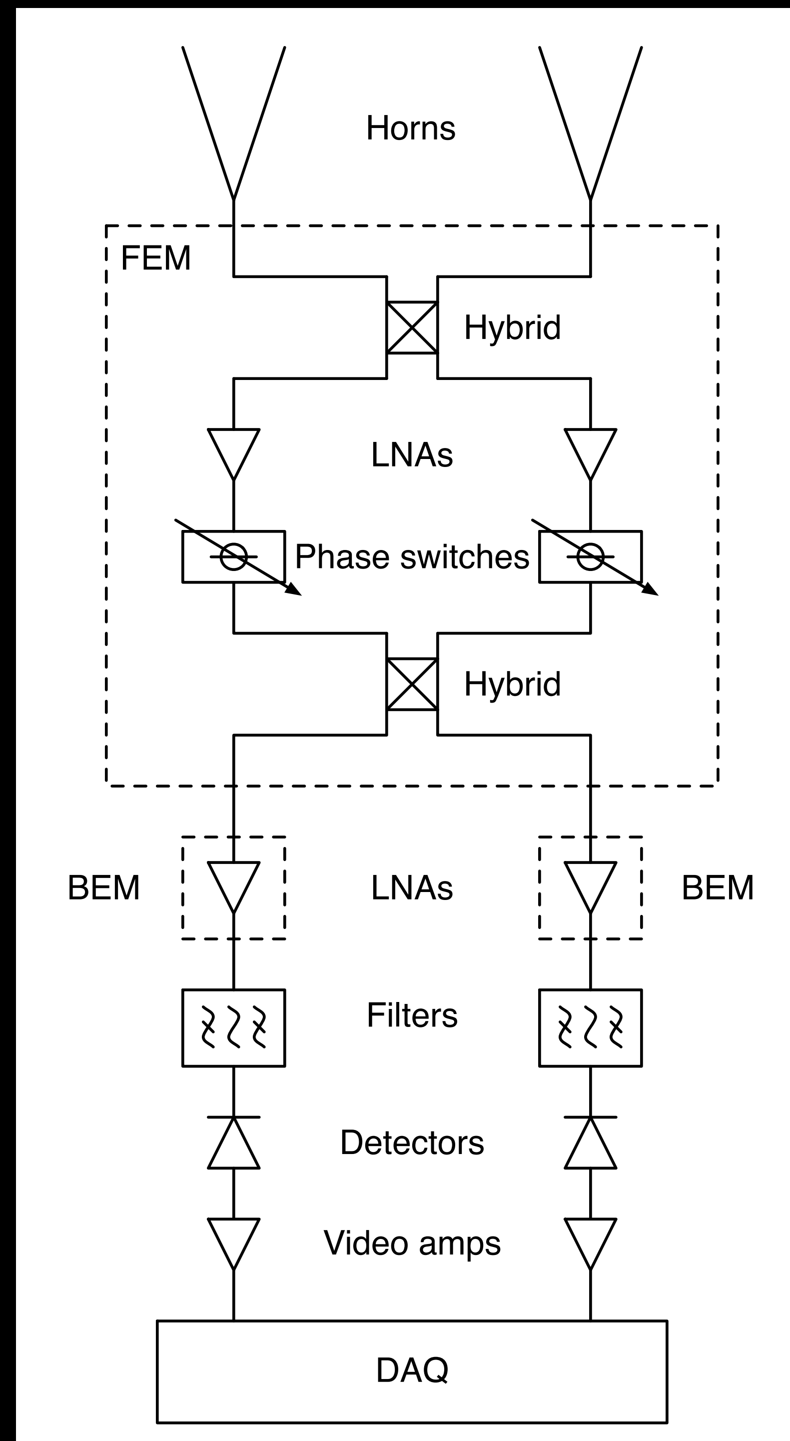
The University of Manchester
Jodrell Bank
Observatory

MANCHESTER
1824

OCRA-AMI Synergies

Mike Peel, on behalf of the OCRA collaboration
(Torun Centre for Astronomy; Jodrell Bank Centre for Astrophysics;
University of Bristol)



