(Day1) User's Meeting FY2019
11/17/2019, 13:00 - 13:20

Michitoshi Yoshida
(Subaru Telescope)

Title: **Welcome & Subaru Observatory Report**

Abstract: N/A

(Day1) User's Meeting FY2019
11/17/2019, 13:20 - 13:30

Tae-Soo Pyo
(Subaru Telescope/NAOJ)

Title: **Science Operation Report for FY2019**

Abstract: The status and issues on the science operation of Subaru Telescope in FY2019 will be present : human resource update, schedule conditions, HSC Queue mode summary, remote observations, announcement about S20A & S20B, etc.

(Day1) User's Meeting FY2019
11/17/2019, 13:30 - 13:45

Takashi Hattori
(Subaru Telescope)

Title: **Status of Existing Facility Instruments**

Abstract: I will report the status of the existing facility instruments.

(Day1) User's Meeting FY2019
11/17/2019, 13:45 - 13:55

Kiaina Schubert
(Subaru Telescope)

Title: **Computer & Data Management**

Abstract: User report of Subaru computing, network and archive enviroments for 2019.

(Day1) User's Meeting FY2019
11/17/2019, 13:55 - 14:05

Hisanori Furusawa
(NAOJ)

Title: **Status report of a new data analysis cluster system**

Abstract: NAOJ/Astronomy Data Center (ADC) and Subaru Telescope cooperate to support open-use users who work on observing data taken with Subaru Telescope. We develop a PC cluster (~1300core, 5PB storage) at Mitaka as a new open-use facility, where users can process their own data.Currently, the system is optimized for a large volume of HSC data analysis. The data analysis pipeline hscPipe is available across the computing nodes, and prototype operation with realistic data processing is successfully done. Processes for data processing are basically to be submitted and managed through a batch job system. We set up multiple job queues to host at least five concurrent activities by different users. From the S19B semester this year, we are going to start to offer the system to open-use HSC observers as well as the HSC-SSP data production user. The observers are given a higher priories to execute their jobs by the job scheduler for a defined term. We are preparing to accommodate general users with limited resources, too. We will report the current status of the cluster system, including known issues and ongoing efforts for improvements. We will also briefly review related open-use services.

(Day1) User's Meeting FY2019
11/17/2019, 14:05 - 14:15

James Ferreira
(Subaru Telescope)

Title: **Day-time Operation Report**

Abstract: Status and summary of activities from Day-time operators.

(Day1) User's Meeting FY2019
11/17/2019, 14:15 - 14:25

Michael Letawsky
(Subaru Telescope)

Title: **Night Crew Report**

Abstract: Status and summary of activities from night operators.

(Day1) User's Meeting FY2019
11/17/2019, 14:25 - 14:35

Hideaki Fujiwara
(Subaru Telescope)

Title: **PIO report**

Abstract: The goal of the Public Information and Outreach (PIO) Office is to document, share, and promote the activities and scientific achievements of Subaru Telescope throughout the general population. In this report, we introduce our recent PIO activities, particularly focusing press releases, facility tours, and outreach activities for the local community as well as people in Japan.

(Day1) User's Meeting FY2019
11/17/2019, 14:35 - 14:50

Tadayuki Kodama
(Astronomical Institute, Tohoku University)

Title: **SAC report**

Abstract: I will report on the recent discussions at SAC.

(Day1) User's Meeting FY2019
11/17/2019, 14:50 - 15:05

Kentaro Motohara
(University of Tokyo)

Title: **Time Allocation Committee Report**

Abstract: I will report status of the time allocation committee, especially concentrated on the selection process of S20A.

(Day1) User's Meeting FY2019
11/17/2019, 15:40 - 15:50

Hilton Lewis
(W. M. Keck Observatory)

Title: **W. M. Keck Observatory Update**

Abstract: Discuss the current state of the Keck observatory and plans for future instrumentation.

(Day1) User's Meeting FY2019
11/17/2019, 15:50 - 16:00

Atsuko Nitta
(Gemini Observatory)

Title: **Gemini Observatory - Now and Future**

Abstract: I will review current operation at Gemini Observatory and share what's coming as we prepare for the future with facilities such as LSST and JWST coming online. The Gemini community will undoubtedly want to obtain follow up observations for various transients objects discovered by LSST. When JWST is launched, we expect our community to want to use the Gemini telescopes in ways that compliment JWST's data. I will report the status of some of the projects we are completing with these new telescopes in mind including our new Gemini North AO system, new visiting and facility instruments and new Operation Control Software (OCS). Gemini remains a flexible facility to efficiently gather a wide range of astronomical data and these new projects will help us be even more so in the future.

(Day1) User's Meeting FY2019
11/17/2019, 16:00 - 16:10

Doug Simons
(CFHT)

Title: **Celebrating 40 Years of Discovery and a Bright Future at CFHT**

Abstract: With the passage of 2 generations since CFHT was built on Maunakea in the late 1970's, much has changed in the world - cell phones, internet, supercomputers, segmented mirror technology, adaptive optics, dark energy, black holes, gravitational waves, Pluto's demotion, twitter, the end of the Cold War, etc. One thing hasn't changed though – CFHT's importance to modern astronomy. As a leading research facility used by astronomers worldwide throughout its 40-year history, seminal observations at CFHT crucially supported the discovery of Dark Energy, detection of the first cosmic gravitational lenses, and tracking the first interstellar object ('Oumuamua). CFHT's annual publications rate now exceeds 200 per year and has never been higher in our 40-year history. The story behind CFHT's success, and how we intend to propel CFHT forward with a quantum leap in technology, will be covered in this presentation.

(Day1) User's Meeting FY2019
11/17/2019, 16:10 - 16:20

Bob McLaren
(Institute for Astronomy)

Title: **The University of Hawaii Perspective**

Abstract: The presentation will describe recent developments at the UH-operated MKO telescopes: 2.2-meter, UKIRT, and IRTF. This will be followed by a discussion of the future prospects and challenges facing the MKO's from the UH perspective. These include: the development of a new Master Plan, the efforts underway to obtain a new land authorization for the period beyond the year 2033, the related sublease issues, and the need to maintain and enhance the infrastructure.

(Day1) User's Meeting FY2019
11/17/2019, 16:20 - 16:30

Satoshi Miyazaki
(NAOJ)

Title: **Hyper Suprime-Cam SSP**

Abstract: We will give a progress report of HSC-SSP.

(Day1) User's Meeting FY2019
11/17/2019, 16:30 - 16:40

Bunei Sato
(Tokyo Institute of Technology)

Title: **Search for planets like Earth around late-M dwarfs: precise radial-velocity survey with IRD**

Abstract: IRD is a high-dispersion near-infrared spectrograph for Subaru telescope. We can currently achieve radial-velocity precision of about 2 m/s for M-type dwarfs with IRD. IRD-SSP aims at detecting earth-mass (~1-3ME) planets in habitable zone around late-M dwarfs, and unveiling planet population in wide range of mass and orbit around late-M dwarfs. We expect to find about 60 planets in 60 sample stars by 5-year survey. The first-two-year survey (19A-20B; 70 nights) is now tentatively approved, and the first observation started this February. We here report current status of the program and discuss future prospects.

