer” marquee were also very popular. For the more adventurous, a local charter company ran helicopter joyflights over the telescope throughout both days, a novelty deemed a great success on all sides.

A highlight of the weekend was an outdoor screening of the movie *The Dish*, held on the Saturday night in a paddock adjacent to the dish. (For the historically minded, the projector screen was mounted on the frame of the long disused 408-MHz calibration horn.) With a barbecue provided by Rotary of Parkes prior to the screening, an estimated audience of 600 from far and wide settled back and enjoyed the film on a beautiful evening with the illuminated 64-metre telescope as the backdrop. As if on cue, the moon rose behind the screen halfway through the film—a truly magical moment! Many letters appeared subsequently in the local papers pronouncing the evening a tremendous success, and requesting it become a regular event.

In all over 3,000 people visited the Observatory over the weekend. Most stayed for several hours, and the feedback from visitors was entirely positive.

New Visitors Centre for the Parkes Observatory

The long-awaited official opening of the upgraded Parkes Visitors Centre and grounds took place on 24 March 2001, attended by local and visiting dignitaries, and with CSIRO's new Chief Executive Geoff Garrett performing the honours.

The new centre has double the floor-space of the old, with greatly increased space for exhibits, shop and audio-visuals. The new entrance to the Centre complements newly landscaped grounds to present a welcoming and attractive face to visitors. The new design features a dedicated audio-visual theatre and lecture room specifically designed to encourage visits from school groups. Many new and upgraded displays have been introduced to the Visitors Centre, mainly through the efforts of Helen Sim and Lucia Bromley-Gambaro. Fabulous video footage of the construction of the telescope and of the Apollo 11 mission, extracted from deep within the archives, is a great new feature. Improving and adding to the exhibits is the focus for activity in the short-term future, with emphasis on more interactive displays a priority for 2002.



Rick Twardy, Manager of the Parkes Visitors Centre



Photo: John Sarkissian

CSIRO Chief Executive Dr Geoff Garrett, opening the Parkes Visitors Centre

The Centre now boasts two new audio-visual shows. The first was produced for the ATNF by the Australian Business Theatre, using the same multiple slide projector format as the original, and was premiered in August 2000. Response to this show has been excellent, both in feedback and in increased attendance. After the formal Opening Ceremony in March 2001, the Visitors Centre premiered a new three-dimensional virtual reality tour of the Solar System entitled *The Sun—What a Star*. This show, produced by the Swinburne University of Technology's Astrophysics & Supercomputing group, complements the more traditional program of the slide show very nicely, and is also proving to be a crowd-pleaser. Visitors are also able to roam the grounds and inspect a number of new outdoor exhibits. The opening of the Discovery Centre was well timed: since the release of the film *The Dish* in October 2000, the Parkes visitor numbers have more than doubled.

Computing

Marsfield computer services

The information technology (IT) infrastructure at the CSIRO Marsfield site is managed by the computer services group (CSG), CTIP, while ATNF-specific tasks such as astronomical software and user support are managed by the ATNF. There were no staff changes to the CSG in 2001.

Observatory Computer Committee and Computerfests

Computer staff at each of the three main ATNF sites report to a local program leader. Coordination across the sites is performed by a four-person Observatory Computer Committee (OCC). This holds three meetings per year, rotated between the sites.

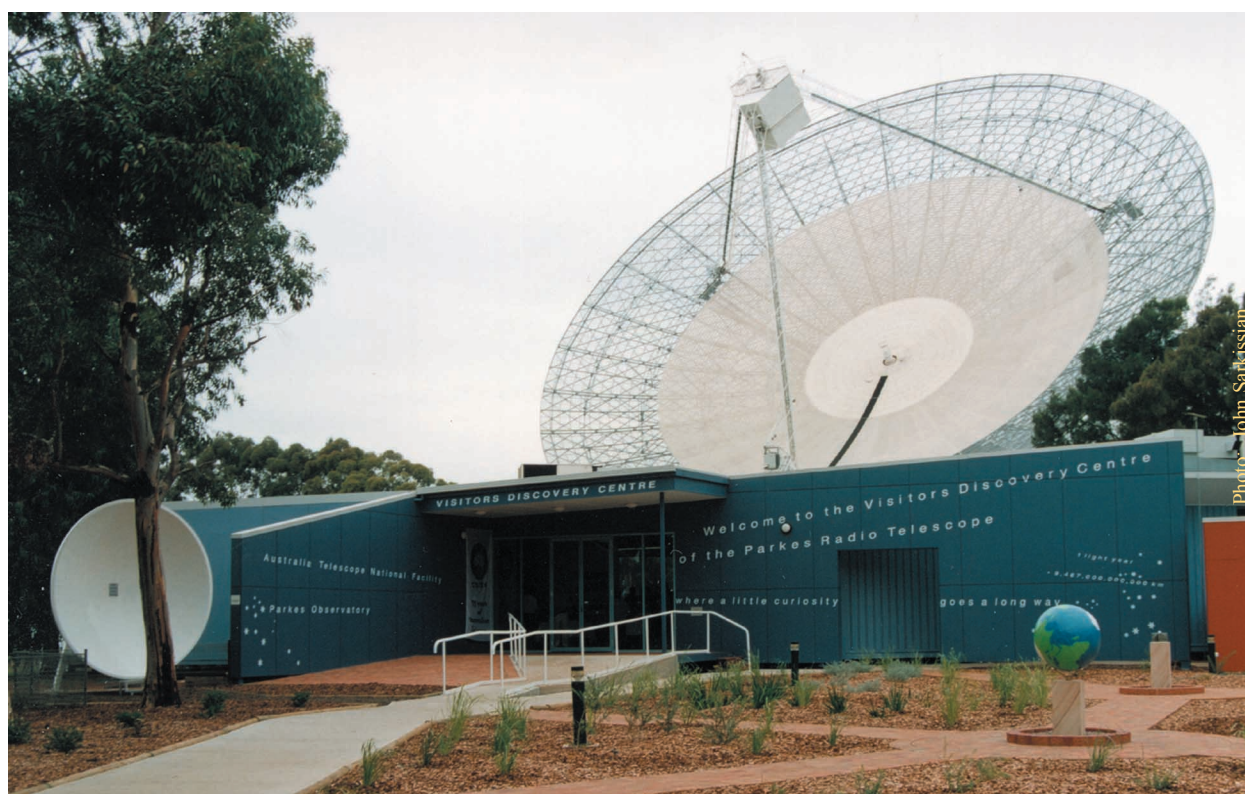
“Computerfests” are held in association with the OCC meetings. These gather together many ATNF staff working in computing related areas. The Computerfests provide a forum for staff who might

not otherwise meet each other to discuss common interests and this helps coordinate the computer developments between the sites.

Unified email

In 2001 CSIRO experienced significant change in its IT infrastructure. Most visible to staff was the “unified email project”. The main aims of this project are that all CSIRO users will have their email boxes on Exchange servers which communicate with a small set of email “clients”. This process allows email users to read standard email attachments and provides other collaboration tools. As part of this project, all CSIRO email addresses now have a standard form—Firstname.Lastname@csiro.au. The ATNF now supports the email clients Outlook (which is used by the majority of CSIRO staff), Netscape and Pine.

To manage the change to unified email required substantial resources from the CSG and other ATNF IT staff. The transition went reasonably



The Visitors Discovery Centre at the Parkes Observatory

smoothly, although there were some initial disruptions, in particular from “lost” emails. The transition, for many staff, from the mail client Eudora to Outlook also caused some initial problems.

Nexus authentication

Authentication domains are used to check the user names and passwords of computer users. Another significant IT-related change which began in 2001 is that CSIRO is moving to a single authentication domain, called “Nexus”. For this domain, staff and visitors will log in using a CSIRO identification code as their username. Nexus computer accounts currently require that human resources staff allocate the CSIRO identification codes while IT staff allocate the computer accounts. This process will be streamlined in future.

aips++ development

aips++ is an object-oriented data processing environment being constructed by an international consortium of leading radio astronomy observatories. Four ATNF staff members contribute to the development of core aips++. ATNF also uses aips++ as its toolkit for the development of the successful multibeam pipeline software. In 2001 the project continued to have a development cycle of six months, with a new software release at the end of each cycle. The aips++ software is distributed to approximately 10 institutions in Australia.

At a synthesis workshop held in Narrabri in September 2001 (page 42), practical aips++ sessions were held for students so that they could learn how to use the toolkit structure. These sessions were well received. In addition, some of the 2001/2002 summer vacation students used the aips++ toolkit to good effect as the basis for their software development.

ATCA polarization data can now be fully calibrated in aips++. An ATCA-specific calibration tool is being developed to make this as simple as it is useful.

The aips++ team has also been working closely with members of the ALMA project as they evaluate whether to use aips++ as their main data processing environment. This work has proceeded well and aips++ has successfully delivered what has been requested of it so far. A final decision is yet to be made.

Spectrum management

CSIRO, initially through the Division of Radiophysics and later through the ATNF, has been involved in activities related to spectrum management and the protection of radio astronomy for about 30 years. Following John Whiteoak’s retirement in 2001, Tasso Tzioumis has taken over responsibility for these activities. The areas in which the ATNF are currently involved include:

- ◆ Participation in national spectrum planning and protection activities through the Australian Communications Authority (ACA).
- ◆ Participation in regional and international meetings under the auspices of the International Telecommunication Union (ITU). These include regular meetings of ITU Study Group 7 (Science Services).
- ◆ Participation by the ATNF Director in the Working Party meetings of the OECD megascience forum where an international task force is being set up to investigate radio-frequency interference and protection measures.
- ◆ Participation in IUCAF (Inter-Union Commission for the Allocation of Frequencies), an inter-union committee of the IAU, URSI and COSPAR. IUCAF provides a scientific committee and frequency allocations for radio astronomy and space science.
- ◆ In August 2001 a new committee, the Radio Astronomy Frequency Committee in the Asia Pacific Region (RAFCAP) was formed to co-ordinate the spectrum management activities in the region. Tasso Tzioumis is the secretary for this committee.

Equal Employment Opportunity

The ATNF has an active EEO group with five EEO contact officers. Two are based in Sydney, two are at Narrabri and one is at Parkes. Staff at any of the sites can contact any of the EEO officers and are assured that all discussions will be held in confidence. The EEO officers meet several times a year and work to promote good workplace relations, to provide information and advice to staff and management on EEO policies, and to support staff involved in complaints procedures. To promote EEO within the ATNF, staff talks are given at each of the ATNF sites. EEO talks are also given to summer vacation students and to new staff. The group has an EEO resource library and maintains extensive Web pages at

<http://www.atnf.csiro.au/management/hr/eoo>.

Occupational health and safety

Each ATNF site has its own occupational health and safety committee, which meets at least four times a year to review issues and identify any new hazards. Each workplace is assessed annually by a member of the local committee, and a formal report made. Training programs in a number of areas (e.g. training for supervisors, ergonomics, correct lifting techniques, electrical safety and defensive driving) are offered throughout the year.

Over a number of years the ATNF's rate of occupational health and safety incidents has been in line with that of similar institutions, such as the Anglo-Australian Observatory and the Very Large Array. In 2001 the ATNF recorded a total of 16 incidents with a total time lost of 26.2 weeks. The standardized incidence rate of 13 incidents per 100 full-time equivalent employees was slightly below the rate for all of CSIRO.



The Parkes Radio Telescope

OBSERVATORY REPORTS

Australia Telescope Compact Array

Technical developments and the MNRF upgrade

The ATNF, together with the University of Tasmania, is approaching completion on a set of substantial projects under the Commonwealth Government's Major National Research Facilities (MNRF) program, governed by a contract signed with the Government in February 1997. The contract provides \$11M to:

- ◆ **upgrade the Australia Telescope Compact Array** to work at high (millimetre-wave) frequencies;
- ◆ **extend the VLBI capabilities** of both the ATNF and the University of Tasmania, and operate the University's Hobart and Ceduna Observatories as National Facilities;
- ◆ **extend international collaboration in astronomy** with funds administered by the ATNF, acting on advice from the Australian Academy of Science's National Committee for Astronomy; and
- ◆ **perform strategic research** on mitigating radio-frequency interference and on array technology for the next generation of radio telescopes.

Details of the MNRF program can be found at www.atnf.csiro.au/projects/mnrf/.

The upgraded telescopes of the ATNF and University of Tasmania will give Australian astronomers important new observational tools. In particular, the millimetre-wave upgrade of the Compact Array allows astronomers to image the signature emission from many cosmically important molecules active in southern hemisphere regions. The upgraded array will be able to work in a "tied-array" mode, which will give it a collecting area equivalent to a 50-m diameter millimetre-wave dish—an unusually powerful instrument.

During 2001, with various components of the MNRF upgrade being delivered, the Compact Array became a useful instrument at 12- and 3-mm wavelengths. The interim system was open to proposals during the May and September terms. The system, however, was an interim one, and proposals were on a shared risk basis and required an ATNF staff collaborator.

New configurations

Part of the current Compact Array upgrade provides new antenna stations to support improved compact array configurations, ultimately using the new north spur to provide north – south baselines. The first new configuration to become available, the EW352 array, was scheduled during 3 – 24 October. This configuration, with its complementary partner EW367, replaces the 375-m array that was used for the last time on 12 July 2001. Outfitting all the new stations is progressing well, with observations using the north spur planned for mid-2002.

New receivers

The 12- and 3-mm receivers are a key component of the high-frequency upgrade. An important feature of the high-frequency receivers is that they use MMIC (monolithic microwave integrated circuit) technology in the low-noise systems. In 1999 a decision was made to use indium phosphide (InP) MMICs for both the 12- and 3-mm receivers, rather than the gallium arsenide (GaAs) MMICs originally proposed for the 3-mm receiver. The InP MMICs will greatly increase the sensitivity of the array.