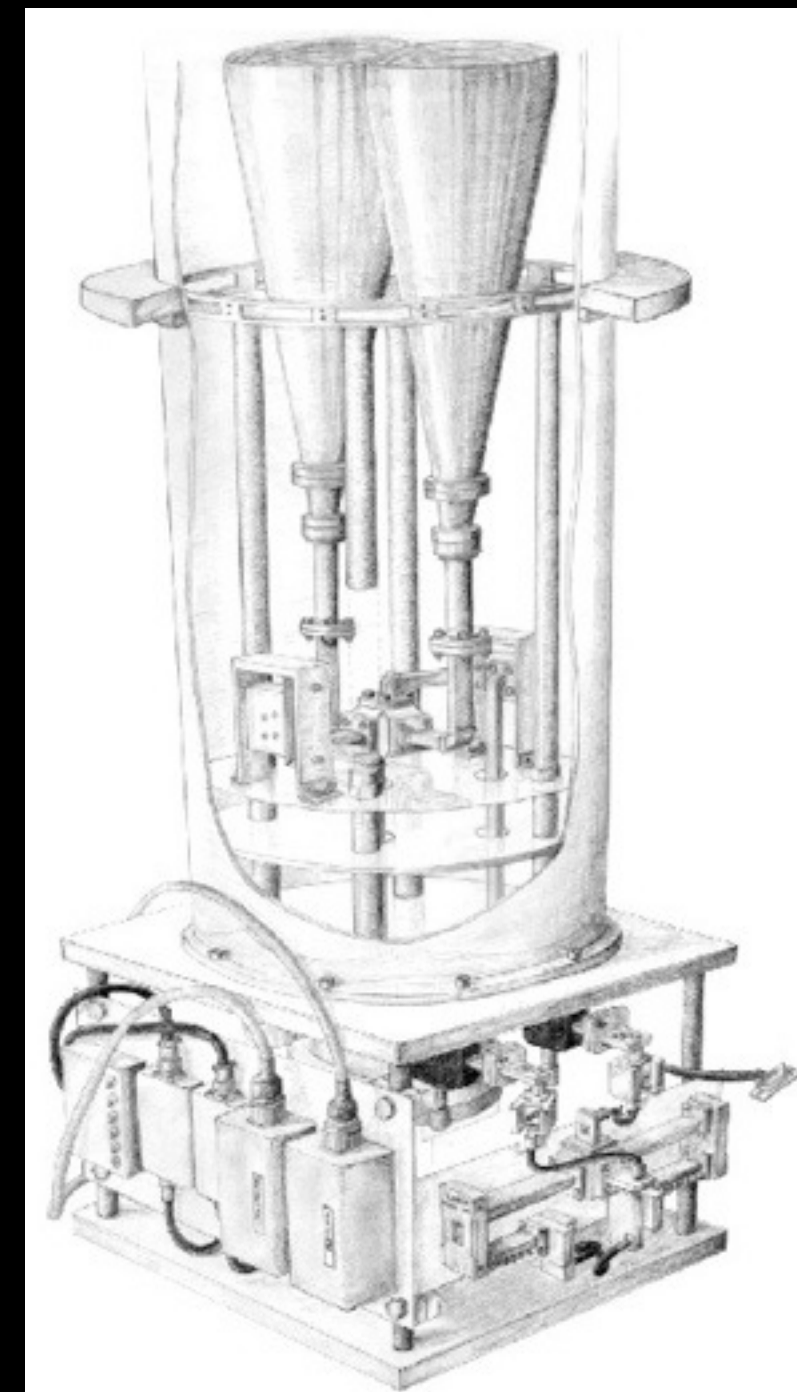
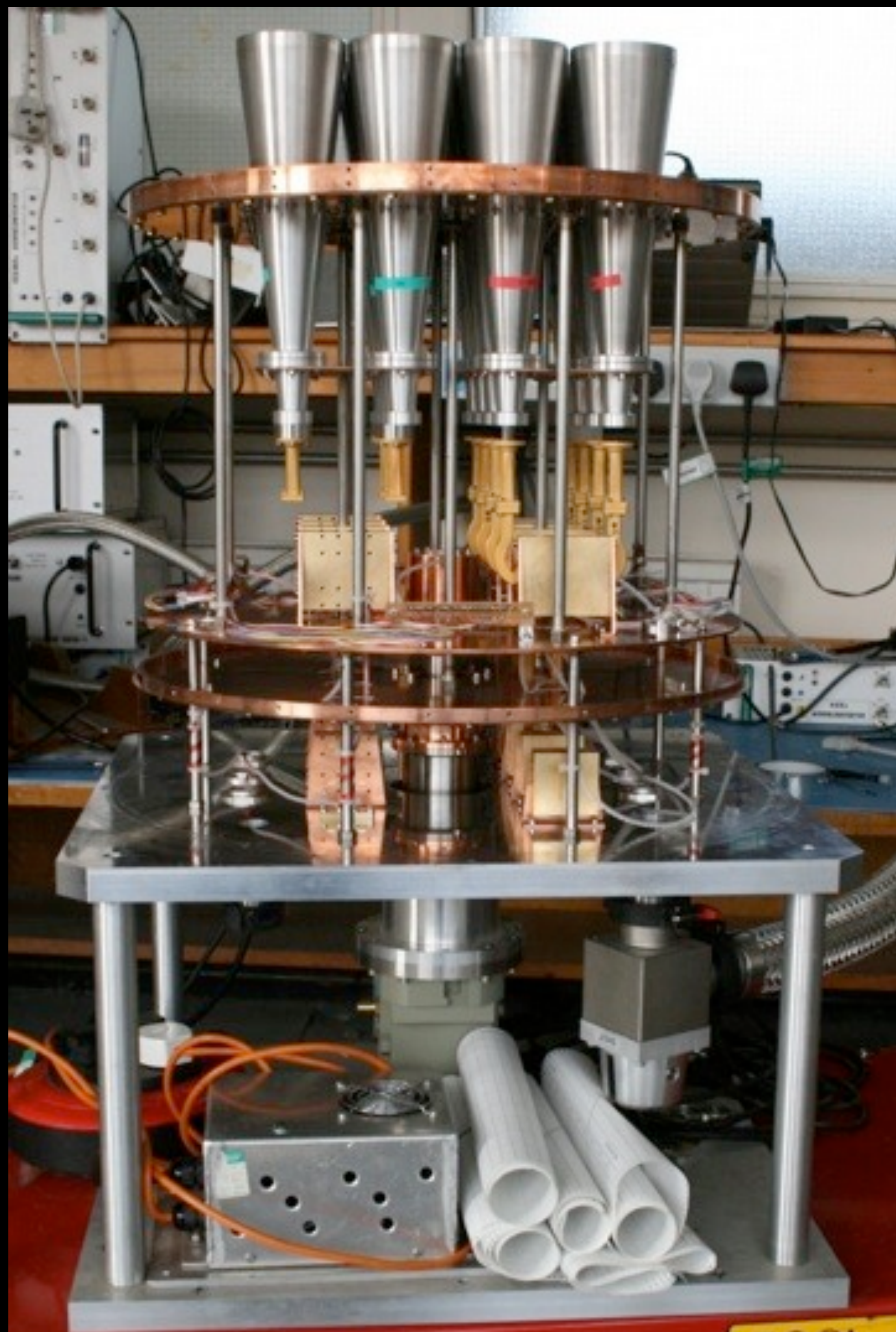


Image credit: S. Lowe



	OCRA-p	OCRA-F
Beams	2	8
Frequency	27-33GHz	26-36GHz
Tsys (on sky)	40	50
Noise	7 mJy $s^{0.5}$	7 mJy $s^{0.5}$
Resolution	1.2 arcmin (3.2 arcmin beamthrow)	

Comparable resolution to AMI at twice the frequency

The University of Manchester
Jodrell Bank
Observatory

MANCHESTER
1824

Monthly Notices of the Royal Astronomical Society

Mon. Not. R. Astron. Soc. **406**, 1853–1864 (2010) doi:10.1111/j.1365-2966.2010.16784.x

