The Herschel view of HII regions in M 33 (HERM33ES)

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Abstract

Within the framework of the HERM33ES Key Project (Kramer et al. 2010), using the high resolution and sensitivity of the Herschel photometric data, we study the compact emission in the Local Group spiral galaxy M 33. We present a catalogue of 159 compact emission sources in M 33 identified by SExtractor in the 250 μm SPIRE band which is the one that provides the best spatial resolution. We measure fluxes at 24 μm and Hα for those 159 extracted sources. We find a very strong Pearson correlation coefficient with the MIPS 24 μm emission (r_{24} = 0.94) and a rather strong correlation with the Hα emission, although with more scatter ($r_{H\alpha}$ = 0.83). Due to the very strong link between the 250 μm compact emission and the 24 μm and Hα emissions, by recovering the star formation rate from standard recipes for HII regions, we are able to provide star formation rate calibrations based on the 250 μm compact emission alone. Finally, the morphological study of a set of three Hα shells shows that there is a displacement between far-ultraviolet and the SPIRE bands, while the Hα structure is in general much more coincident with the cool dust.

SPIRE 250 μm calibration of the star formation rate for HII regions in M 33

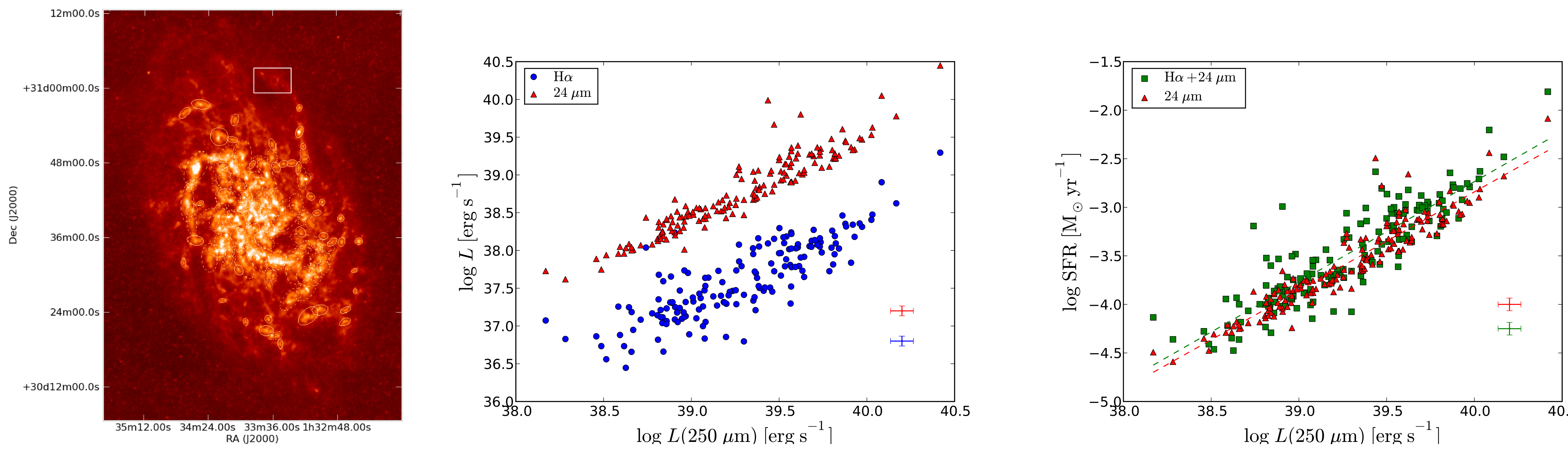

Figure: Herschel SPIRE 250 μm (left), the catalogue of extracted sources is overplotted. Hα and 24 μm emissions as a function of the 250 μm SPIRE emission (centre). SFR from 24 μm and from Hα+24 μm emissions as a function of the 250 μm emission (right).

In order to create a catalogue of compact emission sources in the SPIRE 250 μm band, we use the SExtractor software (Bertin & Arnouts 1996). The photometry of the 159 extracted sources is computed using the parameter FLUX_ISO given by SExtractor, which uses isophotal photometry (sum of all the pixels above a threshold given by the lowest isophot: 16 times the background r.m.s.). Since most of the extracted objects are along the spiral pattern of the galaxy, we believe many of the sources may be directly linked to SF. This suggests that the SPIRE 250 μm compact emission could be a reliable SF tracer in the vicinity of HII regions. Therefore, we concentrate our preliminary work on the 250 μm compact emission and compare its properties with standard SF tracers such as the Hα emission line and the 24 μm compact emission linked to HII regions (Calzetti et al. 2005, 2007). To recover the Hα+24 μm SFR, our best fit leads to:

