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INVESTIGATION OF TWO REPORTED ARCMINUTE-SCALE MICROWAVE DECREMENTS AT 28.5 GHz

W. L. HOLZAPFEL,[1] J. E. CARLSTROM,[2] L. GREGO,[3] M. JOY,[4] AND E. D. REESE[2]

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ABSTRACT

The Ryle telescope has been used at a frequency of 15 GHz, to detect a flux decrement in the direction of the quasar pair PC 1643+4631A, B. This signal was interpreted as the Sunyaev-Zeldovich effect (SZE) produced by a distant cluster of galaxies. In the course of an effort to measure cosmic microwave background (CMB) anisotropies with a deep pointing of the VLA at 8.4 GHz, a second group detected a similar, but smaller, decrement. They also proposed that this signal might be explained as the SZE signal produced by a distant galaxy cluster. We report observations with the Berkeley-Illinois-Maryland Association (BIMA) interferometer operating at 28.5 GHz, in which we find no evidence for a SZE signal in the direction of either of the proposed clusters. In the case of the Ryle detection, the BIMA data are inconsistent with the SZE model proposed to explain the observed decrement at greater than 99.99% confidence. Together with published X-ray and optical searches, these results make a compelling case against the interpretation of the Ryle decrement as being due to the SZE in a massive cluster of galaxies. For the smaller VLA source, the BIMA observations are not as constraining. The BIMA data are inconsistent with the proposed SZE model at greater than 90% confidence.

Subject headings: cosmic microwave background — cosmology: observations — galaxies: clusters: general — techniques: interferometric

1. INTRODUCTION

The Sunyaev-Zeldovich effect (SZE) is the scattering of cosmic microwave background (CMB) photons by the hot plasma bound to massive clusters of galaxies. This scattering results in a spectral distortion of the CMB, observable at wavelengths from the radio to the submillimeter. At frequencies lower than ~217 GHz, the SZE is observed as a decrement in the temperature of the CMB toward massive clusters of galaxies. In the Rayleigh-Jeans portion of the spectrum, the temperature decrement depends only weakly on frequency and is given by $\Delta T/T_{\rm CMB} \approx -2y$, where y is the Comptonization, which is a constant property of the hot plasma. Therefore, at radio frequencies, the SZE flux of a given source increases with frequency approximately as $\Delta S_\nu \propto \nu^2$.

Because the SZE surface brightness of distant clusters is independent of redshift, radio surveys have the potential to be a particularly powerful method of locating distant galaxy clusters. In low-density universes, clusters are presently not evolving rapidly and should exist relatively unchanged to high redshift. The ability of cluster number counts, especially at high redshift, to distinguish between different cosmological models has been extensively discussed; see, e.g., Barbosa et al. (1998).

Significant detections of the SZE have been obtained for dozens of X-ray and optically selected clusters (see Birkinshaw 1999 for a review). Historically, the sensitivity and sky coverage of radio surveys have not been sufficient to allow the detection of unknown clusters through their SZE signal. However, recent advances in detector technology and observing strategy have placed the goal of using the SZE to search for distant unknown clusters within reach. Recently, two groups working with sensitive interferometers have reported detections of small angular scale flux decrements that are not in the direction of known clusters of galaxies. If the interpretation of these signals as the SZE in distant clusters is correct, these detections are of profound cosmological significance (Bartlett, Blanchard, & Barbosa 1998). The lack of supporting evidence for low-redshift clusters in the direction of the flux decrements and the difficulty of reconciling very high redshift clusters with favored cosmological models have prompted several authors to propose alternative explanations for the decrements (Natarajan & Sigurdson 1999; Dabrowski 1997).

We have observed fields containing the reported decrements with the Berkeley-Illinois-Maryland Association (BIMA) and Owens Valley Radio Observatory (OVRO) interferometers configured with sensitive 28.5 GHz receivers. In this work, we review the previous observations of these fields and explore the constraints that the BIMA and OVRO results place on the explanation of the observed decrements as the SZE in distant clusters. In a companion paper, we use the observations of the two fields discussed here and five additional fields to place limits on arcminute-scale CMB anisotropies (Holzapfel et al. 2000).

