Title: New Surveys in the Galactic Bulge

Abstract: I present a brief review of progress and issues in the study of the Galactic bulge. The Blanco DECam Bulge Survey (BDBS) is now completely analyzed, resulting in psf photometry in SDSS ugrizY, spanning 200 sq. deg. We will present and discuss photometry of the numerous globular clusters covered in the footprint. We also have a new correlation between color and metallicity that yields individual metallicities of red clump stars to 0.2 dex. We find no support for multi-modal abundance distributions at $|b|<6$ deg, with indications of bimodality at higher latitude. Overall, the bulk of the mass in the bulge is well fit by a one zone simple model of chemical evolution with a single peak abundance. I will also present a new derivation of the abundance gradient, and will present new stellar compositions for the nuclear star cluster. There is significant potential for followup of BDBS using the prime focus spectrograph at Subaru.
Title: Near-infrared windows of precise and detailed chemical measurements for galactic archaeology

Abstract: In the rapidly growing field of galactic archaeology, a variety of data on stellar fossils, including photometric and spectroscopic, have been collected and used for revealing the history of the Galaxy and nearby galaxies. Among the different kinds of data, near-infrared spectra can provide us with unique information especially on stars obscured by interstellar reddening (see, e.g., great achievements with APOGEE’s spectra in the H band, around 1.6 micron). Before we can use near-infrared spectra fully, however, basic studies such as identification of absorption lines are required. We have been investigating WINERED spectra covering 0.91 to 1.35 micron, zYJ bands, and made progress in establishing methods (e.g., for the telluric correction) and a list of absorption lines to make precise chemical analyses possible with spectra in these wavebands. For example, after identifying good iron lines to measure Fe abundances, we have recently found absorption lines of s-process and r-process elements. We will discuss what can be done with zYJ-band spectra based on our recent works, and give perspectives of future targets in galactic archaeology for near-infrared spectrographs including WINERED (to be attached to Magellan Clay 6.5m telescope soon) and Subaru’s current and future spectrographs, i.e., IRCS, IRD, and PFS.
 Title: Extinction study toward the Inner Milky Way with Subaru HSC

Abstract: It is known that the extinction law toward the Galactic bulge (GB) is very different from Cardelli’s standard extinction law. Most studies have been conducted with NIR and only a small portion of the inner GB has been studied with optical imaging due to the high extinction. These studies showed that the observed $A_V/A_K$ is 60-80% higher than the estimate from the standard extinction law. To measure the intrinsic brightness of and/or distance to the objects toward the inner GB, it is critical to understand the amount of extinction that depends on the wavelengths. Also, such study will be important for optical precursor, concurrent and follow-up observation of the WFIRST, Small-JASMINE and PRIME survey. We observed about 30 sq. deg around the Galactic center to measure the optical extinction with Subaru HSC using g, r2, i2, and z-band filters. We measure the color and magnitude of Red Clump Giant in the color-magnitude-diagram of each sight line to derive the extinction ratio to NIR by combining VISTA VVV survey data. We confirm that the extinction toward the inner GB cannot be explained by the standard extinction law. In this presentation, we report and discuss our result.
Title: **Mass segregation -- a new indicator of binary, IMBH, stellar-mass black hole**

Abstract: This study presents the radial mass segregation profile of 32 Galactic globular clusters (GCs). Most of them are found to be mass-segregated due to two-body relaxation effects. Recent simulations show that binaries, intermediate-mass black hole (IMBH), stellar-mass black hole system can quench mass segregation in relaxed GCs. Combing mass segregation and core binary fractions (fc), We find an anti-correlation between them when fc is below 0.1. Then the quenching effects tends to saturate at higher fc. Seven low mass-segregated GCs are selected as possible IMBH holders. However, they are not strong candidates considering core binary fractions. Finally, GCs potentially having stellar-mass black hole subsystem are studied. They lie in low mass-segregation end, which suggests a possible quenching effects introduced by stellar-mass black hole population.
Title: LAMOST/Subaru exploration on the early evolution and formation of the Milky Way