(Day1) User's Meeting FY2019
11/17/2019, 16:40 - 16:50

Sakurako Okamoto
(Subaru Telescope)

Title: **Subaru Near-Field Cosmology Survey**

Abstract: I will present an overview of the intensive program S19A-060I. We are conducting a systematic HSC imaging survey of seven nearby late-type galaxies to determine the true nature of stellar contents in the large-scale structures, derive age and metallicity constraints for the extended component, and search for new satellites, streams, stellar debris and globular clusters.

(Day1) User's Meeting FY2019
11/17/2019, 16:50 - 17:00

Masahiro Takada
(Kavli IPMU)

Title: **Status report on intensive program "Constraining ~10M_sun PBHs with HSC microlensing search of M31 stars"**

Abstract: Our intensive program "Constraining ~10M_sun PBHs with HSC microlensing search of M31 stars" was awarded. Our proposed observations started since 2018B semester, and are still ongoing under queue mode. We have so far received data taken for several nights. Here we report the current status of our program.

(Day1) User's Meeting FY2019
11/17/2019, 17:00 - 17:10

Norio Narita
(ABC)

Title: **Progress report of Subaru IRD TESS Intensive Follow-up Project**

Abstract: In 2018, the Transiting Exoplanet Survey Satellite (TESS}, which searches for small planets around nearby bright stars, and the Subaru IRD, which can monitor precise radial velocities of cool dwarfs, have successfully started operations. Taking this perfect opportunity of the starting of TESS and IRD, we have started Subaru IRD TESS Intensive Follow-up Project since S19A semester. I will introduce the current status of the TESS mission and report early results from this project.

(Day1) User's Meeting FY2019
11/17/2019, 17:10 - 17:20

Yoshiki Matsuoka
(Ehime University)

Title: **Subaru Intensive Searches for the Most Distant Quasars**

Abstract: I will present an overview and latest results of our past and ongoing Subaru intensive programs to search for the most distant quasars, based on the Hyper Suprime-Cam SSP survey data.

Synergy with TMT
11/18/2019, 9:00 - 9:15

Tomonori Usuda
(NAOJ)

Title: **Thirty Meter Telescope (TMT)**

Abstract: Based on the scientific and engineering success of Subaru Telescope, astronomers are preparing to begin construction of the Thirty Meter Telescope (TMT) at Maunakea, Hawai`i as an international science project. The TMT is an extremely large 30-meter optical/infrared telescope under the collaboration of five partner countries including Japan, USA, Canada, China, and India. In 2014, an agreement was executed between the participating organizations, TMT International Observatory was founded to assume the construction and operation of the observatory, and construction commenced.

With an aperture of 30m, TMT will have more than 10 times as much light-gathering power as the Subaru Telescope, and more than 10 times the resolution of the Hubble telescope to deepen the human perception of the structure and evolution of the Universe, and the origins of stars, planets and life.

Although the Hawai`i onsite construction is delayed, mass production of the telescope primary mirror, design works of the telescope subsystems including science instruments have proceeded according to plan in the partner countries.
I present the progress of the TMT project, status of the Hawai`i construction site, and Japan's progress on its work share.

Synergy with TMT
11/18/2019, 9:15 - 9:40

Chaeles Beichman
(NASA Exoplanet Science Institite (IPAC,JPL,Caltech))

Title: **Exoplanets in the Era of 30 m Telescopes**

Abstract: The era of the Extremely Large Telescopes (ELTs) is fast approaching and will revolutionize exoplanet science in a way even beyond what will be possible from space. The combination of the enormous collecting area and the exquisite angular resolution of ELTs will enable the detection and characterization of exoplanets from gas giants and sub-Neptunes and even into the realm of Earths and Super-Earths. Precise radial velocity measurements will attempt to detect Earths in the Habitable Zones of solar-type stars while transit spectroscopy will probe the atmospheres of a broad range of planets masses orbiting a wide variety of host stars. Direct imaging and spectroscopy will, for the first time, enter the inner reaches of planetary systems where exoplanets are much more plentiful than they are at larger orbital distances. For M stars it is plausible to consider direct imaging down to the level of Habitable Zone Earths. Diffraction-limited, single-mode-fiber fed instrumentation enabled by Adaptive Optics will make it possible to build instruments combing high spatial resolution (10 mas) and high spectral (R~150,000) resolution instruments at modest cost. These new instruments will be able to characterize elemental and molecular abundances, atmospheric structure and even weather patterns on these other worlds.

Synergy with TMT
11/18/2019, 9:40 - 10:05

Mark Dickinson
(NOAO)

Title: **Studying galaxy evolution with TMT and Subaru in the global era of Extremely Large Telescopes**

Abstract: After two decades of observations with 8-10 meter class telescopes, some of today's forefront astronomical problems demand new facilities with still larger apertures. The forthcoming generation of Extremely Large Telescopes (ELTs) will offer tremendous gains in angular resolution and sensitivity, opening new frontiers in nearly all areas of astrophysics, from our Solar System to cosmology.

There will be important scientific synergies between the ELTs and the 8-10m telescopes. I will examine some cases for studies of galaxy formation and evolution, with special emphasis on Subaru and the Thirty Meter Telescope (TMT). I will also discuss TMT's part in the US ELT Program (US-ELTP), a partnership between NOAO, TMT and the Giant Magellan Telescope to provide US national access to a 2-telescope, 2-hemisphere ELT system. The US ELT Program can also provide unique opportunities for international collaboration spanning the global partnerships of TMT and GMT.

Synergy with TMT
11/18/2019, 10:05 - 10:30

Masashi Chiba
(Tohoku University)

Title: **Exploring the Local Universe with TMT**

Abstract: TMT will provide important opportunities for revolutionary discoveries in the studies of the Local Universe including all galaxies in the Local Group and beyond. Here we preset several key science cases to be addressed and performed with TMT, especially in synergy with past and future Subaru contributions in this field of research.

Future Wide-Field Surveys
11/18/2019, 10:35 - 10:50

Satoshi Miyazaki
(NAOJ)

Title: **Introduction for this session**

Abstract: Introduction for this session

Future Wide-Field Surveys
11/18/2019, 10:50 - 11:30

Michael Wood-Vasey
(University of Pittsburgh)

Title: **The LSST Dark Energy Science Collaboration**

Abstract: The Large Synoptic Survey Telescope (LSST) will revolutionize a wide range of fields across astronomy. It will be particularly powerful for the next generation of investigations of cosmology and dark energy. The LSST Dark Energy Science Collaboration (DESC) is a large international collaboration that is preparing to make high-accuracy measurements of fundamental cosmological parameters using data from LSST. By using measurements from weak lensing, galaxy clustering, clusters, supernovae, and strong lensing, DESC will determine the tightest constraints on dark energy to date from this flagship facility of the next decade.

