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A Statistical Comparison of the Near Infrared Emission with the Hα Emission from the HII regions of NGC4321, NGC4736 and NGC4254

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Abstract. We report on our ongoing project "Statistical studies of HII regions in the nearby extra-galaxies". We present an overview of our detailed study of warm dust in the nearby Galaxy NGC 4321 (M100), measuring the flux values in the 4 Spitzer-IRAC bands of some 275 HII regions in M100. In addition, we present new measurements of the flux values in the 4 Spitzer-IRAC bands of a complete sample of 70 isolated luminous HII regions in NGC 4736 and 157 regions in NGC 4254. We study the relations between the Hα luminosity and the near-IR luminosity and temperature of HII regions in the three galaxies. We estimate the near-IR luminosities and compare them with the Hα luminosities from archive and literature sources. We find a linear relation between the Hα luminosity and the IRAC luminosity for the HII regions, but no apparent relation between the luminosity and the colour temperature of the regions in any of the three galaxies. The colour temperatures of regions especially in M100 and NGC4254 are confined to a surprisingly narrow range, with a small fraction forming a higher temperature tail to the distribution. These results give new insight into the size function and the 3D distribution of the dust in these regions, and we propose scenarios to explain them.

Keywords. galaxies: HII regions,galaxies:individual(M100,NGC4736,NGC4254),galaxies: NIR emssion

1. Introduction

One of the primary goals of this project is to compare the luminosity functions from infrared emission with the luminosity functions derived from Hα emission. This project is mainly divided into two schemes: pilot scheme and main scheme. M100 is chosen as the "pilot galaxy" in the pilot scheme (see Chan & Beckman 2013). In this report, we present the overview and first insights of the pilot study of NGC 4736 and NGC 4254. The image of M100 and its calibrated Hα luminosity were obtained from Knapen (1998). The optical Hα images of NGC 4736 and of NGC 4254 are from Knapen *et al.*(2004) and their HII region catalogues are from Bradley *et al.*(2006). All of them are selected as our referenced data. The SINGS/IRAC images of M100, NGC4736 and NGC4254 were obtained from the SINGS Public Data Set Archive. (http://sings.stsci.edu/). The detailed measurement procedure is described in Chan & Beckman (2013).

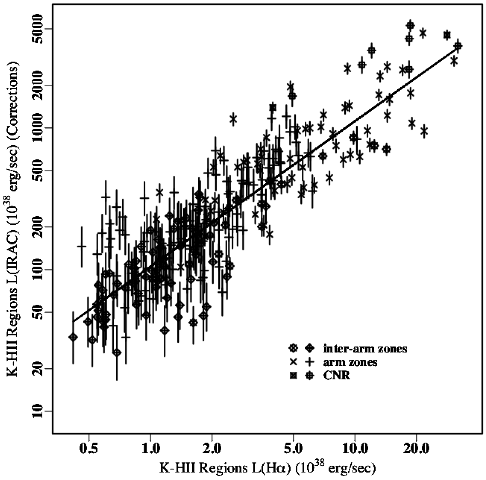

Figure 1. The integrated IR luminosities of the HII regions in M100 plotted against their Hα luminosities. The correlation does not depend on whether a region is in an arm or in the interarm zone in M100

2. Results and Summary

• The origin of the emission in the 3.6 μm and in the other IRAC bands is different. We suggest that the 3.6 μm excess is mainly due to the PAH C-H stretching feature (PAHs with $N_c < 50$ carbon atoms) (see Fig. 6 in Draine & Li 2007).

• By using a chi-squared fitting technique, we estimate IRAC 3-band colour temperatures from around 250 K up to around 400 K.

• *The correlation between L(Hα) and L(IRAC).* There is a strong correlation between the L(Hα) and L(IRAC) of the selected HII regions (see Fig. 1). We propose that this strong correlation be used for studying star formation rate issues. Calibrating this relation and combining the IRAC luminosity with the mid-IR luminosity should allow a practical derivation of the star formation rates without direct recourse to Hα observations.

• *Hα luminosity and infrared colour temperature.* It is notable that the IRAC 3-band colour temperature shows no significant dependence on the HII region luminosity (see Fig 2. in Beckman *et al.*2015). These results give new insight into the size function and the 3D distribution of the dust in these regions. The size distribution scenario for the strongly restricted range of dust temperatures is that at least a large fraction of the grains is very small. In other words, we may be observing stochastically heated nano-sized dust grains so that their "temperatures" are independent of the illuminating field (e.g.: Drain & Li 2007). In the 3D distribution scenario to account for the narrow dust temperature range, the cluster of hot stars is surrounded by a dust-free inner sphere, where the dust has been ablated (dust destruction model) or swept outwards (stellar-wind model) or a combination of both effects.

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