AMiBA: Now and Future

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Abstract

AMiBA is an interferometric experiment designed to study cosmology through the observation of the anisotropy in Cosmic Microwave Background (CMB). Its first-phase setup, a 7-antenna system, focuses on the observation of galaxy clusters through the Sunyaev-Zel'dovich (S-Z) effect. The current AMiBA operates at 86-104 GHz with 7 close-packed antennas of 60 cm in diameter giving a synthesized resolution of 6 arcminutes. An observing strategy with on-off-source switching is used to minimize the effects from electronic offset and ground pickup. In 2007, we have successfully imaged 6 S-Z clusters. The expanded AMiBA, expected to be completed in the early 2009, will contain 13 antennas of 120 cm in diameter giving a synthesized resolution of about 1 arcminute. In this talk, we will report the results of the first-year observation in 2007 on several massive low-redshift (z~0.2) clusters, and discuss the prospects of the expanded AMiBA that will start operating in 2009. Data analysis and possible systematic effects will be also addressed.

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I. Observational Results in 2007

The Y.T. Lee Array for Microwave Background Anisotropy (previously named as Array for Microwave Background Anisotropy, AMiBA) is an interferometric experiment initiated in Taiwan in 2000 and dedicated on Mauna Loa in Hawaii on October 3, 2006. In 2007, we observed 6 S-Z clusters, whose details are summarized in table 1 and Figure 1.

S-Z cluster	z	X-ray temp [keV]	β	Θ_c [arcsec]	Y2500 [mJy] (30 GHz)	Y2500 [mJy] (145 GHz)	notes
A2142	0.089	8.68±0.12	1.0±0.3	221.4±8.4	-	-	merger; lensing data
A2163	0.202	12.2±1.0	0.674±0.010	87.5±2.5	143	533	merger with shock; high-temp. regions
A2261	0.224	8.82±0.35	0.516±0.013	15.7±1.1	40	440	lensing data
A2390	0.232	10.13±1.10	0.67	52.0	78	-	relaxed; lensing data
A1689	0.183	9.66±0.20	0.609±0.005	26.6±0.7	57	460	relaxed; lensing data; almost isothermal
A1995	0.322	8.59±0.70	0.770±0.80	38.9±5.0	25		

Table 1: Basic properties of the S-Z clusters observed by 7-dish AMiBA in 2007.

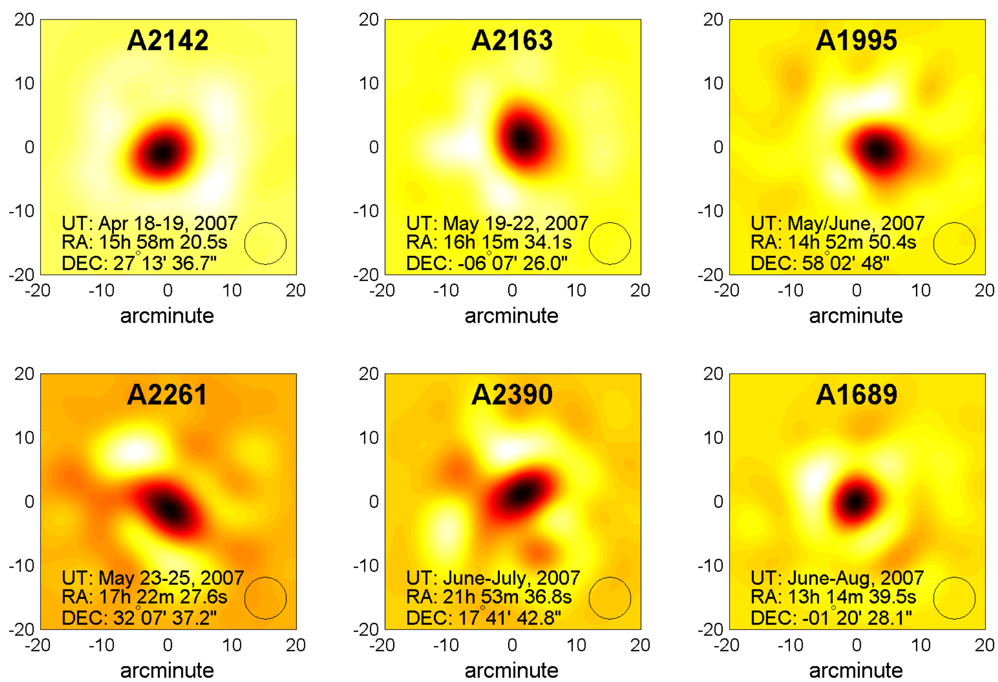

Figure 1: The S-Z clusters imaged by 7-dish AMiBA in 2007. The evident temperature decrement at the cluster centers is a theoretically expected feature for S-Z signals at around 90 GHz. These images can be studied with the X-ray and the weak-lensing images in order to investigate the cluster physics and the dark matter distribution.