In this talk I will summarize the LSST capabilities, mission, and partnership model. I will then discuss the key DESC cosmological probes, the challenges expected for each probe, and the predicted combined cosmological constraints.

Future Wide-Field Surveys
11/18/2019, 11:30 - 11:55

Jean-Charles Cuillandre
(CEA Saclay / Observatoire de Paris)

Title: **The Euclid Survey**

Abstract: The ESA Euclid spacecraft will be launched in June 2022 and, over the following 6 years, will cover 15,000 square degrees of extragalactic sky. Euclid will measure the geometry and growth of structure in the dark Universe through gravitational lensing and galaxy clustering. The two on-board scientific instruments, designed for galaxy shape and redshift measurements at visible and near-infrared wavelengths, will yield a truly unique and revolutionary legacy dataset that will enable countless scientific studies in fields ranging from cosmology to the Galaxy. The mission relies on ground-based observations to provide deep multi-band (ugriz) photometry to deliver the photometric redshifts for gravitational lensing tomography. This talk first summarizes the current status of the ESA mission (spacecraft, instruments, operations and dataset production by the Euclid Consortium). The second part of the talk focuses on plans for the space survey, which also includes a 40 square degree deep survey composed of three areas spread across the sky, as well as the critical complementary ground-based observations needed for the mission to achieve its goals.

Future Wide-Field Surveys
11/18/2019, 13:30 - 13:55

Mike Hudson
(Waterloo Centre for Astrophysics)

Title: **Euclid Science and Synergies**

Abstract: The Euclid mission aims at understanding why the expansion of the Universe is accelerating and what is the nature of the source responsible for this acceleration.The imprints of dark energy and gravity will be tracked by Euclid using two complementary cosmological probes to capture signatures of the expansion rate of the Universe and the growth of cosmic structures: weak gravitational lensing; and galaxy clustering (both through baryonic acoustic oscillations and redshift-space distortions). Although low-redshift cosmology is the primary driver of the mission, a wide range of science will be possible with the Euclid data. The Euclid Mission aims to survey over 15,000 square degrees of the extragalactic sky with imaging in a wide visible (riz) band at 0.1" resolution, near-infrared photometry (Y, J, and H) and near-infrared spectroscopy. As a result, the Euclid Mission will generate a vast data set for legacy science, including broadband visible images and near-infrared photometry of roughly 1.5 billion galaxies and near-infrared spectroscopy of roughly 25 million galaxies. Such a large data set will touch on many aspects of astrophysics, on many different scales, from the formation and evolution of galaxies down to the detection of brown dwarfs. In additions, "Euclid Deep Fields"' covering around 40 square degrees in total will be also observed, extending the scientific scope of the mission to the high-redshift Universe. This talk will describe the surveys and the key science cases, and it aims to stimulate ideas for complementary and followup observations with Subaru and other telescopes.

Future Wide-Field Surveys
11/18/2019, 13:55 - 14:20

Jeffrey W Kruk
(NASA/GSFC)

Title: **WFIRST: Project Overview and Status**

Abstract: The Wide-Field InfraRed Survey Telescope (WFIRST) will be the next NASA Astrophysics strategic mission to follow JWST. The observatory payload consists of a Hubble-size telescope aperture with a wide-field NIR instrument and a coronagraph operating at visible wavelengths that employs state-of-the-art wavefront sensing and control. The Wide-field instrument is optimized for large area NIR imaging and spectroscopic surveys, with performance requirements driven by programs to study cosmology and exoplanet detection via gravitational microlensing. All data will be public immediately, and substantial general observer and archival research programs will be supported.
The WFIRST Project is presently in Phase B, with the confirmation review expected in early 2020. We will present an overview of the present mission design and expected performance, a summary of Project status, and a description of representative observing programs.

Future Wide-Field Surveys
11/18/2019, 14:20 - 14:45

Jason Rhodes
(NASA JPL/IPMU)

Title: **WFIRST's General Observer and Coronagraph Instrument (CGI) Programs**

Abstract: WFIRST will carry out a robust General Observer (GO) program in which anyone can propose WFIRST observations and peer review will pick the most compelling science. The GO program will use 25% of the time in WFIRST's primary mission and ~100% of the time in a possible extended mission. The WFIRST Coronagraph Instrument (CGI) will carry out technology demonstration observations over the course of 3 months of observing time in the first 1q8 months of WFIRT operations. If the performance of the CGI warrants it, further science observations might be made with CGI after the technology demonstration.

WFIRST-Subaru Synergy
11/18/2019, 15:30 - 15:50

Takahiro Sumi
(Osaka University)

Title: **Subaru-WFIRST Synergistic Observation white paper**

Abstract: Subaru-WFIRST Synergistic Observations have the potential to enhance science that cannot be done by either telescope alone. The unprecedentedly deep and wide field NIR imaging capability of WFIRST is complementary to the wide field unique instruments of Subaru for both imaging and spectroscopy. JAXA and NASA are discussing about the potential contribution of Japan for the WFIRST project. One significant aspect discussed so far is to conducting the Subaru-WFIRST Synergistic Observations to benefit both WFIRST project and the Subaru science community. Representatives from the WFIRST Formulation Science Working Group (FSWG), the WFIRST Project, the Japanese Subaru community, and the Japanese WFIRST working group organized the second Subaru-WFIRST Workshop in December 2018 to discuss the most compelling joint observations which significantly enhance the WFIRST Core Survey science cases or enable new science programs based on the unique combination of Subaru and WFIRST. We overview the white paper which summarized these discussions and show some details of bulge and microlensing sciences.

WFIRST-Subaru Synergy
11/18/2019, 15:50 - 16:15

Masahiro Takada
(Kavli IPMU)

Title: **Synergetic cosmology program with Subaru and WFIRST**

Abstract: Here I would like to discuss what kinds of opportunities in cosmology are available by combining datasets from the WFIRST and Subaru Telescope.

WFIRST-Subaru Synergy
11/18/2019, 16:15 - 16:40

Masami Ouchi
(NAOJ/U. Tokyo)

Title: **Subaru-WFIRST Deep Fields and Galaxy Evolution Studies**

Abstract: I introduce our discussion about the deep field observations jointly conducted with Subaru and WFIRST, and present strawman plans for galaxy evolution studies.

