Title: Cosmological constraints from galaxy-galaxy lensing and clustering with the Subaru HSC and SDSS BOSS data

Abstract: Hyper Suprime-Cam (HSC) is the wide-field prime focus camera on the Subaru Telescope, which provides the 1.77 sq. degree field-of-view with superb image quality (~0.6” seeing FWHM) and the large light-gathering power enabled by the 8.2-m primary mirror. HSC started the wide, deep optical and near infrared imaging survey in 2014 that will cover 1,400 sq. degree of the sky down to the i-band limiting magnitude i~26. In this talk, we present the preliminary cosmological constraints from galaxy-galaxy weak lensing and clustering measurements combining three dimensional position information from the SDSS BOSS survey and accurate galaxy shapes from the HSC first-year data. Compared to the traditional cosmic shear measurement, this method is less prone to observational systematics such as additive shear bias and photometric redshift bias. The major challenge is building a robust model to marginalize the galaxy-halo connection without biasing cosmological constraints. We first introduce such model based on Dark Emulator (Nishimachi et al. 2018) and our extensive tests of its robustness. We then discuss our cosmological constraints from the measurements, which is the one of the most stringent constraints of their kind to date. We will also discuss a perspective of combined galaxy-galaxy lensing and clustering analyses in the PFS era.
Abstract: Subaru PFS will conduct a cosmological survey over 1,400 square degrees in the sky to measure the distribution of the galaxies with unprecedented redshift coverage and galaxy number density. The PFS cosmology survey will provide us crucial insights into the dark energy, modified gravity, and massive neutrinos.

In order to design the survey strategy, we need a forecast for the constraint on cosmological parameters. To this end, we have developed the so-called "log-normal simulation" suite (Agrawal et al. 2017; Makiya et al. in prep). The code quickly generates the matter and galaxy density field from the input matter power spectrum, without any systematic uncertainties arising from the numerical implementation. By using this code, we generate the mock galaxy catalog and measure the power spectra in redshift space and weak lensing shear-galaxy cross power spectra, as well as the covariance matrix of them.

In this talk we will show the forecast for the PFS cosmology survey obtained from the log-normal simulations.
We will also discuss our future plan for the development of more realistic simulation suite, which will include fiber allocation, emission line identification and so on.
Title: **Will galaxy bispectrum measurements enhance the science return from PFS?**

Abstract: Yes. To fully extract cosmological information from nonlinear galaxy distribution in redshift space, it is essential to include higher-order statistics beyond the power spectrum. The bispectrum measurements will provide complementary information on Dark Energy and the total neutrino mass to the power spectrum measurements. While almost all previous works assume the simplest Gaussian error in computing the Fisher matrix including the bispectrum, this work precisely estimates non-Gaussian errors on the bispectrum measurement and provides more realistic forecast. This talk emphasizes that the joint analysis of the power spectrum and the bispectrum improves the constraint on Dark Energy and the total neutrino mass by a factor of about 1.5, compared to the power spectrum only analysis.
Title: The epoch of reionization with the Prime Focus Spectrograph

Abstract: The 40 square degrees Euclid Deep Fields will be observed to 26th magnitude in three near infrared bands. The Cosmic Dawn Survey initiative, will complement the Euclid Deep Fields observable from Hawaii (NEP and CDFS) with deep Spitzer (6000h) and Subaru/HSC (30 nights) data. The combined dataset will have the wavelength coverage and sensitivity needed to construct unbiased, stellar mass complete (M>M*) samples of galaxies to z>8 over an area 100 larger than any existing survey. As the most massive galaxies trace the underlying dark matter distribution, this offers a unique opportunity to map the large-scale structure of the Universe on all relevant cosmic scales throughout the epoch of reionization.