30 GHz observations of sources in the Very Small Array fields

M. P. Gawroński,[1]* M. W. Peel,[2] K. Lancaster,[3] R. A. Battye,[2] M. Birkinshaw,[3] I. W. A. Browne,[2] M. L. Davies,[4] R. J. Davis,[2] R. Feiler,[1] T. M. O. Franzen,[4] R. Génova-Santos,[4] A. J. Kus,[1] S. R. Lowe,[2] B. M. Pazderska,[1] E. Pazderski,[1] G. G. Pooley,[4] B. F. Roukema,[1] E. M. Waldram[4] and P. N. Wilkinson[2]

[1]*Toruń Centre for Astronomy, Nicolaus Copernicus University, 87-100 Toruń/Piwnice, Poland*
[2]*Jodrell Bank Centre for Astrophysics, The University of Manchester, Manchester M13 9PL*
[3]*University of Bristol, Tyndall Avenue, Bristol BS8 1TL*
[4]*Astrophysics Group, Cavendish Laboratory, JJ Thomson Avenue, Cambridge CB3 0HE*

Accepted 2010 April 1. Received 2010 March 30; in original form 2009 August 26

arXiv:0909.1190

ABSTRACT

Small angular scale (high ℓ) studies of cosmic microwave background (CMB) anisotropies require accurate knowledge of the statistical properties of extragalactic sources at cm-mm wavelengths. We have used a 30 GHz dual-beam receiver (One Centimetre Receiver Array prototype) on the Toruń 32-m telescope to measure the flux densities of 121 sources in Very Small Array fields selected at 15 GHz with the Ryle Telescope. We have detected 57 sources above a limiting flux density of 5 mJy, of which 31 sources have a flux density greater than 10 mJy, which is our effective completeness limit. From these measurements we derive a surface density of sources above 10 mJy at 30 GHz of 2.2 ± 0.4 deg^{-2}. This is consistent with the surface density obtained by Mason et al. who observed a large sample of sources selected at a much lower frequency (1.4 GHz). We have also investigated the dependence of the spectral index distribution on flux density by comparing our results with those for sources above 1 Jy selected from the *Wilkinson Microwave Anisotropy Probe* 22 GHz catalogue. We conclude that the proportion of steep spectrum sources increases with decreasing flux density, qualitatively consistent with the predictions of de Zotti et al. We find no evidence for an unexpected population of sources above our completeness limit of 10 mJy whose spectra rise towards high frequencies, which would affect our ability to interpret current high-resolution CMB observations at 30 GHz and above.

Key words: cosmology: observations – radio continuum: general – cosmic background radiation.

1 INTRODUCTION

Extragalactic radio sources are a serious contaminant in observations of primordial cosmic microwave background (CMB) anisotropies on small angular scales (high l; e.g. Toffolatti et al. 2005). In order to estimate the CMB temperature power spectrum with high accuracy, detailed information about the foreground population is required. CMB experiments can be designed to work at any of a range of frequencies from ~20 to ~300 GHz, since the spectrum peaks at ~160 GHz. Extragalactic radio sources are problematic over most of this range, with different source populations, from active galaxies to star-forming galaxies, dominating the contamination in different wavebands. However, information on these contaminating populations is limited, since large-scale high-resolution surveys of the radio sky are restricted to lower frequencies, as for example in the NRAO (National Radio Astronomy Observatory) VLA (Very Large Array) Sky Survey (NVSS; Condon et al. 1998) at 1.4 GHz and the Green Bank 4.85 GHz survey (GB6; Gregory et al. 1996). Model-dependent predictions of the contaminating sources at the frequencies of CMB experiments may be made (e.g. Toffolatti et al. 1998; de Zotti et al. 2005), but these can be unreliable. Source populations can exhibit a wide range of spectral indices so that severe selection effects may arise when extrapolating to high frequencies from the limited set of surveys on which these predictions are based. Thus, for maximum reliability in their cosmological interpretation, it is essential that CMB observations are complemented by deep and carefully selected high-frequency radio source surveys.

The CMB power spectrum has been measured over a wide range of angular scales, from the early low-resolution (7° per beam) work of the *Cosmic Background Explorer* (Smoot et al. 1992), through

*E-mail: motylek@astro.uni.torun.pl

© 2010 The Authors. Journal compilation © 2010 RAS

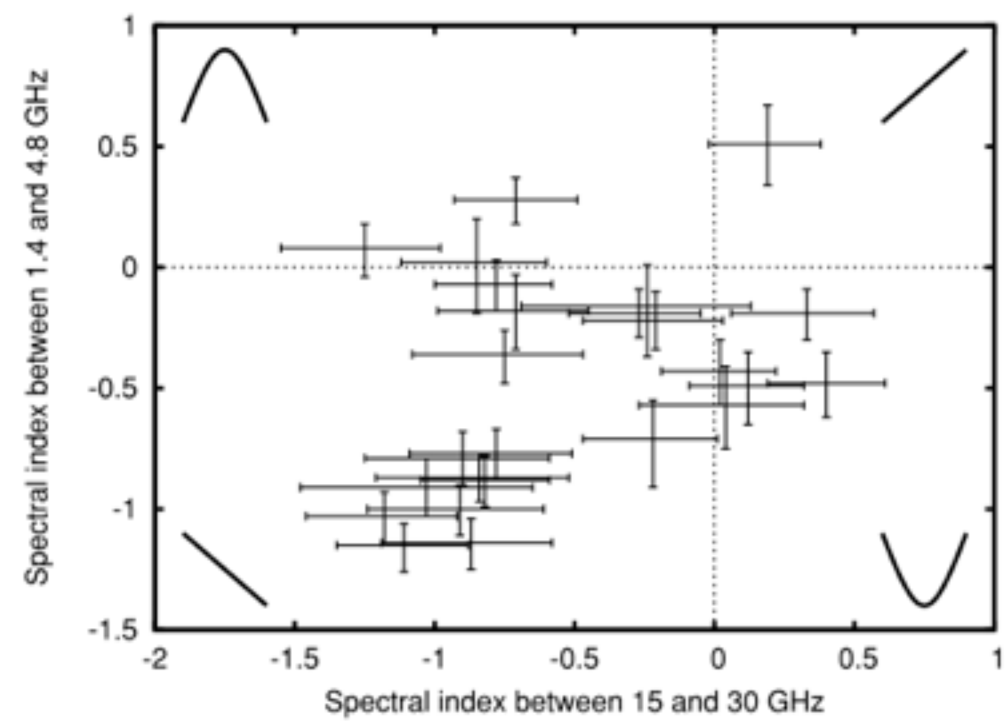


Figure 7. $\alpha_{1.4}^{4.8}$ versus α_{15}^{30} for all sources in this sample with a 30 GHz flux density greater than 10 mJy, and known flux densities at all four frequencies. The diagrams in the corners schematically illustrate the spectral behaviour of the sources in each quadrant.