The high-frequency receivers are contained in a single multiband dewar, with the CSIRO-designed low-noise amplifiers operating at physical temperatures near 20 K. A substantial technology development program has resulted in the ATNF having the capacity to reliably bond wire connections to the tiny integrated-chips and to mount the devices in precision metal housings.

One of the highlights of the year was the installation of a new set of millimetre receivers. Three interim receiver packages, allowing observations at 3 and 12 mm, were installed on antennas 2, 3 and 4 of the Compact Array. As compared with the earlier prototype millimetre receivers, these are “broadband”, dual polarization systems, and have improved system temperatures. Although they are broadband systems, the interim down conversion system means that observations are possible only in two sub-bands at each band. Possible observing ranges at 3 mm are 84,906 – 87,306 MHz, and 88,506 – 91,305 MHz. The 12-mm system can observe in the sub-bands 16,089 – 18,888 MHz and 20,089 – 22,488 MHz. At 12 mm, system calibration is achieved with noise diodes (improved noise diode systems with comparatively flat response over the band have been installed this year). To allow system calibration at 3 mm, a room temperature paddle can be switched in front of the feed horn.

Local oscillator and signal distribution

The local oscillator (LO) in a synthesis telescope is the master reference signal to which all receivers are frequency-locked, and against which variations in signal phase (caused, for example, by structure in cosmic sources) are measured. The LO distribution must therefore be extremely stable. The new Compact Array LO distribution system is based on a “star” topology fibre optic network that uses an optical fibre connection from each of the antenna station posts to the Control Room.

In the final upgraded system the original “daisy-chain” LO distribution to antennas (based on coaxial cables) will be replaced by dedicated optical fibres from the control building to each antenna station. Also, the digitised astronomical signals will be transmitted from each antenna using single-mode rather than the original multi-mode fibres, while dedicated single-mode fibres will also provide time signal and ethernet services to each antenna station. Work has continued with the connecting (splicing) of these fibres at each end. The 160-MHz LO reference is distributed to

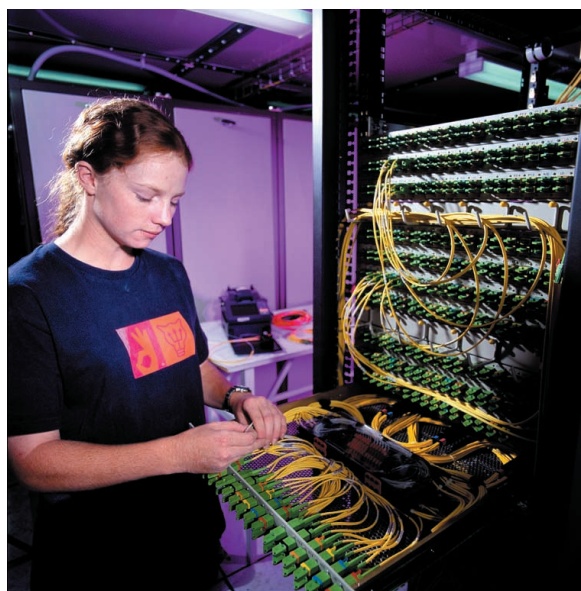


Photo: David Smyth

Alison Ryan working on optical fibre connections for the local oscillator distribution network at the Compact Array.

five of the six antennas on fibre, and a new high frequency reference (13 GHz) is distributed to the three antennas with new mm-wave receivers. Ethernet and time signals are now available on five antennas. Data transmission on single-mode fibres is possible on four of the six antennas.

An impetus for the new distribution system was the realization that phase noise injected into the system by the round-trip phase measurement system was causing significant (approximately 50%) decorrelation of the astronomical signal when observing at 3 mm. The new LO distribution system does not suffer from this flaw—amplitude decorrelation using this is measured at a few per cent, and may be a result of the atmosphere.

Extra stations and the north spur

Under the MNRF program, four new stations have been built on the east – west track of the Compact Array, to give better short-spacing coverage. Extra funding from the CSIRO Capital Investment program has enabled the construction of a further five stations on a north spur line, 214-m long. This spur will let the array better cover the u-v plane when observing with high antenna elevations; these minimize atmospheric distortion at millimetre wavelengths.

The civil engineering component of these projects was completed in 2000 and, while delays have been experienced at Narrabri in cabling all stations, the new facilities will be available concurrently with the completion of the LO distribution system.

Compact Array surface extensions

Five of the Compact Array antennas have been resurfaced with solid panels over their full 22-m diameter, doubling their sensitivity at 100 GHz. The antenna panels were adjusted in 1999 and measured to have an averaged rms surface accuracy of 0.25 mm.

During the 3-mm interferometry in November 2000, typical antenna efficiencies were still rather

low and a pronounced coma lobe was evident in the beam patterns. However, subsequent adjustment of the antennas has led to improved efficiencies and clean beam patterns. At present, the overall antenna efficiencies are approaching 40% at 86 GHz, close to that expected with the originally specified surface accuracy of 0.15 mm.

Pointing, optical alignment and the main reflector

During the year, a concerted effort was made to align the optics of the new millimetre systems so that, to first order, the pointing model and focus setting of the millimetre systems are the same as at centimetre wavelengths. With this now complete, second order effects related to the distortion/movement of the dish surface and subreflector position with elevation are being evaluated. These have an appreciable effect on the gain and efficiency of the dish. These issues are being investigated using a combination of modelling (ray tracing) and astronomical and mechanical measurements of the dishes.

In addition to “mechanical” aspects of the pointing model, an imbalance in the encoder electronics has been identified as the source of a periodic pointing error with amplitude of about five arcseconds. The offending circuitry in the millimetre antennas has been adjusted and the pointing error has improved markedly. Another contributor to pointing errors is related to the servo loop in the antenna control computer. Addressing this problem awaits the completion of the new antenna control computers.

Regardless of the accuracy of the pointing model and pointing hardware, at some level it is envisaged that to achieve the pointing specifications needed for mosaicing at 3-mm wavelengths, reference pointing will be needed. During the year, the reference pointing software has undergone significant development, to make it more robust, flexible and user friendly.

Antenna control computers

The stringent demands of high-frequency observing, the expansion of Compact Array control and monitoring requirements, and concerns about the reliability of the present antenna control computers (ACCs) have combined to make delivery of new-generation ACCs a priority.

Work has continued for some time to develop object-oriented software to run in the new computers. Development work has also begun on the hardware interfaces between antenna systems and input/output devices in the new computers. In 2001, three prototype ACCs were installed in antennas 2, 3 and 4 in parallel with the original PDP11/73 machines. The new units are connected via the new fibre-based ethernet to the control computer network and are providing monitoring services for the new millimetre receiver packages. The ACCs are capable of driving an antenna and controlling the receivers and down conversion system to the point where autocorrelation spectra can be measured. It is envisaged that the old ACCs will be replaced in mid-2002.

Millimetre weather

At 3-mm wavelength, the atmosphere will be a significant consideration in observing at the

Compact Array. The first winter of using the millimetre system tended to confirm the old adage that it is not possible to judge observing conditions simply by looking out the window. During the September term, 15% of scheduled millimetre observing time was replaced with centimetre projects because of unsuitable weather.

In addition to phase errors, opacity and wind-related pointing errors, large fluctuations in both single-dish power and in interferometer amplitude have been identified with “anomalous refraction”, the effective wandering of the antenna primary beam caused by phase gradients across the 22-m aperture. The characteristics of this effect are being investigated.

A form of flexible scheduling, whereby millimetre and centimetre observing proposals can be interchanged depending on the weather, will be trialed in 2002.

Atmospheric phase correction

At millimetre wavelengths, water vapour present in the atmosphere can cause significant distortion to the radio wavefront. A phase correction system is being developed to sense and correct the distortion. The phase correction system will use a room-temperature four-channel radiometer on each antenna, designed to detect water vapour emission while rejecting spurious emission from clouds or other sources. Each radiometer uses a separate horn which is mounted close to the astronomy horn; the offset between radiometer and astronomy horns is approximately five arcminutes.

In 2001, testing of two prototypes, using simple calibration of the radiometer output, has enabled the atmospheric phase to be reduced to the equivalent of 350 microns of path length. The aim had been to correct to about 100 microns. The dominant residual error is from $1/f$ noise originating in the radio frequency amplifiers of the radiometer. Errors with time scales greater than about three to five minutes dominate the error power. Work is progressing on switching schemes to reduce the $1/f$ noise of the system.

Photo: David Smyth



One of the new prototype receivers, in the upper vertex room of antenna 2, installed next to a large white 20-cm feed horn. The feed horn for the 12-mm waveband is in front of the 3-mm waveband (installed inside a vacuum dewar). A radio frequency absorber paddle can be seen above the two horns.

Interference

Radio frequency interference (RFI) remains a challenge for the Observatory. Interference from the Globalstar satellite phone constellation is becoming more problematic at the 13-cm band. This interference is caused by sidelobes of satellite-to-handset transmission. A predictor of the expected interference generated by the constellation (based on known satellite trajectories, antenna pointing centre and decorrelation effects) has been developed and made available as a Web-based tool. This allows astronomers to avoid unfavourable times for critical parts of an observation (e.g. delay setting or primary calibration).

A new RFI survey of the centimetre bands has been carried out. Additionally a survey of the 12-mm band found no RFI.

Work is progressing on post-correlation techniques, using a reference antenna, to remove interference from observations. This is still at an early, research, stage.

Staff

Ben Reddall took a one-year leave-of-absence to take a position at the South Pole providing engineering support for the Degree Angular Scale Interferometer (DASI). Martin Oestreich moved from Sydney to Narrabri to take on the role of Electronics Group Leader. For the last two months of the year, Allan Day, who plays an important part in the Observatory cryogenic systems, also took leave-of-absence to work with the DASI group at the South Pole. During Allan Day's absence, Jock McFee assumed responsibility for the cryogenic systems.

Leigh Panton left the ATNF in early February for a new job on the Gold Coast utilising skills in fibre optics work gained during many months of working on the Compact Array in the "splicing caravan".

From February until the end of the year, the Officer-in-Charge (OIC), Dave McConnell, shared

his time between being based at the ATNF headquarters in Marsfield, and at Narrabri. He spent roughly one week per month in Narrabri. The newly appointed Deputy OIC, Ron Beresford, acted for him in the day-to-day management of the Observatory during his absence. The OIC and Deputy were usually in daily contact, with each taking responsibility for different areas in running the Observatory. Dave McConnell stood down as OIC at the end of December and Bob Sault has been appointed as the Narrabri OIC from 1 January 2002.

After one year at the Observatory, Cliff Harvey resigned in September. Derek Aboltins joined the ATNF in December to take over Cliff's position in the Electronics Group.

After many years providing sterling service at the lodge to both visitors and staff, Chris Forbes resigned shortly before Christmas. Shaun James from the Electronics Group, also resigned shortly before Christmas, to take up a position with the Anglo-Australian Telescope at Siding Spring.

Visits by the new CEO and by Australia's Chief Scientist

On 11 April 2001, the new Chief Executive Officer of CSIRO, Dr Geoff Garrett, made a brief visit to the Observatory. In a day which started with a visit to CSIRO's cotton research station at Myall Vale (Division of Plant Industry), Dr Garrett spent several hours inspecting the Compact Array and addressing staff.

On 5 November 2001, the Compact Array was visited by Robin Batterham (Australia's Chief Scientist), Martin Cole (President, Institute of Engineers) and Peter Jonson (Chairman, Melbourne Institute). After morning tea at the alidade level of an antenna, they had a site tour followed by lunch with the staff, before leaving for Siding Spring.

Student visitors

As part of the collaboration between the ATNF and the Academia Sinica Institute of Astronomy and Astrophysics, Taiwanese student Cheng-Jiun Ma visited the Observatory for three months



Photo: David Smyth

Sunset at the Compact Array

starting in March to gain experience in practical radio astronomy. Working with Ravi Subrahmanyan and Bob Sault, Cheng-Jiun investigated anomalous refraction effects at 3 mm, evaluated the antenna tracking stability using an optical telescope mounted on a Compact Array antenna, and worked on data acquired from a short baseline interferometer with the aim of evaluating methods for rejecting cross-talk.

During the summer months, the Observatory hosted two pairs of vacation scholars. During the summer of 2000 – 2001, Elizabeth Claridge (University of Tasmania) worked with Steven Tingay on bent jets in extragalactic radio sources, and Tim Connors (University of Sydney) worked with Dave McConnell on radio emission from the globular cluster 47 Tucanae. During the summer of 2001 – 2002, vacation scholars Nicolai Grosse (Australian National University) worked with Steven Tingay on gamma-ray loud AGN, and Vicky Safouris (University of Sydney) studied the interstellar medium with Ravi Subrahmanyan.

Narrabri Synthesis Imaging Workshop

The fifth ATNF Synthesis Imaging Workshop was very successfully held at the Observatory during the week of 24 – 28 September. This was the first one held since the flood-affected workshop in September 1988. There was an encouraging increase in attendance, with 35 post-graduates, 10 postdoctoral fellows and a few undergraduates. In addition about 30 speakers and other helpers attended the workshop. In comparison to previous workshops, the students included a larger fraction of those who were predominantly interested in wavelengths other than radio.

