OCRA and AMiBA:

First results from two new Sunyaev Zel'dovich experiments

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OCRA

- SZ imaging & surveys
- Torun, Poland
- 30GHz array receiver
- Prototype installed
- 32-m telescope
- First results published
- Observing large sample
- & XMM-LSS candidates

OVERVIEW

The OCRA (One Centimetre Receiver Array, Browne et al 2000) project is a collaboration between Bristol, the University of Manchester, and the Nicolas Copernicus University in Torun, Poland. The ultimate aim is to build a 100-element continuum receiver which will have excellent surveying and imaging capabilities, ideal for performing blind surveys for SZ clusters. The prototype for OCRA, OCRA-p is a two-element receiver mounted on the 32-m telescope at the Torun centre for Astrophysics. Even at this preliminary stage, while the instrument concept is being tested, high-sensitivity SZ measurements are possible, with imaging and surveying planned for the future. The next-phase detector, OCRA-F, is currently under construction at Jodrell bank. This 16-element array will further prove the instrument concept, and will be ideal for cluster imaging and surveying.

FIRST RESULTS

We have observed a small sample of well-known clusters with OCRA-p in order to assess the performance of the telescope/receiver combination. The clusters are Cl0016+16, MS0451.6-0305, MS1054.4-0321 and Abell 2218, all of which have been studied extensively in X-rays, lensing and SZ. OCRA-p operates via a position switching strategy in order to subtract contamination from the ground and atmosphere. Due to the extended nature of clusters, we naturally subtract out some of the cluster signal. We later apply a β-model analysis based on parameters derived from X-ray data, in order to derive the true SZ signal. We note that this strategy is non-ideal, but in this context, where the observations are confined to the central regions of the clusters, we argue that the adverse effects are small. We apply corrections for known radio sources based on 30GHz flux density values taken from the OVRO/BIMA observations of Reese et al (2002) where available, and extrapolate from lower frequency measurements for the other cases. We detect all four clusters to high significance:

Cluster	ΔT(μK)
Cl0016+16	-1647±302
MS0451.6-0305	-1558±284
MS1054.4-0321	-1722±283
A2218	-1159±288

These measured decrements are in good agreement with results reported in the literature, affirming that our observing strategy, modeling and radio source treatment are all effective. The short integration times (~3 hours for each cluster) required to obtain these clear detections demonstrate the power of OCRA in SZ studies.

For more details, please see Lancaster et al (2007) - MNRAS online early, arXiv:0705.336v1(astroph).

FUTURE PLANS

OCRA-p is now observing 18 clusters selected from the Brightest Cluster Sample (BCS, Ebeling 1998). The sample is highly complete, and will provide an SZ catalogue with uniquely well-understood selection effects. This will enable us to test SZ/X-ray scaling relations (e.g. Cooray 1999) and, through combination with high quality X-ray data, further test cluster models. We also anticipate performing observations of the high-redshift cluster candidates found by the XMM-Newton Large Scale Structure Survey (XMM-LSS) such as that reported by Bremer et al (2006). The two samples will be at significantly different mean redshifts, thus facilitating studies of the evolution of cluster properties.

The OCRA-P commissioning observations also pave the way for SZ imaging, although this will be far more efficient with the multiple-beam OCRA-F. OCRA-F should be ready for installation on the telescope in late 2007, allowing us to make the first well resolved maps of SZ clusters. OCRA-F, and indeed the full 100-beam instrument, will also be used for blind surveys . Radio sources will, of course, be a problem, but corrections will be possible via follow-up observations of suspected sources found in the reference-beam traces.