2. RYLE DECREMENT

2.1. *Ryle Telescope Observations*

The Ryle telescope has been used by Jones et al. (1997) to image the surroundings of a number of radio-quiet quasars at a frequency of 15 GHz. The deepest of these images was toward the $z = 3.8$ quasar pair PC 1643+4631A, B. The CLEANed map, containing baselines from 1.25 to 5.4 kλ, had an rms noise of 33 μJy in a 33″ × 42″ beam and was used to search for point sources. Three point sources with flux densities of 550, 200, and 150 μJy were detected and CLEANed from the visibility data. When only baselines shorter than 1.25 kλ were included, the east-west configuration of the Ryle telescope produced a north-south elongated beam 110″ × 170″. They find an essentially

[1] Department of Physics, University of California, Berkeley, CA 94720.
[2] Department of Astronomy, University of Chicago, Chicago IL 60637.
[3] Harvard-Smithsonian Center for Astrophysics, Mail Stop 83, 60 Garden Street, Cambridge MA 02138.
[4] Space Science Laboratory, SD50, NASA Marshall Space Flight Center, Huntsville AL 35812.

unresolved decrement in the resulting map of -380 ± 64 μJy centered at $\alpha = 16^{h}43^{m}44^{s}.0$, $\delta = +46°30'20''$ (B1950). The authors interpret their signal as being due to the SZE in a massive cluster of galaxies. Modeling the emission by a spherical King model,

$$\Delta T = \Delta T_0 \left(1 + \frac{\theta^2}{\theta_c^2}\right)^{-3\beta/2 + 1/2} , \quad (1)$$

with $\beta = \frac{2}{3}$, they find a minimum value for the central temperature decrement of $\Delta T_0 = -560$ μK, with a corresponding angular core radius of $\theta_c = 60''$.

2.2. *X-Ray*

The *ROSAT* PSPC is sensitive to X-rays in the energy range 0.1–2.4 keV, and is therefore well suited to the study of high-redshift clusters. One of the last observations of the *ROSAT* PSPC was used to search for the X-radiation that would be expected from a massive cluster capable of producing the Ryle decrement (Kneissl, Sunyaev, & White 1998). The total time of exposure was $\sim$16 ks. Within a 1'.5 circular aperture around the reported position of the central decrement, there were only 13 counts, compared to the expected background of 15. This result was used to place a limit on the bolometric flux, $f_X < 1.9 \times 10^{-14}$ ergs cm^{-2} s^{-1} at 99.7% confidence. With these results, Kneissl et al. (1997) established a conservative lower limit on the redshift of any isothermal object with temperature between 0.2 and 10 keV and capable of producing the observed SZE decrement of $z > 2.8$. Open models of the universe with $\Omega_m < 0.25$ predict only one cluster on the entire sky with redshift $3 < z < 4$ and mass $M > 2 \times 10^{15}$ $M_\odot$.

2.3. *Optical*

The field for the radio observations was originally selected by Jones et al. (1997) because of the presence of two radio-quiet quasars, PC 1643+4631A, B, with redshifts $z = 3.79$ and 3.83, respectively, and separated by 198''. It was suggested by Saunders et al. (1997) that, in spite of the difference in redshift, the two quasars might be gravitationally lensed images of the same object. If that is correct, this system would be the largest separation lensed multiple image yet discovered. The X-ray results place any candidate for producing the SZE signal at too high a redshift to produce such lensing, and another, closer lensing mass of $\sim 10^{15}$ $M_\odot$ would be necessary.

The field of PC 1643+4631A, B has been extensively searched for an excess of faint galaxies that might be expected to be associated with a distant cluster. Using the lack of excess galaxies, Saunders et al. (1997) constrained the redshift of any cluster to be $z > 1$. This limit was revised downward somewhat by Cotter et al. (1998), who used simulations to show that a cluster at redshift $z = 1$ would be difficult to locate in the PC 1643+4631A, B field.

