A Massive Star Odyssey, from Main Sequence to Supernova
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A *HST* study of young massive star clusters in compact H II regions of the Magellanic Clouds

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Abstract. We present our results on high resolution imaging and spectroscopy using the *HST* of six high-excitation 'blobs' (HEB). HEBs constitute a rare class of compact H II regions in the Magellanic Clouds. Contrary to the typical H II regions of these galaxies, which are extended structures with sizes greater than 50 pc, the compact H II regions are an order of magnitude smaller having diameters of less than about 3 pc. HEBs are believed to be the final stages in the evolution of the ultra-compact H II regions, whose Galactic counterparts are detected only at infrared and radio wavelengths. We find that despite their small size, HEBs are in general excited by more than one newborn massive star. Color-magnitude diagrams of the exciting stellar population indicate that it is consistent with an O6-O8 type, and far-UV spectroscopy with *HST*-STIS of several of these stars further confirms their youth. Surprisingly though, it also shows an astonishing weakness of their wind profiles and their sub-luminosity, up to ~ 2 mag fainter in M_V than the corresponding dwarfs. Our analysis suggests that these stars are probably in the Hertzsprung-Russell diagram locus of a particularly young class of massive stars, the so-called Vz luminosity class, as they are arriving on the zero age main sequence.

1. General remarks

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 (Heydari-Malayeri *et al.* 2002 and references therein), 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 (MCs) is underestimated since a large number of them are hidden in unresolved small clusters. Even though all compact H II regions belong to the general category of high-excitation 'blobs' (HEBs), they display several distinct characteristics. SMC N 81, while young, is relatively more evolved than N 88A and also

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represents a really isolated massive starburst. SMC N 88A 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 $A_V \simeq 3.5$ mag, which is fairly unique given the gas content and metallicity of the SMC. The LMC region N 159-5, similarly to SMC N 88A, shows no conspicuous stars probably due to its extreme youth. Finally, LMC N 83B 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.

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 N 81. The far-UV spectra 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 ~ 2 mag fainter in M_V than the corresponding dwarfs) make these stars a unique stellar population in the MCs. The weak winds may be related to the low metallicity (reduced radiation pressure) or other phenomena possibly indicating a break-down of the wind-momentum-luminosity relation in these objects (Martins *et al.*, these Proceedings). 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, as they are arriving on the zero age main sequence.

Despite the recent progress, several questions on the nature of HEBs remain open. Is there an evolutionary sequence 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 stellar population? Our data so far cannot exclude the possibility of a low mass component in the luminosity function of HEBs. However, if low mass stars were indeed absent, as the so-called bi-model star formation theories predict, this would give further weight to coalescence scenarios for the formation of massive stars, according to which massive stars form through collisions and coalescence of the low and intermediate mass stellar component. Clearly, high resolution near-IR imaging and spectroscopy of more stars (using *HST*-NICMOS/STIS and VLT-ISAAC), would be highly desirable in order to obtain sufficient new information to address those issues.

References

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