Abstract: A joint project between LAMOST and Subaru has been successfully accomplished, aiming at exploring the early evolution and formation of the Milky Way through metal-poor stars. Through LAMOST-I survey, a large sample of candidates of very metal-poor ([Fe/H] < -2.0) stars and mildly metal-poor (-2.0 < [Fe/H] < -1.0) stars with abnormal kinematics and/or abundance patterns has been obtained (e.g., Li et al. 2018, ApJS). Follow-up observations with Subaru/HDS telescope have been carried out to explore detailed abundance pattern for part of the sample. In this talk, we report the summary of this joint project, including (1) high-resolution chemical abundances of about 400 VMP stars; (2) the first systematic search and discovery of Li-rich VMP stars covering wide evolutionary stages (Li et al. 2018, ApJL); (3) origin of a newly discovered halo moving group (Zhao et al. 2018, ApJ); (4) discovery of the first mildly metal-poor r-II star deficient in α-elements (Xing et al. 2019, Nature Astronomy). The ongoing program based on LAMOST-II and the SAGE Survey will also be briefly introduced.
Title: Mass estimates for early generation stars from detailed abundance patterns of Carbon-Enhanced Metal-Poor stars

Abstract: A remarkable feature of very metal-poor stars is the high frequency of Carbon-Enhanced Metal-Poor (CEMP) stars. CEMP stars with no excess of neutron-capture elements should record nucleosynthesis yields of first generation massive stars. In course of our studies of metal-poor stars with LAMOST and Subaru, we identified an ultra metal-poor ([Fe/H]~ -4) star with large excesses of C and O, as well as of Mg and Si, and determined detailed abundance pattern. Comparisons with predictions of supernova nucleosynthesis models indicate that the progenitor was a massive star with around 25 solar masses. This is a typical mass expected from other extremely metal-poor stars, suggesting that the carbon-excess is not due to its progenitor mass, but is caused by other mechanisms (e.g., rotation). Another CEMP star at the main-sequence turn-off stage identified in our study shows large excesses of neutron-capture elements. The excesses would be provided by mass transfer from a companion AGB star in a binary system. The detailed abundance pattern, compared with AGB models, indicates the progenitor is a low-mass star (~1.4 solar mass). These studies demonstrate that abundances pattern of a large number of elements for CEMP stars provide useful constraints on mass of early generation stars.
Title: **Combining spectroscopy and asteroseismology for halo stars**

Abstract: The Kepler mission enabled us to infer stellar masses for a large number of red giants through asteroseismology. Since the inferred masses are easily converted to stellar ages, combination of asteroseismology and spectroscopy offers us a way to investigate chemical abundances with stellar ages beyond the solar neighborhood. Although such combination has contributed to the understanding of the Galactic disk evolution, its application to halo stars has been limited mainly because of two difficulties: the proximity of the Kepler field to the Galactic plane and possible systematic uncertainty in mass estimate for low-metallicity stars. In order to enlarge a sample of halo stars with asteroseismic information and to investigate the possible systematic, we selected 26 halo stars in the Kepler field based on radial velocity and metallicity measured by large spectroscopic surveys, and obtained high-S/N, high-resolution spectra with Subaru/HDS. High-precision stellar parameters and chemical abundances were derived through a line-by-line differential abundance analysis. Despite our improved precise and accurate effective temperature estimates, asteroseismic scaling relations tend to provide systematically higher mass for low-metallicity stars. The derived masses do not show correlation with chemical abundances within the uncertainties, suggesting that our sample covers a relatively narrow age range.
Title: **Interpreting spectroscopic survey data for metal-poor stars with supernova yield models**

Abstract: With the advent of recent large spectroscopic surveys of metal-poor stars in our Milky Way Galaxy, unprecedentedly large data sets of elemental abundances in the atmosphere of metal-poor stars are now available. Statistical properties of the measured elemental abundances have put useful constraints on nucleosynthetic yields of supernovae of different generations of stars as a function of cosmic time. I would like to present highlight results from our studies of the systematic comparison between observed elemental abundances in metal-poor stars and theoretical core-collapse and Type Ia supernova yield models. Issues and prospects for planned future large spectroscopic surveys will also be discussed.
Title: Effect of interstellar objects on metallicity of low-mass first stars formed in a cosmological model

