A search for intracluster dust of stellar clusters in the LMC

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Abstract

Recently, we have made far-infrared observations with AKARI satellite to search 12 Galactic globular clusters for cold dust within. We found no clear evidence of such intracluster dust. If the dust is dispelled from the cluster in a short timescale, $10^{5\text{-}6}$ yr as has been suggested in out study, it may prevent self chemical enrichment within globular clusters. Since the major contributor to such enrichment is expected to be AGB stars more massive than those present in the current Galactic globular clusters, it is interesting to investigate younger stellar clusters in the Magellanic Clouds. Far-infrared data for the Magellanic clusters are available from the surveys of Spitzer Space Telescope and AKARI satellite. We present preliminary analysis of the Spitzer/MIPS data for 10 LMC clusters with intermediate ages, 10^{8}-10^{10} yr.

1. Introduction

Low and intermediate-mass stars lose their mass at Asymptotic Giant Branch phase (AGB). It is known that dust formation accompany their mass loss in many AGB stars. Terminal velocities of the stellar winds, typically 15 km/s[1], are lower than typical escape velocities from globular clusters, ~30km/s[2]. For this reason, it was expected that the released materials are trapped and accumulated within clusters.

2. Our AKARI survey of Galactic globulars

We observed 12 Galactic globular clusters by using the Far-Infrared Surveyor (FIS) onboard AKARI satellite (Matsunaga et al.[3]). We detected 28 point sources in directions toward 10 clusters and extended emissions toward NGC 2808/6402. However, it was found that most of them are not associated with clusters: point sources are background galaxies and diffuse emissions come from the galactic cirrus. Upper limits of the dust mass are estimated at $(2\text{–}9) \times 10^{-5}\ M_{sun}$ from the background fluctuation in 90 μm. Considering the number of dying red giants, the lifetimes of the dust are as short as $10^{5\text{-}6}$ yr.

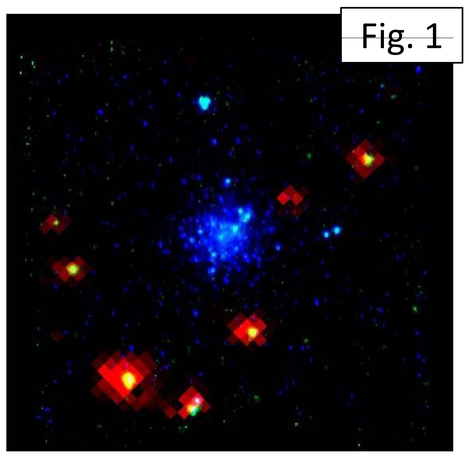

Fig. 1 RGB colored image of NGC 1261 (4um, 15um, 90um). Far-IR point sources appear red on the image. In the ISO/FIRBACK survey of infrared galaxies, many of the far-IR sources were identified as galaxies with red-shifts between 0.03 and 0.13 [4,5].

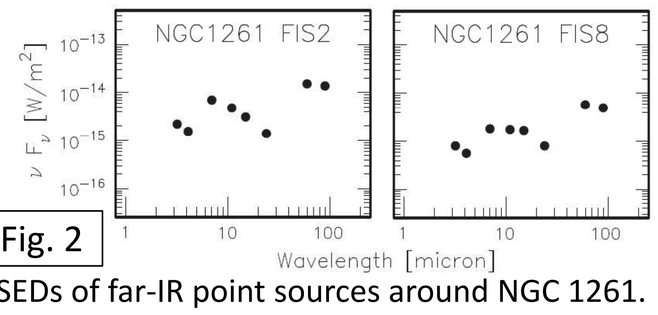

Fig. 2 Examples of the SEDs of far-IR point sources around NGC 1261.

3. The impact on chemical evolution

It is interesting to discuss the evolution, destruction, and/or removal of the intracluster matter in the context of their effects on the chemical evolution in globular clusters. Tsujimoto et al.[7] calculated that, in ω Cen, a significant amount of the mass released from intermediate-mass AGB stars can accrete to surrounding stars during 2 Gyr after the formation of the cluster. It is possible that there remains no significant mass to be accreted if the intracluster matter disappears with the short timescale mentioned above. The fate of the dust can particularly have an effect on enrichment in heavy elements, such as Al, depleted in dust.