The University of Manchester
Jodrell Bank
Observatory

MANCHESTER
1824

A&A 474, 1093–1100 (2007)
DOI: 10.1051/0004-6361:20078034
© ESO 2007

Astronomy & Astrophysics

30 GHz flux density measurements of the Caltech-Jodrell flat-spectrum sources with OCRA-p*
(Research Note)

S. R. Lowe[1], M. P. Gawroński[2], P. N. Wilkinson[1], A. J. Kus[2], I. W. A. Browne[1], E. Pazderski[2], R. Feiler[2], and D. Kettle[1]

[1] University of Manchester, Jodrell Bank Observatory, Macclesfield, Cheshire SK11 9DL, UK
e-mail: Stuart.Lowe@manchester.ac.uk
[2] Toruń Centre for Astronomy, Nicolaus Copernicus University, 87-148 Toruń/Piwnice, Poland
[3] School of Electrical and Electronic Engineering, University of Manchester, UK

Received 7 June 2007 / Accepted 23 July 2007

ABSTRACT

Aims. To measure the 30-GHz flux densities of the 293 sources in the Caltech-Jodrell Bank flat-spectrum (CJF) sample. The measurements are part of an ongoing programme to measure the spectral energy distributions of flat spectrum radio sources and to correlate them with the milliarcsecond structures from VLBI and other measured astrophysical properties.
Methods. The 30-GHz data were obtained with a twin-beam differencing radiometer system mounted on the Toruń 32-m telescope. The system has an angular resolution of 1.2′.
Results. Together with radio spectral data obtained from the literature, the 30-GHz data have enabled us to identify 42 of the CJF sources as Giga-hertz Peaked Spectrum (GPS) sources. Seventeen percent of the sources have rising spectra ($\alpha > 0$) between 5 and 30 GHz.

Key words. astronomical data bases: miscellaneous – radio continuum: galaxies

1. Introduction

The emission from most flat-spectrum radio sources, from radio frequencies through gamma-rays, is thought to arise in relativistic jets and be beamed synchrotron self-Compton emission. Often described as blazar emission it is characterized by two peaks in the spectral energy distribution (SED), one synchrotron and one inverse Compton. From object to object the peak frequency can occur anywhere between 10^{10} Hz to 10^{15} Hz. There are claims that where the peaks occur depends systematically on radio luminosity (Fossati et al. 1998; Ghisellini et al. 2002). The correlation is in the sense that the synchrotron peak frequency increases as the luminosity decreases. This is potentially an important result but has been questioned by several authors (e.g. Antón & Browne 2005). A major problem is, however, the lack of good quality SEDs on well-defined samples of objects and for this reason we have embarked on a programme to try to rectify this deficiency. Flux density measurements at centimeter wavelengths and shorter are the most important in order to define the position of the synchrotron peak. Here we report measurements with a new receiver, OCRA-p on the Torun 32 m Telescope at a wavelength of 1 cm.

The CJF sample is currently the best studied sample of flat-spectrum radio sources. The CJF sample (Taylor et al. 1996) consists of 293 sources selected from three previous VLBI surveys: the PR survey (Pearson & Readhead 1988), the first Caltech-Jodrell (CJ) survey (CJ1: Polatidis et al. 1995) and the second Caltech-Jodrell survey (CJ2: Taylor et al. 1994). The selection criteria were:

1. $S_{4.85\,\mathrm{GHz}} \geq 350$ mJy
2. $\alpha_{1.4\,\mathrm{GHz}}^{4.85\,\mathrm{GHz}} \geq -0.5$[1]
3. $\delta(1950) \geq 35°$
4. $|b| \geq 10°$.

In addition to the structural information obtained in the CJ VLBI surveys, extensive follow-up observations have been made with the VLBA (Britzen et al., in prep) to study the statistics of superluminal motions; redshift information is available for >90% of the sample. Furthermore, all 293 sources have been observed in soft X-rays, either as part of the *ROSAT* All-Sky Survey or in *ROSAT* pointed observations (Britzen et al. 2002). The CJF sample is therefore a natural starting point for a programme aimed at understanding the relationships between the broad-band SEDs and the spatial structure, kinematics and X-ray properties of compact radio sources. Several different types of objects are found in samples selected, like CJF, from radio surveys made at relatively low (few GHz) frequencies. While the sample is dominated by highly-relativistic "core-jet" sources it also contains the precursors of large-scale double sources (the

* Table 2 is also available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/474/1093

[1] $S \propto \nu^{\alpha}$.

Article published by EDP Sciences and available at http://www.aanda.org or http://dx.doi.org/10.1051/0004-6361:20078034

Monthly Notices of the Royal Astronomical Society

Mon. Not. R. Astron. Soc. **410**, 2690–2697 (2011) doi:10.1111/j.1365-2966.2010.17640.x

One Centimetre Receiver Array-prototype observations of the CRATES sources at 30 GHz

M. W. Peel,[1]* M. P. Gawroński,[2] R. A. Battye,[1] M. Birkinshaw,[3] I. W. A. Browne,[1] R. J. Davis,[1] R. Feiler,[2] A. J. Kus,[2] K. Lancaster,[3] S. R. Lowe,[1] B. M. Pazderska,[2] E. Pazderski,[2] B. F. Roukema[2] and P. N. Wilkinson[1]
[1]*Jodrell Bank Centre for Astrophysics, The University of Manchester, Manchester M13 9PL*
[2]*Toruń Centre for Astronomy, Nicolaus Copernicus University, 87-100 Toruń/Piwnice, Poland*
[3]*University of Bristol, Tyndall Avenue, Bristol BS8 1TL*

