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THE PROPERTIES OF DUST EMISSION IN THE GALACTIC CENTER REGION REVEALED BY FIS-FTS OBSERVATIONS

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ABSTRACT

We present the results of far-infrared spectral mapping of the Galactic center region with FIS-FTS, which covered the two massive star-forming clusters, Arches and Quintuplet. We find that two dust components with temperatures of about 20 K and 50 K are required to fit the overall continuum spectra. The warm dust emission is spatially correlated with the [OIII] 88 μm emission and both are likely to be associated with the two clusters, while the cool dust emission is more widely distributed without any clear spatial correlation with the clusters. We find differences in the properties of the ISM around the two clusters, suggesting that the star-forming activity of the Arches cluster is at an earlier stage than that of the Quintuplet cluster.

Key words: ISM: clouds; galaxy: center; infrared: ISM

1. INTRODUCTION

The Galactic center region is luminous in the far-infrared (FIR; $\sim 10^9\ L_\odot$). It is believed that the FIR luminosity is mostly attributed to K and M giants on large scales (Yasuda et al., 2009; Nakagawa et al., 1995). Yet, young OB stars also exist, locally heating the ISM in the Galactic center. For example, the Arches and Quintuplet clusters are famous massive star-forming clusters. We show below their contribution to the FIR luminosity and discuss their differences in the FIR properties.

2. OBSERVATIONS

We observed the Galactic center region that contains the two massive star-forming young clusters, the Quintuplet and the Arches cluster. Fig. 1 shows the areas mapped with the SW array, overlaid on the radio 20 cm continuum map (Yusef-Zadeh et al., 1984). With FIS-FTS, we performed the spectral mapping of an area of $\sim 10' \times 10'$ including the clusters to obtain a low-resolution ($\Delta\sigma \sim$1.2 cm^{-1}) spectrum at every spatial bin of $30'' \times 30''$.

3. RESULTS

Fig. 2 shows the spectrum integrated over the total area covered by both SW and LW; the SW spectrum (90-140 cm^{-1}) and the LW spectrum (60-90 cm^{-1}) are combined into one spectrum. A two temperature gray-body model with T $\sim$ 20 K and $\sim$ 50 K reproduces the spectrum very well. The spectrum is decomposed into the warm and cold dust components at every spatial bin. Their spatial distributions are shown in Fig. 3.

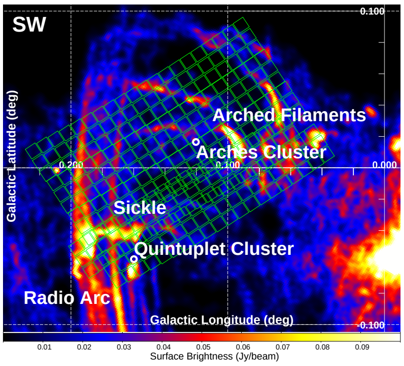

Fig. 1. Observed region. The boxes indicate the SW array pixels, overlaid on the radio 20 cm continuum image (Yusef-Zadeh et al., 1984).

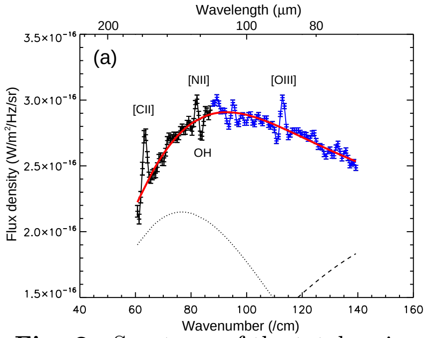

Fig. 2. Spectrum of the total region.

TABLE 1.
Dust Masses around the Clusters Estimated from Spectral Fitting

	Warm dust	Cold dust
Arches	26 $M_\odot$	2.1×10^3 $M_\odot$
Quintuplet	15 $M_\odot$	1.3×10^3 $M_\odot$

4. DISCUSSION

The [OIII] 88 μm emission is likely to be associated with the highly-ionized gas locally heated by the Arches and Quintuplet clusters. The warm dust is spatially correlated with [OIII] and thus with the clusters (Fig. 3 (a)), while the cold dust component does not spatially correspond to the clusters (Fig. 3 (b)).

We estimate dust masses around the clusters, and find that warm dust is a minor contribution to the total dust mass (Table 1). The warm dust is more abundant near the Arches cluster, while the [OIII] emission is more prominent near the Quintuplet cluster. The differences suggest that the star-forming activity of the Arches cluster is at an earlier stage than that of the Quintuplet cluster.

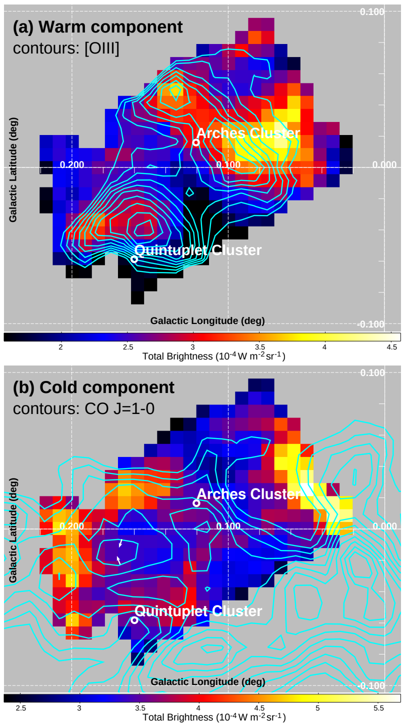

Fig. 3. Maps of (a) warm dust with the contours of [OIII] 88 μm (Yasuda et al., 2009; Kaneda et al., 2012), and (b) cold dust with the contours of the integrated CO(J=1-0) emission (Oka et al., 1998).

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