4. Objects and their Spitzer data

We selected interim-age clusters from the lists in Mackey & Gilmore[6] and van Loon et al.[7] under the conditions: $10^8 < \text{Age[yr]} < 10^9$ yr and Mass > $10^5\ M_{sun}$. Amongst such 14 clusters, the Spitzer/MIPS data are available for 10 (Table 1). Their locations are indicated in Figure 3. The MIPS data were obtained for the SAGE project (Meixner et al. [8]).

Table 1 List of the clusters we studied. They are grouped by eye inspection into A—C as follows according to the appearance of far-IR map as follows:
A—No significant emission was found around the cluster,
B—The large-scale interstellar dust has a strong effect in the field,
C—There is a mass-losing star which is also bright in 70 μm.

Cluster	log (Age)	log (Mass)	Group	Cluster	log (Age)	log (Mass)	Group
NGC1651	9.30	5.24	A	NGC1978	9.39	5.2	A
NGC1718	9.30	5.10	B	NGC2031	8.20	5.13	A
NGC1783	9.48	5.5	B	NGC2121	9.51	5.69	A
NGC1852	9.48	5.0	C	Hodge 4	9.34	5.39	A
NGC1856	8.12	6.51	B	SL 663	9.51	5.23	A

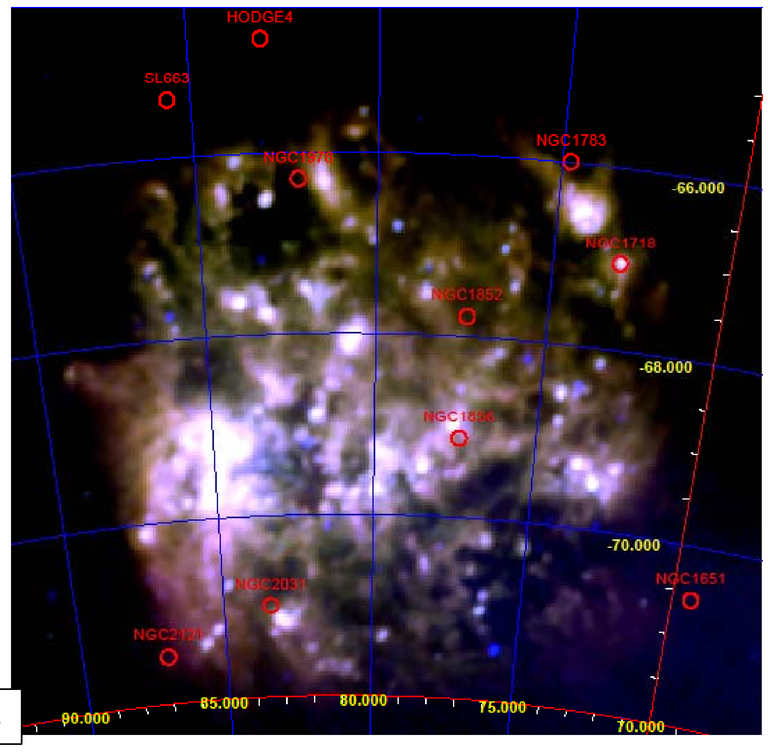

Fig. 3 RGB-colored IRAS map of the LMC (25 μm, 60 μm, 100 μm). The clusters we studied are indicated by red circles.