Abstract:
We investigate metal pollution onto the surface of low-mass first stars (Pop. III survivors) via interstellar objects (ISOs) floating in the Galactic interstellar medium. Only recently, Tanikawa et al. analytically estimated how much metal should collide to an orbiting Pop. III survivor encouraged by the recent discovery of 'Oumuamua and suggested that ISOs are the most dominant contributor of metal enrichment of Pop. III survivors. We consider a distribution of ISOs in the Galactic disk again and calculate the ISO accretion rate considering the more realistic orbits of Pop. III survivors' using a high-resolution cosmological N-body simulation that resolves dark matter minihalos. As a result, Pop. III survivors located at solar neighborhood have a number of chances of ISO (> 100 m) collisions, typically 5 million times in the last 5 Gyr, which is one order of magnitude greater than estimated in the previous study. Metal-poor stars so far discovered are possible to be metal-free Pop. III stars on birth.
Title: Spectroscopic Surveys of Stars in Dwarf Galaxies

Abstract: To unravel the formation history of the Milky Way, spectroscopic surveys are currently being carried out to gather chemical abundance ratios and kinematic information of stars throughout the Galaxy. High-resolution spectra of ~1 million stars are being collected through the US SDSS-APOGEE survey, the Australian GALAH survey, and the European ESO-Gaia survey, while lower resolution spectra have been collected through other US SDSS surveys, the Chinese LAMOST survey, and the European Gaia mission. Already Gaia has revealed previously unknown accretion events of dwarf galaxies through detailed chemo-dynamical analyses (i.e., Gaia-Sequoia and Gaia-Enceladus/Sausage). I will review the current results, and speculate on the exciting surveys for the next decade, involving larger telescopes (WEAVE, 4MOST, and PFS) that will reach into the nearby dwarf galaxies. These surveys will also benefit from the power of homogeneous data collecting and analysis methods, including machine learning techniques that may be necessary to keep up with the data flow.
Title: **Sub-Chandrasekhar Type Ia Supernovae in Dwarf Galaxies**

Abstract: There is no consensus on the progenitors of Type Ia supernovae (SNe Ia) despite their importance for cosmology and chemical evolution. I address this question using Keck/DEIMOS abundance measurements of Mg, Si, Ca, Cr, Fe, Co, and Ni. I describe a simple chemical evolution model that provides the observationally inferred yields of SNe Ia. I compare these yields to recent theoretical predictions for two classes of Chandrasekhar-mass SN Ia as well as sub-Chandrasekhar SNe Ia. Most of the inferred SN Ia yields are consistent with all of the theoretical models, but [Ni/Fe] is consistent only with sub-Chandrasekhar models. I conclude that the dominant type of SN Ia in ancient dwarf galaxies is the explosion of a sub-Chandrasekhar white dwarf.
Title: Diversity of the dark matter distributions in the Galactic dwarf satellites

Abstract: Lambda cold dark matter (LCDM) model is remarkably successful at explaining the large-scale structure of the Universe, whereas there are several controversial issues that this model holds on non-linear scales. For instance, core/cusp problem is one of the outstanding issues in LCDM model. However, current kinematic studies of dwarf spheroidal (dSph) galaxies are unable to determine precisely dark halo structures in these galaxies because of the presence of degeneracy in mass models, which stems largely from sample volume and incomplete dynamical models. In particular, previous kinematic studies typically treat dSphs as spherically symmetric systems for simplicity. To obtain more realistic limits on density profiles of their dark matter halos, we apply our constructed non-spherical dynamical models to current kinematic data for the classical dSphs and then we revisit core/cusp problem. As a result, although there are still large uncertainties, we find the diversity of inner slope of dark matter density profiles in the dSphs. In this talk, we will introduce our mass models and present the estimated dark matter density profiles in the dSphs. Then, I will discuss the origin of the diversity in terms of star formation history and alternative dark matter models.
Title: New Insights into the Stellar and Dark Halos in the Milky Way and Andromeda as Revealed from Subaru

