Triggered Star Formation in a Turbulent ISM
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UCHII regions in the Antennae

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Abstract. We explore the physical characteristics of young stellar clusters in the Antennae by combining recent ground- and space-based mid-infrared observations with a newly developed set of diagnostic diagrams. Spitzer data give an overview of the star-forming regions extending over hundreds of parsecs, showing a dominant diffuse ISM component with a density of 10^2 cm^{-3} plus a small fraction of very compact material (10^6 cm^{-3}). With its higher spatial resolution VISIR gives a close-up view of the latter component. Its emission line ratios suggest that these regions are fundamentally different from local star-forming regions. Instead of having small isolated UCHII regions, as in local star-forming regions, the average density of the medium of the whole region falls in the (ultra)compact regime, exceeding 10^4 cm^{-3} over tens of parsecs.

1. Data and models

Two star-forming regions in the overlap region of the Antennae galaxies (NGC 4038/39) were observed in the mid-infrared both from the ground, with VISIR at the ESO VLT (Snijders *et al.* 2006), as from space, with Spitzer IRS.

To model the observed mid-infrared spectra we have used the latest version of Starburst99 (v5.1) combined with the photoionization code MappingsIII. We computed spectral energy distributions of stellar clusters with a Salpeter IMF between 0.1 and 100 $M_\odot$ for various metallicities, embedded in a dusty HII region. A model grid was built exploring the effect of varying densities of the ISM and intensity of the ionizing radiation (characterised by the ionization parameter U). The emission line fluxes in the output spectra are used to construct diagnostic diagrams.

2. Spitzer versus VISIR

Combining various emission line ratios from the Spitzer spectra reveals that a uniform ISM cannot explain the data. A combination of a large proportion of low density (=90%; 10^2 cm^{-3}) and a small fraction of very compact material (10^6 cm^{-3}) is required to reproduce the observations. This can be interpreted as a giant diffuse ionized region with a number of UCHII regions below Spitzers resolution limit (several hundreds of parsecs).

The observed line ratios in the VISIR spectra require a two component ISM as well, though with considerably higher densities. At least half of the matter at intermediate densities (10^4 cm^{-3}) and the remainder moderately to very dense (10^4 – 10^6 cm^{-3}). With its higher spatial resolution (40 – 50 pc) VISIR probes the (ultra)compact cores of star formation, which are clearly fundamentally different from local star-forming regions.

References

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