5. Examples of the investigated images

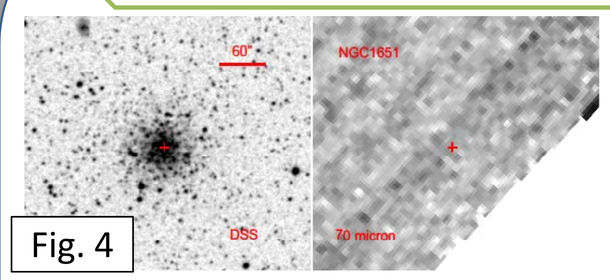

Fig. 4

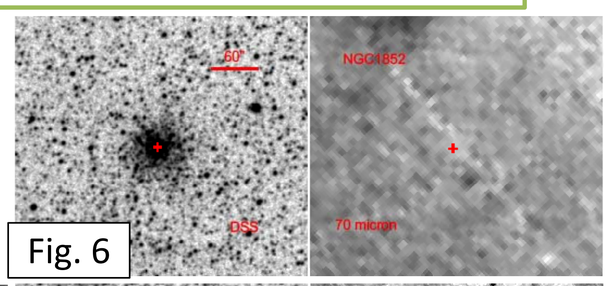

Fig. 6

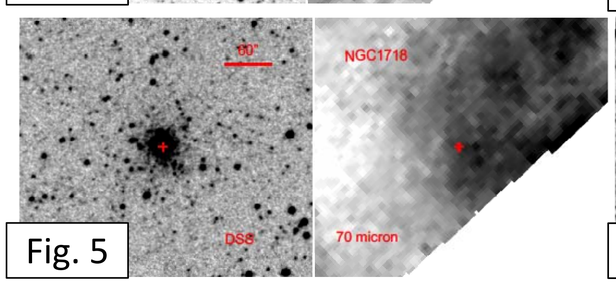

Fig. 5

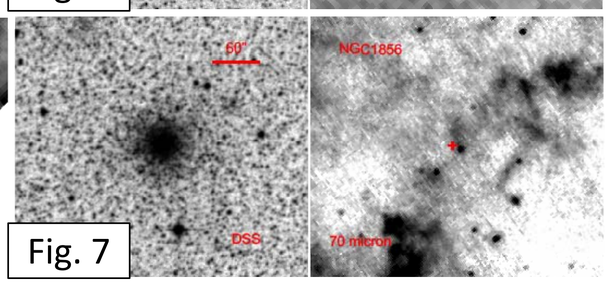

Fig. 7

6. A serendipitous discovery of compact group of galaxies?

A peculiar object(s) was found during our research. The source has three separated cores and surrounding diffuse emission (Fig. 8). The SED between 3.6 and 70 μm suggests that it is a group of background galaxies.

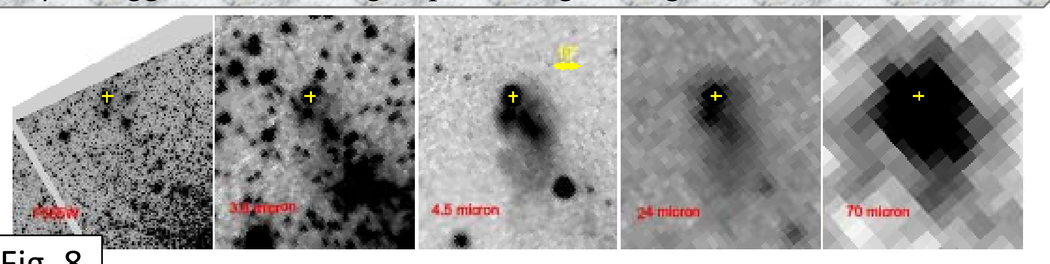

Fig. 8 Multi-wavelength images of a candidate group of galaxies. The brightest peak is indicated by a yellow cross.

References

[1] McDonald & van Loon (2007, A&A, *476*, 1261)
[2] Gnedin et al. (2002, ApJ, *568*, L23)
[3] Matsunaga et al. (submitted)
[4] Puget et al. (1999, A&A, *345*, 29)
[5] Patris et al. (2003, A&A, *412*, 349)
[6] Tsujimoto et al. (2007, ApJ, *654*, L139)
[7] Mackey & Gilmore (2003, MN, *338*, 85)
[8] van Loon et al. (2005, A&A, *442*, 597)
[9] Meixner et al. (2006, AJ, *132*, 2268)

We investigated far-IR images of intermediate-age clusters in the LMC with the Spitzer archival data. For the clusters projected toward the large-scale interstellar medium, it is not easy to extract the intracluster dust if any exists. For many clusters with quiet background, we did not find prominent emission of the intracluster dust.