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AKARI OBSERVATION OF THE FLUCTUATION OF THE NEAR-INFRARED BACKGROUND

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ABSTRACT

We report a search for fluctuations of the sky brightness toward the North Ecliptic Pole with AKARI, at 2.4, 3.2, and 4.1 μm. The stacked images with a diameter of 10 arcminutes of the AKARI-Monitor Field show a spatial structure on the scale of a few hundred arcseconds. A power spectrum analysis shows that there is a significant excess fluctuation at angular scales larger than 100 arcseconds that cannot be explained by zodiacal light, diffuse Galactic light, shot noise of faint galaxies, or clustering of low-redshift galaxies. These findings indicate that the detected fluctuation could be attributed to the first stars of the universe, i.e., Population III stars.

Key words: cosmology: observations; conferences: proceedings

1. INTRODUCTION

Observations of the near-infrared background are believed to be very important for investigating the formation and evolution of the first stars in the Universe. Some theoretical studies state that the first stars may be massive and bright compared to nearby stars and may leave their traces in sky brightness and fluctuation of sky brightness on the near-infrared wavelength to the present day.

2. OBSERVATION AND DATA REDUCTION

2.1. Observation

To investigate fluctuations of the near-infrared images, we used monitor field image that is located near the NEP. The AKARI IRC has made very frequent imaging of the monitor field for the purpose of checking the stability of the instruments. Table 1 shows some parameters of the monitor field used in this study.

Table 1.
Parameters Used and Obtained in this Study

Item	2.4 μm	3.2 μm	4.1 μm
Number of stacked images	40	39	24
Total integration time (minutes)	29.6	28.9	17.8
Percentage of remaining pixels (%)	47.7	46.7	47.1
Limiting magnitude (AB mag)	22.9	23.2	23.8

2.2. Data Reduction

In order to obtain the fluctuations in sky brightness, we identified and removed stars and galaxies. Bright center parts of objects are masked, and faint wing parts of objects are subtracted by using the instrument PSF. Images before and after removing objects are presented in Fig. 1.

3. RESULTS

The lower panel in Fig. 1 clearly shows structure, and fluctuation spectra of the sky also show excess fluctuation above shot noise at angles larger than 100 arcsec-

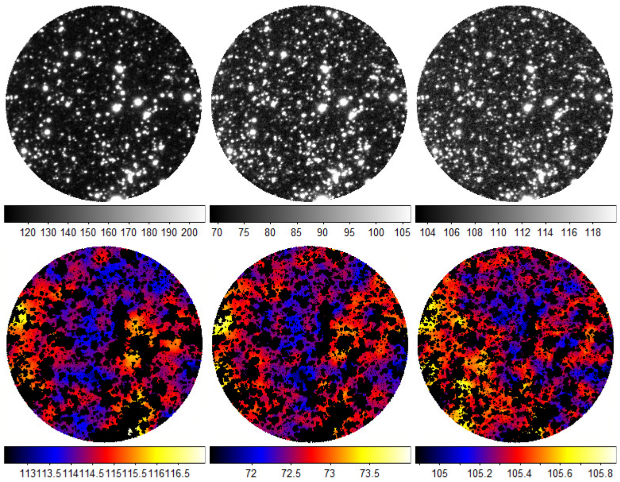

Fig. 1. Upper: monitor field images. Lower: smoothed images after removing objects. Black regions in the lower panel represent masked pixels. Images correspond to 2.4, 3.2, and 4.1 μm from left to right. The unit is nW m^{-2} sr^{-1}.

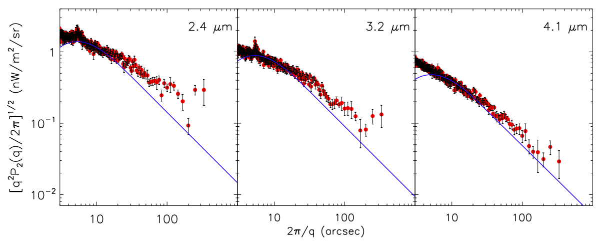

Fig. 2. Fluctuation spectra of the sky obtained by two-dimensional FFT. q and $P_2(q)$ represent angular wavenumber and power spectrum. Blue solid lines represent fluctuation spectra of shot noise due to unresolved faint galaxies, which are estimated by simulation.

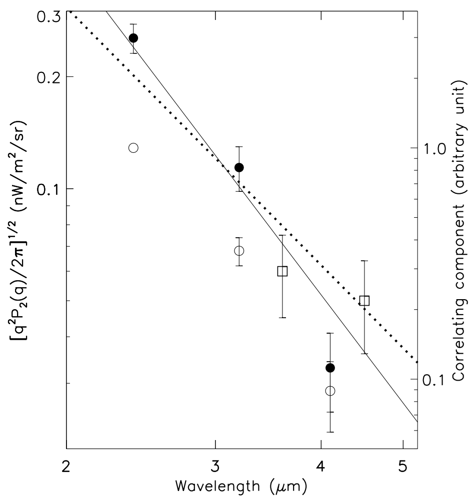

Fig. 3. Spectrum of excess fluctuation at large scale in this study (filled circles) is compared with the Spitzer result (squares) (Kashlinsky et al., 2005). The correlating component (open circles) represents correlation between 2.4 μm image and other band images. The solid line is λ^{-3}, while the dotted line is the spectrum in Figure 20 of Fernandez et al. (2010).

onds (Fig. 2). Excess fluctuation at large scale in Fig. 2 can also be explained by various foreground components. Thus, we investigated them as follows, and showed that their contribution is inadequate to explain the excess fluctuation in Fig. 2.

- Zodiacal light: The excess fluctuation is much higher than that expected from fluctuation of zodiacal emission at 18 μm observed with AKARI.
- Diffuse Galactic light: Since DGL is closely related to the dust column density, we examined its correlation with the far-infrared image and found no significant correlation.
- Clustering of low-redshift galaxies: Fluctuation obtained from the catalogued galaxies (Sullivan et al., 2007) is significantly lower than that observed with AKARI.

Furthermore, the spectrum of the fluctuation shows fairly blue color (Fig. 3) which is consistent with the model of early populations by Fernandez et al. (2010).

4. SUMMARY

We performed a fluctuation analysis for a sky region with a diameter of 10 arcminutes toward the NEP. A power spectrum analysis indicates that a significant excess fluctuation exists at angular scales larger than 100 arcseconds, which cannot be explained by zodiacal light, DGL, shot noise from faint galaxies, or clustering of low-redshift galaxies.

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