Abstract: We present our new insights into stellar and dark halo structures in the Milky Way and Andromeda galaxies based on observations with the Subaru Telescope. This talk is especially focused on the results using the Hyper Suprime-Cam (HSC). The combination of the superb image quality and depth of Subaru/HSC and its use for the wide-field multi-band survey have enabled us to identify and study new faint dwarf satellites and field halo stars in the Milky Way halo beyond the reach of previous surveys. Andromeda’s halo has also been imaged with HSC, revealing new features. We show here the implications for both the formation scenarios of stellar halos and the missing satellite problem of dark halos. We also present our prospects in this field of research based on the upcoming large spectroscopic survey with Prime Focus Spectrograph (PFS).
Title: The Old are Rich: Metallicity Distributions of Old Stars in the Milky Way and M31

Abstract: The metallicity distribution of old stars in galaxies at zero redshift provides insight into the effectiveness of feedback processes at high redshift, when the stars formed, and into the depth of the potential well in which the stars formed. I will present our estimation of the metallicity distributions of stars older than 8Gyr, consistent with forming at redshifts greater than unity, that are currently located in the inner regions of the two massive spiral galaxies of the Local Group, namely the Milky Way and M31. We find a large population of such old stars in both galaxies, and a significant fraction in each has metallicity close to the solar value. We infer that the stars formed within relatively deep potential wells, corresponding to massive substructures. We further compare these metallicity distributions with those predicted for old stars in cosmological hydrodynamical simulations of Milky Way analogs, and discuss the implications.
Title: **Subaru Hyper Suprime-Cam Wide-Field Imaging Survey of the Local Group Galaxies: Andromeda and the Seven Dwarfs**

Abstract: We have carried out wide-field imaging survey for the Local Group galaxies using Hyper Suprime-Cam (HSC). HSC is the world’s best imager to explore galaxies in the Local Group which often have large apparent sizes, and the Subaru Telescope on Maunakea provides the excellent image quality which is essential for the photometry of the individual stars belonging to these galaxies. Our targets include large Andromeda galaxy (M31) and seven dwarf galaxies with different characteristics.

In this presentation, we highlight intriguing findings obtained from our survey, focusing on the halo of M31, quiescent dwarf spheroidal galaxy Ursa Minor, and active star-forming dwarf irregular galaxy NGC 6822. Our survey reveals the shape of the stellar streams in the northwest halo of M31 in unprecedented detail and shows the hint of hidden diffuse substructure. We obtained deep photometric data which reaches well below the main sequence turnoff point for Ursa Minor, allowing us to investigate binary population. The deep Halpha image obtained with our survey reveals that NGC 6822 hosts diffuse and low-luminosity HII regions in the outer part of the galaxy to ~6kpc from the center.
Title: The Power of Wide Field Surveys for Revealing the Past, Present and Future of the Andromeda System

Abstract: The Andromeda Galaxy (M31) is the nexus of the near-far galaxy evolution connection and a principal data point for near-field cosmology. Due to its proximity, M31 can be resolved into individual stars like the Milky Way. Unlike the MW, we have the advantage of a global view of M31, enabling M31 to be observed with techniques that also apply to more distant galaxies. Moreover, recent evidence suggests that M31 may have survived a major merger within the last several Gyr, shaping the morphology of its stellar halo and triggering a starburst, while leaving the stellar disk largely intact. The MW and M31 thus provide complementary opportunities for in-depth studies of the disks, halos, and satellites of L* galaxies. I will review our current understanding of the merger history of the M31 system, and highlight the progress to be made with wide field facilities for photometry and spectroscopy. These facilities will transform our ability to observationally constrain the merger history of M31, via chemo-dynamical analyses and star formation histories of phase-mixed stars accreted at early times, as well as stars in surviving tidal debris features and M31’s extended disk. This will yield an unprecedented view of the hierarchical formation of the M31 system and the subhalos that built it into the L* galaxy we observe today.
Title: Iron and Alpha Element Abundances in the Outer Disk, Giant Southern Stream, and Inner Halo of Andromeda

