Dust Content of Virgo Star-Forming Dwarf Galaxies

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Abstract We investigate the dust properties of a small sample of Virgo cluster dwarf galaxies drawn from the science demonstration phase data set of the *Herschel* Virgo Cluster Survey (HeViCS). These galaxies have low metallicities ($7.8 < 12 + \log(O/H) < 8.3$) and star formation rates $\lesssim 0.1\ M_{\odot}\ yr^{-1}$. We measure

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the spectral energy distribution (SED) from 100 to 500 μm and derive dust temperatures and masses. The SEDs are fitted by a cool component with T $\lesssim$ 20 K, implying dust masses around 10^5 $M_\odot$ and dust-to-gas ratios ($\mathcal{D}$) within the range 10^{-3}–10^{-2}.

1 Introduction

Star-forming dwarf galaxies are fragile systems which can be easily affected by the environment where they are evolving through different processes, such as tidal interactions, ram pressure stripping, collisions and mergers. How these processes affect their dust content though is still a matter of debate. Mid/far-infrared (MIR/FIR) and submillimetre (submm) observations have provided information about the different dust components in dwarfs, showing that even metal-poor galaxies may host a significant amount of dust [4, 12]. Since most of these studies have focused mainly on bright and isolated dwarfs [5–7], little is known about the interplay between the environment and the dust content of low-mass and low-metallicity systems. As part of the *Herschel* Open Time Key Project, the HeViCS survey [2] will map an area of 64 square degrees of the Virgo cluster with PACS [18] and SPIRE [9] to investigate the dust content of the different morphological types within the cluster. The dwarf galaxy population of the Virgo cluster is dominated by dwarf ellipticals, but also contains a non-negligible fraction (∼10%) of late-type dwarfs with signs of current star formation activity [1]. Here we present the FIR properties of three star-forming dwarfs detected in the HeViCS Science Demonstration Phase (SDP) data set.

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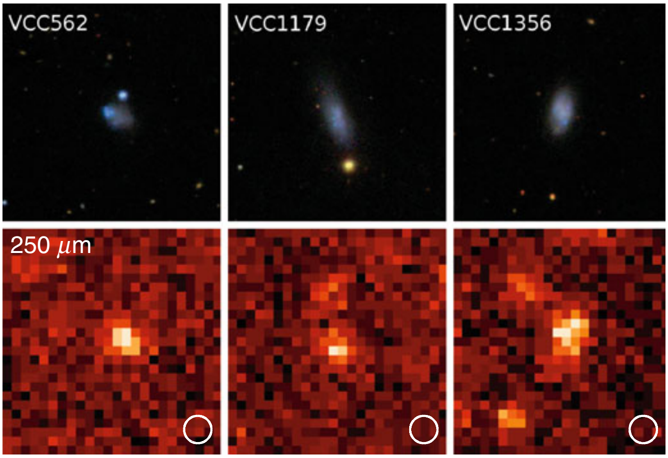

Fig. 1 SDSS and *Herschel* images of VCC 562, VCC 1179, VCC 1356 at 250 μm

2 Data Set

The SDP data set of the HeViCS survey probes a 4° × 4° region around the center of the cluster. More details on the observations can be found in [2]. The data were reduced using the Level I procedures described in [19]. The angular resolution for PACS in fast scan parallel mode is 7″ × 12″.7 and 11″.6 × 15″.7, at 100, and 160 μm, respectively. For SPIRE, the PSF FWHM is 18″.1, 25″.2, and 36″.9 at 250, 350, and 500 μm respectively. The SDP field contains 28 late-type low-luminosity galaxies classified in the Virgo cluster catalog [1] as Sm (7), Im (12), blue compact dwarf (BCD) (6) and dIrr (3). Three BCDs have been detected with both PACS and SPIRE: VCC 562, VCC 1179, VCC 1356 and here we present their FIR properties. Figure 1 shows optical SDSS and SPIRE (250 μm) data for the three BCDs in our sample.

3 Dust Masses and Dust-to-Gas Mass Ratios

We fitted the PACS+SPIRE SEDs with a single modified Planck function and an emissivity law $k_\nu \propto \nu^\beta$ with $\beta = 2$ to derive the temperature of the dust (Fig. 2; left panel). We assessed the dust masses using the 250 μm flux densities, and the emissivity $k_\nu = 4.67$ cm^2 g^{-1} at 250 μm [15]. The resulting dust masses are few times 10^5 M$_\odot$, and the dust temperatures are around 20 K. However, Fig. 2 shows that the 500 μm fluxes of VCC 1179 and VCC 1356 tend to be underestimated by the single-temperature fits. This difference could either be due to an additional cold (∼10 K) dust component [5–7], to an enhanced abundance of small grains [16] or to the different optical properties of the amorphous dust grains [17]. A more

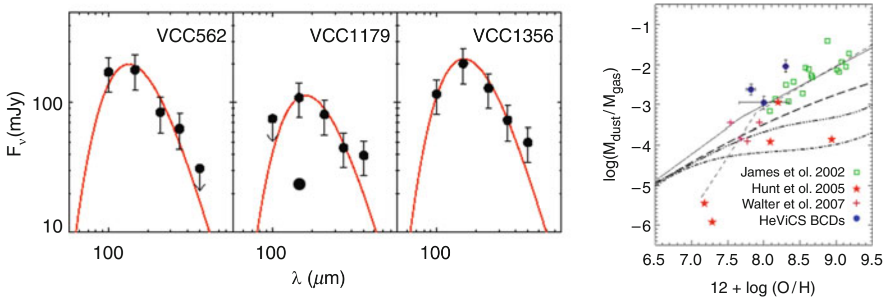

Fig. 2 *Left*: SED fitting of the three dwarfs under study. *Right*: $\mathcal{D}$ vs oxygen abundance; HeViCS dwarfs are shown as filled circles and they are compared to data and models from the literature

detailed discussion on the excess at 500 μm can be found in [10]. We determined the gas-to-dust mass ratios ($\mathcal{D}$) using HI masses available from the ALFALFA catalog [8]. We assumed the total gas mass was given by the atomic component only, including a correction of 1.36 for helium. Figure 2 (right panel) shows $\mathcal{D}$ for the Virgo BCDs (filled circles) as a function of nebular oxygen abundance. Also illustrated are data from the literature [13, 14, 20]. Selected model predictions for the $\mathcal{D}$ vs metallicity relation are also shown [3, 11]. Our estimates of $\mathcal{D}$ for the three dwarfs, based on the single-temperature fit to the data, are roughly consistent with the predictions of dust formation models from [3].

4 Conclusions

We presented the FIR properties of three BCDs in Virgo detected in the HeViCS survey. The data indicate a cool dust component with T $\lesssim$ 20 K and dust masses around 10^5 $M_\odot$. The completion of the full area of the survey will enable us to study a larger sample of star-forming dwarf galaxies, and to place more stringent constraints on the dust content of these systems in a dense cluster environment.

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