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AN X-RAY AND SZ BRIGHT DIFFUSE SOURCE TOWARD M31: A LOCAL HOT BRIDGE

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ABSTRACT

We report a large-scale ($r \approx 20^\circ$) X-ray and Sunyaev-Zeldovich (SZ)-bright diffuse enhancement toward M31, which might be a Local Hot Bridge connecting the Milky Way (MW) with M31. We subtract the Galactic emission from the all-sky O VII and O VIII emission line measurement survey, and find that the emission of these two ions is enhanced within $r \approx 20^\circ$ around M31. The mean emission enhancements are 5.6 ± 1.3 L.U., and 2.8 ± 0.6 L.U. for O VII and O VIII, respectively ($> 4\sigma$ for both ions). We also extract the SZ signal around M31, which suggests a surface brightness y of $2 - 4 \times 10^{-7}$, an enhancement $> 2.5\sigma$ (and a best fit of 5.9σ). These three measurements trace the hot gas with a temperature $\log T(\mathrm{K}) > 6$, showing similar plateau shapes (flat within $\approx 15^\circ$, and zero beyond $\approx 30^\circ$). A single-phase assumption leads to a temperature of $\log T(\mathrm{K}) = 6.34 \pm 0.03$, which is determined by the O VII/O VIII line ratio. Combining X-ray and SZ measurements, we suggest that this feature is unlikely to be the hot halo around M31 (too massive) or in the MW (too high pressure and X-ray bright). The plateau shape may be explained by a cylinder connecting the MW and M31 (the Local Hot Bridge). We constrain its length to be about 400 kpc, with a radius of 120 kpc, a density of $\approx 2 \times 10^{-4} - 10^{-3}$ cm^{-3}, and a metallicity of $0.02 - 0.1\ Z_\odot$. The baryon mass is $\gtrsim 10^{11}\ M_\odot$, and the oxygen mass is about $\gtrsim 10^8\ M_\odot$, which contribute to the baryon or metal budget of the Local Group.

Рентген: XMM-Newton (649 LOS)