This workshop included two two-hour “practical sessions” and a site tour to complement the formal lectures and tutorials. During the practical sessions, the students were able to take part in activities such as observing, data analysis, working with a basic interferometer operating at 22 MHz, and using the antennas as single dishes at both millimetre and centimetre wavelengths. All the formal parts of the workshop were well rated by

the students, with the practical sessions, in particular, being highly successful. The presentations made at the workshop have been placed on the Web at

<http://www.atnf.csiro.au/synthesis/talks.html>

Observatory improvements

A network connection has been installed to the Lodge. This will provide more facilities for monitoring the telescope operation while relaxing over a meal. The main staircase in the control building has been renovated to give a gentler angle. The former staircase was steep and failed to meet building regulations. A number of improvements were made to the grounds, including a new fence around the new car park at the Visitors Centre and the planting of an avenue of native shrubs along the path to the Lodge.

Mopra

Operations

During 2001 the use of Mopra continued to be restricted to VLBI and millimetre observations only. VLBI observations were taken as part of the Long Baseline Array (LBA) and in conjunction with the VLBI Space Observatory Program (VSOP) project. Although there were a small number of projects involving the 12-mm receiver, the bulk of the millimetre proposals used the 3-mm system. The millimetre observing was split between National Facility time and time given to the University of New South Wales (UNSW). This year was the final year of a three-year agreement with the UNSW, whereby the university was given access to the telescope during the winter months.



A Compact Array antenna

Photo: David Smyth

This was in exchange for financial support to re-surface the antenna in 1999 and for observing support for time allocated by the ATNF for National Facility use. This year 70 days were given to the UNSW for their use, and an additional 38 days were scheduled to outside observers as National Facility time. In total, 38% of the year was scheduled observing time or time allocated to the UNSW.

Staff

In 2001 there were no permanent staff at Mopra. Engineering support was provided from Narrabri and Sydney. Observing support was provided either through the UNSW agreement, or by the ATNF VLBI group. Robina Otrupcek was employed on a casual basis to support space VLBI observations.

Table 3 *Mopra time use, 2001*

Observing mode	days
National Facility time	38.1
UNSW time	69.7
VSOP	10.0
VLBI	21.7
Total	139.5

Mopra open day

As part of the annual Connabarabran “Festival of the Stars” weekend (which centres on Open Day at Siding Spring Mountain), Mopra was open to the public on 21 October. Ron Beresford gave approximately 100 visitors a brief tour of the telescope.



Photo: John Masterson

The Mopra radio telescope, Coonabarabran

Parkes

Performance and time use

The fraction of time scheduled for all observations in 2001 was 82%, unchanged from the previous year. It is expected that major maintenance works on the telescope will reduce this figure to closer to 70% in 2002.

The fraction of time lost to equipment faults in 2001 was 1.3%, a slight increase on the record low figure of 1.0% for 2000. The time lost due to bad weather (high winds) however was 2.8%, a doubling of the figure for the previous year. This increase reflected an abnormally windy year, particularly around the equinoxes, however improved monitoring of the wind speed and revised safe working practices also contributed.

All major telescope systems performed well throughout the year, with the exception of the 3-cm (X-band) receiver, which failed during a VLBI run in November. Refurbishment of this receiver and the 1.3-cm (K-band) receiver will be a priority in 2002.

A subtle, nagging problem in the telescope's drive system causing it to occasionally stop driving was finally tracked down mid-year and fixed (with components costing less than a dollar). The drive system has since performed extremely reliably.

User feedback

The Web-based user feedback system remains one of the Observatory's most important tools in maintaining successful Observatory operations and services. There were 34 responses from observers in 2001, close to the target figure of one report per observing team per session. Figure 10 (page 18) shows the user ratings on a scale of 1 – 10 in each of the categories included in the questionnaire.

Once again RFI emerges as the most salient single issue with many observers, and the Observatory is committed to maintaining mitigation of RFI as a

high priority. The commissioning of the interference monitoring system (IMS), a sophisticated new system to monitor and identify interfering signals, and the construction of an anechoic room for characterizing new computers and other equipment, were both significant developments on this front in 2001.

Major activities

The northern extensions to both the HI Parkes All-Sky Survey (HIPASS) and the Zone of Avoidance (ZOA) HI survey were completed towards the end of the year. A further extension of the ZOA survey to include the Galactic bulge will continue throughout 2002. Calibrated spectra for HIPASS have been released to the public domain, with the ZOA and northern extensions to follow in 2002. Observing programs with the narrowband multibeam system to confirm the statistical completeness of the main surveys are well progressed, with the large galaxy catalogues expected to be published also in 2002.

The Jodrell Bank-ATNF-Bologna Galactic pulsar survey is nearly complete. Follow-up timing observations will continue into 2002. The delay in completing the survey has been due entirely to its great success in finding many more pulsars than anticipated. More than half of all known pulsars have now been found at Parkes, with the number still growing.

Some smaller surveys have also achieved notable success in finding millisecond recycled pulsars away from the Galactic plane. The stability of these millisecond pulsars, matched by the Observatory's state-of-the-art timing system, is opening windows onto a number of hitherto inaccessible physical effects, and is maintaining the Observatory's position at the forefront of this research.

A new "common-view" GPS timing system has been commissioned at the Observatory, providing a second long-term stable comparison clock, independent of the conventional GPS receiver systems.

Zenith drive repairs

Preparations are underway to replace both zenith drive gearboxes and pinions, and to refurbish the rack gears in 2002. The drive systems have performed extremely well with minimal maintenance for the last 40 years, but are now nearing the end of their useful lives.

New developments

The commissioning of a new GHz-bandwidth correlator in 2002 will significantly enhance both pulsar and spectral line observing capabilities. The new correlator is particularly well-matched to a new dual-frequency receiver tailored for pulsar timing, which will also be commissioned in 2002.

The Caltech-Parkes-Swinburne baseband data recorder (CPSR), will be upgraded with a several-fold increase in recording bandwidth, allowing precise timing observations to be extended to many more millisecond pulsar systems than is currently possible. Measurements made with the existing recorder have already set a new standard in pulsar timing accuracy.

Looking further ahead, a collaboration with Jodrell Bank to design a new multibeam receiver for Parkes has commenced. The new receiver will operate at 6.7 GHz to make a comprehensive survey of methanol molecular maser emission in the Milky Way and Magellanic Clouds.

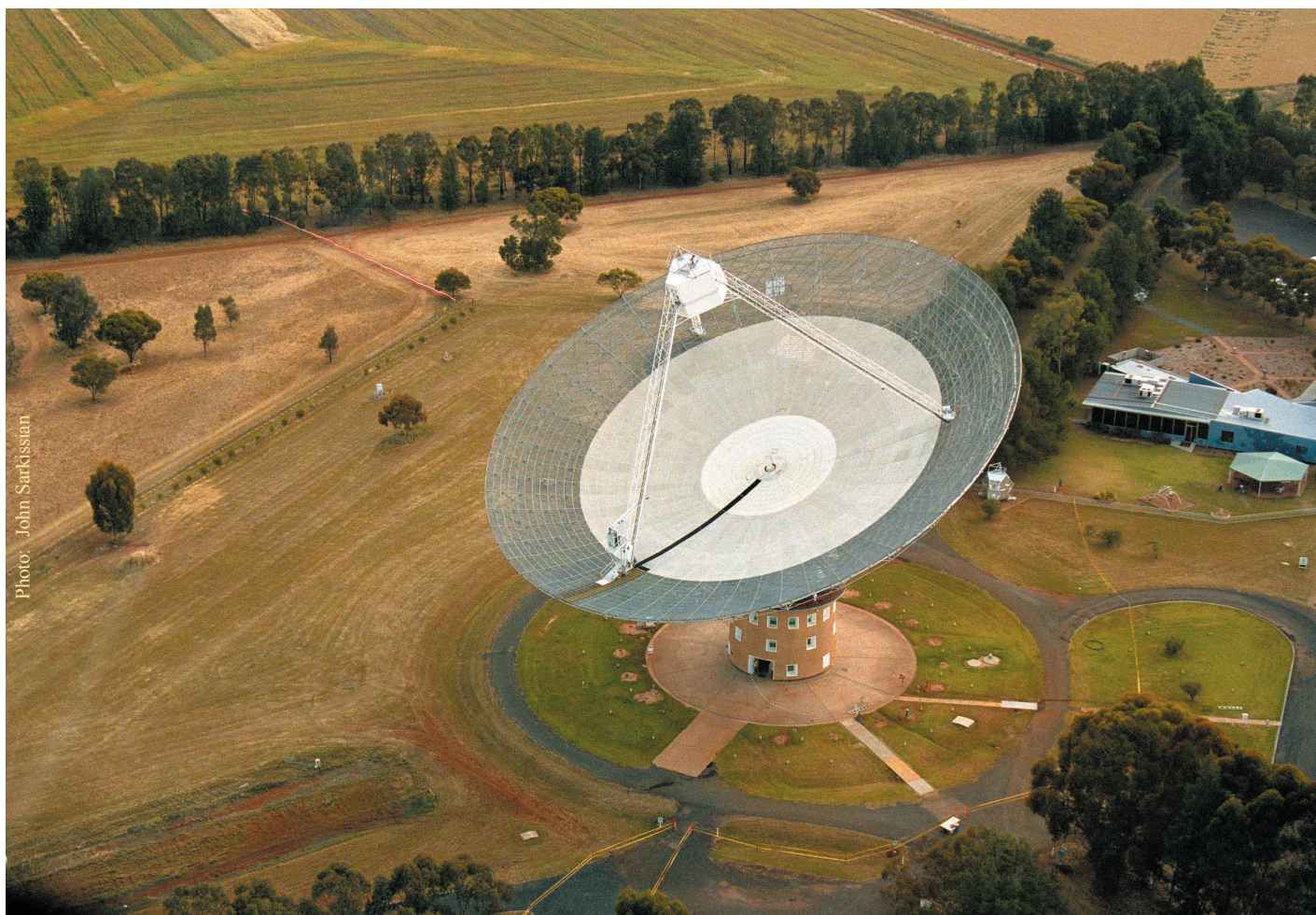


Photo: John Sarkissian

An aerial view of the Parkes radio telescope and surrounding land. The Parkes Visitors Centre is on the right-hand side of the image.

The Australian Long Baseline Array

LBA astrometry project

A new postdoctoral position, funded by the United States Naval Observatory (USNO), started in late 2000 with the appointment of Dr Roopesh Ojha and allowed the commencement in 2001 of the joint ATNF-USNO collaborative astrometry program. This is a major and ambitious program over five years aiming to improve significantly the fundamental reference frame in the southern hemisphere. It consists of two distinct but complementary observational phases:

- ◆ VLBI imaging at 8.4 GHz using the LBA in its standard S2-recorder observing mode, to determine the structure of all radio sources observed in the VLBI astrometry program. Source structure is often the limiting factor in astrometric accuracy and the imaging will help achieve much more accurate astrometric positions by removing any residual structure effects. During 2001 four VLBI imaging sessions were scheduled under this program.
- ◆ VLBI astrometry with standard MkIIIA/MKIV observations at S/X-bands to increase the number of astrometric sources in the south. Parkes and Hobart participate in these observations with other telescopes in the Asia Pacific region. During 2001 two sessions of such observations were performed.

The ATNF-USNO collaboration has also enabled the addition of the NASA Kokee Park antenna (Hawaii) as part of the LBA. An Australian S2 system was installed at Kokee in 2000 and the system has been successfully used during all observing sessions in 2001.

VLBI polarization

Work also commenced in 2001 towards establishing full polarimetric VLBI observations with the LBA, primarily through the efforts of Dr Roopesh Ojha who has continued to work on the calibration of LBA polarimetric observations. A very successful one-day workshop on VLBI polarization was held in early 2001. All VLBI imaging observations in the astrometry program are now performed with full polarization measurements.

Upgrades

The upgrades to the Hobart and Ceduna telescopes under the MNRF program were essentially completed during 2001.

New cooled receivers have been built and installed in the Hobart antenna. The new 21-cm receiver was used routinely for LBA observations and has provided much improved sensitivity. An innovative cooled receiver using a single dewar to house five bands at frequencies between 5 and 22 GHz has been built and tested. It will be commissioned on the telescope in 2002.

At Ceduna, the new 22-GHz receiver has been used in LBA observations, the pointing has been significantly improved, and the observing system has been streamlined for simpler and easier operations.

VSOP

The radio astronomy satellite HALCA (Highly Advanced Laboratory for Communications and Astrophysics) was launched in February 1997. This satellite is used together with a global network of ground-based radio telescopes, for the VLBI Space Observatory Program.

Full VSOP observations continued throughout 2001 and involved the Compact Array, Mopra, Hobart and Ceduna antennas. Mopra was the most heavily used antenna with extensive support for general observing time VSOP observations as well as the mission-led VSOP survey program. NASA

support for VSOP will cease in February 2002 and thus 2001 was the last year of full-scale VSOP operations. The VSOP survey program will continue in 2002 primarily using the Canadian S2 correlator and will include several southern hemisphere telescopes.

Proposals and scheduling

There was strong proposal demand for the LBA in 2001, with an oversubscription rate of 2.0, slightly higher than the rate of 1.7 for the previous year. Proposals covered a wide range of areas, including polarimetry and high-resolution spectroscopy. A significant amount of time was scheduled for the new astrometric program. Access to the NASA Deep Space Network (DSN) Tidbinbilla telescopes continued to present problems with the effective scheduling of the LBA array, particularly for sensitive observations requiring the large 70-m antenna.

Operations

There were four LBA observing sessions in 2001. Overall the LBA performed well and a summary is shown in Table 4 below. The overall success rate for the LBA in 2001 was 84%, the same rate as for 2000 but with a 45% increase in observing time. Many of the telescopes continued with success rates over 95%. However, single system failures at Parkes (receiver), Hobart (cryogenics) and Ceduna (hydrogen maser) led to significant time losses on these antennas with a corresponding loss in the overall array performance.