Abstract: Measurements of chemical abundances ([Fe/H] and [alpha/Fe]) in individual stars can probe the formation history of a galaxy. In contrast to the Milky Way (MW), relatively little is known about [alpha/Fe] of individual red giant branch (RGB) stars in M31. To make progress with existing telescopes, we have measured abundances from deep, low-resolution DEIMOS spectroscopy (R ~ 2500) of individual M31 RGB stars using spectral synthesis. I will present measurements of [alpha/Fe] and [Fe/H] for 71 M31 RGB stars across fields spanning the inner halo, Giant Southern Stream, and outer disk. Prior to this work, only 4 M31 halo stars had such measurements. I will place our measurements in context via comparisons to the abundances of MW and M31 dwarf galaxies, in addition to the MW stellar halo and outer disk. I will discuss what the abundance distributions reveal about the progenitor(s) of M31’s halo, including the Giant Southern Stream, and the formation of M31’s disk. Lastly, I will discuss our measurements of [alpha/Fe] and [Fe/H] in the context of PFS.
Title: The Chemical Evolution of Andromeda's Satellites from Coadded Spectra

Abstract: Detailed, comprehensive chemical abundance measurements are integral to unraveling the formation history and evolution of galaxy halos and their satellite systems. As part of the largest systematic study to date of chemical abundances in Andromeda (M31), the SPLASH survey has obtained medium-resolution spectra across the M31 disk, halo, and its dwarf spheroidal (dSph) satellite system. Where it is not possible to determine abundance measurements for individual red giant branch (RGB) stars (signal-to-noise ratio \( \lesssim 5 \ \text{Å}^{-1} \)), we propose a method to derive \([\text{Fe/H}]\) and \([\alpha/\text{Fe}]\) measurements from co-added spectra, focusing on RGB stars in the M31 outer halo and dSphs. We validate our method by comparing the resulting abundance measurements from the low-S/N, co-added spectra with individual abundance measurements from high-S/N spectra in similar regions of the parameter space. We present abundance distributions based on co-added measurements for ten M31 dSphs and outer halo fields, and compare these results with the observed chemistry of the Milky Way halo and its dSphs. These abundance measurements from low-S/N spectra greatly increase the number of measurements of the chemical composition of M31 and its satellites, and place M31 in context with complementary studies of the Milky Way.
Title: The Missing Satellite Problem Outside Of The Local Group

Abstract: The widely accepted LCDM model reproduces the matter distribution in the Universe extremely well. However, there are possible tensions between observations and models on small scales (<~1 Mpc). One such issue is the missing satellite problem: more than an order of magnitude shortage of the observed number of dwarf satellite galaxies in the LG. So far, the problem has been addressed mostly within the Local Group (LG) with an assumption that the LG is a typical halo in the Universe. However, it may not be a valid assumption. Furthermore, cosmological tests have to be performed statistically. To mitigate these issues, we are now carrying out an observing program with Hyper Suprime-Cam on the Subaru Telescope to address the problem with a statistically significant sample of MW-like galaxies. As a pilot observation, we observed two galaxies with MW-like masses located at 15-20 Mpc. Satellite galaxies around them are selected on the basis of surface brightness with a careful visual screening to eliminate contaminants. Accounting for the detection incompleteness as well as background contamination, we successfully derive luminosity functions down to $M_V \sim -9.5$mag. The observed luminosity functions show a factor of two difference between the two galaxies despite that they have similar halo masses. This indicates that there is a large diversity in the satellite abundance at a given halo mass, demonstrating the need for a statistical sample. We are now in the process of increasing the sample and we discuss future prospects of the project.
Title: Wide-field imaging and spectroscopy of the nearest galaxy cluster