Deep UVR imaging is an efficient means to find $z = 3$–4 galaxies. Multicolor imaging has been used to place limits on the surface number density of Lyman-break galaxies at $z > 3$ in the direction of the Ryle decrement (Cotter & Haynes 1998; Haynes et al. 1998). These papers claim a 2 σ excess of galaxies over the number expected from the work of Steidel et al. (1998), although, as they point out, the number of objects leading to this result is small. Ferreras et al. (1998) have imaged the region surrounding PC 1643+4631A in the UVR bands. The corner of their 3'.8 $\times$ 3'.8 frame includes the position of the observed decrement. They find that the Lyman-break galaxies are homogeneously distributed across the frame, and do not clump near the reported position of the decrement. This result is reproduced by Haynes et al. (1998). In fact, they find an anticorrelation between the position of Lyman-break galaxies and the Ryle decrement, although the small number of galaxies makes the significance questionable. Given the magnitude limits of the observations, the authors claim that it would be unlikely that galaxies at redshift $z = 3.81$ could be detected. They go on to propose that the dearth of galaxies in the direction of the Ryle decrement is consistent with the lensing signature of a massive cluster at $z \sim 2$. However, the X-ray results place any cluster capable of producing the observed decrement at a redshift of $z > 2.8$, at which point it would be incapable of producing the supposed lensing. Therefore, we conclude that there is no optical evidence for a massive galaxy cluster in the direction of PC 1643+4631A, B.

2.4. *BIMA and OVRO Observations*

We observed a field centered near the Ryle decrement with our centimeter-wave receivers mounted on nine of the 6.1 m telescopes of the BIMA array. This system has been used to obtain high signal-to-noise ratio images of the SZE toward more than 15 clusters, and for more than 20 clusters if we include observations with the same receivers mounted on the OVRO millimeter array (see Carlstrom et al. 1999).

The primary beam at our observing frequency of 28.5 GHz is 6'.6 FWHM. To achieve high brightness sensitivity, seven telescopes were arranged in a compact nonredundant configuration contained within a triangular region roughly 18 m on a side. To improve discrimination against point sources, the remaining two telescopes were placed at stations 47 m east and 70 m north from the center of the compact array. The primary beam and the range of projected baselines (0.6 to 8.3 kλ) are well matched to the 15 GHz Ryle telescope observations (Jones et al. 1997). The position of the observed decrement, which we used for our pointing and phase center, is listed in Table 1.

The system temperatures, scaled to above the atmosphere, ranged from 35 to 55 K, depending on atmospheric water vapor content and elevation of the source. The signals were combined in the BIMA 2 bit digital correlator configured for eight contiguous 100 MHz sections, each with 32 complex channels. After bandpass corrections were made and end channels dropped, channels from each correlator section were averaged to produce eight 100 MHz channels

TABLE 1

BIMA Pointing Centers and Decrement Positions

Description	α (J2000)	δ (J2000)
Ryle decrement	16 45 11.3	+46 24 56
BIMA field	16 45 11.3	+46 24 56
VLA decrement north	13 12 17.1	+42 37 42
VLA decrement center	13 12 17.1	+42 37 28
VLA decrement south	13 12 17.2	+42 37 14
BIMA field	13 12 17.4	+42 38 05

Note.—The entries for BIMA field give the coordinates of the pointing and phase centers for the BIMA observations. The VLA decrement is elongated in declination, and we have included the positions of the northern and southern subpeaks. Units of right ascension are hours, minutes, and seconds, and units of declination are degrees, arcminutes, and arcseconds.

and one wide-band 800 MHz channel. The equivalent noise bandwidth of the wide-band channel after accounting for digitization losses and dropped end channels was 540 MHz. The total on-source integration time for this field was 43.1 hr, spread over 7 days during the period 1997 June 15–August 15, and on 1998 September 3. Using all the data to produce a naturally weighted image resulted in a beam size of $34'' \times 26''$ and a map rms of 91 μJy beam^{-1}, which corresponds to a Rayleigh-Jeans (RJ) temperature map rms of 160 μK. We increased the brightness sensitivity of the image by applying a filter to the visibility (*u-v*) data. Applying a Gaussian *u-v* taper with a half-amplitude cutoff of 0.8 kλ resulted in a beam size of $101'' \times 97''$ and an image rms of 185 μJy beam^{-1}, which corresponds to a RJ temperature map rms of 26 μK. There appear to be several weak point sources in the images, but nothing resembling a flux decrement.