Accepted 2010 September 4. Received 2010 September 1; in original form 2010 July 29

ABSTRACT
Knowledge of the population of radio sources in the range ~2–200 GHz is important for understanding their effects on measurements of the cosmic microwave background power spectrum. We report measurements of the 30-GHz flux densities of 605 radio sources from the Combined Radio All-sky Targeted Eight-GHz Survey (CRATES), which have been made with the One Centimetre Receiver Array-prototype (OCRA-p) on the Toruń 32-m telescope. The flux densities of sources that were also observed by *Wilkinson Microwave Anisotropy Probe* (*WMAP*) and previous OCRA surveys are in broad agreement with those reported here, however a number of sources display intrinsic variability. We find a good correlation between the 30 GHz and *Fermi* gamma-ray flux densities for common sources. We examine the radio spectra of all observed sources and report a number of gigahertz-peaked and inverted spectrum sources. These measurements will be useful for comparison to those from the Low Frequency Instrument of the *Planck* satellite, which will make some of its most sensitive observations in the region covered here.

Key words: astronomical data bases: miscellaneous – galaxies: active – galaxies: statistics – cosmology: observations.

1 INTRODUCTION

Emission from blazars dominates the high-latitude sky at high radio frequencies and also at gamma-ray frequencies. Blazars are a major foreground contaminant of observations of the cosmic microwave background (CMB), particularly at high multipoles. In order to subtract effects of such objects from CMB observations, it is necessary to know the flux densities of individual bright sources as well as the statistical properties of the overall source population. Knowledge of the brightest individual sources comes directly from the CMB surveys themselves. *Wilkinson Microwave Anisotropy Probe* (*WMAP*) has detected sources down to ~0.5 Jy at 22–93 GHz (Gold et al. 2010) and the more sensitive Low Frequency Instrument (LFI) in the *Planck* satellite will detect sources with flux densities of a few hundred mJy at 33, 44 and 70 GHz. However, a knowledge of the statistical properties of significantly weaker sources is desirable.

At the present time, there are no point source surveys with the appropriate combinations of flux density limit and frequencies to understand the contaminating effect that these sources have on CMB experiments such as *Planck*. Thus at present one must rely on measuring the high-frequency properties of sources selected from lower frequency surveys in order to infer the high-frequency population statistics. We have a programme aimed at characterizing the high-frequency radio source population in total intensity (Lowe et al. 2007; Gawroński et al. 2010) and polarization (Battye et al. 2010; Jackson et al. 2010). The present paper is the latest in this series, being intermediate in flux density between the strong (>350 mJy at 4.85 GHz) Caltech–Jodrell Bank flat-spectrum (CJF) sample (Lowe et al. 2007) and the weaker Very Small Array (VSA) sources (Gawroński et al. 2010).

The Combined Radio All-sky Targeted Eight-GHz Survey (CRATES; Healey et al. 2007) is a sample of ~11 000 strong flat-spectrum sources with measured flux densities at 8.4 GHz. CRATES is currently the most complete large-area, flat-spectrum point source sample at flux densities of hundreds of mJy. It samples a flux density range starting over an order of magnitude lower than the *WMAP* source sample (Gold et al. 2010). Thus CRATES sources represent excellent targets to follow up at higher frequencies.

The CRATES sample was originally selected to study blazars – radio-loud active galactic nuclei in which the relativistic jet axis points close to the observer's line of sight. This angle of

*E-mail: mnras@mikepeel.net

© 2010 The Authors. Journal compilation © 2010 RAS

The University of Manchester
Jodrell Bank
Observatory

MANCHESTER
1824

Mon. Not. R. Astron. Soc. **378**, 673–680 (2007) doi:10.1111/j.1365-

Preliminary Sunyaev–Zel'dovich observations of galaxy clusters with OCRA-p

Katy Lancaster,[1]* Mark Birkinshaw,[1] Marcin P. Gawroński,[3] Ian Browne,[2] Roman Feiler,[3] Andrzej Kus,[3] Stuart Lowe,[2] Eugeniusz Pazderski[3] and Peter Wilkinson[2]

[1] *University of Bristol, Tyndall Avenue, Bristol BS8 1TL*
[2] *Jodrell Bank Observatory, University of Manchester, Macclesfield, Cheshire SK11 9DL*
[3] *Torun Centre for Astronomy, Nicolaus Copernicus University, ul. Gagarina 11, 87-100 Torun, Poland*

Accepted 2007 March 29. Received 2007 March 28; in original form 2006 November 3

ABSTRACT

We present 30-GHz Sunyaev–Zel'dovich (SZ) observations of a sample of four
with a prototype of the One Centimetre Receiver Array (OCRA-p) which
the Torun 32-m telescope. The clusters (Cl 0016+16, MS 0451.6–0305, MS 10
Abell 2218) are popular SZ targets and serve as commissioning observatio
detected with clear significance (4–6σ) and values for the central temperature
in good agreement with measurements reported in the literature. We believe
effects are successfully suppressed by our observing strategy. The relatively s
times required to obtain these results demonstrate the power of OCRA-p and it
future SZ studies.

Key words: galaxies: clusters: individual: Cl 0016+16 – galaxies: clust
MS 0451.6–0305 – galaxies: clusters: individual: MS 1054.4–0321 – galaxi
dividual: A2218 – cosmic microwave background – cosmology: observations.

1 INTRODUCTION

The Sunyaev–Zel'dovich (SZ) effect is a spectral distortion of the cosmic microwave background (CMB) caused by the inverse Compton scattering of CMB photons off the hot plasma found in clusters of galaxies. At low radio frequencies the SZ effect manifests itself as a fractional decrement in the CMB of the order of 10^{-4}, whereas at frequencies greater than ~220 GHz an increment is observed.