WFIRST-Subaru Synergy
11/18/2019, 16:40 - 17:05

James Rhoads
(NASA GSFC)

Title: **Combining WFIRST and Subaru Observations to Study Cosmic Dawn**

Abstract: WFIRST and Subaru will offer an unprecedented combination of capabilities for understanding Cosmic Dawn and cosmological reionization. Our WFIRST science investigation team has been examining strategies to measure ionizing photon production through WFIRST imaging surveys, and to probe Lyman alpha transmission throught the intergalactic medium using deep WFIRST slitless spectroscopy. Subaru PFS spectroscopy offers resolving power, sensitivity, and multiplexing that will enable measurement of Lyman alpha line profiles for numerous, modest sized galaxies, as well as measuring near-zone sizes for epoch-of-reionization quasars in WFIRST surveys. HSC imaging can provide optical SED constraints, including medium and narrow-band capabilities not otherwise available. We are also exploring synergies with upcoming redshifted 21cm experiments. Together, these capabilities will allow studies of reionization that would not be possible with either WFIRST or Subaru alone.

(Day4) Subaru Telescope of the Future: PFS
11/20/2019, 13:00 - 13:20

Naoyuki Tamura
(Kavli Institute for the Physics and Mathematics of the Universe, the University of Tokyo)

Title: **PFS: The next generation Subaru's facility instrument under integration**

Abstract: PFS (Prime Focus Spectrograph), a next generation facility instruments on the Subaru telescope, is a very wide-field, massively multiplexed, and optical & near-infrared spectrograph. 2394 reconfigurable fibers will be distributed in the 1.3 degree-diameter field of view. The spectrograph system has been designed with 3 arms of blue, red, and near-infrared cameras to simultaneously deliver spectra from 380nm to 1260nm in one exposure. The international team under the initiative of Kavli IPMU are actively integrating and testing the hardware and software of the subsystems. After we delivered one of the subsystems Metrology Camera System to the observatory at the summit of Maunakea last year in 2018, we subsequently tested it on the telescope and recently succeeded in demonstrating a part of the fiber configuration process with a pinhole mask illuminated from its behind at the prime focus to mimic the backlit fiber array in the real prime focus instrument for PFS. The development of the other subsystems is also progressing steadily, aiming at starting engineering observation in 2020, and science operation from 2022. In this presentation, I will give an overview of the instrumentation, current status and future perspectives.

(Day4) Subaru Telescope of the Future: PFS
11/20/2019, 13:20 - 13:40

Masahiro Takada
(Kavli IPMU)

Title: **PFS SSP survey planning**

Abstract: The PFS Science Collaboration team is planning to carry out inter-connected, coherent three science programs, Cosmology, Galaxy Evolution and Galactic Archaeology, with the Prime Focus Spectrograph, under the SSP framework. We envision that we will start our survey from 2022. Here I will describe the survey designs and strategies to achieve the scientific goals.

(Day4) Subaru Telescope of the Future: PFS
11/20/2019, 13:40 - 14:00

Jeffrey Newman
(U. Pittsburgh)

Title: **PFS and LSST: Stronger Together**

Abstract: LSST will provide unprecedented deep imaging of more than half of the sky over the course of its ten-year survey. However, unlike the case for SDSS, there is no corresponding spectroscopic survey currently planned. The PFS spectrograph is uniquely capable of helping to fill this gap. In this talk, I will describe a variety of ways that the combination of PFS and LSST can enable new science. I will particularly focus on the use of PFS spectroscopy to train photometric redshift algorithms, which has the potential to improve dark energy constraints from LSST by ~40%. Similar machine learning-based techniques can be used to label galaxies across the LSST footprint with a wide variety of properties (stellar mass, star formation rate, etc.) using mappings from LSST photometry to match PFS-inferred characteristics for limited training sets. Through such methods, the combination of PFS and LSST can enable a wide variety of new science that neither project could achieve on its own.

(Day4) Subaru Telescope of the Future: PFS
11/20/2019, 14:00 - 14:20

David Schlegel
(Lawrence Berkeley National Lab)

Title: **DESI Installation Challenges, First Light, and Survey Plan**

Abstract: The Dark Energy Spectroscopic Instrument (DESI) addressed construction and installation challenges completing its 5000-fiber focal plane and 10 optical spectrographs in 2019. As a dedicated instrument at the Mayall 4-m Telescope at Kitt Peak, it will target 35 million galaxies and quasars over its 5-year survey. First light spectra will be presented. Early survey data is likely to cover the equatorial footprint of the Subaru Hyper Suprime-Cam imaging, enabling synergies between DESI and the Subaru Prime Focus Spectrograph.

(Day4) Subaru Telescope of the Future: PFS
11/20/2019, 14:20 - 14:40

Tadayuki Kodama
(Astronomical Institute, Tohoku University)

Title: **Revealing the build-up of large scale structures and galaxy populations therein with PFS^2**

Abstract: We have been tracing the cosmic large scale structures hosting galaxy clusters/groups since z=1.7 to 0.4 with HSC (HSC^2 survey), and constructing a unique sample of recently quenched galaxies (RQGs) along the structures. With a systematic spectroscopic follow-up program with PFS (PFS^2 survey) on the unique samples of rare objects such as distant clusters and RQGs we wil investigate the growth of galaxy structures with cosmic times, and unveil the star formation histories of galaxies therein, such as biased galaxy formation and environmental quenching as well as the intrinsic evolution of galaxies related to the mass of the systems.

(Day4) Subaru Telescope of the Future: PFS
11/20/2019, 14:40 - 15:00

Hitoshi Murayama
(Kavli IPMU, Univ.Tokyo / UC Berkeley)

Title: **Why PFS is exciting for fundamental physics**

Abstract: The planned survey with Prime Focus Spectrograph on the Subaru telescope will enable comprehensive tests on the current standard paradigm of the evolution of the Universe called ΛCDM. The paradigm is based on many assumptions: general relativity, flat FRW metric, nearly scale-invariant adiabatic Gaussian perturbation, hierarchical structure formation, cosmological constant, massless neutrinos, and deionization from stellar formation. The PFS survey will challenge all of these assumptions with real data. I believe PFS will provide legacy data for fundamental science of the Universe for decades to come.

(Day4) Subaru Telescope of the Future: ULTIMATE
11/20/2019, 15:50 - 16:00

Yousuke Minowa
(Subaru Telescope)

Title: **ULTIMATE-Subaru: Project Overview and Current Status**

Abstract: ULTIMATE-Subaru is a next large facility instrument project at Subaru telescope. We will develop a wide-field near-infrared (1.0-2.5 micron) imager at Cassegrain (Cs) and a multi-object spectrograph at Nasmyth IR (NsIR) with the aid of a ground-layer adaptive optics system (GLAO), which will uniformly improve the seeing over a wide field of view up to ~20 arcmin in diameter. The GLAO system consists of an adaptive secondary mirror (ASM), a laser guide star facility (LGSF), and wavefront sensor systems at NsIR and Cs foci. The expected spatial resolution by the GLAO correction is about 0.2 arcsec FWHM in K-band under moderate seeing conditions at Subaru. In this presentation, we present the overview, current status, and plan for ULTIMATE-Subaru project.