In the summer of 1998, we performed supplementary observations with the OVRO millimeter array outfitted with the same 28.5 GHz receivers used for the BIMA observations. The large collecting area of the six 10.4 m OVRO telescopes and 2 GHz analog correlator provide excellent point-source sensitivity. For a description of the OVRO system with Ka-band HEMT receivers see Carlstrom, Joy, & Grego (1996). In the week of 1998 June 15–22, we performed three deep observations, each centered on one of the three point sources reported by Jones et al. (1997). The coverage was not uniform, but for each of the three observations the array produced a naturally weighted beam $\sim 11'' \times 13''$ and a map rms of $\sim$100–150 μJy beam^{-1}. Simultaneously fitting to all the OVRO and BIMA *u-v* data, we detect three significant point sources in the field. The fluxes of the sources are all $\sim$200 μJy, and their positions agree well with those of the three sources found in the Ryle observations. Holzapfel et al. (2000) give a detailed description of the procedure for measuring the point sources and list the positions and fluxes of the three significant sources. The point-source model is important for the anisotropy analysis presented in that work, but, as we show here, it has little effect on the SZE model constraints.

The combination of the OVRO and BIMA data show no evidence for the flux decrement that would be expected from the interpretation of the Ryle decrement as the SZE in a distant cluster of galaxies. To quantify this result, we fit the *u-v* data to the SZE cluster model proposed by Jones et al. (1997) to describe the Ryle data. Fixing the position and shape parameters ($\beta = \frac{2}{3}$, $\theta_c = 60''$) of the spherical King model, we fit for the central decrement. After subtracting the three detected point sources, we find a best-fit central decrement of $\Delta T_0 = +49 \pm 85$ μK. This result is clearly inconsistent with the minimal model used to fit to the Ryle data of $\Delta T_0 = -560$ μK.

Because of the different spatial scales of the SZE model and point sources, the combination of the OVRO and BIMA data are able to simultaneously determine the positions and fluxes of the point sources while constraining the SZE model. We have repeated the fit for the central decrement, while allowing the positions and fluxes of the three sources to simultaneously vary. The point-source fluxes and positions are virtually unchanged from the previously determined values, and the central decrement is found to be $\Delta T_0 = +48 \pm 90$ μK. In fact, removing the known point sources has no significant effect on the results; repeating the model fit without subtracting any point sources, we find $\Delta T_0 = +73 \pm 87$ μK. Point-source variability could lead to subtle changes in the appropriate point-source model; however, the results we present are essentially independent of the point-source model used. Over the broad range of point-source models we have considered, the BIMA and OVRO data are inconsistent with the SZE cluster model of Jones et al. (1997) at greater than 6 σ.

To investigate what range of models for an SZE cluster the BIMA data are consistent with, we have fitted the *u-v* data to a grid of spherical King models (eq. [1]). The values of β and the angular core radius, θ_c, are largely degenerate, so we have fixed β to a typical observed value of $\frac{2}{3}$. Fitting the models to our data, we generate confidence intervals in the two free parameters, the central temperature decrement, ΔT_0, and the angular core radius, θ_c. Figure 1 shows confidence intervals for a large range of model parameters. For $\theta_c \sim 60''$, only points near $\Delta T_0 = 0$ result in acceptable fits to the data. The point marked with a cross in Figure 1 corresponds to the minimum King model used by Jones et al. (1997) to describe the Ryle data: $\beta = \frac{2}{3}$, $\theta_c = 60''$, and $\Delta T_0 = -560$ μK. The BIMA data are inconsistent with the interpretation of the Ryle decrement as the SZE in a distant cluster at greater than 99.99% confidence.

Because of the east-west configuration of the Ryle array, the synthesized beam is considerably elongated in declination. Is it possible that a weak SZE signal well matched to the Ryle beam could escape detection with BIMA? To answer this question quantitatively, we have used the BIMA data to constrain highly elliptical cluster models that would be well matched to the Ryle beam. We fix the axial ratio to 2.0 and the major axis core radius to $\theta_c = 85''$; in this model, the flux of the source is identical to the symmetric model. Fitting the BIMA data to this model, we find $\Delta T_0 = +15 \pm 79$ μK. If we assume that $\Delta T_0 = -560$ μK, the BIMA data are inconsistent with this SZE model at greater than 7 σ. We have repeated these calculations with spherical and elliptical Gaussian models for the emission; the results are equally constraining. We conclude that elongated emission or other subtleties in the SZE model cannot account for the nondetection of the proposed cluster by BIMA.