Since the first SZ detections in the 1970s (Birkinshaw, Gull & Northover 1978) much progress has been made. Extensive interferometric studies have been undertaken, from the first SZ images (Jones et al. 1993), to the use of cluster samples to perform cosmological studies (e.g. Grego et al. 2001; Reese et al. 2002; Saunders et al. 2003; Jones et al. 2005; Bonamente et al. 2006). Radiometers (e.g. Myers et al. 1997) and bolometers (e.g. Benson et al. 2004) have also been used to good effect. More recently, purpose-built CMB instruments have proved their worth in SZ studies (Udomprasert et al. 2004; Lancaster et al. 2005), although contamination from primordial anisotropies can severely limit the achievable signal-to-noise ratio.

Measurements of the thermal and kinematic SZ effects are studied for the unique information that they can provide on cosmology

and the structures of cluster atmospheres (see re
shaw 1999 and Carlstrom, Holder & Reese 2002
work in the field of SZ studies to date has been
non-ideal instruments, numerous purpose-built SZ
currently under construction (e.g. AMiBA, Lo, C
2000; AMI, Kneissl et al. 2001; SZA, Loh et
Kosowsky 2003; SPT, Ruhl et al. 2004) all with
of performing blind surveys. Such work will explo
shift independence of the SZ effect to produce cata
essentially mass-limited, and thus less affected by
plague selection via optical or X-ray methods. S
counts will be used to further constrain the cosmol
study cluster evolution from formation until the pr
scopes which have the capability to produce high
will additionally provide the opportunity to better u
physics.

The One Centimetre Receiver Array (OCRA
2000) is a planned 100-element continuum receive
excellent surveying and imaging capabilities, and
for performing blind surveys in order to study ra
lations and SZ clusters. The prototype for OCR
two-element receiver mounted on the 32-m teles
Centre for Astrophysics of the Nicolas Coper
Poland. Even at this preliminary stage, while
concept is being tested, high-sensitivity SZ m

*E-mail: katy.lancaster@bristol.ac.uk

© 2007 The Authors. Journal compilation © 2007 RAS

Mon. Not. R. Astron. Soc. **000**, 1–14 () Printed 21 June 2011 (MN LaTeX style file v2.2)

arXiv:1106.3766v1 [astro-ph.CO] 19 Jun 2011

Sunyaev Zel'dovich observations of a statistically complete sample of galaxy clusters with OCRA-p

Katy Lancaster[1], Mark Birkinshaw[1], Marcin P. Gawroński[2], Richard Battye[3], Ian Browne[3], Richard Davis[3], Paul Giles[1], Roman Feiler[2], Andrzej Kus[2], Bartosz Lew[2], Stuart Lowe[3], Ben Maughan[1], Abdulaziz Mohammad[1], Bogna Pazderska[2], Eugeniusz Pazderski[2], Mike Peel[3], Boud Roukema[2] and Peter Wilkinson[3]

[1] *H. H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL*
[2] *Toruń Centre for Astronomy, Nicolaus Copernicus University, ul. Gagarina 11, 87-100 Toruń, Poland*
[3] *Jodrell Bank Centre for Astrophysics, The University of Manchester, Alan Turing Building, Manchester M13 9PL*

Received **insert**; Accepted **insert**

ABSTRACT

We present 30 GHz Sunyaev Zel'dovich observations of a statistically complete sample of galaxy clusters with OCRA-p. The clusters are the 18 most X–ray luminous clusters at $z > 0.2$ in the ROSAT Brightest Cluster Sample. We correct for contaminant radio sources via supplementary observations with the Green Bank Telescope, also at 30 GHz, and remove a cluster that is contaminated by an unresolved X-ray source. All 17 remaining clusters have central SZ effects with Comptonisation parameter y_0 exceeding 1.9×10^{-4}, and 13 are detected at significance $\geqslant 3\sigma$. We use our data to examine scalings between y_0 and X-ray temperature, X-ray luminosity, and the X-ray mass proxy Y_X, and find good agreement with predictions from self-similar models of cluster formation, with an intrinsic scatter in y_0 of about 25%. We also comment on the success of the observations in the face of the contaminant source population, and the implications for upcoming cm-wave surveys.

Key words: cosmology: observations – cosmic microwave background – galaxies: clusters: individual (A1835, ZWCL1953, A689, ZWCL3146, RXJ1532.9+3021, A2390, A2219, RXJ2129.6+0005, A2261, A781, A697, A1763, A68, A520, A267, RXJ0439.0+0715, ZWCL7160, A773) – methods: observational

1 INTRODUCTION

The thermal Sunyaev Zel'dovich (SZ) effect (Sunyaev & Zel'dovich 1972) is a spectral distortion of the Cosmic Microwave Background (CMB) radiation due to inverse Compton scattering by the hot gas in galaxy clusters. It has long been exploited in cosmological and cluster studies in order to derive, for example, the Hubble constant (e.g. Hughes & Birkinshaw 1998, Mason et al. 2001, Reese et al. 2002, Saunders et al. 2003, Bonamente et al. 2006) and the gas mass fraction (e.g. Grego et al. 2001, Lancaster et al. 2005, LaRoque et al. 2006). Thanks to well developed techniques, detections are becoming routine although signal–to–noise remains quite poor. However, we are entering an era of purpose–built instruments so this is set to improve dramatically, enabling SZ research to reach its evident potential.

The main focus of the SZ community at present is to utilise the redshift–independence of the SZ surface brightness in order to perform blind surveys for galaxy clusters. While other techniques suffer from large intrinsic biases and complex selection effects, SZ surveys will produce almost *mass–limited* catalogues and thus far superior datasets for constraining cosmological models. The dedicated SZ surveys, for example Planck (Ade et al. 2011), SPT (Staniszewski et al. 2009, Vanderlinde et al. 2010), ACT (Menanteau et al. 2010, Marriage et al. 2010) and the SZA (Muchovej et al. 2011) are now generating results. Many more are expected in the near future, e.g. from AMI (Zwart et al. 2008). In order to fully exploit the results of these surveys, it will be necessary to improve understanding of both the 'selection effect' due to the presence of unsubtracted radio sources, and also the scalings between cluster SZ observ-

The University of Manchester
Jodrell Bank
Observatory

A&A 498, 463–470 (2009)
DOI: 10.1051/0004-6361/200811369
© ESO 2009

Astronomy & Astrophysics

Survey of planetary nebulae at 30 GHz with OCRA-p

B. M. Pazderska[1], M. P. Gawroński[1], R. Feiler[1], M. Birkinshaw[3], I. W. A. Browne[2], R. Davis[2], A. J. Kus[1], K. Lancaster[3], S. R. Lowe[2], E. Pazderski[1], M. Peel[2], and P. N. Wilkinson[2]