(Day4) Subaru Telescope of the Future: ULTIMATE
11/20/2019, 16:00 - 16:15

Akio Inoue
(Waseda University)

Title: **ULTIMATE prospects for galaxy surveys beyond z=10**

Abstract: I will present a forecast of wide-field galaxy surveys with future near-infrared imaging facilities such as Euclid, WFIRST and Subaru ULTIMATE. Among them, ULTIMATE has a unique K-band imaging capability which is essential to select galaxy candidates at z>11 securely.

(Day4) Subaru Telescope of the Future: ULTIMATE
11/20/2019, 16:15 - 16:30

Kate Whitaker
(UMass Amherst)

Title: **Tracing the Life Cycles of Massive Galaxies up to Cosmic Noon: Prospects with ULTIMATE-Subaru**

Abstract: In this talk, I will discuss using the wide-field. adaptive optics capabilities proposed for the ULTIMATE-Subaru imaging survey to study the formation of massive galaxies, tracing their emergence at z~5 to their rapid growth and demise by z~1. In particular, I will discuss lessons learned from previous near-infrared medium-band surveys such as the NEWFIRM Medium-Band Survey and ZFOURGE. Deep, high spatial-resolution rest-optical medium-band imaging from ULTIMATE-Subaru will enable the discovery and census of the first quenching (compact) galaxies. Moreover, it will push our understanding of the build-up for stellar mass as a function of environment to new frontiers. ULTIMATE-Subaru would be a powerful tool to trace galaxy formation and evolution from cosmic dawn to the peak epoch of star formation at cosmic noon, critical time periods with many remaining open questions.

(Day4) Subaru Telescope of the Future: ULTIMATE
11/20/2019, 16:30 - 16:45

Takashi Moriya
(NAOJ)

Title: **Time domain astronomy with ULTIMATE-Subaru**

Abstract: I will overview the time domain science that can be investigated by ULTIMATE-Subaru.

(Day4) Subaru Telescope of the Future: ULTIMATE
11/20/2019, 16:45 - 17:00

Eric Peng
(Peking University)

Title: **Galaxy evolution in the local Universe with ULTIMATE**

Abstract: The combination of wide-field coverage and high spatial resolution provided by ULTIMATE-Subaru will be a powerful tool to study the local Universe. I will present a variety of local science cases for ULTIMATE-Subaru, from the Milky Way to nearby galaxies.

(Day4) Subaru Telescope of the Future: ULTIMATE
11/20/2019, 17:00 - 17:15

Daisuke Suzuki
(ISAS / JAXA)

Title: **ULTIMATE microlensing survey**

Abstract: The microlensing events toward the inner Galactic center ($|b| < 0.5$ deg) are expected to be very different from those observed toward the optical microlensing field (b~-3deg). The typical event time scale of bulge-lens and bulge-source events would be ~ 2 days, whereas those toward the less extincted field have typical event time scale of ~ 20 days. The planetary signal would last a few hours toward the inner Galactic center. To observe such short microlensing events and the planetary signals toward the highly extincted region, K-band, wide FOV, and high-resolution are required, and ULTIMATE-Subaru is the best facility for this purpose. Such survey will, for the first time, allow us to study the planet frequency in the dense stellar environment. We will present a microlensing survey planned with ULTIMATE-Subaru. Also, we will mention possible synergies with other surveys toward the Galactic center: PRIME, WFIRST and JASMINE.

(Day4) Subaru Telescope of the Future: ULTIMATE
11/20/2019, 17:15 - 17:20

Yusei Koyama
(Subaru Telescope)

Title: **ULTIMATE session summary/promotion**

Abstract: N/A

(Day6) Science Keynotes
11/22/2019, 13:30 - 14:00

Mike Brown
(Caltech)

Title: **The search for Planet Nine**

Abstract: The recent suggestion of evidence for a massive ninth planet in the outer solar system has set off a worldwide search to find this latest member of our planetary family. I will discuss the evidence for the planet and show how we are working to constrain the mass and orbital parameters of the body. These constraints place Subaru as the optimal observatory to carry out the search. I will show results from the Caltech/Japanese search using HSC and discuss prospect from detection.

(Day6) Science Keynotes
11/22/2019, 14:00 - 14:30

Motohide Tamura
(University of Tokyo/Astrobiology Center/NAOJ)

Title: **Exploring Exoplanet and Star/Planet Formation Studies with Subaru**

Abstract: With its high image-quality and large light-gathering power, the Subaru telescope has been at the forefront in the many fields of astronomy including star and planet formation as well as exoplanet observations. Starting with the first coronagraph with adaptive optics on 8-m class telescopes CIAO in 2000 (first light), its exoplanet PI-type instruments have been constantly upgraded to HiCIAO in 2009, and then to current SCExAO extreme adaptive optics and CHARIS IFU spectrometer. Polarimetry is another key word for Subaru and well applied to these fields since the telescope first light. I will highlight the scientific results on exoplanets, disks, and star forming regions using these instruments as well as observatory instruments. In particular, the results of the SEEDS SSP project and prospects of the IRD-SSP project will be emphasized. I will then discuss how we can expand these 8-m telescope capabilities to the 30-m ones for these fields.

(Day6) Science Keynotes
11/22/2019, 14:30 - 15:00

Vasily Belokurov
(Institute of Astronomy)

Title: **The Milky Way halo revolution**

Abstract: The last 20 years have seen a revolution in the studies of the Milky Way halo. I will review the progress, highlighting the discoveries of faint halo sub-structures: satellites and streams. These observations have strong implications for the formation of our Galaxy and the nature of Dark Matter.

(Day6) Science Keynotes
11/22/2019, 15:30 - 16:00

Jeff Cooke
(Swinburne University)

Title: **Transient Astronomy and the role of Subaru**

Abstract: The Subaru Observatory conducts the deepest wide-field surveys in the world. These surveys, along with deep imaging and spectroscopic follow-up capabilities, has enabled Subaru to make significant contributions to transient astronomy. I will discuss some past and current work with Subaru in the time domain, ranging from supernovae at low and high redshift, GRBs, AGN, moving objects, and fast transients. This work has helped us understand the physics of these events and has discovered new and interesting phenomena. I will discuss the important role of Subaru for future time domain research, probing deep into new territory and, with space-based missions, leading the exploration of events shortly after the Big Bang and prospects in the era of multi-messenger astronomy.

(Day6) Science Keynotes
11/22/2019, 16:00 - 16:30

Sandra Faber
(UC Santa Cruz)

Title: **Galaxy Formation and Evolution: What Is Simple, and What Remains Mysterious**

Abstract: I will attempt to review the major aspects of galaxy formation -- including dark matter assembly, baryon assembly, development of structure, interstellar medium, star-formation history, black hole growth, and quenching -- with the aim of deciding which of these topics are falling nicely into place and which remain mysterious. The goal is to develop a few key questions that other speakers at the session may wish to comment on.