Table 4 Long Baseline Array observations, 2001

Telescope	Parkes	Compact Array	Mopra	Hobart	Ceduna	Tidbinbilla	Hartebeesthoek	Kokee	LBA
hours observed	525	529	524	400	359	32	122	70	574
success rate %	86	99	97	77	86	77	99	98	84

TECHNOLOGY DEVELOPMENTS

MNRF-2001 proposal

In early 2001 the Government announced, as part of a new innovation statement, a new Major National Research Facilities program. Following a great deal of discussion at the ATNF and other astronomical institutions, the decision was made to combine the two highest priorities of the Australian astronomical community into one proposal for MNRF funding. These priorities, as identified by the Australian astronomical community in the report *Beyond 2000: The Way Ahead*, are additional access to the optical/infrared telescopes of the Gemini project and development of the SKA—the next generation radio telescope. This MNRF proposal was submitted to AusIndustry on 11 May 2001.

The specific aims of the program are to:

- ◆ **Increase Australia's share** in the International Gemini Telescopes (currently 5%). The MNRF funds will be used initially to purchase an additional share of Gemini. In addition it is hoped that future instrument construction contracts will enable further engagement in the Gemini program. This program will not only provide Australian astronomers with a bigger share of Gemini observing time, but will also improve the capabilities of the Gemini telescopes, and advertise Australia's expertise in instrument building, hopefully leading to more contracts to build instruments for other international telescopes.

- ◆ **Develop enabling technologies** for the SKA. The way in which we plan to do this not only develops the technologies which will be necessary for the construction of the SKA, but will also enhance our existing radio telescopes such as the Australia Telescope Compact Array, and reinforce Australia's bid as the prime location to host the SKA.

On 21 August 2001, Senator Nick Minchin, Minister for Industry, Science and Resources, announced the allocation of \$155M under the MNRF-2001 program to fifteen successful proposals. Of these the ATNF-led proposal was granted the largest single allocation of \$23.5M.

The combination of optical and radio astronomy priorities in the program mean that the activities of the Australian astronomical community as a whole are now closely aligned. The proposal also builds upon the strength and experience of the original MNRF-funded upgrade of the ATNF and University of Tasmania radio astronomy facilities, the high frequency upgrade of the Compact Array and the upgrade of Australian VLBI facilities.

The institutions that contributed to the successful proposal were CSIRO ATNF, the Anglo-Australian Observatory, the Australian National University Research School of Astronomy and Astrophysics, Swinburne University of Technology, the University of Sydney, the University of Melbourne, the University of New South Wales, the Government of Western Australia, CTIP, University of Melbourne, Advanced Powder Technologies Pty Ltd, CEA Technologies Pty Ltd and Dell Computer Pty Ltd.

Executive Special Project

In December 1997 CSIRO's Chief Executive Officer, Dr Malcolm McIntosh, announced a number of projects to be undertaken by large research teams within CSIRO in the 1997 – 2000 triennium. One of these projects was a joint proposal of the ATNF and CTIP to develop high frequency integrated circuits for radio astronomy and telecommunications. The circuit designs are developed within ATNF and CTIP and are fabricated in the USA by the US foundry TRW using their leading-edge indium phosphide foundry process. Devices produced under the program include monolithic microwave integrated circuits (MMICS) and high speed digitiser circuits.

Monolithic microwave integrated circuits

Wafers from the final foundry run of InP high electron mobility transistor (HEMT) devices were delivered in November 2001. These wafers contained production quantities of successful

designs from the initial foundry run as well as several new circuits. On-wafer testing showed that the performance of existing designs was maintained over the two fabrication runs. A number of new designs were also shown to have excellent performance. In particular, two new low-noise wideband 3-mm amplifiers offer the prospect of extending the frequency coverage of ATNF receivers in the band to 115 GHz. Packaged circuits from this final run should be available in mid-2002.

High-speed digitiser circuits

Tests on the packaged InP heterojunction bipolar transistor (HBT) digitiser circuits were completed in March 2001. These confirmed the excellent results obtained in the on-wafer tests. Successful operation of the digitiser/demultiplexer circuit was demonstrated at 4 Giga-samples per second in conjunction with a 2-GHz bandwidth correlator. These circuits will be used in the new 2-GHz bandwidth correlator which will be installed at Parkes in March 2002.



Photo: Department of Industry, Science and Resources

Senator The Hon Nick Minchin, Minister for Industry, Science and Resources, announcing the successful MNRF-2001 proposals.

The Square Kilometre Array

The ATNF is one of a consortium of major radio astronomy institutions in 11 countries now planning the world's next-generation large radio telescope, the Square Kilometre Array (SKA). This instrument's one million square metres of collecting area will make it 100 times more sensitive than the best present-day instruments. This area will be distributed across many hundreds, perhaps thousands, of kilometres in a location yet to be decided. Using a combination of technologies, the SKA will cover frequency ranges from 150 MHz to above 10 GHz.

A main scientific driver for this enormous array is to study the early Universe at centimetre wavelengths and to complement next generation telescopes operating at other wavelengths. The ATNF is a very active player in the SKA consortium and, with input from universities and other Divisions across CSIRO, is making major contributions to the design of the array in several key areas including the antenna elements, the receivers, signal processing, the correlator, site investigations, array configurations and interference mitigation. Construction of the SKA is expected to start by 2012.

SKA meetings

An important milestone in Australian SKA work was reached in late 2000 with the formation of the Australian SKA Consortium, a 14-member steering committee constituted from CSIRO, other research organizations, industry, science policy bodies and professional organizations. The first meeting of the Consortium was held in February 2001 together with a one-day open symposium on SKA-related astronomy and engineering issues.

An international SKA meeting was held at Berkeley (USA) on 9 – 12 July 2001. Australia was well represented at this meeting with a strong contingent from both the ATNF and CTIP. Between the two Divisions five oral papers and

11 poster papers were presented. The topics covered included antenna issues, interference mitigation, correlator development, demonstrator requirements, radio-quiet reserves and site considerations. Ron Ekers, Peter Hall and Bruce Thomas were also active in strategic roles following election to senior positions within the SKA international project structure.

Antennas for the SKA

Antennas are the highest profile components in the various SKA concept designs. The SKA goal is to have many simultaneous, widely-separated beams.

Constructing antennas which are capable of efficient operation over a wide frequency range, and which yield many beams “placeable” over the whole sky, is a formidable challenge to designers. To build the SKA at an affordable price within the next 10 – 15 years, heavy reliance is being placed on new materials and manufacturing techniques, and on economies of scale.

The successful outcome of the MNRF-2001 proposal has given considerable impetus to SKA antenna prototype design. Three types of antenna are under active consideration in Australia. The first is the Luneburg lens—a spherical lens characterized by an inhomogeneous but spherically-symmetric refractive index profile. This antenna combines the advantages of optical beam forming with inherently wide bandwidth capability. Its main attraction for the SKA is the ease with which multibeaming and source tracking can be achieved.

While the Luneburg lens was first proposed in 1944, its use to date has been somewhat limited. Cost and loss issues make the lens viable only if new ways of producing artificial dielectrics can be found. In 2001 a joint project between four CSIRO Divisions* was instigated to investigate and develop suitable artificial dielectric materials. For these investigations low-density, low-loss foam is being doped with small ceramic inclusions to produce artificial dielectrics. As part of the MNRF-2001 proposal, a prototype lens will be constructed out of this material.

* CTIP (CSIRO Telecommunications and Industrial Physics), ATNF, CMS (CSIRO Molecular Science) and CMST (CSIRO Manufacturing Science and Technology).

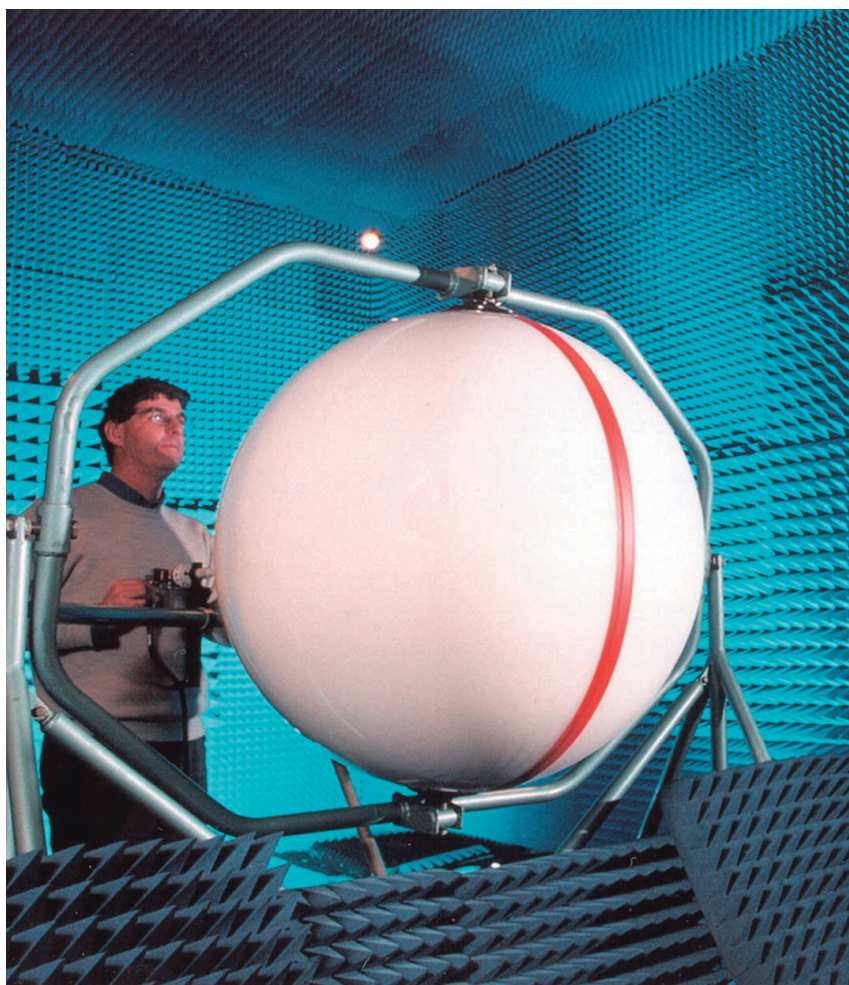


Photo: David Smyth

Dr Peter Hall testing a Luneburg lens in the CSIRO near-field test chamber at Marsfield, Sydney.

In collaboration with the Pushchino Radio Astronomy Observatory in Russia, the ATNF has acquired a commercial 0.9-m diameter Luneburg lens from the Russian company KONKUR. This lens has been used in tests of the near-field and far-field antenna performance. The results indicate good beam-forming properties and the knowledge gained from the tests will be used in upgrading antenna metrology techniques for future CSIRO-produced lenses.

The second proposal for an SKA antenna element is based around a cylindrical reflector. The advantage of the cylindrical reflector is simplicity, since the reflector has only one direction of curvature.

This provides for an economical structure, where a rotation of the reflector provides azimuthal coverage while a line feed provides the elevation coverage of the sky. In principle, a phased array line feed can provide multiple beams within an elevation fan beam. The main challenge for this proposal is in the design of the broadband, dual polarization line feed; this aspect is included in the MNRF-2001 proposal where, in conjunction with Sydney University, part of the Molonglo Observatory Synthesis Telescope is being used to examine the feasibility of cylindrical reflectors as antenna elements for the SKA.

Finally, ATNF and CTIP are expanding their SKA activities in the area of phased array antennas,

either in aperture or focal surface roles. It is now clear that phased arrays will be central to many SKA design concepts. A milestone in 2001 was the establishment of collaboration with ASTRON, emphasizing wide bandwidth performance and low-cost integration of electronics. Part of this work is being undertaken within the FARADAY project, a consortium of European Union radio astronomy groups working on focal plane arrays. By the end of 2003 the ATNF will have decided, on the basis of first-round prototyping, which antennas, or combination of antennas, offer the most promising direction for Australian SKA demonstrators.

Interference mitigation

In addition to antenna design, engineers are all too aware of the importance of other systems, such as signal transmission and interference mitigation. To meet its scientific objectives, the SKA will need to observe outside the narrow bands reserved for radio astronomy. As part of the SKA research program, the ATNF is actively involved in the development of both pre-correlation (coherent) and post-correlation (incoherent) interference mitigation techniques.

The ATNF has made extensive use of its “software radio telescope” concept to develop and test interference mitigation algorithms on real data.

Using the S2 VLBI system, signals (astronomical and interference) have been recorded coherently from the Parkes radio telescope and individual elements of the Compact Array. These recordings have been distributed internationally to several groups interested in new signal processing techniques and, using workstation and super-computer facilities in Australia, it has been possible to experiment with, and evaluate, a number of different approaches. In common with most other groups, initial ATNF work involved coherent adaptive processing. However, new techniques have been developed which invoke post-correlation analogues of the adaptive process, vastly reducing the computational load and making interference mitigation testable on real telescopes.

In 2001 research into radio frequency interference mitigation techniques has continued at ATNF and the University of Sydney, and algorithms have been tested in software on baseband data from the ATCA, Parkes radio telescope and the Rapid Prototyping Array at the University of California, Berkeley.



© 2002 Swinburne Centre for Astrophysics and Super Computing, ATNF
Image: Dr Chris Fluke

An artist's impression showing one station of the Square Kilometer Array, composed of a number of Luneberg Lens antennas.



