The Standard IMF in the Outskirts of M83

KODA, Jin (Stony Brook University)
YAGI, Masafumi (NAOJ)
BOISSIER, Samuel (Laboratoire d'Astrophysique de Marseille)
GIL DE PAZ, Armando (Universidad Complutense de Madrid)
IMANISHI, Masatoshi (NAOJ)
DONOVAN MEYER, Jennifer (Stony Brook University)
MADORE, Barry F. (Carnegie Institution of Washington)
THILKER, David A. (The Johns Hopkins University)

The initial mass function (IMF) is of crucial importance to developing models of star formation and galaxy evolution. Most observations are consistent with a universal IMF [1]; however, recently, a non-universal IMF has been inferred [2]. The IMF in low-density environments could be truncated (or steeper) at its high-mass end. Fewer high-mass stars appear to form in dwarf and low surface brightness galaxies [3].

The Galaxy Evolution Explorer (GALEX) ultraviolet (UV) satellite has revealed tantalizing evidence for star formation far beyond the optical edge of galactic disks. These extended UV (XUV) disks are providing a new opportunity for studying the mode of star formation in extremely low-density, low star-forming environments. By capitalizing on the exceedingly high sensitivity and wide field-of-view of the Suprime-Cam, we observe the whole extension of the large XUV disk of the nearby galaxy M83 (Figure 1). GALEX UV images are sensitive to both O and B stars but cannot distinguish between them, while Subaru Hα images are sensitive almost exclusively to O stars since only O stars produce appreciable HII regions. Therefore, the combination of Subaru and GALEX can determine the high-mass end of the IMF. Suprime-Cam with the Hα filter (i.e., NA659) detects every HII region around a single O star at the distance of M83.

Our new observations enable the first complete census of very young stellar clusters over the entire XUV disk. Combining Subaru and GALEX data with a stellar population synthesis model, we find that (1) the standard, but stochastically-sampled, IMF is preferred over the truncated (or steeper) IMF, because there are low mass stellar clusters ($10^{2-3}\,M_\odot$) that host massive O stars, which should not exist under the truncated IMF; that (2) the standard Salpeter IMF and a simple aging effect explain the counts of FUV-bright and Hα-bright clusters with masses $> 10^3\,M_\odot$; and that (3) the Hα to FUV flux ratio over the XUV disk supports the standard IMF. To reach conclusion (2), we assumed instantaneous cluster formation and a constant cluster formation rate over the XUV disk.

Suprime-Cam covers a large area even outside the XUV disk − far beyond the detection limit of the HI gas. This permits us to statistically separate the stellar clusters in the disk from background contamination. The new data, model, and previous spectroscopic studies provide overall consistent results with respect to the internal dust extinction ($A_V \sim 0.1$ mag) and low metallicity ($\sim 0.2\,Z_\odot$) using the dust extinction curve of the Small Magellanic Cloud. The background subtraction and extinction correction have been the major issues in studies of the IMF in external galaxies. This result is published in [4].

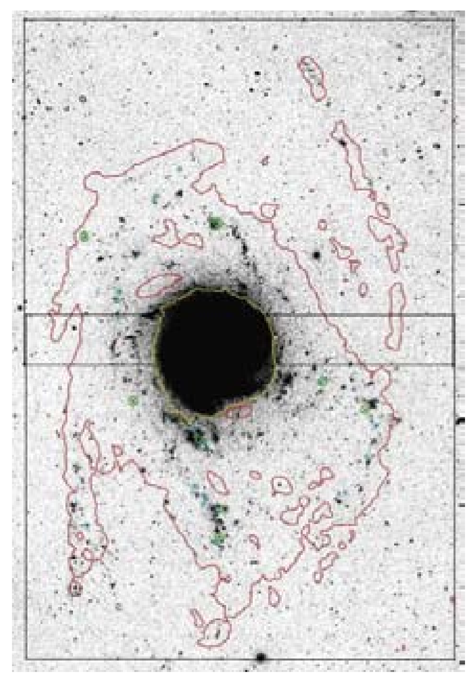

Figure 1: Suprime-Cam coverage of the XUV disk of M83. The background is a GALEX far-UV (FUV) image. Solid overlapping rectangles are two Suprime-Cam pointings. The inner (yellow) contour is roughly at the traditional edge of the optical disk. The outer (red) counter is at an HI surface density of 1.5×10^{20} cm^{-2} [5]. The Hα-bright clusters (NA659 − $R_c < -1$ mag) are also plotted: green for clusters with $> 10^3\,M_\odot$ and cyan for the ones with $< 10^3\,M_\odot$.

References

[1] Kroupa, P.: 2002, *Science*, **295**, 82.
[2] Bastian, N., Covey, K. R., Meyer, M. R.: 2010, *ARA&A*, **48**, 339.
[3] Meurer, G., Wong, O. I., Kim, J. H., et al.: 2009, *ApJ*, **695**, 765.
[4] Koda, J., Yagi, M., Boissier, S., et al.: 2012, *ApJ*, **749**, 20.
[5] Miller, E. D., Bregman, J. N., Wakker, B. P.: 2009, *ApJ*, **692**, 470.