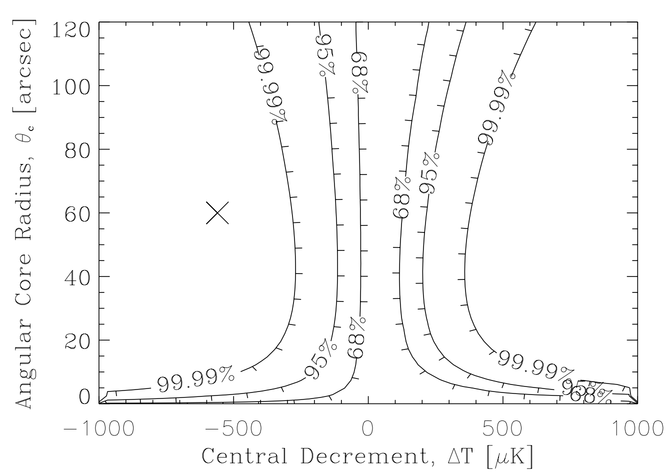

FIG. 1.—Confidence intervals for fits of the data from the BIMA and OVRO observations of the Ryle decrement to a spherical King model. The cross marks the values of model parameters adopted by Jones et al. (1997) to describe their observed decrement. The BIMA data are inconsistent with this and any similar SZE model at greater than 99.99% confidence.

2.5. *Discussion*

The X-ray results imply that any cluster capable of producing the observed SZE decrement would have to be at a redshift of $z > 2.8$. The optical observations are not as constraining, but show no evidence of a massive cluster. The BIMA and OVRO data we present are inconsistent with the SZE model proposed by Jones et al. (1997) at greater than 99.99% confidence. This result is insensitive to the details of the point-source and cluster emission models. Given the combination of the unlikely redshift range to which the X-ray constraints would push the cluster and the significance of the BIMA nondetection, all additional evidence points against the interpretation of the Ryle decrement as being due to the SZE in a cluster of galaxies.

3. VLA DECREMENT

3.1. *VLA Observations*

The Very Large Array (VLA) has been used to perform a sensitive search for CMB anisotropies on angular scales of 6″–80″ (Partridge et al. 1997). These observations consist of several hundred hours of observations at 8.44 GHz. The observed field, as defined by the primary beam half-power points, was 5′.2 wide, centered on the coordinates $\alpha = 13^h12^m17^s.4$, $\delta = +42°38′05″$ (J2000). This field was chosen to be free of point sources, with flux density $S_{8.4\ \mathrm{GHz}} \geq 0.5$ mJy. All positive features brighter than 7 μJy (4.7 σ) were located in the full-resolution map and subtracted from the *u*-*v* data. The CLEANed 6″ resolution map had an rms noise of 1.5 μJy, making it the most sensitive radio map at any frequency or resolution. An isolated, negative flux feature approximately 30″ × 65″ in size with a peak amplitude of -250 μK was found in the residual map. After point-source subtraction, the significance of the feature was 5.5 σ, with approximately 680 independent beams in the field of view. Richards et al. (1997) interpret this feature as the SZE signal of a distant cluster. The image is extended in declination, with considerable substructure. It has a northern decrement of -13.9 ± 3.3 μJy (-250 ± 60 μK) in the 30″ resolution VLA image, and a southern decrement of similar amplitude. The positions of these two features are given in Table 1. Richards et al. (1997) describe the observed signal with a spherical King model with $\beta = \frac{2}{3}$, $\theta_c = 15″$, and central decrement of $\Delta T_0 = -250$ μK.

3.2. *X-Ray*

As related by Richards et al. (1997), E. Hu & L. Cowie (1996, private communication) obtained a sensitive *ROSAT* HRI image of the region containing the source. These observations were used to constrain the flux in the HRI 0.1–2.4 keV band, $f_X < 2 \times 10^{-14}$ ergs cm^{-2} s^{-1} at the 3 σ level. Fixing $\beta = \frac{2}{3}$, Richards et al. (1997) used the observed decrement to estimate possible cluster parameters, specifically the cluster X-ray luminosity $L_X \sim 2 \times 10^{44}$ ergs s^{-1}, and gas mass, $M_{\mathrm{gas}} \sim 10^{13}$ $M_\odot$. The lack of observed X-ray emission is used to argue that the cluster, if it exists, must be at redshift $z > 1.5$.

3.3. *Optical*

Optical images of the region containing the decrement had been produced as part of the *Hubble Space Telescope* (*HST*) Medium Deep Survey. Two quasars at the identical redshift of $z = 2.561$ separated by 100″ were discovered in the image. For the two quasars to be the lensed images of a single object, an intervening mass of $\sim 10^{15}$ $M_\odot$ would be required. The spectra of the two objects also appear to be radically different. The presence of these two quasars in such close proximity led Richards et al. (1997) to propose that they might be members of a cluster at that redshift.