The Mileura station in Western Australia is one of several sites being tested as a possible location for the SKA. In 2001, radio data were taken to survey the area and determine whether it is a radio-quiet site.



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SKA site investigations

Four states (Western Australia, South Australia, New South Wales and Queensland) are carrying out studies to determine candidate locations (of about 50-kilometre diameter) for the central section of the SKA. In addition, Western Australia is being considered as one of three possible sites for locating the Low Frequency Array (LOFAR), the low-frequency counterpart of SKA. A decision relating to a site for LOFAR is expected in early 2003, with preliminary proposals for an SKA site due in October 2004.

One of the major steps in the SKA and LOFAR site evaluation process is the completion of high-sensitivity radio-quietness tests. A preliminary testing program was carried out on Mileura Station in the Murchison region of Western Australia in March – April 2001. This was supported by industry in Western Australia following awards of field-testing contracts by the Western Australian Government. The ATNF also participated, and was responsible for the data processing. Initial results indicate that the radio spectrum at this representative site is indeed extremely “quiet” over a broad frequency range.

Integrated RF systems

This year a working group on integrated radio-frequency systems has been formed to develop highly-integrated receiver solutions for the SKA and its demonstrator antennas. The ATNF will complete an uncooled GaAs MMIC low-noise amplifier design in the first half of 2002 and, with international collaborators, will then examine silicon germanium (SiGe) MMIC options. These prototypes will be used to select the most appropriate semiconductor technology for Australian SKA demonstrators. Following the preliminary work, integrated receiver solutions for the SKA will be investigated; these may include the use of micro-electronic mechanical systems for switches and tunable inductors, and on-chip fibre optic interfaces.

APPENDICES

A: Financial information

Expenditure budget 2000-2001 \$1,000s

Operation of the Narrabri (Paul Wild) Observatory ¹	2,862
Operation of the Parkes Observatory ²	1,989
Research support Marsfield (ATNF contribution) ³	1,999
Engineering and development	2,484
Office of Director	575
Astrophysics program	1,421
Computing	799
National Facility support	1,026
Major repairs and maintenance	290
Executive Special Project	420
MNRF project	1,907
Square Kilometre Array	380
Corporate repairs and maintenance	160
TOTAL	16,312

Revenue budget 2000-2001

Direct appropriation	12,362
Research and services revenue	809
MNRF project	1,255
Other external revenue ⁴	300
Corporate repairs and maintenance	160
TOTAL⁴	14,886

Notes:

1. Includes the operation of the Observatory's Visitors Centre and the Mopra Observatory.
2. Includes the operation of the Observatory's Visitors Centre.
3. The ATNF shares its Sydney headquarters with CSIRO Telecommunications and Industrial Physics.
4. The revenue shortfall was funded from ATNF reserves.

B: Staff list, 1 July 2001

ATNF staff

Sydney

J E Archer (Administration)
 J M H Barends (Astrophysics/Computing PA)
 R J Bolton (Receivers)
 M A Bowen (Receivers)
 M L Bromley (National Facility Support)
 J W Brooks (Assistant Director,
 & Engineering Manager)
 W N Brouw (Astrophysics/Computing)
 M R Calabretta (Computing)
 G J Carrad (Receivers)
 J L Caswell (Astrophysics)
 J M Chapman (Head, National Facility Support)
 R R Chekkala (Electronics)
 A P Chipendale (SKA)
 E R Davis (Electronics)
 E de Blok (Bolton Fellow, Astrophysics)
 V Drazenovic (National Facility Support)
 A R Dunning (Receivers)
 R D Ekers (ATNF Director)
 R H Ferris (Electronics)
 G J Gay (Receivers)
 T J Getts (LBA)
 R G Gough (Receivers)
 D S Gunawan (ATNF/CSIRO Postdoctoral
 Fellow)
 G R Graves (Receivers)
 E Hakvoort (Receivers)
 P J Hall (Head, SKA Program)
 P J Howson (Divisional Secretary)
 S A Jackson (Receivers)
 E P Kachwalla (National Facility Support)
 H P Kanoniuk (Receivers)
 L Kedziora-Chudczer (AAO/ATNF
 Postdoctoral Fellow, Astrophysics)
 M J Kesteven (Astrophysics/Engineering Research)
 N E B Killeen (Head, Computing)
 B S Koribalski (Astrophysics)
 M R Leach (Electronics)
 J M J Lie (Receivers)
 P A Lilie (Receivers)
 S M Little (Administration)

M Macquarding (Computing)
 S Magri (Electronics)
 R N Manchester (Astrophysics)
 G A Manefield (Engineering PA)
 V J McIntyre (Computing)
 G G Moorey (overseas)
 R P Norris (Acting Director)
 E G Pacey (Director's PA)
 D P Rayner (Astrophysics)
 L J Reilly (Receivers)
 P P Roberts (Electronics)
 R J Sault (Computing/SKA)
 H L Sim (National Facility Support PR)
 M W Sinclair (Head, Receivers)
 L G Staveley-Smith (Head, Astrophysics)
 M Storey (SKA site Studies/PASA)
 P B Sykes (Receivers)
 B M Thomas (Engineering Research)
 A K Tzioumis (Astrophysics/LBA)
 M Walker (ATNF/USyd Research Fellow,
 Astrophysics)
 G War (ATNF/USyd Postdoctoral Fellow)
 B Wilson (Administration)
 W E Wilson (Head, Electronics)
 T H Wong (Bolton Fellow, Astrophysics)
 A M Wright (National Facility Support)

Staff shared with CSIRO Telecommunications and Industrial Physics

Administration

S F Clark
 O A D'Amico
 C Duffy
 C D Hodges
 K J Lambert
 S O'Toole
 C K Spence
 B Wróbk

Engineering services

M A Bourne

P Bonvino
G R Cook
P Cooper
B A Egan
W Finch
G Hughes
T M Huynh
O Iannello
M J McDonald
R A Moncay
B F Parsons (Assistant Engineering Manager)
P A Sharp
J R Uden
B Wilcockson (Assistant Engineering Manager)
M R Wright

Library

A Joos
C M van der Leeuw

Narrabri

R P Behrendt (Electronics)
R J Beresford (Electronics)
D P Brodrick (Computing)
D J C Brooke (Electronics)
D J Campbell (Antennas & Site Services)
S J Cunningham (Computing)
A F Day (Electronics)
O P Dowd (Antennas & Site Services)
C F Forbes (Lodge)
K Forbes (Administration)
J Giovannis (Computing)
T M Gordon (Antennas & Site Services)
M E Guest (Lodge)
C Harvey (Electronics)
S M James (Electronics)
J Houldsworth (PA)
B D Johnson (Antennas & Site Services)
T J Kennedy (Visitors Centre)
C W Leven (Antennas & Site Services)
J C McFee (Electronics)
M F McFee (Administration)
D McConnell (Officer-in-Charge)
B W Reddall (Electronics)
M H Rees (Lodge)
A G Ryan (Antennas & Site Services)
R Subrahmanyam (Electronics)
G J Sunderland (Antennas & Site Services)

S Tingay (Bolton Fellow)
R M Wark (Operations)
J C Wieringa (Library)
M H Wieringa (Computing)
C A Wilson (Lodge)

Parkes

J K Cole (Lodge)
J M Crocker (Site Services)
G T Freeman (Administration)
J Hockings (Visitors Centre)
S Hoyle (Computing)
A J Hunt (Electronics/Servo)
S A Ingram (Lodge/Site Services)
R T Lees (Site Services)
S L Mader (Operations)
M P McColl (RF systems)
B A Preisig (Electronics/Servo)
K F Reeves (Site Services)
J E Reynolds (Officer-in-Charge)
J M Sarkissian (Operations)
M R Smith (RF systems)
G Spratt (Computing)
E R Troup (overseas)
B Turner (Site Services)
R R Twardy (Visitors Centre)

Canberra

J F Bell (ARC Fellow, Astrophysics)
D L Jauncey (Astrophysics)
J E J Lovell (ATNF/CTIP Postdoctoral Fellow)

C: Committee membership

ATNF Steering Committee 2001

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Prof R D Cannon, Anglo-Australian Observatory

Secretary

Mrs E Pacey, ATNF

Members

Ex-Officio

Prof R D Ekers, Director, ATNF

Prof B Boyle, Director, Anglo-Australian Observatory

Dr W King, Chief, CSIRO Telecommunications and Industrial Physics

Dr R L Sandland, Deputy Chief Executive, CSIRO

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Astronomers

Dr E Sadler, University of Sydney

Dr M Bailes, Swinburne University of Technology

International advisers

Prof Kwok-yung (Fred) Lo, Director, Institute of Astronomy and Astrophysics, Academia Sinica (Taiwan)

Prof K M Menten, Director, Max Planck Institute for Radio Astronomy, Bonn, Germany

Dr R Williams, Director, Space Telescope Science Institute, USA

Industry

Dr R H Frater, Vice President Innovation, Res Med, North Ryde

Dr S Rotherham, Managing Director, Networks Cable & Wireless Optus, Australia

MNRF Technical Advisory Committee

Dr S Guilloteau, Institut de Radio Astronomie Millimetrique (France)

Dr P Napier, National Radio Astronomy Observatory (USA)

Dr R Padman, Mullard Radio Astronomy Observatory (UK)

Dr A Young, CSIRO Telecommunications and Industrial Physics (Australia)

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Australia Telescope Users Committee 2001

Chairman

Dr A Green, University of Sydney

Secretary

Mr V McIntyre, ATNF

Members

Dr Ramesh Balasubrahmanyam, University of New South Wales

Dr D Barnes, University of Swinburne

Ms H Bignall[#], University of Adelaide

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Dr S Ellingsen, University of Tasmania

Ms T Getts^{#*}, Macquarie University

Dr B Gibson^{*}, University of Swinburne

Dr C Jackson, RSAA, Australian National University

Dr D Jauncey, ATNF

Dr C Lineweaver, University of New South Wales

Mr D Mitchell^{#*}, ADFA

Mr E Muller[#], University of Wollongong

Dr R Sood, University of Western Sydney

Dr M Walker, University of Sydney

Dr T Wong^{*}, ATNF

Dr M Zwaan^{*}, University of Melbourne

*** New member in 2001**

Student member

Australia Telescope Time Assignment Committee 2001

Chairman

Prof R D Ekers, Director, ATNF (present for March 2001 meeting only)

Acting Chair

Dr R Manchester, ATNF (Acting Chair from May 2001)

Secretary

Dr J Chapman, ATNF

Members

Prof R Norris, ATNF (Acting Director from May 2001)

Dr D McConnell*, Office-in-Charge, Narrabri Observatory, ATNF

Dr J Reynolds*, Officer-in-Charge, Parkes Observatory, ATNF

Dr M Wardle, University of Sydney

Dr R Balasubrahmanyam, University of New South Wales

Dr M Sevenster, RSAA, Australian National University (to March 2001)

Dr M Drinkwater, University of Melbourne (to July 2001)

Dr S Ryder, Anglo-Australian Observatory (from July 2001)

Dr B Schmidt, RSAA, Australian National University (from November 2001)

*** non-voting members**

D: Observing programs

Observations made with the Australia Telescope Compact Array January to December 2001

Observers	Affiliations	Program Title	Number	Hours
McConnell, Sault, Subrahmanyan, Tingay, Reynolds, Wark, Wieringa, Brodrick	ATNF, ATNF, ATNF, ATNF, ATNF, ATNF, ATNF, ATNF	ATCA calibrators	C007	135.5
Manchester, Gaensler, Staveley-Smith, Tzioumis, Wheaton, Kesteven, Reynolds	ANTF, MIT, ATNF, ATNF, USyd, ATNF, ATNF	SNR 1987A	C015	72
Fender	UAm	Observations of GRB J1550-564	CX026	10
Sadler	USyd	Tests for large L-band survey	CX027	10
Subrahmanyan	ATNF	AMiBA tests	CX028	1
Harnett	UTS	Magnetic fields in NGC 6215 & NGC 6221	CX029	3
Tingay, Rayner	ATNF, ATNF	Farady rotation measurement of PKS 1718-649	CX030	6
Fender	UAm	X-ray transient	CX031	6
Fender	UAm	X-ray transient 4U 1608	CX032	6
Ryder, Staveley-Smith, Schlegel	JAC, ATNF, SAO	The 1978 supernova in NGC 1313	C184	13
Duncan, White	ATNF, UMar	High-spatial resolution observations of Eta Carinae	C186	13
Duncan, White	ATNF, UMar	The radio properties of the luminous blue variable WRA 751	C312	13
Oosterloo, Morganti, Sadler	NFRA, IRA, USyd	HI in elliptical galaxies	C530	61
Rayner, Ojha, Sault, Norris	UTas, ATNF, ATNF, ATNF	Circular polarization of GPS sources	C561	48
Hopkins, Chan, Cram, Afonso, Mobasher,	UPitt, USyd, USyd, ImCol, ImCol,	The ATCA Phoenix large area ultra-deep survey	C572	64
Dickey, McClure-Griffiths, Green, Wieringa, Haynes, Gaensler	UMinn, UMinn, USyd, ATNF, ATNF, MIT	The southern Galactic plane survey	C596	26.5
Kedziora-Chudczer, Jauncey, Wieringa, Reynolds, Tzioumis, Nicolson, others	ATNF, ATNF, ATNF, ATNF, ATNF, HartRAO	Monitoring observations of PKS 0405-385 (cont)	C611	46
Frail, Kulkarni, Berger, Galama, Wieringa, Wark, Subrahmanyan, McConnell,	NRAO, Caltech, Caltech, Caltech, ATNF, ATNF, ATNF, ATNF	The radio afterglows from gamma-ray bursts	C651	NAPA
Huynh, Jackson, Norris, Ekers, Sault, Wieringa	RSAA, RSAA, ATNF, ATNF, ATNF, ATNF	Probing star formation and AGN in the HDF-S	C727	303.5
Rayner, Sault, Norris, Ojha	UTas, ATNF, ATNF, ATNF	Circular polarization of PKS 1934-638 at 3 cm	C745	24
Stappers, Gaensler, Getts	UAm, MIT, ATNF	Radio emission from SAX J1808.4-3658	C751	NAPA
Corbel, Fender, Nowak, Wilms, Tzioumis	UAm, JILA, AITub, ATNF	NAPA observations of GX 339-4 in the very high state	C767	12
Chapman, Dougherty, Leitherer, Koribalski, Williams, Moffatt, Setia-Gunawan	ATNF, DRAO, STScI, ATNF, ROE, UMont, ATNF	The radio light curve of Gamma Velorum	C787	51