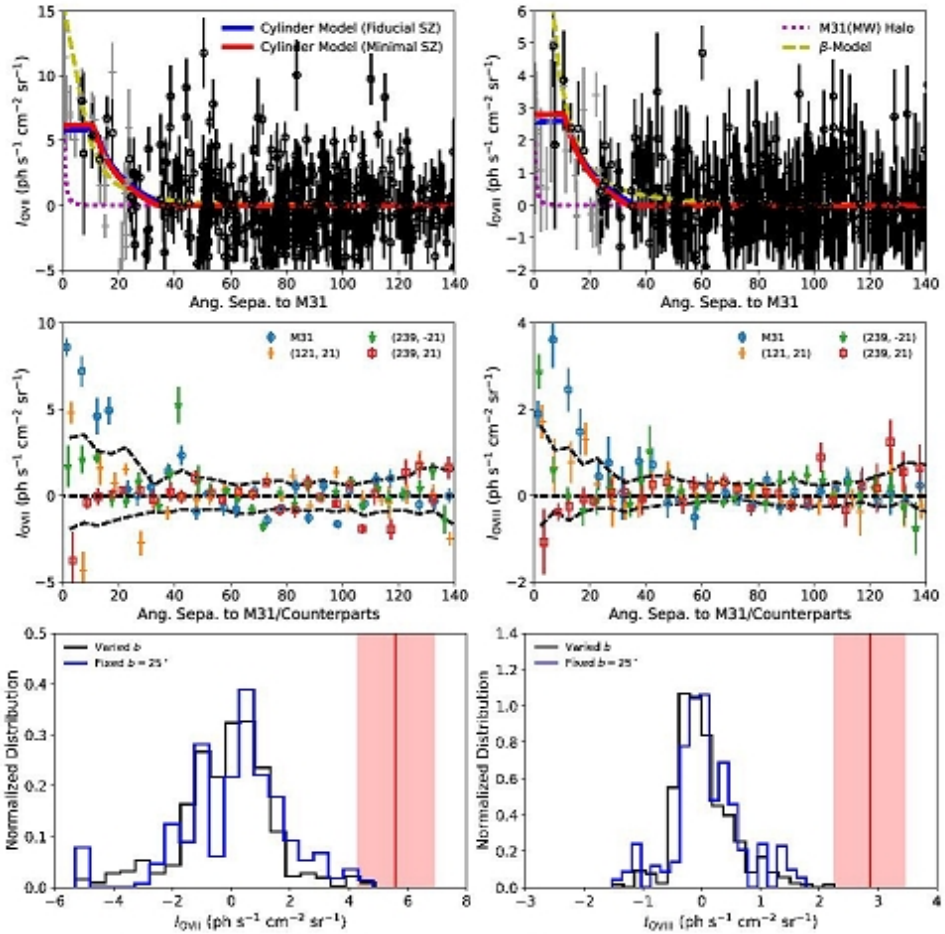

FIG. 1.— The upper two panels show the X-ray emission line measurements (corrected for the MW model) for O VII (left) and O VIII (right). The black circles are adopted from MB15, while the grey crosses are from HS12 (the 1868 sight line sample), which may have more contamination. For both samples, we masked out the region within 60° around the Galactic center, and the measurements with large uncertainties (> 3 L.U. for O VII and > 2 L.U. for O VIII). The yellow dashed lines are a projected β-model based on the input model from the SZ extraction, which has a core of 8°. This model systematically overestimates the strengths of O VII, O VIII emission measurements and SZ y. The magenta dotted lines are a projected MW-like halo at the distance of M31. The blue and red solid lines are the Bridge (cylinder) model connecting the MW and M31 for fiducial SZ (left) and minimal SZ (right), which are shown in the Fig. 2. The middle panels show the radial profile (5° bins) of O VII and O VIII Galactic-symmetric regions of M31 ($l = 121.17°$ or $238.83°$, $b = \pm 21.57°$). In these two plots, sight lines have the same weights in the HS12 and the MB15 samples. The black dashed lines show the 1σ uncertainty of the radial profile of random sight lines with fixed $b = \pm 25°$. The signals toward M31 are higher than the other three regions and random sight lines, which indicates it is not some systematical feature associated with the Galactic disk. In the lower panels, we compare the M31 O VII and O VIII measurements to the strength distribution of random sight lines (within 20°) over the entire sky (black) and with fixed latitudes at $b = \pm 25°$ (blue). These tests leads to significances of 3.6σ (3.0σ for fixed b) and 5.6σ (4.8σ) for O VII and O VIII measurements, respectively.