$$\mathbf{SFR}\ [\mathrm{M}_\odot\ \mathrm{yr}^{-1}] = 8.71 \times 10^{-45} L(250\ \mu\mathrm{m})^{1.03} \quad , \qquad (1)$$

where $L(250\ \mu\mathrm{m})$ is in erg s^{-1}. To recover the SFR(24), we need the following calibration:

$$\mathbf{SFR}\ [\mathrm{M}_\odot\ \mathrm{yr}^{-1}] = 3.47 \times 10^{-44} L(250\ \mu\mathrm{m})^{1.02} \quad , \qquad (2)$$

also with $L(250\ \mu\mathrm{m})$ in erg s^{-1}. The uncertainties are 0.04 and 0.03 for the exponents in Eqs. 1 and 2, respectively, while the calibration constants have uncertainties of 4.0 and 2.7%, respectively. Please, see Verley et al. (2010) for more information.

SPIRE emission distributions for HII regions

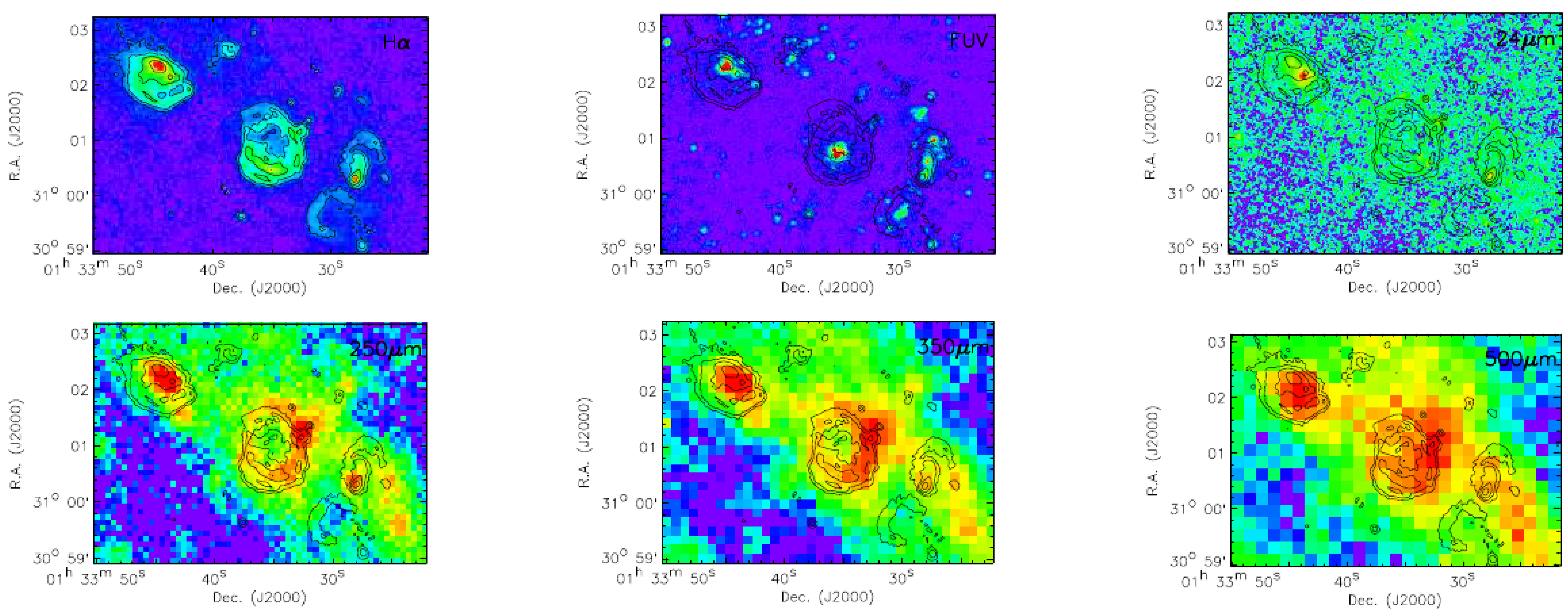

Figure: Top-left: Continuum-subtracted Hα image of a set of large shells in the outer north part of M 33. Contours are overlaid in this image to better enhance the shell features (levels are at 20, 49, 122, 300 of Hα emission measure) and repeated in the other images for comparison.

Taking advantage of the unprecedented Herschel resolution at these wavelengths, we also focus on a more precise study of some striking Hα shells in the northern part of the galaxy. The morphological study of the Hα shells shows a displacement between far-ultraviolet, Hα, and the SPIRE bands. The different locations of the Hα and far-ultraviolet emissions with respect to the SPIRE cool dust emission leads to a dynamical age of a few Myr for the Hα shells and the associated cool dust.

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