Abstract: Studies of nearby galaxies and their environments stretch the ability of observational facilities to go both wide and deep. I will discuss results from the Next Generation Virgo Cluster Survey (NGVS), a multi-wavelength program of imaging and spectroscopy across 100+ square degrees in the nearest galaxy cluster to a point source depth of $g \sim 26$ mag. At these depths, the cluster is teeming with dwarf galaxies and globular clusters. I will present what we have learned about the assembly of the Virgo cluster core, and present opportunities for future wide-field spectroscopic facilities like Subaru/PFS and MSE.
Title: Star Formation and the IMF in the Outskirts of Nearby Galaxies

Abstract: The GALEX UV satellite discovered evidence of star formation (SF) far beyond the optical edge of galactic disks (i.e. extended UV disks, or XUV disks). Star formation in the low-density outskirts is a prime target for studies of IMF variations. A truncated IMF (i.e., the absence of O stars) has been suggested, but is still on debate. We present a deep Halpha survey of 10 local XUV disks using the Subaru Prime Focus Camera (Suprime-Cam). The combination of UV emission (O or B stars) and Halpha emission (predominantly O stars) constrains the high-mass end of the IMF. We find a large number of HII regions in nearly all XUV disks as opposed to the prediction by the truncated IMF. More specifically, we find that the stochastic IMF is preferred over the truncated IMF, since even some low-mass stellar clusters ($10^2$-3 Msun) have massive O-stars, and that the standard IMF and a simple aging effect can explain the counts of UV-bright and Halpha-bright clusters. These suggest that massive stars are forming in the low-density outskirts as opposed to the previous expectation.
Title: Super-massive black holes in nearby galaxies

Abstract: During the talk, I will first review the observational evidence for the existence of supermassive black holes in nearby galaxies, the methodology used to detect them, and the connection they share with their host galaxies. I will then move to describe what I believe to be the most pressing scientific questions that still need answering, and the role of current and future facilities in advancing the field.
Abstract: A clear understanding of galaxy formation and of dark matter requires detailed analysis of all galaxy types and environments, including those found only beyond the Local Group, and which is enabled only by the advent of 8-10m telescopes. I will discuss intensive campaigns from Subaru imaging and Keck spectroscopy, of galaxies ranging from the grandest to the most tenuous, and using both field stars and multiple populations of globular clusters as chemodynamical tracers. These include results from the recently completed SLUGGS survey of massive early-type galaxies -- with assembly clues found in their halos -- and ongoing work on ultra-diffuse galaxies -- with surprises about their dark matter content and chemical composition.
Title: The mass-to-light ratios and dark matter fractions of the dwarf ETGs from IFU galaxy surveys

Abstract: The difference in the mass-to-light ratios of ordinary galaxies is usually less than one order of magnitude, but some studies suggest difference of dwarf galaxies can be more than three orders of magnitude, which could mean that dwarf galaxies have different amounts of dark matter. The kinematics and dynamics of dwarf galaxies can be well studied with the help of several integral field unit (IFU) galaxy survey. We investigate the mass-to-light ratios and dark matter fraction of the dwarf early-type galaxies (ETGs) using IFU data, and try to explore the differences between dwarf galaxies and ordinary galaxies from perspective of dark matter.
Title: Keck Spectroscopy of the Resolved Stellar Populations of Local Group/Local Volume Galaxies

Abstract: I will present the latest results from our research group's deep Keck DEIMOS spectroscopy of resolved stellar populations in the Milky Way's remote outer halo (HALO7D survey), stellar disks of M31 and M33 (PHAT and SPLASH surveys), and in Milky Way analogs and their dwarf satellites within D <~ 3.5 Mpc in the Local Volume (PISCeS project) and globular clusters in Virgo cluster galaxies (NGVS project). Results include: (1) the first 6D (spatial + kinematical) phase space and chemical abundance measurements of Sun-like stars in the Milky Way's remote outer halo; (2) kinematics as a function of stellar age in M31 and M33 disks; (3) use of a new co-added SBF spectroscopy technique to target partially resolved stellar populations beyond the Local Group and to thereby study the assembly of large galactic halos in a variety of group environments across the Sculptor, M81, and Centaurus A groups; and (4) kinematics and chemical enrichment of globular cluster satellites of Virgo cluster dwarf galaxies, ultra-diffuse galaxies, and M87 and intra-cluster globular clusters.
Title: **Galaxy Distances and Peculiar Velocities**