AMiBA

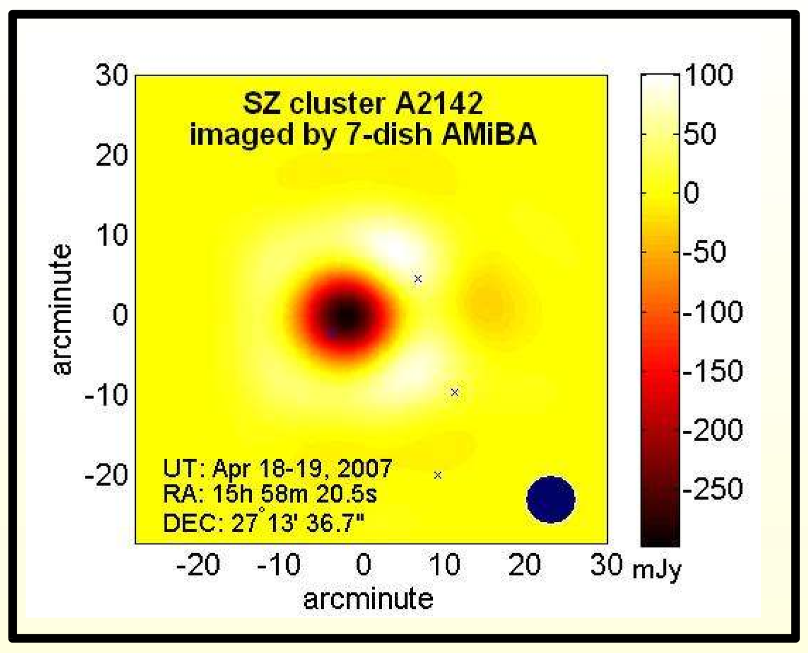
- SZ surveys
- High-l CMB power
- CMB polarisation
- Mauna Loa, Hawaii
- 90 GHz Interferometer
- Platform-mounted
- 7 dishes (commissioning)

OVERVIEW

The AMiBA (Array for Microwave Background Anisotropy) project is a focus of research of the Institute of Astronomy and Astrophysics of the Academia Sinica (ASIAA) and the National Taiwan University. AMiBA is a table mounted interferometer mounted on Mauna Loa, and operates at 90GHz. It will ultimately consist of 13 1.2m antennas, and will be sufficiently sensitive for performing blind SZ surveys, probing the high-l CMB power spectrum, and for detecting CMB polarisation. It is currently well into the commissioning phase. Seven 60cm antennas are mounted on the platform, providing resolution comparable with previous experiments such as the VSA (e.g. Watson et al 2003) and CBI (e.g. Padin et al 2001). This will facilitate cross-checking of results in the early stages, and additionally makes AMiBA ideal for studying low-redshift clusters.

FIRST SZ LIGHT

Since the seven dishes were mounted in Autumn 2006, the AMiBA team have carried out rigorous testing. AMiBA is a co-mounted interferometer, and like similar instruments, requires a tailored observing strategy in order to eliminate the problem of ground emission. A two-patch technique has been applied to observations of planets with excellent results. Abell 2142 was chosen as the first SZ target due to its relatively large angular size and strong SZ effect (see e.g. Lancaster et al 2005). After less than 6 hours integration, the cluster was detected convincingly:



The blue crosses indicate the positions of radio sources, all of which do not appear to have been detected at by AMiBA. This map is not cleaned, so artifacts from the AMiBA beam may be present. The peak signal is ~300mJy.

FUTURE PLANS

AMiBA is still undergoing tests and, as part of this commissioning, is observing a sample of well-known clusters for both verification and scientific purposes. Results from these preliminary SZ observations will be published in the near future, and will be followed by observations of primordial CMB fluctuations. Once the team are satisfied with the telescope's performance and calibration, efforts will turn to the next phase.

The 1.2m dishes for AMiBA are currently under construction, and should be available later in the year. This will dramatically increase the telescope's sensitivity and angular resolution, facilitating blind surveys for SZ clusters. Combination of data with other experiments (e.g. OCRA, and AMI, Barker et al 2006) will provide multi-frequency information, thus enabling spectroscopic separation of the thermal SZ from the kinematic signal, CMB primordials, and radio sources. Once in its final configuration, AMiBA will detect any cluster at z > 0.5, with mass > 4 x 10^{14} $M_\odot$ to 5σ in just three hours, making it an extremely competitive survey instrument.