M81 Galactic Archaeology with Subaru/Hyper Suprime-Cam

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The currently favored cosmological models are based on the idea of hierarchical structure formation: the structures in the universe such as galaxies develop from small "overdensities" to become large-scale objects [1]. The Milky Way and M81 grew over time via the agglomeration of numerous smaller building blocks, some of which may have survived later mergers to become present-day dwarf satellite galaxies [2]. Over the last decade, a number of new satellite galaxies, stellar streams, and over-densities around the Milky Way and the M31 have been discovered in the large photometric surveys [3]. However, the outskirts of two large spirals are the only places that have been surveyed to sufficiently faint depths to enable detailed tests of hierarchical galaxy assembly process across wide scales.

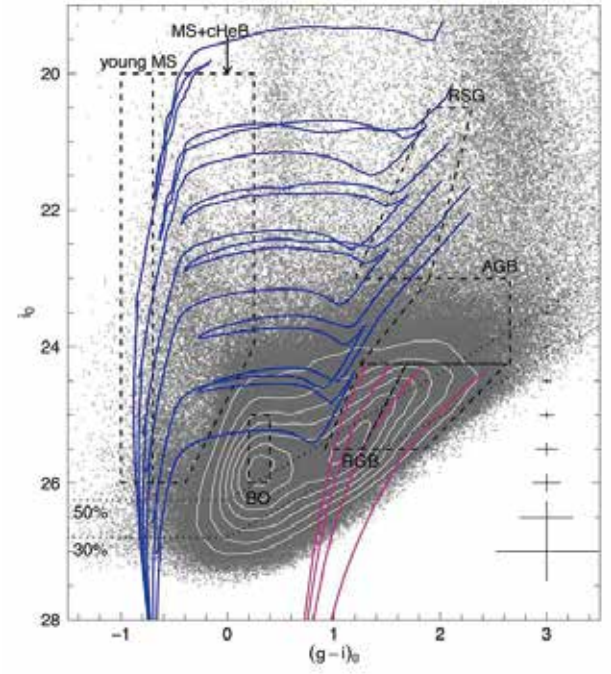

Figure 1: Dereddened CMD of stellar objects. The dashed boxes delineate the selection criteria for different stellar populations and are used to construct the maps of young and old stellar contents presented in Fig. 2.

We are conducting a state-of-the-art wide-field mapping survey of the M81 Group with Hyper Suprime-Cam (HSC) on Subaru. Figure 1 shows the resulting color-magnitude diagram (CMD) of roughly 550,000 dereddend point sources found in the 4 deg^2 area around M81 [4]. Theoretical isochrones are overlaid to aid in understanding the range of stellar populations. The left panel of Figure 2 shows the spatial distribution of stars in young MS and MS+cHeB boxes of Figure 1. Overall distribution of young stars agrees extremely well with those of the HI blobs. Bright stars are mainly located in the inner disk of M81, while most of young stars in the outlying associations are fainter than $i_0 \sim 24$ and have similar luminosity distributions each other, suggesting that star formation in these tidal features was synchronized and may have stopped about 30 Myr ago. The right panel of Figure 2 shows the spatial distribution of RGB stars. A tidal stream between M81 and M82 can clearly be seen, and the outer regions of M82 and NGC 3077 exhibit an S-shaped morphology. The NGC 3077 halo is extended far beyond the R_{25} (r = 2.7′). Numerical modeling suggests the encounters between NGC 3077, M81, and M82 took place ~200–300 Myr ago, which may not leave enough time to restore equilibrium in the NGC 3077 halo. The dwarf galaxies such as IKN and BK5N cannot be seen in the maps of young stars, but appear as overdensities of old populations, implying they have not formed as a result of the recent interaction.

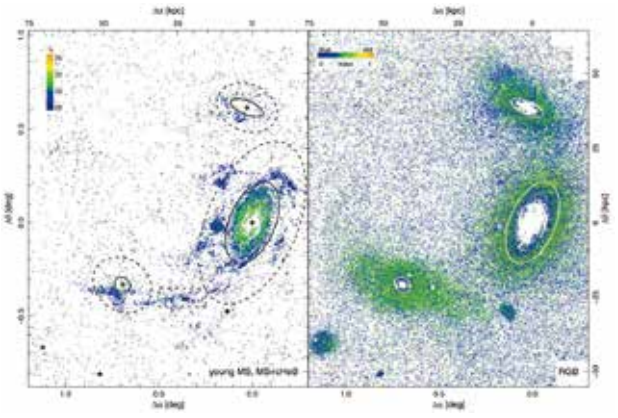

Figure 2: *Left*: The spatial distribution of MS and cHeB stars that are color coded according to the luminosity with transparency. *Right*: The spatial distribution of RGB stars. The color of each point represents the $(g-i)_0$ color of star with transparency. The solid lines are R_{25} radii of galaxies.

References

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[3] Willman, B., et al.: 2005, *ApJ*, **626**, 85.
[4] Okamoto, S., et al.: 2015, *ApJ*, **809**, L1.