Abstract: Twenty years ago, a dispute over the value of the Hubble Constant was resolved by the adoption of a standard model of a topologically flat universe with an important component of vacuum energy. Today, evidence regarding the value of the Hubble Constant is suggesting that this standard model is incomplete. The Cosmicflows program continues to enlarge and provide increasingly detailed information about the expansion of the universe. A particular focus of the program is studies of the patterns of deviations from the mean expansion, motions responding to structure in the distribution of matter: the cosmic web.
Abstract: We present the detailed results from our deep wide-field imaging survey of the M81 group with the Subaru/HSC. We report on the analysis of the structures, stellar populations, and metallicities of old dwarf galaxies NGC3077, IKN, KDG061, KDG064, BK5N, d0955+70, d1015+69, and d1014+68 as well as young stellar systems around M81, such as Arp’s Loop, Holmberg IX, BK3N, NW-stream. Several candidates for yet undiscovered faint dwarf galaxies in the M81 group will also be introduced. Okamoto et al. (2015, ApJ 809, L1) discovered an extended halo structure with S-shape elongated tails of a peculiar galaxy NFC3077, obvious feature of tidal interaction. With a help of numerical simulation, we demonstrate that this tidal feature was formed during the latest close encounters between M81, M82, and NGC 3077. It is not clear whether this was the first close encounters of M81, M82 and NGC3077. If NGC3077 is still surrounded by the dark matter halo, it implies that the tidal interaction occurred for the first time in the M81 group. Kinematic studies of inter galactic globular clusters and planetary nebulae would tell us the past history of tidal interaction in this group of galaxies. Finally “Subaru Near Field Cosmology Survey” will be briefly introduced.
Title: The Nature of Low Mass Galaxies Beyond the Local Group with the Dragonfly Telephoto Array

Abstract: Low mass galaxies are a significant component of the galaxy population and provide a unique testing ground for theoretical predictions of Cosmology. In particular, the currently unconstrained number density and properties of dwarf galaxies beyond the Local Group holds the potential to provide important constraints on modern theories of galaxy formation and the nature of dark matter. The lack of observed low mass galaxies beyond the Local Group, possibly due to their extremely low surface brightnesses, leads to a significant uncertainty in understanding the physical processes involved in their formation in a LCDM framework. Performing a systematic deep, wide-field search for faint objects is therefore of great importance. In this talk, I will present recent results from the Dragonfly Telescope, which has identified large numbers of low surface brightness galaxies including large populations of “Ultra Diffuse Galaxies”. I will then present our strategy for finding low mass galaxies as part of the Dragonfly Wide Field Survey, covering 300 square degrees in the Stripe82 and GAMA fields, first results, as well as follow-up work, trying to understand the nature of their dark matter halos by studying their kinematics.
Title: Studying Nearby Satellite Galaxy Systems with Wide-field Surveys and Surface Brightness Fluctuations

Abstract: Studying the dwarf satellites of nearby galaxies and nearby field dwarfs is hampered by the lack of easy distance measures for low surface brightness (LSB) galaxies that are discovered in photometric surveys. We have explored the use of surface brightness fluctuation (SBF) measurements as a powerful tool for determining the distance to nearby dwarf galaxies and have derived a calibration that is appropriate for these often blue systems that is based solely on the tip of the red giant branch. SBF is the perfect tool for wide-field imagers like Subaru/HSC, CFHT/Megacam, LSST, and WFIRST as LSB galaxies can be discovered and their distances measured without any follow-up. Using archival Megacam data, we have conducted an extensive search for dwarf satellites around a wide variety of hosts in the Local Volume. We will discuss initial results comparing the luminosity functions of dwarf satellite systems of hosts both similar and dissimilar to the Milky Way.
Title: **Identification of faint X-ray sources composing Galactic Ridge X-ray Emission by Subaru/MOIRCS**

Abstract: Presence of the seemingly extended hard X-ray emission along the Galactic plane has been known since early 1980’s (the Galactic Ridge X-ray Emission; GRXE). Deep X-ray observation of the GRXE on Galactic bulge resolved ~80% of the GRXE into faint X-ray point sources. These sources are considered to be active binary and cataclysmic variables. Since interstellar absorption is significant toward the Galactic Bulge, NIR observation is necessary. Among the X-ray sources, we could identify only 11% sources brighter than Ks~16 mag with the IRSF telescope. We carried out spectroscopy of the bright NIR sources by Subaru/MOIRCS and searched the population of them (Morihana et al., 2016).