Corbett, Norris, Appleton, Dopita, Struck, Kewley, Zezas	AAO, ATNF, UIow, RSAA, UIow, CfA, CfA	ATCA imaging of COLA galaxies with compact radio cores	C793	26
Fender, Norris, Sault, Pooley, Rayner	UAm, ATNF, ATNF, MRAO, UTas	Circular polarization of radio-bright X-ray transients (NAPA)	C857	NAPA
Mohan, Dwarakanath, Walker	RRI, RRI, USyd	HI 21-cm absorption study towards the Galactic centre	C863	30
Kregel, de Blok, van der Kruit, Freeman	KI, ATNF, KI, RSSA	HI structure and kinematics of edge-on spiral galaxies	C869	102
Edwards, Lovell, Reynolds, Tzioumis, Jauncey	ISA, ATNF, ATNF, ATNF, ATNF	Imaging and monitoring the gravitational lens B1152+199	C878	6
Gentile, Klein, Kalberla, Salucci, Borriello,	UBonn, UBonn, SISSA, UBonn, SISSA	The dark matter distribution in disk galaxies	C885	82.5
Kardasheve, Slee, Stathakis, Pavlenko, Tsarevsky,	ASC, ATNF, AAO, CAO ATNF	Search for new Galactic microquasars among ROSAT sources	C886	33
Leahy, Killeen	JBO, ATNF	Pinning down the physics of FR II radio galaxies	C888	12
O'Brien, Bosma, Freeman	RSAA, Obs. de Marseille, RSAA	Probing the dark matter halos of thin edge-on galaxies	C894	30
Subrahmanyan	ATNF	Recurrent activity in the giant radio galaxy 0707-359	C899	51
Subrahmanyan, Tingay	ATNF, ATNF	Evolution in morphologies of radio galaxies	C900	52.5
Prandoni, Gregorini, Parma, Vettolani, Ruiter, Wieringa, Ekers	IRA-CNR, IRA-CNR, NCR, NCR, OABol, ATNF, ATNF	The nature of the faint radio population	C909	109.5
Tingay, Slee, Sadler	ATNF, ATNF, USyd	ATCA imaging of Pictor A at 1.4, 2.5 and 4.8 GHz	C911	84
Fender, Spencer, Tzioumis, Wu, Johnston, van der Klis	UAm, ATNF, USyd AAO, UAm	Cir X-1: relativistic jet – cloud interaction	C917	54
McIntyre, Chu, Meixner, Dickey, Staveley-Smith, Milne, Sault, Dickel, Klein, Plante	ATNF, Uil, Uil, UMinn, ATNF, ATNF, ATNF, Uil, UBonn, Uil	A 5- and 8.6-GHz survey of the LMC with the ATCA	C918	142.5
Han, Liang, Chen	BAO, UBr, BAO	Radio sources of the strongest linear polarization	C922	84
Liang, Hunstead, Birkinshaw	UBr, USyd, UBr	Measuring the magnetic field in the hottest cluster of galaxies	C923	51
Vreeswijk, Fender, Garrett, Strom, Rol, Kaper, Tingay	UAm, UAm, JIVE, UAm, UAm, UAm, ATNF	Probing the star-formation rate in the host of GRB 990712	C924	24.5
Romani, Johnston, Roberts, Doherty	UStan, USyd, UMcGill, USyd	HI observations of the rabbit	C926	39
Bignall, Jauncey, Tzioumis, Rayner, Lovell, Kedziora- Chudezer, Macquart, McCulloch, Nicolson, Tingay	UAd, ATNF, ATNF, ATNF, ATNF, ATNF, USyd, UTas, HartRAO, ATNF	The micro-arcsec structure and polarization of flat spectrum radio sources	C927	365.5
Burton, Brooks, Rathborne	UNSW, ESO, UNSW	Interface regions in molecular clouds	C928	85.5
Ott, Papaderos, Fritz, Noeske, Fricke, Izotov, Guseva, Thuan, Klein	RAIUB, UStern, UStern, UStern, UStern, AOK, AOK, UVir, UVir	HI envelopes of young blue compact dwarf galaxies	C929	73
De Brueck, van Breugel, Rocca-Volmerange, Sadler, Vries	IAP, LNL, IAP, USyd, LNL	High redshift radio galaxies in the southern hemisphere	C931	42

Corbel, Fender, Tomsick, Kaaret	CEA Saclay, UAm, CASS/UCSD, CfA/SAO	NAPA observations of soft X-ray transients in the low – hard state	C932	NAPA
Ryder, Koribalski, Staveley-Smith	AAO, ATNF, ATNF	Mapping the diffuse gas around NGC 2442	C933	50
Ryan, Webster, Staveley-Smith	UMelb, UMelb, ATNF	Column density distribution function of the local universe from HI emission	C934	169.5
Pavlov, Manchester	Penn State, ATNF	Proper motion of the nearest pulsar	C935	13
Manchester	ATNF	Search for nebula emission around PSR J1357-6435	C936	13
Johnston, Romani, Roberts, Green, Gaensler	USyd, UStan, UMcGill, USyd, MIT	G312.4-0.4: the radio counterpart to 3EG 1410-6147	C937	26
Sault, Macquart, Kedziora-Chudczer, Rayner	ATNF, USyd, ATNF, ATNF	The nature of pmnj1326-5256	C938	42.5
Brogan, Green, Goss	NRAO, USyd, NRAO	OH 1720-MHz maser search in LMC supernova remnants	C939	78
Dubner, Green, Reynoso, Giacani, Johnston, Goss	IAFE, USyd, IAFE, IAFE, USyd, NRAO	The interstellar medium towards peculiar neutron stars	C940	39
Sault, Hall, Carrad, Jackson	ATNF, ATNF, ATNF, ATNF	Water vapour radiometer tests	C941	39.5
Koribalski, Staveley-Smith, Ryder, Ryan-Weber	ATNF, ATNF, AAO, UMelb	The HIPASS bright galaxy catalogue	C942	248
Caswell	ATNF	22-GHz test observations for masers and UC HII regions	C943	28
Dodson, Subrahmanyan, Ellingsen, Minier	UTas, ATNF, UTas, OSO	A search for ammonia at the site of methanol masers	C944	17.5
Greenwood, Ellingsen, Dodson	UTas, UTas, UTas	The spatial scale of anomalous 1720-MHz emission	C945	54
Dodson, McConnell, Deshpande, Golap, Lewis	UTas, ATNF, RRI, NRAO, UTas	Imaging the Vela compact PWN at C-band	C946	90
Lovell, Winn, Jauncey, Edwards	ATNF, MIT, ATNF, ISAS	Imaging a new gravitational lens candidate	C947	14
Wong	ATNF	Dense molecular gas in the LMC and in NGC 6334	C949	55
Sadler, Oosterloo, Morganti, Barnes, de Blok, Koribalski, Staveley-Smith	USyd, NFRA, NFRA, Swinb, ATNF, ATNF, ATNF	An unbiased study of the HI properties of early-type galaxies	C950	52
Koribalski, Wong, mm science team	ATNF, ATNF, ATNF	3-mm observing techniques with ATCA	C951	153.5
Caswell	ATNF	Search for 1720-MHz OH masers in star -formation regions	C952	31
Cram, Chan, Mobahser, Killeen, Sadler, Jackson	USyd, USyd, STScI, ATNF, USyd, ANU	Radio continuum observations of star-forming galaxies and AGN in the 2dF redshift surveys	C953	96
Berger	Caltech	Multi-frequency monitoring of the brown dwarf LP944-20	C954	26
Hunstead, Cotter	USyd, MRAO	The extraordinary radio galaxy B1221-43	C956	12
Gaensler, Baganoff, Dickey, McClure-Griffiths, Lazio, Kassim, LaRosa, Green	MIT, MIT, UMin, UMin, NRL, NRL, Keenesaw State Uni, USyd	Polarization and magnetic fields near the Galactic centre	C957	24.5
Johnson, Pisano, Kobulnicky, Indebetouw	UWis, UWis, UCol	A survey for ultradense HII regions	C958	37

Saripalli, Hunstead, Subrahmanyan, Storch-Bergmann	ATNF, USyd, ATNF, IAG	Recurrent nuclear activity in radio galaxies	C959	98.5
Rosenberg, Putman, Stocke, Shull, Ryan-Weber	CASA, CASA, CASA, CASA, UMelb	An HI study of the Lyman alpha absorber/galaxy connection	C960	42
McClure-Griffiths, Dickey, Gaensler, Green	UMinn, UMinn, MIT, USyd	Studies of Galactic chimneys: high resolution	C961	68
Kanekar, Subrahmanyan, Chengalur	NCRA, ATNF, NCRA	HI 21-cm absorption from the Galactic WNM	C962	28
Ryan, Webster, Staveley-Smith	UMelb, UMelb, ATNF	Local Lyman-alpha absorption systems: Association with galaxies	C963	25
Kilborn, Staveley-Smith, Disney, Minchin, Grossi, Boyce	JBOO, ATNF, UCardiff, UCardiff, UBr	Structure of the most massive HI galaxies	C965	72
Zwaan, Drinkwater	UMelb, UMelb	The HI content of high z galaxies and the evolution of ω -HI	C966	47
Johnson, Indebetouw, Kobulnicky, Churfchwell, Conti	UCol, UCol, UWisc, UWisc, UCol	Ultracompact HII regions in the Magellanic Clouds	C967	48
Cannon, McClure-Griffiths, Skillman	UMinn, UMinn, UMinn	The multiphase dynamics of NGC 625	C968	72
Dodson, Ellingsen, Cragg, Godfrey	UTas, UTas, Monash, Monash	Multi-transitional observations of OH masers	C969	51.5
Minchin, Disney, Knezek, Kilborn, Freeman, Gallagher, Grossi, Davies, Boyce	UW, UW, KPNO, JBO, RSAA, UWis, UW, UBr	The evolution of extreme gas-rich galaxies	C970	74.5
Subrahmanyan, Hunstead, Klamer	ATNF, USyd, USyd	WATs in a compact group	C972	25
Beasley, Staveley-Smith, Claussen	Caltech, ATNF, NRAO	A water maser survey of the Magellanic Clouds	C973	36
Benaglia, Romero, Pollock, Koribalski	IAR, IAR, CSCLtd, ATNF	Search for non thermal emission towards the stellar system WACK 2134	C976	12
Saripalli, Hunstead, Subrahmanyan	ATNF, USyd, ATNF	SUMSS giant radio galaxy candidates	C977	48
Setia-Gunawan, Chapman, Duncan, Koribalski, White	ATNF, ATNF, ATNF, ATNF, UMar	Millimetre observations of massive stars	C978	36
Horellou, Koribalski	OSO, ATNF	HI in the gigantic interacting galaxy NGC 6872	C979	37
Budding, Slee, Carter, Mengel	CIITNZ, ATNF, UQld, UQld	Orbital phase dependent radio emission from CC Eri	C980	2.5
Manchester, Staveley-Smith, Wheaton, Gaensler, Kesteven	ATNF, ATNF, USyd, MIT, ATNF	SNR 1987A at 12 mm	C981	36
Rayner, Norris, Koribalski, Curran	ATNF, ATNF, ATNF, UNSW	Shocked gas in NGC 253	C982	9
Balasubrahmanyam, Burton, Wong, Storey	UNSW, UNSW, ATNF, UNSW	Imaging the hot molecular core – I17470-2853	C983	24
Staveley-Smith, Saunders, Sadler, Norris, Drake	ATNF, AAO, USyd, ATNF, RSAA	The molecular content of ultraluminous infrared galaxies	C984	25.5
Butler, Sault	NRAO, ATNF	Observation of Venus	C985	12
Sault, Staveley-Smith, McConnell, Ojha, Ryan-Weber	ATNF, ATNF, ATNF, ATNF, UMelb	ATNF synthesis imaging workshop practical sessions	C986	11
Macquart, Ekers, Subrahmanyan, Sault	USyd, ATNF, ATNF, ATNF	Variability in Sgr A* at millimetre wavelengths	C987	12
Sridharan, Bourke, Balasubrahmanyam, Zhang	CfA, CfA, UNSW, CfA	A systematic study of isolated high-mass protostars	C988	30