(Day6) Science Keynotes
11/22/2019, 16:30 - 17:00

Masayuki Akiyama
(Tohoku University)

Title: **Tracing the accretion growth history of super massive black holes with wide-field surveys**

Abstract: Utilizing the unique wide-field imaging and spectroscopic capabilities, the Subaru telescope has been contributing to understandings of the statistical properties of AGNs, and the accretion growth history of super massive black holes. In combination with wide-field multi-wavelength surveys in X-ray, MIR, and radio wavelengths, the Subaru telescope provide unique constraints on the SMBH growth especially in the last 100 Gyrs ($z<2$). In the near future, further big step forward is expected in the understanding of the early growth history of SMBHs by statistical observations of AGNs at $z>2$ with the Prime Focus Spectrograph.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 9:00 - 9:20

Hervé Bouy
(University of Bordeaux, France)

Title: **Combining 20 years of Subaru data to search for young brown dwarfs and planetary mass objects**

Abstract: Despite the tremendous progress achieved over the past decade, the study of stellar formation is far from complete. We have not yet measured the minimum mass for star formation, nor the shape of the IMF down to the least massive free-floating planets, or know how universal this shape is. Although clusters are the building blocks of galaxies, little is known about their early dynamical evolution and dispersal into the field. The COSMIC-DANCE project aims at answering these fundamental questions and revealing the shape of the IMF down to the fragmentation limit and with a precision and completeness surpassing current surveys. To achive these goals, we compare deep archival Subaru SuprimeCam images obtained over the past 20 years with newer HSC images. Combined with wide-field images from other world-class facilities, we derive proper motions for tens of millions of sources with an accuracy comparable to Gaia but 4 to 5 mag deeper. Feeding these proper motions and the multi-wavelength photometry to innovative hyper-dimensional data mining techniques, we securely identify all cluster members and derive the ultimate census over the entire mass spectrum and down to the fragmentation limit.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 9:20 - 9:40

Per Calissendorff
(Stockholm University)

Title: **Spectral characterization of newly detected young substellar binaries**

Abstract: Multiplicity studies of stars and brown dwarfs have shown a decrease in multiplicity frequency as a function of primary mass and spectral type, stretching down all the way to the substellar mass-regime. However, at the very bottom of the stellar and substellar initial mass function, multiplicity is not very well-constrained. By associating low-mass brown dwarfs to young moving groups we may constrain their ages, which otherwise prove difficult to do. We are thus at a point where we can compare the multiplicity rates for both older and younger samples of substellar brown dwarfs. We present the results from observations of 14 young low-mass brown dwarfs using the VLT/SINFONI IFS with LGS-AO, detecting 3 new binary systems. These results indicate for higher multiplicity frequencies for younger populations of brown dwarfs, and that older systems may have undergone dynamical interactions disrupting primordial binaries. We discover some of these companions to be of planetary-mass, and that they have small separations, translating to orbital periods of just a few decades. Dynamical masses can hence be obtained within just a few years of astrometric monitoring, making these systems excellent benchmarks for calibrating evolutionary models in an otherwise scarcely probed mass-regime.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 9:40 - 10:00

Jinshi Sai
(The University of Tokyo/NAOJ)

Title: **ALMA Observations of the Late-Phase Protostar L1489 IRS: Warped or Misaligned Disk Structure**

Abstract: Formation process of protoplanetary disks is still unclear even though disks are essential, key objects for star and planet formation. To understand how disks form and evolve, it is necessary to reveal geometrical and kinematical structures of disks around protostars during disk formation phase. We present observational results of the Class I protostar L1489 IRS at high spatial resolutions of <50 au using ALMA. Our observations in the C18O J=2-1 line have revealed that the disk having Kepler rotation extends up to r~600 au with gaps at r~150-300 au. Interestingly, the disk plane changes its position angle at the gap positions by ~15 degree. Comparing these observational results with kinematic disk models, it is found that the disk around L1489 IRS can be explained as a warped disk or two misaligned inner and outer disks. Theoretical simulations suggest that such change of the disk position angle could be formed by accretion from a misaligned envelope surrounding the disk.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 10:00 - 10:20

Hiroyuki Ishikawa
(SOKENDAI)

Title: **Detailed Chemical Analysis of M Dwarfs by High-Dispersion Near-Infrared Spectroscopy with IRD**

Abstract: It is crucial to know the chemical composition of the host stars to understand the formation of and the composition of terrestrial planets. Detection of such planets around M dwarfs are rapidly increasing. We are developing the chemical abundance analysis scheme based on the high dispersion near-infrared spectroscopy. Data is obtained from IRD on the 8.2-m Subaru Telescope here on Hawaii and the similar instrument on the 3.5-m Calar Alto telescope in Spain; both offers high dispersion spectroscopy with wide wavelength coverage. In this presentation, we report the chemical analysis of 8 species – Fe, Na, Mg, Al, K, Ca, Ti, and Cr – on M dwarfs. For M dwarfs in binary systems with FGK primaries, we compared our results and the values in the literature about the primaries. The results agree within the error margin, which is still larger than expected though. We think it is because the depth of the absorption lines is sensitive not only to the absorbers but also to the electrons ejected by the ionization of other elements such as Na. We will apply this analysis method on all the data coming from the IRD SSP to understand the distribution of chemical abundances of nearby M dwarfs.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Invited talk
11/19/2019, 10:30 - 11:10

Masahiro Ikoma
(University of Tokyo)

Title: **Progress in and prospects for understanding of planet formation**

Abstract: Considerable progress in understanding of planet formation has been made in the last two decades, thanks to continuous progress in exoplanet observation. Last year a new satellite for transiting exoplanet survey (TESS) was launched, opening a new era of characterization of atmospheres of close-in exoplanets. On one hand, development of direct imaging technique is enabling to detect and observe distant, young exoplanets including accreting gas giants. Here I review such progress that exoplanet observations have brought about in understanding of planet formation. Then I discuss what observational constraints are expected from the Subaru Telescope for further understanding of the origins and diversity of exoplanets.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 11:10 - 11:30

Yasunori Hori
(Astrobiology Center)

Title: **Are Planets Rare in Open Clusters?**

Abstract: In clustered environments, stellar encounters can liberate planets from their host stars via close encounters. The detection probability of planets suggests that the planet population in open clusters resembles that in the field. Only a few dozen planet-hosting stars, however, have been discovered in open clusters. We explore the survival rates of planets against stellar encounters in open clusters similar to the Pleiades, Hyades, and Praesepe and embedded clusters. We performed a series of N-body simulations of star clusters, modeling the three open clusters and embedded clusters. We find that less than 1.5 % of close-in planets within 1 AU and at most 7 % of planets with 1-10 AU are ejected by stellar encounters in clustered environments after the dynamical evolution of star clusters. We expect no significant difference between the frequency of short-period planets in open clusters and that in the field. Besides, our simulations imply that most of planets (within 10au) around FGKM-type stars are likely to survive against stellar encounters in open clusters. If a planet population from 0.01-100 AU in an open cluster initially follows the observed planet distribution in the field, the production rate of free-floating planet per star is 0.0096-0.18, where we have assumed that all the stars initially have one giant planet with a mass of 1-13 Mjup in a circular orbit. These values are compatible with the observed fraction of free-floating planets, 0.25 per main-sequence star.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"

