Rediscovering our Galaxy
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HSC Wide and Deep Imaging Survey for the Milky Way Satellite Galaxies

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Abstract. We have carried out an imaging survey for Local Group dwarf spheroidal galaxy Ursa Minor (UMi) using Hyper Suprime-Cam (HSC) on the 8.2m Subaru Telescope. Wide and deep data obtained by HSC enable us to investigate the extent of UMi which is revealed to extend out to twice the nominal tidal radius. The fraction of binary systems is also investigated from the morphology of the main sequence and estimated to be ∼0.4.

Keywords. Local Group, dwarf galaxy, star formation, structure

1. Introduction

Satellite galaxies are the major residents in the halo of our Galaxy and important constituents as building blocks of the halo. Nonetheless, data for these systems that is at the same time wide and deep, is often lacking, because of their large apparent sizes. We have carried out an imaging survey for Local Group dwarf galaxies using Hyper Suprime-Cam (HSC) on the 8.2m Subaru Telescope aiming to shed a light on the nature of these galaxies. HSC is a Giga pixel CCD camera with 1.5 degrees field of view attached to the prime focus of the Subaru Telescope. Together with the high spatial resolution and high sensitivity realized by the Subaru Telescope, HSC is the best instrument for exploring Local Group galaxies. Our survey covers the target galaxies beyond their tidal radii down to the depth unexplored by previous surveys, namely a few magnitude below the main sequence turnoff points, making it the ultimate survey for the Local Group dwarf galaxies.

2. Dwarf Spheroidal Galaxy Ursa Minor (UMi)

Ursa Minor, which is the main target analyzed in this article, is one of the classical dwarf spheroidal galaxies located ∼60 kpc away from us. UMi is suggested to be a dark matter dominated galaxy (M/L within $r_{1/2} = 290$ M⊙/L⊙; Pace *et al.* 2014) and to host hidden substructures in the main body from radial velocity analysis (e.g., Pace *et al.* 2014) and structural analysis (e.g., Palma *et al.* 2003), making it an intriguing target in the halo of our Galaxy.

HSC covers the galaxy out beyond the nominal tidal radius with 4 pointings. The color-magnitude diagrams (CMDs) reveal the real extent of this galaxy; we see stars belonging to the sub-giant branch or upper main sequence outnumbering the foreground/background stars even out to twice the tidal radius. No significant difference in the stellar population is found between this extended component and the main body of the galaxy, suggesting that those stars in the extended component would probably be those expelled from the main body.

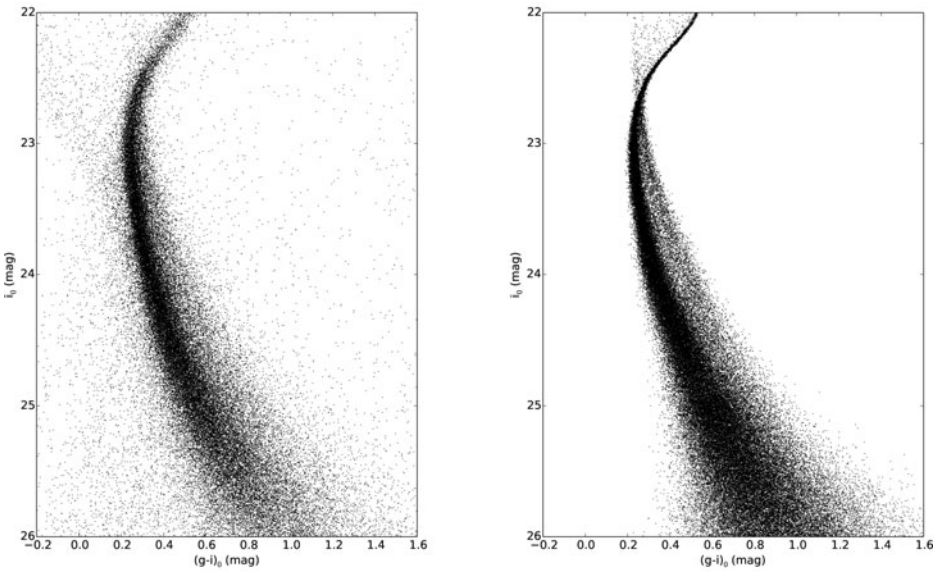

Figure 1. Zoomed views of the observed (left) and simulated (right) CMDs. For simulation, $q = 0.4$ is adopted.

We also investigate the fraction of binary systems of this galaxy from the morphology of the main sequence following the method applied for Galactic globular clusters by Milone *et al.* (2010). This method is applicable since the HSC images are deep enough to probe well below the main sequence turnoff. Although binary systems in UMi are unresolved and observed as single stars, the brightness and color of the system are altered according to the secondary/primary mass fraction. As a result, at the main sequence magnitude range, they are distributed at the redder and brighter side of the main sequence (see Figure 1). By simulating the CMDs with various fraction of binary systems and comparing them with the observed CMD, one can estimate the fraction of binary systems.

We make simulated CMDs by adopting the Salpeter initial mass function and Padova isochrone of 11 Gyr and Z=0.0004 and assuming a flat distribution for the mass fraction of binary systems ($q = M_{secondary}/M_{primary}$). As shown in Figure 1, the simulated CMD does not perfectly reproduce the observed CMDs for $i_0 < 23$ mag because only photometric errors are incorporated for the simulation and no blue straggler model is introduced. On the other hand, the observed stars are incomplete for $i_0 > 25$ mag. By comparing the magnitude range of $23 < i_0 < 24.5$, the binary fraction is estimated to be ∼0.4. The value is consistent with those estimated for the other Local Group dwarf spheroidal galaxies (Carina, Fornax, Sculptor, and Sextans) from the radial velocity measurements (Minor 2013).

References

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