[1] Toruń Centre for Astronomy, Nicolaus Copernicus University, 87-100 Toruń/Piwnice, Poland
e-mail: bogna@epsrv.astro.uni.torun.pl
[2] Jodrell Bank Centre for Astrophysics, University of Manchester, Manchester M13 9PL, UK
[3] University of Bristol, Tyndall Avenue, Bristol BS8 ITL, UK

Received 17 November 2008 / Accepted 18 February 2009

ABSTRACT

Aims. We report the results of a survey of 442 planetary nebulae at 30 GHz. The purpose of the survey is to develop a list of planetary nebulae as calibration sources that could be used for high frequency calibration in future. For 41 PNe with sufficient data, we test the emission mechanisms in order to evaluate whether or not spinning dust plays an important role in their spectra at 30 GHz.
Methods. The 30-GHz data were obtained with a twin-beam differencing radiometer, OCRA-p, which is in operation on the Toruń 32-m telescope. Sources were scanned both in right ascension and declination. We estimated flux densities at 30 GHz using a free-free emission model and compared it with our data.
Results. The primary result is a catalogue containing the flux densities of 93 planetary nebulae at 30 GHz. Sources with sufficient data were compared with a spectral model of free-free emission. The model shows that free-free emission can generally explain the observed flux densities at 30 GHz thus no other emission mechanism is needed to account for the high-frequency spectra.

Key words. radio continuum: general – planetary nebulae: general

1. Introduction

The planetary nebula (PN) phase in the evolution of low mass stars lasts only about 10^4 years. It begins once the central star reaches an effective temperature of 20 000 K and ionises the shell of material developed during asymptotic giant branch (AGB) evolution. The end of this phase is defined by termination of nuclear burning in a thin outer shell of the star and then rapid dispersal of the nebula. At radio wavelengths, planetary nebulae emit continuum radiation in a free-free process and are among the brightest Galactic radio sources. Their radio flux densities do not suffer the high levels of extinction present in the optical regime. Since most planetary nebulae occupy the Galactic plane where extinction is high, radio detections and radio flux density measurements are important.

Planetary nebulae are mostly compact sources because they are distant or intrinsically small. Their relatively strong and stable radio emission makes them good candidates as calibration sources.

Many radio continuum observations of planetary nebulae have been made at 1.4, 5 and 14.7 GHz (see Condon & Kaplan 1998; Acker et al. 1994; Aaquist & Kwok 1990; Milne & Aller 1982). There is still only limited data at frequencies above 30 GHz and most of those observations were obtained with interferometers such as the VLA; relatively little comes from single dishes. To extend the spectral range and to make total flux density measurements, we have used the new One Centimetre Radio Array prototype (OCRA-p) receiver to observe planetary nebulae at 30 GHz. This receiver is mounted on Toruń's 32-m radio telescope and is described in Sect. 2. OCRA-p receiver is outlined in detail by Lowe (2005). The survey for planetary nebulae was one of the first successful observations made using this system (together with measurements of flat-spectrum sources by Lowe et al. (2007), and observations of the Sunayaev Zel'dovich effect by Lancaster et al. (2007)). The purpose was to make a list of high frequency calibrators, which can be used to support sky surveys and to test the emission mechanisms in order to evaluate whether or not spinning dust plays an important role in PN spectra.

Our new survey of planetary nebulae brought detections of 93 sources at 30 GHz out of 442, for which the selection criteria are described in Sect. 3. The observing techniques and data reduction process are described in Sect. 3. The results are described in Sect. 4. The comparison of flux densities with the free-free emission model proposed by Siódmiak & Tylenda (2001) is described in Sect. 5. Section 6 contains the final conclusions. The measured 30-GHz flux densities of all detected PNe are given in Table 2.

2. OCRA-p

OCRA-p is a 2-element prototype for OCRA (Browne et al. 2000) – a 100-element array receiver. The OCRA-p receiver was constructed at the University of Manchester and was funded by a EU Faraday FP6 grant together with the Royal Society Paul Instrument fund. It has been mounted on the Toruń 32-m radio telescope owned by the Centre for Astronomy, Nicolaus Copernicus University, Toruń in Poland.

The basic OCRA design was based on the prototype demonstrator for the Planck Low Frequency Instrument (Mandolesi et al. 2000) and is similar to the *K*-band receivers mounted on the WMAP spacecraft (Jarosik et al. 2003). The nominal system specification is presented in Table 1. OCRA-p has two closely spaced feeds in the secondary focus of the 32 m telescope and thus there is very similar atmospheric emission in each beam. The basic observing mode with this radiometer involve switching continuously between the two horns and between two states of a 277–*Hz* phase switch (0 and 180°), located in one arm of the receiver. The switching frequency is much greater than the

Article published by EDP Sciences

Outside
GCN
IAUCs
Other
MacOS: Dashboard Widget
Follow ATel on Twitter

The Astronomer's Telegram

Post a New Telegram | Search | Information
Telegram Index
Obtain Credential To Post | RSS Feeds | Email Settings

Present Time: 29 Sep 2011; 11:21 UT

ATel News
ATELstream
ATel Community Site

[Previous | Next |]

Radio detection of V407 Cyg at 30GHz with OCRA-p on the Torun telescope

ATel #2511: M.P. Gawronski (TCfA, Torun, Poland), M.W. Peel (JBCA, Manchester, UK), R. Feiler, A.J. Kus, B.M. Pazderska, E. Pazderski (TCfA, Torun, Poland), I.W.A. Browne, R.J. Davis, S.R. Lowe, P.N. Wilkinson (JBCA, Manchester, UK), M. Birkinshaw, K. Lancaster (University of Bristol , Bristol, UK)
on ***25 Mar 2010; 17:09 UT***
Credential Certification: Michael Peel (michael.peel@manchester.ac.uk)