Invited talk

11/19/2019, 13:20 - 14:00

Mitsuhiko Honda

(Okayama University of Science)

Title: **Evolution of solids and planet formation revealed by Subaru**

Abstract: Solids (e.g. silicates, ice) in the protoplanetary disk are the ingredients of planets and play a major role on the planet formation. Subaru Telescope has been operating several unique instruments and revealed the evolution of the solids in the disk for 20 years. In this talk, I will review the achievements done by Subaru telescope, and discuss the future prospects of this science topic with Subaru and TMT.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 14:00 - 14:20

Garima Singh
(Observatoire de Paris)

Title: **Discovery of an azimuthal density gradient in a gas-rich debris disk possibly related to a massive collision**

Abstract: The gas-rich debris disk of HD 141569 (Herbig Ae/Be star at 116 pc), discovered in 1999 with the HST in near-IR and later in visible revealed multiple rings and outer spirals extended as far out as 410 AU. More recently the exoplanet imager SPHERE has been able to resolve several non-uniform concentric rings inside the inner cavity (<100 AU)[1]. A North-South asymmetry was discovered in the brightest ringlets at 40 AU, which is aligned with the disk projected major axis. This asymmetry cannot be explained by the dust light scattering properties. Furthermore the post-processing techniques used for scattered light observations in total intensity impact the shape and local photometry of extended objects[2]. With the newly acquired polarimetric data using the dual polarimetric imaging mode of SPHERE/IRDIS, we discovered that the Lorentzian azimuthal distribution of the intensity reported in the innermost ring is significantly different in total intensity and polarized intensity. In this talk, I will present the hypothesis based on the massive collisions[3] between planet embryos that explain how both images can be described as a combination of a phase function and an azimuthal dust density variation which takes a Lorentzian profile peaking to the south-west of the ring.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 14:20 - 14:40

Riouhei Nakatani
(RIKEN)

Title: **Radiation Hydrodynamics Simulations of Photoevaporating Protoplanetary Disks: Implications to Metallicity Dependence of Disk Lifetimes**

Abstract: While protoplanetary disks are considered to have lifetimes of several million yr in the solar neighborhood, recent observations suggest that the disk lifetimes are shorter in a low-metallicity environment (Yasui et al. 2009, 2010). We perform a suite of radiation hydrodynamics simulations of photoevaporating disks with various metallicities to study their long-term evolution and the metallicity dependence of mass-loss rates. Our simulations follow hydrodynamics, radiative transfer, and nonequilibrium chemistry in a self-consistent manner. We also consistently calculate dust-grain temperatures by solving the radiative transfer of the stellar irradiation and grain (re-)emission. As photo-heating sources for the gas, we take account of far-ultraviolet (FUV), extreme-ultraviolet (EUV), and X-ray, which prior works have suggested important to drive photoevaporation but either of their relative importance or their interplaying effects is not well resolved.
In the fiducial case with solar metallicity, including the X-ray effects does not significantly increase the photoevaporation rate when compared to the case with ultra-violet (UV) radiation only. At sub-solar metallicities in the range of $Z \gtrsim 10^{-1.5}$ Zsun, the photoevaporation rate increases as metallicity decrease owing to the reduced opacity of the disk medium. The result is consistent with the observational trend that disk lifetimes are shorter in low metallicity environments. In contrast, the photoevaporation rate decreases at even lower metallicities of $Z \lesssim 10^{-1.5}$ Zsun, because dust-gas collisional cooling remains efficient compared to far UV photoelectric heating whose efficiency depends on metallicity. The net cooling in the interior of the disk suppresses the photoevaporation. However, adding X-ray radiation significantly increases the photoevaporation rate, especially at $Z \sim 10^{-2}$ Zsun. Although the X-ray radiation itself does not drive strong photoevaporative flows, X-rays penetrate deep into the neutral region in the disk, increase the ionization degree there, and reduce positive charges of grains. Consequently, the effect of photoelectric heating by far UV radiation is strengthened by the X-rays and enhances the disk photoevaporation.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 14:40 - 15:00

Takayuki Muto
(Kogakuin University)

Title: **Multi-wavelength High Resolution Observations of Protoplanetary Disks**

Abstract: High resolution observations of protoplanetary disks have found various structures such as rings, gaps and spirals. The near infrared polarization imaging observations are sensitive to small dust grains at the surface of the disk while sub-mm observations reveal the structures of large grains and molecular gas at the midplane. The combination of near infrared and sub-mm observations is therefore a key to understand the structures of protoplanetary disks. The SEEDS project observed several tens of disks using HiCIAO/AO188 on board Subaru and now ALMA has observed more than 100 disks at the spatial resolution of <=0.2 asec and several tens of disks at <=0.1 asec at sub-mm wavelengths. We present several case studies of disk imaging observations at different wavelengths to understand the distribution of dust particles. We also present the prospects on direct imaging observations of an accreting young planet using sub-mm and near infrared high resolution observations. If time allows, we present recent progress of our archival survey to reveal the statistical properties of disk structures. Finally, we discuss prospects towards future high contrast imaging observations with TMT and/or extended ALMA.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Invited talk
11/19/2019, 15:30 - 16:10

Tyler Groff
(NASA Goddard Space Flight Center)

Title: **Exoplanet Imaging with CHARIS and Future Synergies with WFIRST CGI**

Abstract: The principal science goal of directly imaging exoplanets is spectroscopy. At Subaru, the SCExAO instrument uses the CHARIS integral field spectrograph (IFS) to take spectra of young, self-luminous companions and disks in the near-infrared. CHARIS provides both R70 and R20 spectral resolutions across the J, H, and K bands. Of the two, R20 is the primary observing mode, which provides both excellent spectral coverage of the companions and a larger bandpass for advanced speckle subtraction techniques. Looking to the future, the WFIRST CoronaGraph Instrument (CGI) is a technology demonstration for future missions whose spectroscopic techniques are rooted in what has been demonstrated at ground observatories. CGI will reach very high contrast in broadband light with advanced wavefront control and coronagraphy techniques, paving the way for characterizing Earth-like planets. The spectral resolution of CGI spectroscopic modes is R50 with 15% bandpasses from 600 to 970nm. The calibration, speckle subtraction, and spectral extraction methods for CGI spectroscopy has a strong heritage from techniques developed for SCExAO+CHARIS. We discuss such synergies between CHARIS and CGI characterization capabilities from both a science and engineering perspective, including the new Wollaston polarization upgrade to CHARIS.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 16:10 - 16:30