II. Expansion of AMiBA in 2008/2009

AMiBA is expandable to a total of 19 elements, and currently has been funded to expand to 13 elements with dishes of 1.2 m in diameter. The 13-element system is expected to start operating in the early 2009. Its specifications are listed in Table 2. Figure 2 shows its current setup.

<table>
<tr><th colspan="4">Common features</th></tr>
<tr><td>Dual-channel receiver</td><td>MMIC; L and R</td><td>Platform</td><td>6 m configurable; carbon fiber</td></tr>
<tr><td>Operation frequency</td><td>86-102 GHz</td><td>Correlator</td><td>analog (bandwidth 16 GHz)</td></tr>
<tr><td>Site</td><td colspan="3">Mauna Loa (3400 m in elevation)</td></tr>
<tr><td>Mounting system</td><td colspan="3">Hexapod (±30° in polarization; 30°-90° in elevation)</td></tr>
<tr><th colspan="4">7-element</th></tr>
<tr><td>Antenna</td><td>60-cm Cassegrain; carbon fiber</td><td>Synthesized resolution</td><td>6 arcmin</td></tr>
<tr><td>FOV</td><td>23 arcmin</td><td>Observation type</td><td>targeted</td></tr>
<tr><th colspan="4">13-element</th></tr>
<tr><td>Antenna</td><td>120-cm Cassegrain; carbon fiber</td><td>Synthesized resolution</td><td>2 arcmin</td></tr>
<tr><td>FOV</td><td>11 arcmin</td><td>Observation type</td><td>targeted and survey</td></tr>
</table>

Table 2: Specifications of 7-element AMiBA in 2007, and its 13-element expansion in 2008.

Figure2. AMiBA with its initial 7-element configuration with 60cm reflectors operating on Mauna Loa.

The 13-element AMiBA will aim to detect 50-100 S-Z clusters per year. A possible configuration of the antennas and its u-v coverage are shown in Figure 3. Figure 4 shows a simulated S-Z field of 1 square degree and the corresponding image recovered by the 13-element AMiBA. Figure 5 shows the redshift distribution of S-Z clusters from simulated AMiBA deep survey. The peak-flux limit is about 3.3 mJy/beam, giving a mass limit of about $2\times10^{14}h^{-1}\mathrm{M}_{\odot}$.

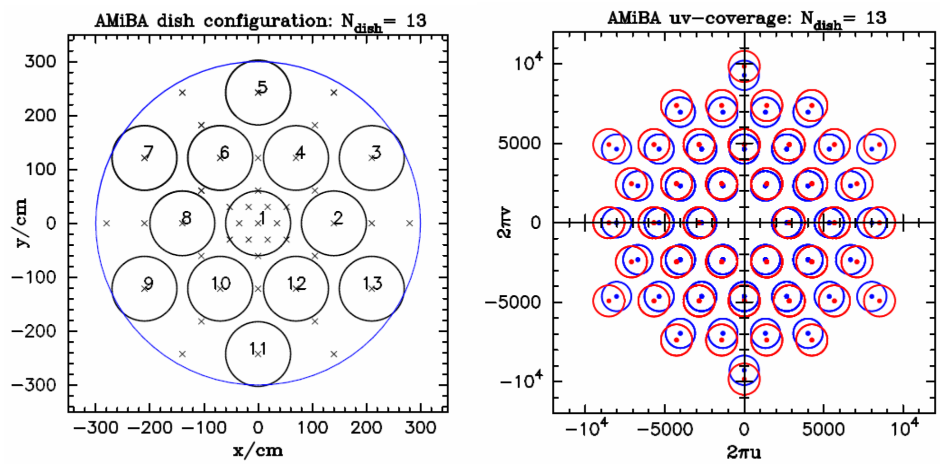

Figure3. A possible antenna configuration (left) and its u-v coverage (right) for the 13-element AMiBA.