I will present plans for a PFS survey of the Euclid Deep Fields which will enable a range of ground breaking science that would otherwise not be possible, including: 1) constraining cosmology and the interplay between dark matter and baryonic matter through the epoch of reionization, 2) constraining the main sequence of star formation, the stellar mass function, and the stellar to halo mass function of galaxies to z=10 and 3) finding and understanding the first reionized bubbles in the Universe.
Title: Subaru Study on the SPin Parity Distribution of Galaxies and Structure Formation

Abstract: Observational studies on the inhomogeneity of the scalar density field in the Universe by means of microwave background radiation and 3D mapping of galaxy distribution were successful in constraining structure formation scenarios of the Universe. Next step could be studies on the vector fields of the Universe. Recent study of 146 nearby spiral galaxies by the authors provides a corroborative evidence that all the spiral galaxies are trailing. This finding enables us to decide the sign of the line-of-sight component of the spin vector of each spiral, just from their images, whether the spiral is S-wise or Z-wise. We are using the deep learning algorithm to judge S/Z winding of 50,000 spiral galaxies up to a redshift 0.8 in the HSC Wide image data covering up to a scale of 1Gpc. Tidal spin-up, pancake collapse, and primordial whirl scenarios predict different distribution of galaxy spins. We are looking for any anisotropy and early result of the study will be reported. We could even use another bit of information on the spin vector orientation by making a second round PSF spectroscopy for each galaxy at a point offset along the major axis from their center.
Title: **3D Tomographic Mapping of the z~2-3 IGM with Subaru PFS**

Abstract: By targeting high area densities of star-forming galaxies at z~3 as background sources probing the HI Lyman-alpha forest absorption at z~2.5, it is feasible to create 3D absorption maps of the IGM on scales of a few cMpc. This enables various scientific applications including studying galaxy protocluster evolution, measuring galaxy-filament intrinsic alignments, constraining large-scale AGN feedback, and others. I will review results from the CLAMATO pilot survey on the Keck-I telescope, and then describe the IGM tomography component planned for the Subaru PFS SSP survey.
Title: Shedding New Light on the AGN Demographics with Prime Focus Spectrograph

Abstract: Understanding the birth and growth of supermassive black holes (SMBHs) is a key to unravelling the riddle of galaxy evolution across cosmic time. On the observational side, it requires a sufficiently complete sample of active galactic nuclei (AGNs), selected over a wide range of the electromagnetic spectrum. I will present a preliminary design of such a comprehensive AGN survey, exploiting the exquisite survey ability of the Subaru Prime Focus Spectrograph; this is a result of several years of active discussions among (mostly Japanese, so far) AGN researchers. The proposed survey can be accomplished with only a few per cent of fiber-hour resources planned in the SSP Galaxy Evolution and Cosmology surveys, and yet it will provide crucial insight into the fundamental roles that SMBHs have played in galaxy evolution.
Title: What can we learn about the IGM-galaxy connection from 3D tomography map?

Abstract: The link between the intergalactic medium (IGM) and galaxies is a key to understand the evolution of baryonic matter and galaxies. It is because the IGM and galaxies continuously interact with each other — galaxies increase their stellar mass by acquiring gas from the IGM, and pollute the IGM gas with metals. Neutral hydrogen gas (HI) in the IGM has often been traced by Lyα forest absorption lines in background quasars’ spectra. However, the small number density of quasars makes it difficult to reconstruct a tomographic HI gas distribution in the IGM. Recently, CLAMATO (COSMOS Lyα Mapping And Tomography Observations: Lee et al. 2018) has provided a 3D tomography cube of the intergalactic gas at z ~ 2.0-2.5 using quasars and star-forming galaxies as background sources. The CLAMATO cube enables us to examine the IGM over $3.15 \times 10^5 \, h^{-3}$ comoving Mpc$^3$ with a relatively good spatial resolution of $\sim 3 \, h^{-1}$ Mpc. Using the CLAMATO cube together with publicly available galaxy catalogs, we conduct cross-correlation analysis and investigate the connection between galaxies and the IGM. In this talk, we will present the similarity and distinction of correlation functions depending on stellar mass or line emission of galaxies.
PFS Science Contribution
contribution talk
11/22/2019, 11:00 - 11:15

Rosemary Wyse
(Johns Hopkins University)

