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THE ANATOMY OF STAR FORMATION IN NGC 300

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ABSTRACT

The *Spitzer Space Telescope* was used to study the mid- to far-infrared properties of NGC 300 and to compare dust emission to Hα to elucidate the heating of the interstellar medium (ISM) and the star formation cycle at scales smaller than 100 pc. The new data allow us to discern clear differences in the spatial distribution of 8 μm dust emission with respect to 24 μm dust and to H II regions traced by Hα light. The 8 μm emission highlights the rims of H II regions, and the 24 μm emission is more strongly peaked in star-forming regions than 8 μm. We confirm the existence and approximate amplitude of interstellar dust emission at 4.5 μm, detected statistically in *Infrared Space Observatory* (*ISO*) data, and conclude it arises in star-forming regions. When averaging over regions larger than ~1 kpc, the ratio of Hα to aromatic feature emission in NGC 300 is consistent with the values observed in disks of spiral galaxies. The mid- to far-infrared spectral energy distribution of dust emission is generally consistent with pre-*Spitzer* models.

Subject headings: galaxies: individual (NGC 300) — galaxies: ISM — infrared: galaxies — stars: formation

Online material: color figure

1. INTRODUCTION

NGC 300 is a SA(s)d galaxy in the Sculptor group of galaxies, at a distance of about 2.1 Mpc (Freedman et al. 1992), viewed at an inclination of about 50° (Puche et al. 1990). Its total luminosities in the blue band (3855–4985 Å) and in the far-infrared (42.5–122.5 μm, estimated from *Spitzer Space Telescope* data) are $\sim 3.3 \times 10^8$ and 2.2×10^8 $L_{\odot,\,\mathrm{bol}}$, respectively. Its L_{FIR}/L_B ratio is thus very close to the average ratio for the blue magnitude–limited sample studied by Thuan & Sauvage (1992). Because of its large angular extent and low surface brightness, no reliable total radio continuum flux measurement exists (only discrete sources are detected). NGC 300 has a striking appearance in the visible and in Hα due to several H II regions with nearly circular shapes and various degrees of filling-in (Deharveng et al. 1988; Hoopes et al. 1996; see Fig. 1 [Plate 1]). Its large H I envelope (Puche et al. 1990) extends well beyond the visible image. Pannuti et al. (2000) reported a total of 44 supernova remnant (SNR) candidates, evidence that the current star formation activity manifested as H II regions has been ongoing for tens of millions of years (see also Butler et al. 2004). The gas-phase oxygen abundance varies between about 1.4 and 0.4 times the solar value across the disk of the galaxy (Deharveng et al. 1988). Because of its proximity, NGC 300 allows *Spitzer* (Werner et al. 2004) to compare dust emission to other interstellar medium (ISM) components and discern the interplay between the ISM and the star formation cycle at scales smaller than 100 pc.

2. OBSERVATIONS AND DATA REDUCTION

The Infrared Array Camera (IRAC; Fazio et al. 2004) observations of NGC 300 are 12 s frames and map the galaxy in approximately half-array spacings, yielding a total time per sky position of 48 s. They were reduced with the standard *Spitzer* Science Center data reduction pipeline (ver. 9.5). Because of the readout of bright point sources, the signal was reduced (pulled down) in some columns of the array;[5] a correction measured from the map was applied. Persistent images left by bright sources were found by median-combining all the dithered positions together and identifying any remaining sources. These objects were removed from individual frames. The data were then combined into a mosaic using a cosmic-ray rejection and a background matching applied between overlapping fields of view. The relative photometric uncertainty is of the order of 5%, and the absolute uncertainty is 10%; uncertainty tied to the angular sizes of source and measuring aperture contributes up to 15%.

Images of NGC 300 at 24, 70, and 160 μm were obtained with the Multiband Imaging Photometer for *Spitzer* (MIPS; Rieke et al. 2004) in the scan-map mode. The final mosaics have a total exposure time of approximately 160, 80, and 16 s per point at 24, 70, and 160 μm, respectively. The MIPS images were reduced using the MIPS Instrument Team Data Analysis Tool (Gordon et al. 2004) as described by Engelbracht et al. (2004). The uncertainties on the final absolute calibrations are estimated at 10%, 20%, and 20% for the 24, 70, and 160 μm data, respectively. The 70 and 160 μm images exhibit linear streaks along the scan direction, which are residual instrumental artifacts due to the time-dependent responsivity of the Ge detectors and affect the photometry in large apertures.

The Hα (6563 Å) + [N II] (6583 and 6548 Å) map was derived from images posted in the NASA/IPAC Extragalactic Database by Larsen & Richtler (1999). The narrowband image containing Hα emission and the *R*-band image were aligned and rescaled to subtract the stellar continuum, deriving the scaling factor from aperture photometry on 32 bright stars. Residuals from saturated or improperly subtracted stars were

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[5] See the *Spitzer* Observer's Manual at http://ssc.spitzer.caltech.edu/documents/som/.