Subjects: Radio, Nova, Transient, Variables

Referred to by ATel #: 2514, 2529, 2536, 2546, 2741, 2905

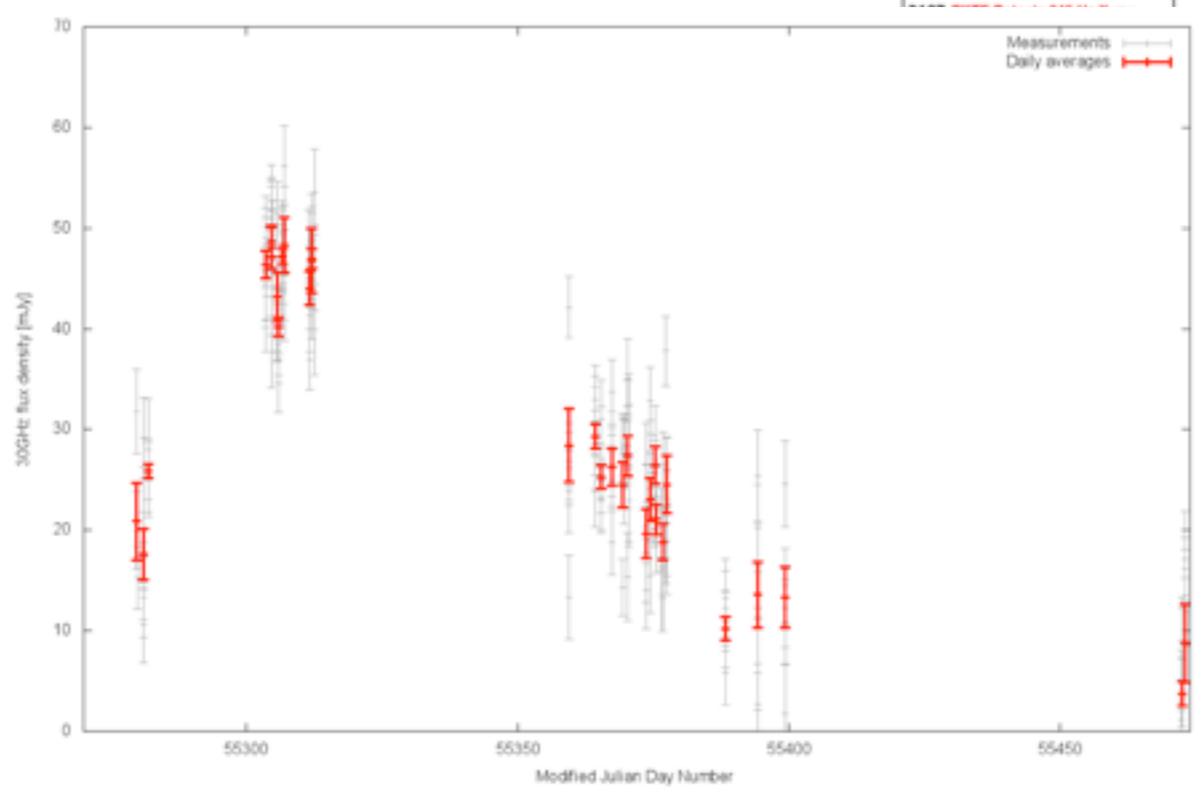
Following the Fermi-LAT detection of the transient gamma-ray source J2102+4542 lying close to the galactic plane (ATEL #2487; also see ATEL #2498), and the optical observations of a nova outburst in the same region from V407 Cyg (AAVSO Alert 419 / Special Notice 201), we have observed V407 Cyg at 30 GHz using the One Centimetre Receiver Array Prototype (OCRA-p) on the Torun 32-m telescope and detected it at high significance.

The measured flux densities for two separate observing sessions are: 23 ± 3 mJy at 4UT on 24 March 2010 and 18 ± 3 mJy at 10UT on 25 March 2010. The source position observed was RA: 21h 02m 09.8s, Dec: +45d 46m 33.0s (J2000).

Intriguingly, this is significantly lower than the tentative detection at 32 GHz of ~60mJy reported in ATEL #2506, indicating a potential decrease of flux density over time, although we currently see no evidence of significant time variations from the OCRA-p measurements.

We will continue observing V407 Cyg over the coming days/weeks, weather permitting. We encourage other telescopes to observe the source, particularly at high radio frequencies.

Related
2905 OCRA monitoring of V407 Cyg at 30GHz
2741 EVLA monitoring of V407 Cyg
2546 Discovery of coronal emission lines in V407 Cyg
2536 VLBI detection of V407 Cyg
2529 V407 Cyg: Allen Telescope Array Observations
2514 15-GHz flux density of V
2511 Radio detection of V407 Cyg at 30GHz with OCRA-p on the Torun telescope
2506 Radio detection of V407 Cyg - the possible counterpart of the new Fermi LAT Gamma-ray Transient J2102+4542 with the Effelsberg 100-m, OVRO 40-m and IRAM 30-m telescopes
2498 INTEGRAL view of the sky field containing Fermi J2102+4542
2487 Fermi LAT Detection of a New Galactic Plane Gamma-ray Transient in the Cygnus Region: Fermi J2102+4542, and its Possible Association with V407 Cyg
2232 Radio upper limits for the accreting millisecond X-ray pulsar IGR J17511-3057
2220 XMM-Newton gives spectral modeling and updated ephemeris of the Accreting Millisecond Pulsar IGR J17511-3057
2216 A candidate near-infrared counterpart to IGRJ 17511-3057
2215 Chandra Observations of IGR J17511-3057: A Revised Source Position
2199 Discovery of 245 Hz burst oscillations from the accreting millisecond pulsar IGR J17511-3057
2198 Swift follow-up of the newly discovered burster millisecond pulsar IGR J17511-3057



Current observations

- Following up WMAP and Planck sources
  Radio catalogue selected at 30-100GHz
- Monitoring strongest Fermi sources (part of F-GAMMA)
- SZ observations of high-redshift clusters
- Observing variable sources as opportunities arise

Conclusions

- OCRA has similar resolution to AMI at twice the frequency
- Particularly suited to follow-up observations
- Measure spectra at wider range of frequencies
- Can also map out regions - particularly useful for AME studies