Title: The Disequilibrium State of the Milky Way Disk

Abstract: The six-dimensional phase-space data from the Gaia satellite revealed that the local stellar disk is in a state of disequilibrium. Ongoing spectroscopic surveys have allowed the addition of chemical abundances, allowing thick and thin disks to be analysed separately. The thin disk shows stronger signatures of interactions with gravitational perturbations, as may be expected, and is warped and corrugated, with accompanying velocity asymmetries. The passage of the Sagittarius Dwarf through the outer disk is plausibly the cause of much of the observed complexities, but interactions with the Galactic bar and spiral arms cannot be neglected. The capabilities of the Prime Focus Spectrograph offers an unprecedented view of the outer disk and I will outline the scientific goals and expectations from proposed observations.
PFS Science Contribution
contribution talk
11/22/2019, 11:15 - 11:30

Brent Belland
(California Institute of Technology)

Title: **NGC 6822 as a probe of morphological evolution of dwarf galaxies**

Abstract: Rotationally supported dwarf irregular galaxies appear to transition into dispersion supported dwarf spheroidal galaxies in the presence of a massive host galaxy. However, in many dwarf irregulars, the old red giant population is dispersion supported. The transition between the rotation supported gas and dispersion supported stellar population over time may reveal information about the formation history of these dwarf irregulars. As the nearest isolated dwarf irregular galaxy, NGC 6822 allows for a detailed study of this dynamical transition. I will discuss some current analysis of the evolution of rotational support with metallicity in the red giant branch stars and analyze rotation support in the younger supergiant population. However, to improve on these studies we need an instrument with a wide field of view measuring many young and old stars. NGC 6822 has been selected as a PFS target in the galactic archaeology study due to the instrument's strengths in these areas. I will discuss observational strategy for acquiring velocities, metallicities, and alpha abundances for over 5000 stars in NGC 6822. The combination of sample size and areal coverage ensure that Subaru PFS will have a transformational role in studying morphological evolution of dwarf galaxies.
PFS Science Contribution
contribution talk
11/22/2019, 11:30 - 11:45

Kohei Hayashi
(ICRR, The University of Tokyo)

Title: Dark matter in dwarf galaxies in the Subaru-PFS era

Abstract: The dwarf galaxies in the Local Group are excellent laboratories for studying the fundamental properties of dark matter and its role in the galaxy formation. These galaxies are sufficiently close to measure line-of-sight velocities of resolved stars. This kinematic information enables us to study structural properties of their dark matter halos. However, there are non-negligible uncertainties on the determination of dark matter profiles. In particular, this study has been hampered by the degeneracy between dark matter mass density and the anisotropy of the stellar velocity dispersion tensor, which can lead to erroneous mass estimates. Breaking the mass-velocity anisotropy degeneracy requires sufficiently large kinematic samples over large areas out to the outer parts of dSphs. The combination of the 1.25 deg$^2$ field and 2394 fibers of the Subaru Prime Focus Spectrograph (PFS) will allow us to make significant progress in this undertaking. Furthermore, the unique capability of PFS will permit us to revisit core/cusp problem. In this talk, I will present our effort to characterize the dark matter distributions of dSphs with current spectrographs. Then, I will discuss the feasibility and future prospects for this dark matter study with Subaru-PFS survey using mock stellar samples.
Title: Stellar Abundances in the Local Group: Keck Now, PFS Soon

Abstract: The abundances of stars encode a galaxy's history of gas flow, assembly by mergers, and nucleosynthesis. I will discuss Keck Observatory's contribution to stellar abundances in the Local Group with a particular focus on the multi-object spectrograph DEIMOS. I will show how the stellar mass of a dwarf galaxy dictates the shape of its metallicity distribution and the evolution of $\text{[alpha/Fe]}$. I will also show that these trends are the same for satellites of the Milky Way and M31 but not necessarily for isolated dwarf galaxies. I will also discuss some recent work on interpreting the evolution of specific elements, like barium, in the context of neutron star mergers and AGB stars.

Despite Keck's major contribution, I will show that our understanding of nucleosynthesis and galactic chemical evolution in the Local Group is still limited by sample size and spectrograph field of view. Subaru/PFS will revolutionize these fields of study by providing abundances of $>30,000$ stars in the Local Group. This capability is enabled by a medium-resolution mode that exists specifically for this purpose. I will discuss the transformational advances PFS will enable in Local Group dwarf galaxies and the stellar halo of M31.