Brocksopp, Fender, Tingay	ULivJM, UAm, ATNF	NAPA radio jets in recurrent X-ray transients	C989	NAPA
Punsly, Tingay	BoeingSS, ATNF	Estimates of the kinetic luminosity for five southern hemisphere quasars	C990	25.5
Lovell, Winn, Gaensler, Tingay, Wieringa, Kedziora-Chudczar, Ojha, Reynolds, Tzioumis	ATNF, CfA, CfA, ATNF, ATNF, ATNF, ANTF, ATNF, ATNF	Flux monitoring of gravitationally lensed quasars	C991	51
Becker, Schaudel, Filipovic, Jones, Weisskopf, Aschenbach	MPE, MPE, UWS, UWS, MSFC, SFC, MPE	A radio follow-up of X-ray selected SNR candidates	C992	20
Leahy, Killeen	JBO, ATNF	A bow shock around PKS 1637-77?	C994	13
Hunstead, Rose, Christiansen, Liang	USyd, UCSU, USCU, UBr	The merging double cluster A3125/A3128	C995	41
Wright, van Dishoeck, Wong	ADFA, LO, ATNF	Observations of pre-planetary disks at 3 mm	C996	21
Camilo, Gaensler, Manchester, Possenti, Stairs, Lyne	UCLmba, CfA, ATNF, OABol, NRAO, UMan	A pulsar bow-shock nebula in SNR G284.3-1.8	C997	25
De Breuck, Sadler, Hunstead, van Breugel	IAP, USyd, USyd, IGPP	High redshift radio galaxies from the SUMSS	C1000	40
Ryan-Weber, Webster, Staveley-Smith	UMelb, UMelb, ATNF	NGC 1533 – morphological evolution caught in the act	C1003	12
Buttery, Cotter, Hunstead, Sadler	MRAO, MRAO, USyd, USyd	Cluster searches with SUMSS	C1004	13
Dahlem, Ehle	ESO, ESA	HI observations of galaxies with radio halos	C1005	75
Ryder, Zurita, Beckman	AAO, IAC, IAC	The origin of the diffuse ionized gas in NGC 1313	C1007	36
Vergani, Dettmar, Klein	RAIUB, Ruhr-University, UBonn	The case of IC 4745	C1008	12

Observations made with the Parkes Telescope January to December 2001

Observers	Affiliations	Program Title	Number	Hours
Kaspi, Manchester, Bailes	UMcGill, ATNF, Swinb	Long-term monitoring of PSR J0045-7319	P138	36.25
Bailes, Ord, van Straten, Manchester, Sarkissian, Anderson, Kulkarni	Swinb, Swinb, Swinb, ANTF, ATNF, Caltech, Caltech	Precision pulsar timing	P140	713.25
Freeman	RSAA	Northern extension of HIPASS	P248	505
Manchester, Lewis, Sarkissian, Kaspi, Bailes	ATNF, UTas, ATNF, UMcGill, Swinb	Timing of young pulsars	P262	132.25
Lyne, Kramer, Manchester, Camilo, Stairs, Hobbs, D'Amico, Possenti, Kaspi, Joshi	JBOO, JBOO, ANTF, UCLmba, NRAO, UMan, OABol, OABol, UMcGill, UMan	Pulsar multibeam survey	P268	726
Kramer, Manchester, Lyne	MIT, ATNF, JBOO	A deep pulsar survey of the Magellanic Clouds	P269	177.75
Manchester, Camilo, Lyne, Kramer, Hobbs, Stairs, Kaspi, D'Amico, Possenti	ATNF, UCol, JBO, JBO, UMan, NRAO, UMcGill, OABol, OABol	Timing of multibeam pulsar survey discoveries	P276	268.25
Lyne, Kramer, Camilo, Freire, Manchester, Lorimer, D'Amico	JBO, JBO, JBO, JBO, ATNF, NAIC, UBol	Timing and searching for millisecond pulsars in 47 Tucanae	P282	152.5

Manchester, Kaspi, Fan, Crawford	ATNF, UMcGill, UHK, LMC Corp	Timing and vonfirmation of new Magellanic Cloud pulsars	P294	30.5
D'Amico, Lyne, Manchester, Sarkissian, Possenti, Fici, Camilo, Ransom	UBol, JBO, ATNF, ATNF, UBol, CINECA, JBO, Harvard	Search for and timing of pulsars in globular clusters	P303	462
Lyne, Stairs, Kramer, Manchester	JBO, JBO, JBO, ATNF	Magnetospheric changes in PSR B1828-11	P340	12
Stairs, Manchester, Lyne, Kramer, Kaspi, Camilo	JBO, ATNF, JBO, JBO, McGill, UCLmba	Periastron studies of PSR 1740-3052	P341	58.5
Koribasliki, Staveley-Smith, Putman, Kilborn, Gibson	ATNF, ATNF, RSAA, UMelb, Swinb	Protogalaxies, high-velocity clouds or Magellanic debris?	P349	116
Forbes, Mundell, Barnes, Terlevich, McKay	Swinb, LivJMU, Swinb, UBr, LivJMU	Formation and evolution of galaxies in groups – the role of HI	P352	119.75
Staveley-Smith, Koribalski, Henning, Kraan-Kortweg, Sadler, Schroeder, Stewart, Price, Green	ATNF, ATNF, UNM, UGuan, USyd, Nice, ULeic, UNM, USyd	A northern extension to the ZOA survey	P357	290.25
Kaspi, Roberts, Romani, Johnston	UMcGill, UMcGill, UStan, USyd	Deep pulse searches of three pulsar wind nebula candidates	P358	29.5
Jacoby, Bailes, Ord, Kaplan, Kulkarni, Anderson	Caltech, Swinb, Swinb, Caltech, Caltech, Caltech	A search for radio pulsations from isolated neutron stars	P359	34.75
Jacoby, Bailes, Ord, Kulkarni, Anderson	Caltech, Swinb, Swinb, Caltech, Caltech	A high-latitude millisecond pulsar survey	P360	339.5
van Straten, Bailes, Ord	Swinb, Swinb, Swinb	Studies of a relativistic binary pulsar	P361	53
Johnston, Kramer, van Starten, Bailes	USyd, JBO, Swinb, Swinb	Bumps and giants in the Vela pulsar	P362	6.25
Caswell	ATNF	Maser spectra at 6 and 12 GHz	P363	95.25
Danziger, Staveley-Smith, Salucci	OAT, ATNF, SISSA	Tully-Fisher HI widths of spirals containing type Ia supernovae	P364	151.5
Johnston, Romani	USyd, UStan	A search for giant pulses	P365	50
Joshi, Lyne, Manchester, D'Amico, Burgay, Kramer, Possenti	JBO, JBO, ATNF, UBol, UBol, JBO, UBol	Parkes multibeam high-latitude pulsar survey	P366	509.25
Briggs, Barnes, de Blok, Freeman, Gibson, Koribalski, Staveley-Smith, Zwaan, Reynolds	KI, UMelb, ATNF, RSAA, RSAA, ATNF, ATNF, KI, ATNF	Pilot for HIPARK: a 'Parked Parkes' very deep HI strip	P367	132
Furuya, Testi, Cesaroni, Kitamura	OAAI, OAAI, OAAI, ISAS	Multi-epoch H ₂ O maser survey towards southern YSOs	P368	23
Gwinn, Schwartz	UCSB, UCSB	AU-scale structure of HI via doppler gradients and scintillation	P369	27
Gurovich, de Blok, Freeman, Staveley-Smith	RSAA, RSAA, ATNF, RSAA, ATNF	Investigating the baryonic Tully-Fisher relationship	P370	29.25
Th van Loon, Zijlstra, Oliveira, Stanimirovic	IoA, UMIST, ESTEC/ESA Arecibo	Water maser survey in 30 Doradus: mapping violent star formation	P371	90
Rosenberg, Putman, Stocke, Shull	CASA, CASA, CASA, CASA	An HI study of the Lyman alpha absorber/galaxy connection	P372	34.75
McClure-Griffiths, Dickey, Gaensler, Green	UMin, UMin, MIT, USyd	Studies of Galactic chimneys: high sensitivity	P374	54.25
Ryan, Webster, Staveley-Smith	UMelb, UMelb, ATNF	Narrow band observations for local HI column density distribution function	P375	67.5

Ord, Bailes	Swinb, Swinb	Swinburne pulsar spectra studies and drifting sub-pulse investigation	P376	65.5
van Driel, Arnaboldi, Combes, Sparke	OPM, Obs. di Capodimonte, DEMIRM, UWisc	An HI survey of southern polar ring galaxies	P378	98.5
Sobolev, Ellingsen, Cragg, Godfrey	USU, UTas, Monash, Monash	Class II methanol masers at 23.1 GHz	P379	63.25
Rickett, Johnston, Tomlinson	UCSD, USyd, UCSD	Observations for two ISS projects on southern pulsars	P381	52.25
Rickett, Johnston, Stinebring	UCSD, USyd, ObCol	Observations of “arcs” in interstellar scintillation	P382	37
Caswell	ATNF	Spectra of 1720-MHz OH masers in star-formation regions	P383	12.25
Pisano, Gibson, Barnes, Staveley-Smith, Freeman	UWisc, Swinb, Swinb, ATNF, ANU	An HI study of loose groups	P384	64
Kilborn, Disney, Minchin, Grossi, Mader, Boyce	UMan, UCardiff, UCardiff, UCardiff, ATNF, UBr	Narrow-band follow-up of HIPASS galaxies	P386	48.25
Zwaan, Webster, Drinkwater, Meyer, Ryan-Weber	UMelb, UMelb, UMelb, UMelb, UMelb	Completeness and reliability of HIPASS	P387	79.5
Stevens, Webster, Staveley-Smith, Barnes	UMelb, UMelb, ATNF, Swinb	Galaxy interactions and evolution in the group environment	P388	32.25
Meyer, Webster	UMelb, UMelb	Narrow band observations of HIPASS edge-on spirals	P389	82.5
Camilo, Helfand, Gotthelf, Mirabal, Halpern	UClmba, UClmba, UClmba, UClmba	Searching for a pulsar in SNR G16.73+0.08	P390	8.5

Observations made with the Mopra Telescope January to December 2001

Observers	Affiliations	Program Title	Number	Days
Muller, Staveley-Smith, Haynes, Zealey	UWol, ATNF, ATNF, UWol	Mapping and search for CO molecules in the western Magellanic Bridge	M101	3.5
Wright, Maldoni, Boonman, Dishoeck	ADFA, ADFA, LO, LO	The gas and dust content of YSOs	M104	8
Durouchoux, Sood, O'Neill, Rodriguez, Ahmedi	CEA, ADFA, ADFA, CEA, ADFA	Millimetre observations of Galactic jets and microquasars	M106	8
Smith, Schultz	Rice University, UNSW	Line emission from the black hole GRS 1758-258	M107	1
Balasubrahmanyam, Nicastro, Cortiglioni, Carretti, Poppi	UNSW, IFCAI-CNR, ITeSRE-CNR, ITeSRE-CNR, IRA-CNR	A 22-GHz continuum galactic plane survey	M108	7
Ishihara, Nakai, Sato, Hall	NRO, NRO, NRO, ATNF	Search for water maser emission in new southern AGN	M109	7
Migenes, Coziol, Boas, Hickel, Reynolds	UGan, UGuan, CRAAE, INPE, ATNF	A new search for megamasers in warm infrared galaxies	M110	2

VLBI Observations January to December 2001

Observers	Affiliations	Program Title	Number	Hours
Bignall	UAd	IDV 1257-326	VX006	12
Beasley, Claussen, Ellingsen, Reynolds, Tzioumis	NRAO, NRAO, UTas, ATNF, ATNF	Measuring the mass of the Galaxy II	V135	72
Drake, McGregor, Norris, Bignall	RSAA, RSAA, ATNF, UAd	Intermediate radio-loud IRAS galaxies	V143	44
Tingay, Sahai, Preston	ATNF, JPL, JPL	Resolving the radio structure of HE2-90	V144	12
Caswell, Reynolds	ATNF, ATNF	LBA maps of OH masers at 6030 and 6035 MHz in star- formation regions	V145	12
Kardashev, Budding, Ojha, Slee, Tingay, Tsarevsky	ASC, CIT, ATNF, ATNF, ATNF, ATNF	A search for new Galactic microquasars among ROSAT sources	V146	36
Ojha, Tingay, Wardle, Cheung, Urry, Sambruna, Scarpa, Tavecchio, Maraschi, Pesce	ANTF, ATNF, Brandeis University, Brandeis University, STScI, George Mason Uni, ESO, OAiB, OAiB, Eureka Scientific	LBA imaging of the kpc-scale X-ray jet in PKS 0637-752	V147	18
Dodson, Ellingsen, Ojha	UTas, UTas, ATNF	The polarization of methanol maser disks	V148	30
Edwards, Tingay, Lovell, Reynolds, Tzioumis, Ojha, Dodson, Nicolson, Quick	ISAS, ATNF ATNF, ATNF, ATNF, ATNF, UTas, HartRAO, HartRAO	Parsec-scale structure of southern EGRET sources	V151	24