Campos et al. (1998) have searched the vicinity of the quasar pair for evidence of galaxy clustering. They find 56 Lyα-emitting candidates in a 8′ × 14′ field. Four of the five spectroscopically confirmed objects form a 3′ ($\sim$3 Mpc) filament with velocity dispersion 1000 km s^{-1}. This is several times the velocity dispersion one would expect for an unbound system of scale $\sim$3 Mpc. However, the velocity dispersion of only four objects cannot be used to identify a virialized system, and many more spectra will be needed before this claim can be taken seriously.

3.4. *BIMA Observations*

We observed a field in the direction of the VLA decrement with our centimeter-wave receivers mounted on nine of the 6.1 m telescopes of the BIMA array. Total on-source integration time was 35.5 hr, spread over 8 separate days during the period 1997 June 15–August 15. The configuration of the array was identical to that used for the observations of the Ryle decrement. Using all the data to produce a naturally weighted image resulted in a beam size of 33″ × 25″ and an image rms of 100 μJy beam^{-1}, which corresponds to an RJ temperature map rms of 169 μK. Applying a Gaussian *u*-*v* taper with a half-amplitude cutoff of 0.8 kλ resulted in a beam size of 98″ × 94″ and an image rms of 189 μJy beam^{-1}, which corresponds to a RJ temperature map rms of 29 μK. We also created maps limited in *u*-*v* range to search for point-source emission. There is no evidence for the presence of point-source emission or a flux decrement in any of the images.

3.5. *Model Fits*

The brightness sensitivity of the BIMA data is highest at angular scales of 50″–120″, while the sensitivity of the VLA data is highest at scales of 6″–30″. Because of the complimentary nature of the *u*-*v* coverage of the VLA and BIMA data sets, all comparisons are done by fitting to models for the signal. We have investigated whether the spherical King model suggested by Richards et al. (1997) is consistent with the BIMA data. Assuming the decrement to be described by model parameters $\beta = \frac{2}{3}$ and $\theta_c = 15″$, we find a best-fit central decrement $\Delta T_0 = +23 \pm 151$ μK. For larger core radii, the constraints are stronger. Fixing $\theta_c = 30″$, we find $\Delta T_0 = +38 \pm 118$ μK.

Figure 2 shows confidence intervals for fits to a range of spherical King (eq. [1]) models for the SZE model. Again, we have fixed $\beta = \frac{2}{3}$. The cross marks the parameters proposed by Richards et al. (1997), which are $\Delta T_0 = -250$ μK and $\theta_c = 15″$, with the model at the center of the observed decrements. The proposed SZE cluster model is inconsistent with the BIMA data at greater than 90% confidence. We have repeated this analysis for models centered at the north and south peaks of the decrement listed in Table 1. Fixing the emission model to the north and south peaks, we find $\Delta T_0 = +35 \pm 150$ and $+82 \pm 161$ μK, respectively.

We have also investigated $\beta = \frac{2}{3}$ King models with angular core radii $\theta_c < 15″$. The BIMA data is inconsistent with $\theta_c \sim 10″$ models centered at the north peak, center, or south peak positions at greater than 68% confidence. For even smaller core radii, the overlap of the scales where

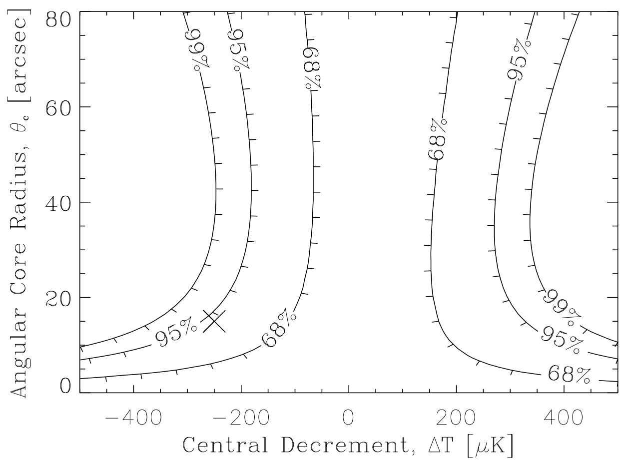

FIG. 2.—Confidence intervals for fits of the data from BIMA observations of the VLA decrement to a spherical King model. The cross marks the values of model parameters adopted by Richards et al. (1997) to describe their observed decrement. The BIMA data are inconsistent with this SZE model at greater than 90% confidence.