To further proceed and elucidate origin of the GRXE, we carried out deep MOIRCS imaging observation to identify dimmer NIR sources and study their colors. As the results, we identified ~55% of X-ray point sources with NIR at the Galactic Bulge. We classified the population using the flux ratio of X-ray and NIR. We further searched counterpart sources of NIR identified sources with Gaia DR2 to know foreground sources. In this poster, we discuss about the nature of faint X-ray sources including this new NIR identified sources.
Title: Multi-phase ISM properties of a nearby radio galaxy NGC1316

Abstract: It is important to study ISM properties of radio galaxies especially for understanding the AGN feedbacks. We investigate molecular and ionized gas properties of a nearby radio galaxy, NGC1316 in the Fornax cluster with ALMA/band-3 and Keck/LRIS observations. We revealed that molecular gas (traced by CO(J=1-0)) shows a complex spatial distribution and velocity field, suggesting that the gas is still in the process of settling down into a rotating disk. Two reasons are considered for the disturbed properties: the gas is recently injected by small satellite galaxies and/or the gas is interacted with a nuclear radio jet. In this contribution, we focus on the latter point. Our ALMA data show signs of gas-jet interactions, namely the nuclear radio jet bends close to where the molecular gas is brightest and the direction of the bending is consistent with that of molecular gas flow. Our Keck data also support this scenario where a non-negligible amount of ionized gas has a disturbed gas motion which is not completely consistent with but similar to molecular gas. In addition, the relative intensity of H-alpha to [NII] is lower than unity elsewhere suggesting the existence of a shock or hard radiation field. This contribution is based on our recent the paper accepted for publication in PASJ (KMM+, arXiv:1905.11085).
Title: **Embedded Massive Young Stellar Objects in the Giant Molecular Clouds of M33**

Abstract: Studying massive young stellar objects (MYSOs) embedded within a giant molecular cloud (GMC) is key to understand how the massive stars/clusters are formed within a GMC (GMC evolution). M33 is one of the best spiral galaxies for this study due to its proximity and preferable inclination, which allow us to resolve the typical size of clusters and GMCs without contamination along the line of sight unlike in our Galaxy. We have recently built a catalog of GMC and young stellar groups (YSGs) in M33 based on CO(3-2) and optical photometry data, and we have classified these GMCs into four different evolutionary stages according to their spatial associations with Hii regions, and the ages of the associated YSGs. Based on JHKs images obtained with MOIRCS, we identified the missing embedded MYSOs from the color-color diagram. In this poster, we present how the distribution of these MYSOs and their fraction changes along the different GMC evolutionary stages.
Abstract: NGC 720 is an E5-type elliptical galaxy with the stellar mass similar to our Galaxy. The galaxy is highly isolated: there is no other L*-class galaxy within 1.5 Mpc radius around it. In order to seek for the hint of such highly isolated early-type galaxy, we took a deep r2-band imaging data of the field around the galaxy using HSC. The data has revealed a large number of very faint dwarf galaxies within 0.3 Mpc region around the galaxy. One of the dwarfs has extremely large effective radius (3.4kpc) and faint central surface brightness (~27mag/arcsec2), satisfying the criteria of the Ultra-diffuse galaxies (UDGs). We see three UDGs in the field, and many more sub-UDGs (re<1.5kpc). Such excess of the UDGs are typical for group environment, implying that the group-merger origin of NGC 720. Indeed, the surface brightness analysis has revealed that NGC 720 has extremely faint ripple structure, which is consistent with the merger origin of the galaxy.