Stellar Populations and Spatial Distributions of Ultra Faint Dwarf Galaxies

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Dwarf spheroidal galaxies (dSphs) around the Milky Way provide us a unique opportunity to investigate galaxy formation and evolution through their resolved stars. Since 2005, extremely faint dwarf (UFD) galaxies and stellar streams are found around the Milky Way [1,2]. The newly discovered UFD galaxies are roughly 10 to 100 times fainter than the well-known "classical" dSphs, having amorphous morphology, and yet are the most dark matter (DM) dominated galaxies. Their star formation histories and detailed structural properties provide a clue to understanding of the galaxy formation at the faint-end and the Galactic tidal effects for the satellite galaxies.

We take deep images of four UFD galaxies, Canes Venatici I, II (CVn I, II), Boötes I (Boö I), and Leo IV, using the Suprime-Cam on the Subaru Telescope [3]. Color-magnitude diagrams (CMDs) extend below mainsequence turnoffs and yield measurements of the ages of stellar populations. The stellar populations of three faint UFD galaxies are estimated to be as old as the Galactic globular cluster M92. We confirm that Boö I dSph has no intrinsic color spread in the MSTO and no spatial difference in the CMD morphology, which indicates that Boö I dSph is composed of an old single stellar population. One of the brightest UFDs, CVn I dSph, shows a relatively younger age (~12.6 Gyr) with respect to fainter dSphs, and the distribution of red horizontal branch (HB) stars is more concentrated toward the center than that of blue HB stars, suggesting that the galaxy contains complex stellar populations. CVn II dSph has the smallest tidal radius of a Milky Way satellite and has a distorted shape, while Leo IV dSph shows a less concentrated spherical shape. The simple stellar population of faint UFDs indicates that the gases in their progenitors were removed more effectively than those of brighter dSphs at the occurrence of their initial star formation. This is reasonable if the progenitors of UFDs belong to less massive halos than those of brighter dSphs.

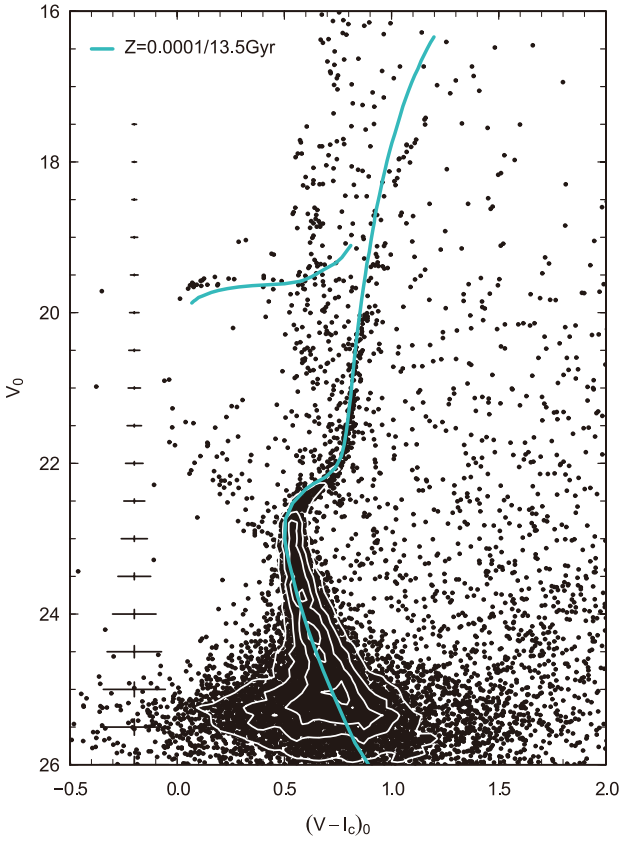

Figure 1: $(V-I_C)_0-V_0$ CMD of whole observed region of Boötes I dSph. The theoretical Padova isochrone of Z=0.0001 and 13.7 Gyr is overlaid.

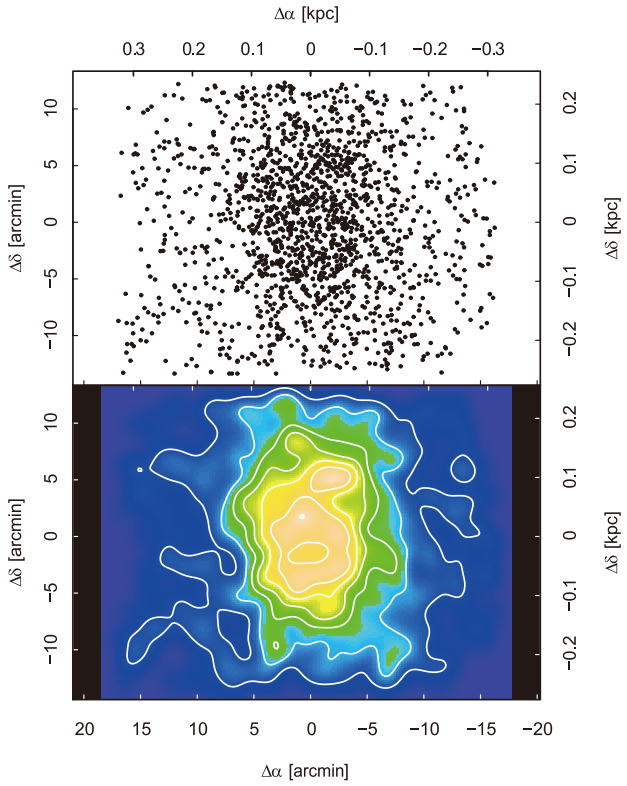

Figure 2: Spatial distribution of the member candidates selected from CMD and iso-density contour of the member candidates of Boötes I dSph.

References

[1] Willman, B., et al.: 2005, *ApJ*, **626**, 85.
[2] Belokurov, V., et al.: 2007, *ApJ*, **654**, 897.
[3] Okamoto, S., et al.: 2012, *ApJ*, **744**, 96.