

# Detection of the unidentified infrared bands in a filament of the dwarf galaxy NGC1569

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**Abstract.** We made near- to mid-infrared imaging and spectroscopic observations of the dwarf galaxy NGC 1569 with the Infrared Camera (IRC) on board *AKARI*. The unidentified infrared (UIR) band features at 6.2, 7.7, and 11.2  $\mu\text{m}$ , which are generally attributed to polycyclic aromatic hydrocarbons (PAHs), are clearly detected in a structure associated with an  $\text{H}\alpha$  filament. The filament is filled with X-ray emission and is thought to be formed by outflow from the galaxy. Since PAHs are destroyed rapidly in hot plasma, it is most likely that PAHs in the filament are produced from fragmentation of large carbonaceous grains in the shock. We also detect excess emission in 2–5  $\mu\text{m}$  in the filament, which may come from very small grains.

**Keywords.** Infrared: galaxies, dust, extinction, galaxies: individual (NGC1569)

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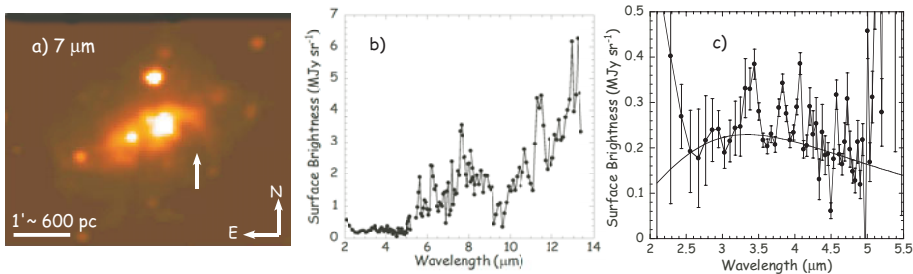
## 1. Introduction

The unidentified infrared (UIR) bands, whose major features appear at 3.3, 6.2, 7.7, 8.6, and 11.2  $\mu\text{m}$ , are seen in the diffuse Galactic emission as well as in external galaxies. Polycyclic aromatic hydrocarbons (PAHs) or PAH-like aromatic groups of carbonaceous materials are thought to be the carriers of the UIR bands. There remains an interesting question where and how the band carriers are produced in galaxies, in particular in dwarf galaxies, which may represent the characteristics of the early universe because of their low-metallicity. We report here the results of near- to mid-infrared imaging and spectroscopic observations of the starburst dwarf galaxy NGC 1569 with the Infrared Camera (IRC) on board *AKARI* (Murakami *et al.* 2007). NGC 1569 is a well-studied nearby galaxy with the metallicity of about a quarter of solar, which harbors several super star clusters (SSCs) in it (e.g., Tokura *et al.* 2006). A number of filamentary structures are detected in  $\text{H}\alpha$  (Hunter *et al.* 1993), which delineate the X-ray emission. It is suggested that the interaction between the galactic wind and the surrounding gas results in superbubbles and  $\text{H}\alpha$  emitting shocked gas (Martin 1998, Martin *et al.* 2002). There is a HI cloud about 5 kpc from the galaxy, which may fuel HI gas into NGC 1569 (Stil & Israel 1998, Mühle *et al.* 2005). We report here the detection of the UIR bands in one of the  $\text{H}\alpha$  filaments and discuss the possible supply source of the band carriers.

## 2. Observations

NGC 1569 was observed in the imaging (at 3, 4, 7, 11, 15, and 24  $\mu\text{m}$ ) and spectroscopic (2–13  $\mu\text{m}$ ) modes of the IRC (Onaka *et al.* 2007, Ohyama *et al.* 2007) on 2006 September 9 and on 2007 March 8, respectively. A western filament appears prominently in the 7  $\mu\text{m}$  image (Figure 1a), which correlates well with the  $\text{H}\alpha$  emission (Hunter *et al.* 1993), while structures corresponding to the filament are not clearly seen in the 15 and 24  $\mu\text{m}$  images. Since the 7  $\mu\text{m}$  band probes the UIR 6.2 and 7.7  $\mu\text{m}$  bands efficiently (Sakon

*et al.* 2007), this result suggests the presence of the UIR bands in the filament and subsequent spectroscopic observations of the filament were carried out. The spectrum of the western filament is shown in Figure 1b after subtracting the sky background. It confirms the presence of the UIR bands at 6.2, 7.7, and 11.2  $\mu\text{m}$  in the filament. There may be weak emission at 3.3 and 8.6  $\mu\text{m}$ , but further observations are needed to confirm their presence.



**Figure 1.** (a) *AKARI*/IRC 7  $\mu\text{m}$  image of NGC 1569. The white arrow indicates the western filament. (b) IRC spectrum of the filament. (c) An enlargement of the near-infrared spectrum of the filament. The solid line indicates a fit with a blackbody (868 K) with a  $\lambda^{-2}$  emissivity.

### 3. Discussion

The UIR bands have been detected in halos of galaxies (Irwin & Madden 2006, Irwin *et al.* 2007) and in filaments produced by outflows (Tacconi-Garman *et al.* 2005) based on imaging observations. The present observations detect the UIR 6.2, 7.7, and 11.2  $\mu\text{m}$  bands in a filamentary structure of a galaxy by spectroscopy for the first time. Since PAHs are destroyed rapidly in hot plasmas, it is most likely that PAHs in the filament are produced by fragmentation of large carbonaceous grains in the shock. Figure 1c also suggests the presence of excess continuum emission at 2–5  $\mu\text{m}$  in the filament. Similar excess emission, which is possibly due to very small grains, has been observed in external galaxies (Lu *et al.* 2003) as well as in the diffuse Galactic emission (Flagey *et al.* 2007).

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