Searches for New Milky Way Satellites from the Subaru/HSC Survey: Discovery of Cetus III

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The current standard theory of structure formation in the universe, Λ model, predicts that a Milky Way (MW)-sized host halo is surrounded by hundreds to thousands of subhalos. However, this prediction is in conflict with the observed number of only ~50 MW satellites. This is the missing satellites problem, which is one of the unresolved issues related to ΛCDM models. One of the possible solutions to the missing satellites problem is that we are still undercounting the population of fainter or more distant satellites in the MW due to various observational biases. Motivated by this, we have started a systematic search for new MW satellites in the course of the Subaru Strategic Program (SSP) using Hyper Suprime-Cam (HSC), and have already discovered an extremely faint satellite candidate, Virgo I, from the early survey data [1].

We report here the discovery of the second new MW satellite candidate, Cetus III, from the first two years of HSC-SSP data [2]. It is estimated that an absolute magnitude of Cetus III is $M_V \sim -2.4$ mag and a heliocentric distance is ~250 kpc in the direction of the constellation Cetus. The areas where we have discovered Cetus III and Virgo I have been previously surveyed by SDSS, but they are beyond the detection limit of SDSS (Fig. 1), Therefore, the Subaru/HSC is able to discover yet unidentified faint or distant satellites owing to its wide and deep survey and is very effective for the search of missing satellites.

Based on ΛCDM models, we will discover about 10 satellites in the completed HSC-SSP survey over ~1400 deg^2 (Fig. 2). Now we have disovered 2 new satellites (Cetus III, Virgo I) from first two years data (~300 deg^2 covered), the frequency of discovery (1 satellite per 100~200 deg^2) is so far consistent with the prediction of ΛCDM models. In the near future, we expect to find more new satellites, and then the completion of HSC-SSP survey will provide important insights into the nature of dark matter and galaxy formation theory by comparing the results of obserbation such as the number and the spatial distribution of satellites with those of ΛCDM models.

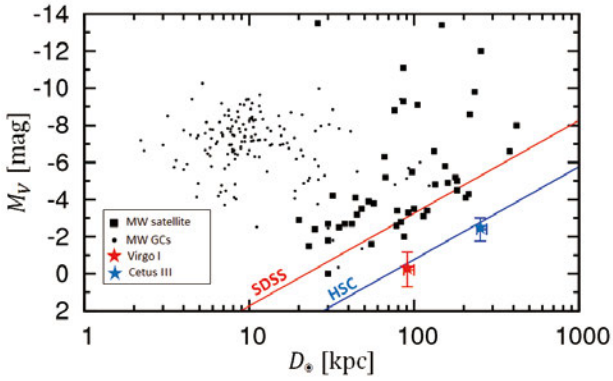

Figure 1: The relation between M_V and heliocentric distance for stellar systems. Dots denote globular clusters in the MW and filled squares denote the MW satellites. The red and blue lines indicate the detection limits of SDSS and HSC, respectively.

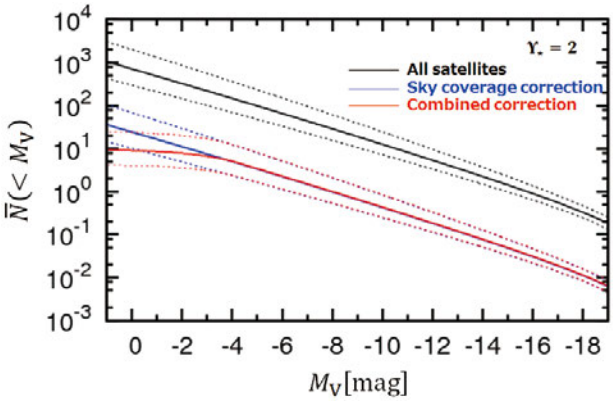

Figure 2: Black solide line denotes the cumulative luminosity function of visible satellites in the MW-sized halo calculated from ΛCDM models. Blue solid line considers the correction only for the sky coverage of the HSC-SSP survey (~1400 deg^2). In addition, red solid line considers the corrections for the detection limit of HSC-SSP survey.

References

[1] Homma, D., et al.: 2016, *ApJ*, **832**, 21.
[2] Homma, D., et al.: 2018, *PASJ*, **70**, 18.