Эффект Сюняева-Зельдовича: WMAP+Planck

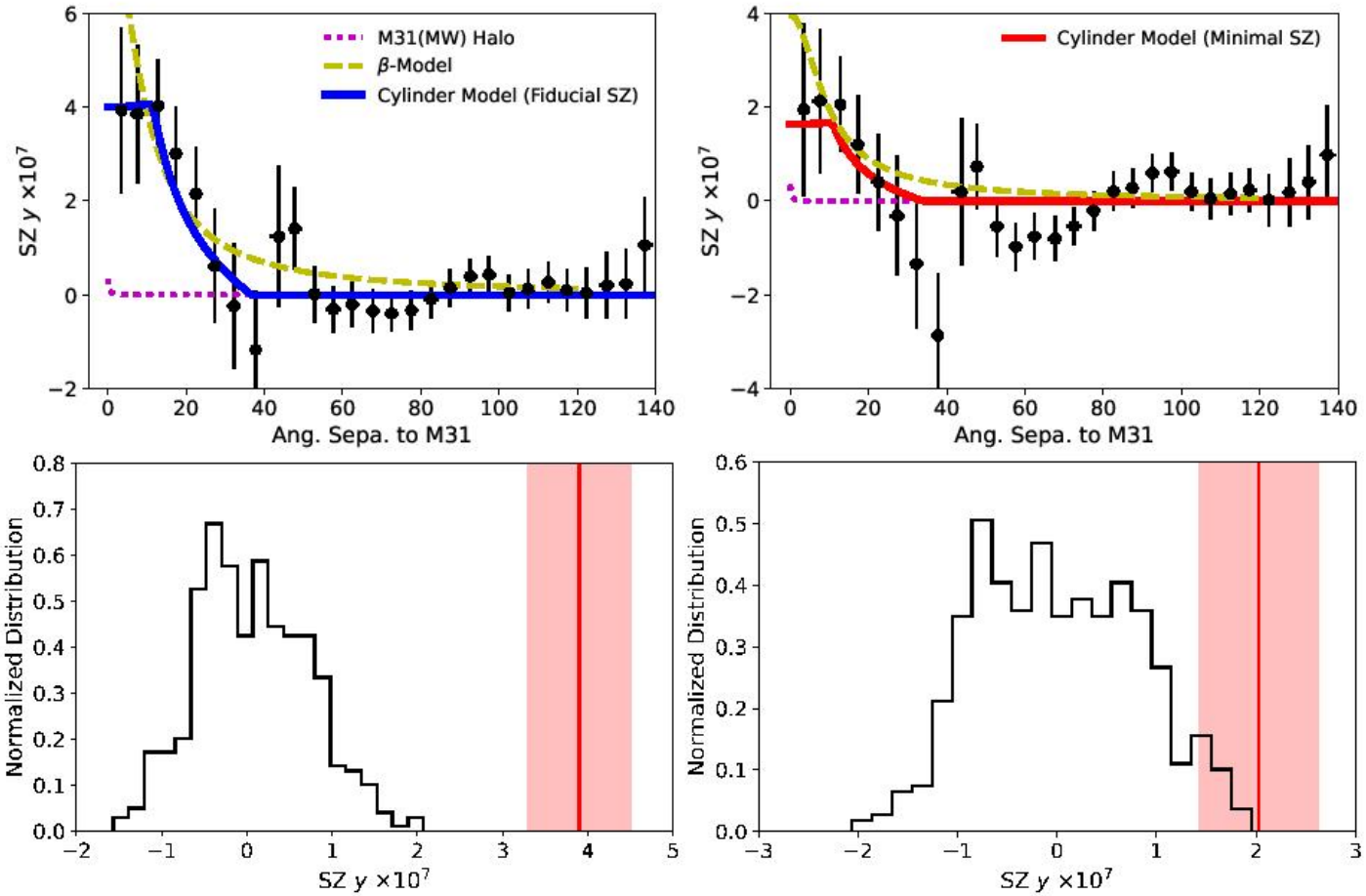

FIG. 2.— The upper two panels show the fiducial SZ extraction (left) and the minimal SZ extraction (right), while different models ha the same colors as Fig. 1. For the SZ extraction, the data points are binned in 5° bins. The fiducial SZ extraction, we include all fo components (i.e., the MW, M31, the local Universe, and the cosmic SZ) in the extraction, which may overestimate the SZ strength. Tl feature at 45° in the fiducial extraction is a random variation with a significance of 1.8σ, which is a result of the small area left after o heavy masking of the Galactic disk, the ecliptic plane, and point sources. By disabling the model of M31 and the MW, we extract tl minimal SZ strength (see the text for details). The β-model is scaled down by a factor of 2 in the minimal SZ plot. The lowers panels sho

Что это в направлении на Андромеду?

- Это не собственное рентгеновское гало Андромеды – если отнести весь рентген на расстояние 700 кпк, то барионов (по кислороду) получится больше космической квоты.
- Это не деталь гало нашей Галактики – получается слишком большое давление в газе.
- Это где-то МЕЖДУ M31 и Milky Way!

Модель с 5ю параметрами

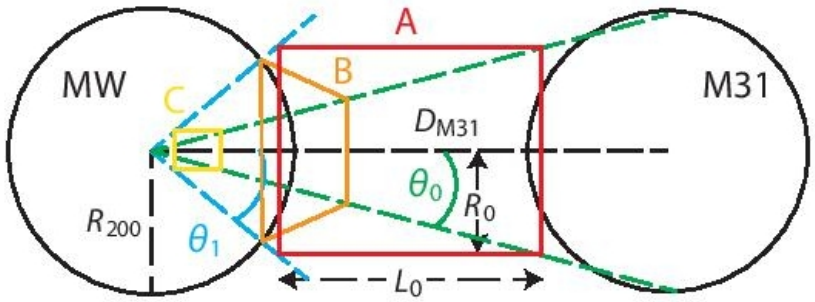

FIG. 3.— An illustration of the geometry of the Local Bridge. The plateau feature indicates two characteristic angels: the ending angle of the plateau (θ_0) and the angle beyond which the emission is zero (θ_1). Case A is the fitting model described in Section 3.3. Cases B and C are discussed in section 3.2.

TABLE 1
PROPERTIES OF THE LOCAL HOT BRIDGE

	Fiducial SZ	Minimal SZ
$I_{\rm OVII,0}$ (L.U.)	$5.7^{+1.3}_{-1.2}$	$6.0^{+1.4}_{-1.3}$
$I_{\rm OVIII,0}$ (L.U.)	$2.5^{+0.6}_{-0.5}$	$2.8^{+0.7}_{-0.6}$
SZy_0	$3.9 \pm 0.8 \times 10^{-7}$	$1.62^{+0.9}_{-1.0} \times 10^{-7}$
L_0 (kpc)	430 ± 150	420 ± 150
D_0 (kpc)	120 ± 20	110 ± 20
$\log n_{\rm H}({\rm cm}^{-1})$	$-2.91^{+0.17}_{-0.14}$	$-3.29^{+0.26}_{-0.45}$
$\log T({\rm K})$	6.35 ± 0.03	6.35 ± 0.03
$\log M_{\rm hot}(M_\odot)$	11.74 ± 0.11	$11.28^{+0.22}_{-0.42}$
$\log M_{\rm oxy}(M_\odot)$	7.68 ± 0.15	$8.08^{+0.46}_{-0.25}$
$L_{\rm OVII}$ (erg s^{-1})	$8.9^{+2.2}_{-2.1} \times 10^{39}$	$8.3^{+2.2}_{-2.0} \times 10^{39}$
$L_{\rm OVIII}$ (erg s^{-1})	$4.5 \pm 1.0 \times 10^{39}$	$4.2^{+1.4}_{-1.2} \times 10^{39}$
$L_{\rm X}{}^a$ (erg s^{-1})	$1.1 \pm 0.3 \times 10^{42}$	$2.6 \pm 0.8 \times 10^{41}$
$\log Z/Z_\odot$	-2.0 ± 0.2	$-1.2^{+0.9}_{-0.4}$

Note: all parameters in this table is based on the single phase assumption, the correction due to the multi-phase medium is in Section 3.4.2.
[a] adopting the APEC model to convert the line emissivity to the bolometric luminosity.

Вывод:

- От 25% до двух третей всех барионов Местной Группы – в этой трубе.
- Говорят, такое уже видели – в Хиксоновской группе HG16.