## The youngest massive star clusters in the Magellanic Clouds

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**Abstract.** High resolution observations with HST have recently allowed us to resolve and study several very tight clusters of newly born massive stars in the Magellanic Clouds. Situated in an extremely rare category of H II regions, being only 5'' to 10'' across and of high excitation and extinction, these stars are just hatching from their natal molecular clouds. Since the SMC is the most metal-poor galaxy observable with very high angular resolution, this work may provide valuable templates for addressing issues of star formation in the very distant metal-poor galaxies of the early Universe.

# 1 Introduction

Our search for the youngest massive stars in the Magellanic Clouds (MCs) started almost two decades ago on the basis of ground-based observations [2]. This led to the discovery of a distinct and very rare class of H II regions in these galaxies, that we called high-excitation compact H II "blobs" (HEBs). Contrary to the typical H II regions of these galaxies which are extended structures with sizes greater than 50 pc, HEBs are an order of magnitude smaller having diameters of less than about 3 pc. HEBs are probably the final stages in the evolution of the ultra-compact H II regions, whose Galactic counterparts are detected only at infrared and radio wavelengths.

# 2 Current HST Imaging and Spectroscopy

The discovery of the very young and compact H II regions has entered a new era with the high resolution capabilities of the HST. Our recent HST observations [3, 4, 5, 7, 6], reveal the stellar content of these objects, so far out of reach from ground-based telescopes, and indicate a turbulent environment typical of newborn massive star forming regions. Our findings suggest that the true number of massive stars in the Magellanic clouds is underestimated since a large number of them are hidden in unresolved small clusters, and even though all compact H II regions belong to the general category of HEBs they display several distinct characteristics (see Fig. 1).



Figure 1: H $\alpha$  images of five of the HEBs observed by HST. North is up, East is to the left and the field of view is  $10 \times 10$  pc for each image. A close-up view of the "Papillon", seen in N159-5 as a dark spot above the absorption lane appearing in white, is presented as the last image. See [3, 4, 5, 7, 6] for details.

A thorough study of the regions is presented in [3, 4, 5, 7, 6], but it is worth mentioning here a few of the majors points. SMC N81, while young, is relatively more evolved than N88A and also represents a really isolated massive starburst. SMC N88A is the latest starburst in a region where former generations of massive stars are present over a large area. It has an elevated extinction with values as high as  $A_V \sim 3.5$  mag which is fairly unique given the gas content and metallicity of the SMC. The LMC region N159-5, similarly to SMC N88A, shows no conspicuous stars probably due to its extreme youth. Finally, LMC N83B represents a rare opportunity where by means of combining the high resolution of the HST with larger scale ground images a rather interesting spatial distribution of the massive stars is observed. We find that this distribution is consistent with the model of fractal / hierarchical structure for the gas which gives rise to the star formation (see [6]).



Figure 2: HST/STIS UV spectrum of the main exciting star in N81 (see [8]).

To examine in more detail the properties of the young massive stars in the HEBs we performed STIS spectroscopy of the major exciting stars of SMC N81 [8]. The Far UV spectra (see Fig. 2), confirmed the extreme youth we had inferred from their broad-band colors revealing features characteristic of an O6–O8 stellar type. However, their astonishingly weak wind profiles and their sub-luminosity (up to  $\sim 2$  mag fainter in  $M_V$  than the corresponding dwarfs) make these stars a unique stellar

population in the MCs. The weak wind must be related to the low metallicity, since it is believed that the metal deficiency of the SMC leads to a reduced radiation pressure responsible for driving the winds of early type stars (i.e. [9]). Our analysis suggests that these very interesting stars are probably in the Hertzsprung-Russell diagram locus of a particularly young class of massive stars, the so-called Vz luminosity class (i.e. [10]), as they are arriving on the zero age main sequence.

## **3** Perspectives

Despite of the recent progress, several questions on the nature of HEBs remain open. Is there an evolutionary secquence among HEBs? We were able to identify some exciting stars in those regions, but we also found evidence of high dust content and their absorption seems to be "patchy". Could it be that our optical imaging misses a part of an embedded the stellar population? Our data so far cannot exclude the possibility of a low mass component in the luminocity function of HEBs. However, if low mass stars were indeed absent, as the so-called bi-model star formation theories predict [11], this would give further weight to coalescence scenarios for the formation of massive stars (i.e [1]) according to which massive stars form through collisions and coalescence of the low and intermediate mass stellar component. Are the stellar winds of most stars in HEBs as weak as the ones in N81, and if so, is this consistent with the fact that the ionized gas surrounding them appears extremely turbulent with strong ionization fronts, cavities, and bright gaseous filaments?

Clearly, high resolution near-IR imaging and spectroscopy of more stars (currently attainable only with HST/STIS), would be highly desirable in order to obtain sufficient new information to address those issues.

#### References

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