E: Affiliations

AAO	Anglo-Australian Observatory, Australia	CRALOL	CRAL Observatoire de Lyon, France
AAT	Anglo-Australian Telescope, Australia	CSR	Center for Space Research, USA
ADFA	Australian Defence Force Academy, Australia	CTIP	CSIRO Telecommunications & Industrial Physics, Australia
AIPr	Astronomical Institute Prague, Czech Republic	DEMIRM	Département d'Etudes de la Matière interstellaire en InfraRouge et Millimétrique l'Observatoire de Paris, France
AITub	Institute of Astronomy, University of Tübingen, Germany	DRAO	Dominion Radio Astrophysical Observatory, Canada
ANU	Australia National University, Australia	ESO	European Southern Observatory, Germany
AO	Arecibo Observatory, USA	ESTEC	ESTEC Astrophysics Division, The Netherlands
AOK	Astronomical Observatory Kiev, Ukraine	GBT	Green Bank Telescope, USA
AOUpp	Astronomiska Observatoriet, Uppsala, Sweden	GMU	George Mason University, USA
ArO	Armagh Observatory, UK	Gray Data	Gray Data Consulting, USA
ASC	Astrospace Centre, Russia	GSFC	Goddard Space Flight Center, USA
ASCR	Academy of Sciences of Czech Republic, Czech Republic	HartRAO	Hartebeesthoek Radio Astronomical Observatory, South Africa
ASIAA	Academia Sinica, IAA, Taiwan	Harvard	Harvard University, USA
ATNF	Australia Telescope National Facility, Australia	HatCreek	Hat Creek Radio Observatory, USA
BAO	Beijing Astronomical Observatory, China	IAC	Instituto de Astrofísica de Canarias, Spain
BIMA	Berkeley-Illinois-Maryland Association, USA	IAFE	Instituto d'Astronomia y Física del Espacio, Argentina
Caltech	California Institute of Technology, USA	IAG	Instituto Astronomico e Geofísico, Brazil
CAO	Cagliari Astronomical Observatory, Italy	IAP	Institute d'Astrophysique Paris, France
CASA	CASA, University of Colorado, USA	IAR	Instituto Argentino de Radioastronomía, Argentina
CDSSC	Canberra Deep Space Communications Complex, Australia	IASp	Institut d'Astrophysique Spatiale, France
CEA	Centre d'Etudes d'Astrophysique, Saclay, France	IFCTR	Instituto de Física Cosmica - CNR, Italy
CfA	Center for Astrophysics, Harvard University, USA	ImCol	Imperial College London, UK
CITNZ	Central Institute of Technology, New Zealand	INPE	Instituto Nacional de Pesquisas Espaciais, Brazil
CO	Carter Observatory, New Zealand	IoA	Institute of Astronomy, UK
Cornell	Cornell University, USA	IPAC	IPAC, Caltech, USA
COSSA	CSIRO Office of Space Science & Applications, Australia	IRA-CNR	Institute of Radio Astronomy, CNR, Bologna, Italy
		ISA	ISAS, JAPAN, Japan
		ISU	Iowa State University, USA
		JAC	Joint Astronomy Centre, Hilo, USA

JBO	Jodrell Bank Observatory, UK	OAT	Osservatorio Astronomico di Trieste, Italy
JHU	John Hopkins University, USA	OCat	Osservatorio Astronomico di Catania, Italy
JILA	JILA, University of Colorado, USA	OHP	Observatoire de Haute Provence, France
JPL	Jet Propulsion Laboratory, USA	OMs	Observatoire de Marseille, France
KI	Kapteyn Institute, Netherlands	ON	Observatorio Nacional, Brazil
KPNO	Kitt Peak National Observatory, USA	Open	Open University, UK
LivJMU	Liverpool John Moores University, UK	OPM	Observatoire de Paris, Meudon, France
LLNL	Lawrence Livermore National Laboratory, USA	OSO	Onsala Space Observatory, Sweden
LO	Leiden Observatory, The Netherlands	PLab	Phillips Lab, USA
LSW	Landessternwahrte Heidelberg, Germany	PMO	Purple Mountain Observatory, China
MSFC	Marshall Space Flight Center, USA	PUCC	Pontificia Universidad Catolica de Chile, Chile
MERLIN	Multi-element Radio Linked Interferometry Network, UK	Queens	Queens University, Canada
MIT	Massachusetts Institute of Technology, USA	RAIUB	Radio Astronomy Institute, University of Bonn, Germany
Monash	Monash University, Australia	RMC	Royal Military College, Canada
MPE	Max Planck Inst. für Extraterrestrische Physik, Germany	ROB	Royal Observatory of Belgium, Belgium
MPIfA	Max Planck Inst. für Astrophysik, Germany	ROE	Royal Observatory Edinburgh, Scotland
MPIfR	Max Planck Inst. für Radioastronomie, Germany	RRI	Raman Research Institute, India
MRAO	Mullard Radio Astronomical Observatory, UK	RSAA	Research School of Astronomy & Astrophysics, Australia
NAIC	National Astronomy and Ionosphere Centre, USA	SETI	SETI Institute, USA
NAOJ	National Astronomical Observatory, Japan	ShO	Shangai Observatory, China
NASA-RC	NASA Ames Research Center, USA	SISSA	Scuola Internazionale Superiore di Studi Avanzati, Trieste, Italy
NFRA	Netherlands Foundation for Research in Astronomy, The Netherlands	StO	Stockholm Observatory, Sweden
NOAO	National Optical Astronomical Observatory, USA	STScI	Space Telescope Science Institute, USA
NRAO	National Radio Astronomy Observatory, USA	Swinb	Swinburne University of Technology, Australia
NRL	Naval Research Laboratories, USA	TGU	Tokyo Gakugei University, Japan
NRO	Nobeyama Radio Observatory, Japan	TIFR	Tata Institute for Radio Astronomy, India
NWU	Northwestern University, USA	UAd	University of Adelaide, Australia
OAAI	Osservatorio Astrofisico di Arcetri, Italy	UAl	University of Alabama, USA
OABol	Osservatorio Astronomico di Bologna, Italy	UAm	University of Amsterdam, The Netherlands
OARome	Osservatorio Astronomico di Roma, Italy	UBir	University of Birmingham, UK
		UBonn	University of Bonn, Germany
		UBos	Boston University, USA

UBr	University of Bristol, UK	UMinn	University of Minnesota, USA
UC	University of Colorado, USA	UMIST	University of Manchester, Institute of Science and Technology, UK
UCal	University of Calgary, Canada	UMont	University of Montreal, Canada
UCB	University of California, Berkeley, USA	UNag	Nagoya University, Japan
UCardiff	University of Cardiff, UK	UNAM	Universidad Nacional Autónoma de México, Mexico
UCha	University of Champagne-Urbana, USA	UNM	University of New Mexico, USA
UChi	University of Chile, Chile	UNSW	University of New South Wales, Australia
UChig	University of Chicago, USA	UOx	University of Oxford, Oxford
UCL	University College London, UK	UPenn	Pennsylvania State University, USA
UClmba	Columbia University, USA	UPitt	University of Pittsburgh, USA
UCLO	University of California Lick Observatory, USA	UQld	University of Queensland, Australia
UCSB	University of California, Santa Barbara, USA	URh	University of Rhodes, South Africa
UCSC	University of California, Santa Cruz, USA	URuh	Ruhr-Universität, Germany
UCSD	University of California, San Diego, USA	USMF	Santa Maria Federal University, Brazil
UDur	University of Durham, England	USNA	US Naval Academy, USA
UEdin	University of Edinburgh, UK	USNO	US Naval Observatory, USA
UEot	Eötvös Loránd University, Hungary	USouth	Southampton University, UK
UGuan	University of Guanajuato, Mexico	UStan	Stanford University, USA
UHel	University of Helsinki, Finland	UStern	Sternwarte University, Germany
UHerts	University of Hertfordshire, UK	USU	Ural State University, Russia
UHilo	University of Hilo, USA	USuss	University of Sussex, UK
UHK	University of Hong Kong, PR China	USyd	University of Sydney, Australia
UIL	University of Illinois, USA	UTas	University of Tasmania, Australia
UIow	Iowa State University, USA	UTex	University of Texas, USA
UKok	Kokugakuin University, Japan	UTor	University of Toronto, Canada
UKST	United Kingdom Schmidt Telescope, Australia	UTS	University of Technology, Sydney, Australia
UKT	Kyushu Tokai University, Japan	UVir	University of Virginia, USA
UKyoto	University of Kyoto, Japan	UW	University of Wales, UK
ULeeds	University of Leeds, UK	UWA	University of Western Australia, Australia
ULeic	University of Leicester, UK	UWash	University of Washington, USA
UMac	Macquarie University, Australia	UWis	University of Wisconsin, USA
UMan	University of Manchester, UK	UWol	University of Wollongong, Australia
UMar	University of Maryland, USA	UWS	University of Western Sydney, Australia
UMaur	University of Mauritius, Mauritius	Yale	Yale University, USA
UMcGill	McGill University, Canada	YU	Yunnan Observatory, China
UMelb	University of Melbourne, Australia		

F: ATNF media releases, 2001

Titanic collision seen in distant universe	06 February
Aussie astronomy technology is star material	30 March
“Tadpole hunters” may net forming planets	23 May
Big telescope opportunities for South Australia	05 June
Giant “eyeball” brings mega-telescope closer	28 June
“The Dish” tests Einstein’s warped space	12 July
“The Dish” turns 40 today	31 October
New Australia Telescope “eyes” look at exploded star	15 November
CSIRO – TRW alliance explores speedy semiconductors	18 December
ATNF media releases can be found on the Web through http://www.atnf.csiro.au/news	

G: 2001 publications

Papers using ATNF data, published in refereed journals

Papers which include ATNF authors are indicated by an asterisk.

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Project title

Mass distributions in rich clusters of galaxies
 Multiwavelength studies of blazars
 Search for HI in dwarf spheroidal galaxies
 Interaction of the Magellanic Stream and other HVCs with the Galactic Halo
 Intermediate radio-loud IRAS galaxies
 Dynamical study of southern interacting galaxies
 Star-formation in interacting galaxies: a multiwavelength study
 Investigating the Baryonic Tully-Fisher relationship
 Molecular spectral line observations of southern molecular clouds
 Constraining the star-formation history of galaxies in the Hubble Deep Field South region with sensitive radio data
 Examining magnetic fields through Faraday rotation measures
 Nearby galaxies in the Zone of Avoidance
 Interstellar chemistry in shocked molecular gas around supernova remnants
 Accurate astrometry of southern radio pulsars
 Timing of young pulsars
 Interference mitigation in radio astronomy
 The kinematics and structure of the Magellanic Bridge
 Probing the shape of dark halos of thin edge-on disk galaxies
 High-speed digitisers for radio astronomy
 Column density distribution function of the local Universe
 A multibeam survey for pulsars over the southern part of the Galactic plane
 The nature of nearby high HI mass-to-light radio field galaxies
 Galaxy populations, dynamics and evolution of the Fornax Cluster
 Hydrodynamical models and an investigation into radio emission from SN 1987A in the Large Magellanic Cloud
 An investigation of pulsar dynamics using improved methods of time series analysis

I: Glossary and abbreviations

3-mm band	The 85 – 115 GHz band of radio frequencies.
AAO	Anglo-Australian Observatory.
AAT	Anglo-Australian Telescope.
ACA	Australian Communications Authority.
ACC	Antenna Control Computer.
AGN	Active Galactic Nuclei.
AMiBA	Array for Microwave Background Anisotropy.
AIPS	Astronomical Image Processing System.
aips++	An object-oriented data processing system for radio telescopes, which is being constructed by an international consortium of leading radio astronomy observatories.
ALMA	Atacama Large Millimetre Array.
APT	Asia-Pacific Telescope.
AT	Australia Telescope.
ATCA	Australia Telescope Compact Array.
ATNF	Australia Telescope National Facility.
ATOMS	Australia Telescope Observatory Management System.
AT Steering Committee	A committee of leading Australian and overseas technical and scientific experts who provide policy advice to the Director of the ATNF, and are appointed by the Minister for Science.
ATUC	Australia Telescope User Committee.
BIMA	Berkeley-Illinois-Maryland Association.
COSPAR	Committee on Space Research.
CPSR	Caltech-Parkes-Swinburne Recorder.
CSIRO	Commonwealth Scientific and Industrial Research Organization.
CTIP	CSIRO Telecommunications and Industrial Physics – a Division of CSIRO partly co-located with the ATNF.
DASI	Degree Angular Scale Interferometer.
DSN	Deep Space Network.
EEO	Equal Employment Opportunity.
GaAs	Gallium Arsenide.
GRB	Gamma-ray Burst.
HALCA	Highly Advanced Laboratory for Communications and Astrophysics. The Japanese VLBI satellite, previously called VSOP.
HBT	Heterojunction Bipolar Transistor.
HEMT	High Electron Mobility Transistor.
HIPASS	HI Parkes All Sky Survey.

HVC	High-Velocity Cloud.
IAU	International Astronomical Union.
IDV	Intra-Day Variability.
IMS	Interference Monitoring System.
InP	Indium Phosphide.
ISM	Interstellar Medium.
IT	Information Technology.
ITU	International Telecommunication Union.
IUCAF	Inter-Union Commission for the Allocation of Frequencies.
JIVE	Joint Institute for VLBI in Europe.
LBA	Long Baseline Array, used for Australian VLBI observations.
LO	Local Oscillator.
LOFAR	Low Frequency Array.
MIRIAD	Multichannel Image Reconstruction Image Analysis and Display. A data-processing package for synthesis data, developed by Bob Sault, ATNF.
MMIC	Monolithic Microwave Integrated Circuit.
MNRF	Major National Research Facilities.
NASA	National Aeronautics and Space Administration. The US space agency.
OCC	Observatory Computer Committee.
OECD	Organization for Economic Cooperation and Development.
OIC	Officer-in-Charge.
RAFCAP	Radio Astronomy Frequency Committee in the Asia Pacific Region.
RFI	Radio Frequency Interference.
SEST	Swedish-ESO Submillimetre Telescope (Chile).
SKA	Square Kilometre Array.
TAC	Time Assignment Committee.
TCS	Telescope Control System.
URSI	International Union of Radio Science.
USNO	United States Naval Observatory.
VLA	Very Large Array.
VLBI	Very Long Baseline Interferometry.
VSOP	VLBI Space Observatory Program.
WRC	World Radiocommunication Conference.
ZOA	Zone of Avoidance.



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