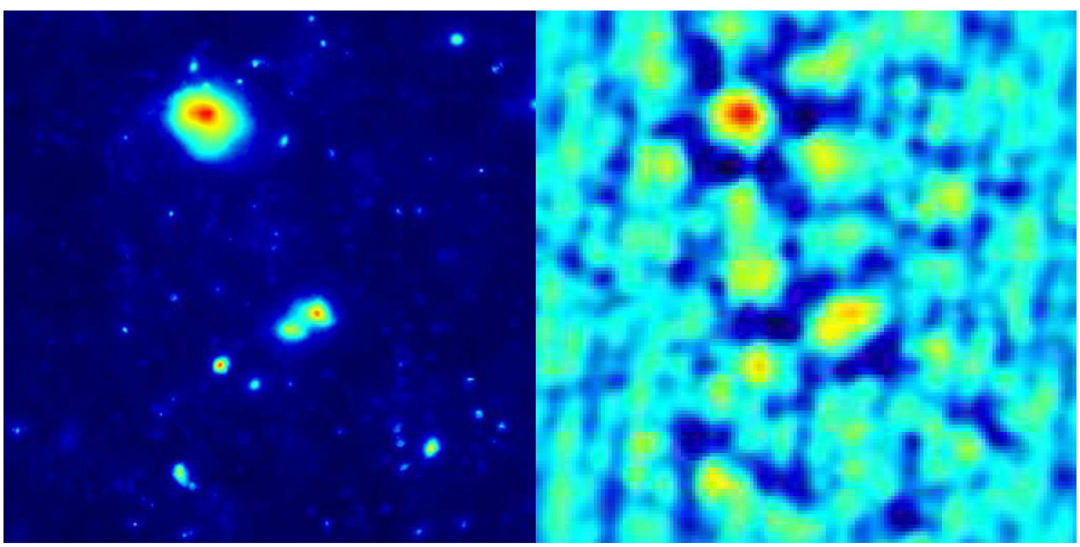

Figure 4. A simulated S-Z field of 1 square degree and the image recovered by the 13-element AMiBA.

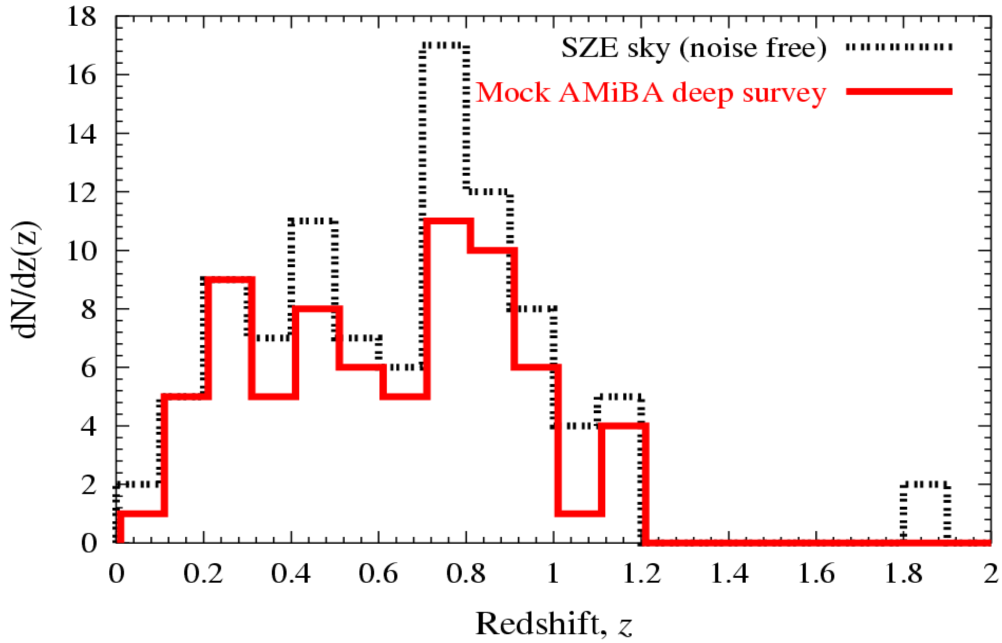

Figure 5. A simulated redshift distribution for deep AMiBA survey.

III. Science Goals and Future collaboration

AMiBA is designed to achieve the following goals:

1. Targeted S-Z observations to determine Hubble parameter and cluster physics.
2. S-Z survey to investigate large-scale structure and background cosmology.
3. Observation of primary CMB for both temperature and polarization to constrain background cosmology.
4. Search for the imprints of cosmic defects to constrain fundamental physics such as SUSY GUT, string theory, hybrid inflation, etc.
5. Search for missing baryons.

To achieve these goals, we have been seeking for collaboration with the following projects: XMM, Subaru, CFHT, and SDSS.