BIMA is sensitive and the model has significant power becomes progressively worse until no meaningful statements about these SZE models can be made.

Figures 2 and 3 of Richards et al. (1997) show the VLA decrement to be quite elongated in declination. We have repeated the fits for cluster emission models that are better matched to the morphology of the observed VLA decrement. For this analysis, we fixed the source position midway between the northern and southern peaks of the VLA image. Assuming the cluster profile to be described by an elliptical King model with an axial ratio of 2 and a major axis described by a core radius of $\theta_c = 19''$ aligned in the north-south direction, the resulting model profile matches the observed signal with FWHM $65'' \times 35''$. Fitting to the BIMA data, we find $\Delta T_0 = +145 \pm 155$ μK. Assuming the central decrement to be $\Delta T_0 = -250$ μK, the BIMA data are inconsistent with this elliptical model for the cluster emission at greater than 95% confidence.

So far, we have only discussed King models for the SZE signal. To test our sensitivity to the exact model for the SZE signal, we have repeated the above analysis with the cluster now modeled by an asymmetric Gaussian profile located at the center of the observed decrement. We fix the FWHM of the model to be $65'' \times 35''$, with the elongation in declination, which appears to be a good approximation of the emission shown in Figure 2 of Richards et al. (1997). Solving for the best-fit amplitude, we find $\Delta T_0 = +146 \pm 125$ μK. Assuming the central decrement to be $\Delta T_0 = -250$ μK, the BIMA data are again inconsistent with this SZE model at greater than 95% confidence.

Due to the lack of supplemental OVRO observations, the limits on point-source confusion for this field are not as good as for the PC 1643+4631A, B field. One might wonder whether a point-source with a rising spectrum could be conspiring to "fill in" the VLA decrement. To investigate the role that point source confusion might play in these measurements, we have added a point source to the center of the cluster source model (where its effect is greatest) and allowed its flux to vary freely during the fits to the SZE model. The best-fit amplitude is $\Delta T_0 = +183 \pm 212$ μK. As expected, the error in the determination of ΔT_0 has increased with the introduction of the point source. However, this result is still inconsistent with a central decrement of $\Delta T_0 = -250$ μK at greater than 95% confidence.

3.6. *Discussion*

The X-ray and optical data do not constrain the presence of a cluster at $z = 2.61$ as proposed by Richards et al. (1997), and there may be some evidence of structure in the distribution of background galaxies in addition to the two quasars in the vicinity of the proposed decrement. The angular scales probed by the VLA and BIMA instruments have little overlap, and the comparison of the two data sets must be made through a model. The BIMA data are inconsistent with the SZE model proposed by Richards et al. (1997) at greater than 90% confidence. These results are insensitive to the details of the SZE model and show no evidence for point-source contamination. Further observations with the OVRO array, or a more extended configuration of the BIMA array, would permit significant tests for the existence of smaller scale SZE decrements.

4. CONCLUSION

We have observed two fields in the direction of flux decrements believed to be due to the SZE in distant clusters of galaxies. In both cases, we do not detect the reported flux decrements and have been able, with varying confidence, to rule out the SZE models proposed by the authors of the detection papers. The BIMA observations are inconsistent with the SZE model put forth by Richards et al. (1997) to describe the VLA decrement at greater than 90% confidence. Because of the similarity of the angular scales on which the BIMA and Ryle telescopes are sensitive, the constraints are particularly strong in the case of the Ryle decrement. The BIMA data are found to be inconsistent with the proposed SZE model at greater than 99.99% confidence. If the BIMA data are to be believed, the Ryle decrement must be due to some mechanism other than the SZE. A model for the flux decrement with amplitude that decreases with increasing frequency could be consistent with both the BIMA and Ryle data; however, there are no obvious candidates for such a source.

It is clear that the SZE will become a powerful tool for the discovery of distant galaxy clusters. The realization of this goal will require not only an increase in sensitivity, but also a deep understanding of the systematic errors associated with each experiment. Ultimately, multifrequency measurements with different instruments provide the strongest discrimination against foreground confusion and systematic errors.

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