Julien Lozi
(Subaru Telescope)

Title: **New NIR spectro-polarimetric modes for the SCExAO instrument**

Abstract: The Subaru Coronagraphic Extreme Adaptive Optics (SCExAO) instrument is a high-contrast imaging system installed at Subaru. It is equipped with a fast visible dual-camera polarimetric module, VAMPIRES, already producing valuable observations of protoplanetary disks and dust shells. We present two new polarimetric modules that were recently implemented,. using the NIR light from y- to K-band and Wollaston prisms. The fast polarization module, similarly to VAMPIRES, uses a fast IR camera that can run at kilohertz frame rates, and a Ferroelectric Liquid Crystal (FLC) device modulating the polarization in a synchronized way with the acquisition. This allows to freeze atmospheric speckles and to calibrate more precisely the degree of polarization of the target, as already demonstrated by VAMPIRES. For the second module, we perform spectro-polarimetric measurements at a slower rate, using the CHARIS Integral Field Spectrograph (IFS). The field-of-view is reduced by a factor 2 in one direction to 2x1 arcsec, to accommodate for the imaging of both polarizations on the same detector without sacrificing the spectral resolution of the instrument. This is the first demonstration of a high-contrast spectro-polarimeter using an IFS. We present on-sky results of the new polarimetric capabilities taken during the commissioning phase, on strongly polarized targets.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/19/2019, 16:30 - 16:50

Thayne Currie
(NASA-Ames/Subaru)

Title: **Spectral Characterization of Directly-Imaged Planets with the Subaru Telescope**

Abstract: The Subaru Telescope has played a critical role in not just the discovery of directly imaged planets around other stars but also their spectral/atmospheric characterization. Early data taken with AO188 helped establish key trends in young jovian exoplanet atmospheres, in particular their clouds and chemistry. Now, SCExAO coupled with the CHARIS integral field spectrograph delivers not just far sharper images but simultaneous JHK spectra diagnostic of the planets' temperatures, gravities, and chemistry. SCExAO/CHARIS also clarifies the nature of controversial objects. In the next decade SCExAO should provide the first detections and characterizations of mature exoplanets in reflected light, paving the way for characterizing an exo-Earth with TMT.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/22/2019, 9:00 - 9:20

Mayuko Mori
(University of Tokyo)

Title: **Transmission Spectroscopy of the Atmosphere of TRAPPIST-1g using Subaru/MOIRCS and Gemini/GMOS-N**

Abstract: Uncovering the composition of planetary atmospheres is important for understanding their formation and evolution. From previous studies using Hubble Space Telescope (de Wit et al. 2018, Wakeford et al. 2019), the TRAPPIST-1 planets seem not to have clear H2/He-dominated atmospheres. However for TRAPPIST-1g, the largest planet in the system, the result was not very clear in the observed wavelength (1.1-1.7um).

We observed a transit of TRAPPIST-1g at wavelengths of 1.3-2.3 um using the MOIRCS spectrograph. This wavelength range is useful to constrain atmosphere models because it covers strong methane absorption lines around 2.3 um. Simultaneously with MOIRCS observation, we obtained Gemini/GMOS-N photometry in r-band, to look for signatures of Rayleigh scattering.

We were able to detect the transit with both instruments. The derived transit depth is ~0.77% in r-band, consistent with previous study at longer wavelengths. This indicates low levels of haze in the TRAPPIST-1g atmosphere, but still we need more observation. For the MOIRCS data, the uncertainty of derived transit depths is too big to constrain any atmosphere models.

In this presentation, I will share the data analyses techniques and the possibility of transmission spectroscopy of future targets using MOIRCS.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/22/2019, 9:20 - 9:40

John Livingston
(University of Tokyo)

Title: **Spitzer observations of the young planet V1298 Tau b**

Abstract: At 24 Myr, V1298 Tau b is the youngest known Jupiter-size transiting planet. However, with only three transits in the initial K2 discovery data, the ephemeris was poorly constrained. Furthermore, the star is fast-rotating and active, so spot-crossing events pose an obstacle precise transit modeling. We observed a transit with the Spitzer Space Telescope in order to mitigate this problem, as spot contrasts on the stellar surface are greatly diminished in the infrared. The Spitzer transit improves the ephemeris precision by an order of magnitude. Furthermore, by measuring a more precise planet radius, the planet will be more useful for studies hoping to constrain the physics of planet formation and evolution.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/22/2019, 9:40 - 10:00

Noriharu Watanabe
(SOKENDAI (Graduate University for Advanced Studies))

Title: **Doppler Tomographic Analysis for Planetary Orbital Precession of WASP-33b**

Abstract: Johnson et al. (2015), henceforth as J+15, found that the transit chord of WASP-33b, which has a 1.2-day-period retrograde circular orbit around a rapidly rotating and pulsating A-type star, changed slightly from 2008 to 2014. They detected its orbital precession due to its flattened host star. However, only two observational epochs, 2008 and 2014, were used in J+15.

To confirm and measure more precisely the precession, we used observational data of WASP-33 which was obtained using the High Dispersion Spectrograph (HDS) in 2011, as well as the data sets of 2008 and 2014 in J+15. After using a method of Doppler tomography, we got the planetary shadow showing a retrograde orbit and a component from stellar pulsations. Then we extracted only the planetary shadow by Fourier filtering.

To measure sky-projected orbital obliquity and impact parameter of each epoch, we adopted an MCMC analysis for the three filtered data with our planetary shadow model. After applying equations of a long-term orbital precession from Iorio (2016) to fit our values, we found that our measured parameters did not follow the model. This disagreement may imply that WASP-33b's precession has an unclear short variation or we have underestimated these errors.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/22/2019, 10:00 - 10:20

Taichi Uyama
(NASA Exoplanet Science Institute, Caltech/IPAC)

Title: **Characterizing a directly-imaged planet Kappa And b with SCExAO**

Abstract: Kappa And b was discovered in the SEEDS survey and follow-up observations have been conducted for its characterizations. We present the latest Kappa And b observations with Subaru/SCExAO+HiCIAO HY-bands imaging and Subaru/SCExAOI+CHARIS JHK-bands low-resolution spectroscopy. By combining our results with previous studies we investigated Kappa And b's spectrum and performed orbital fitting, which suggests that Kappa And b is likely an L0-L1 object and has an eccentric orbit. Our results promote following observations for with TMT for further discussions of formation/evolution scenarios of Kappa And b.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution talk
11/22/2019, 10:20 - 10:40

Ruben Asensio-Torres
(Stockholm University / Max Planck Institute for Astronomy)

Title: **First results from BEAST: The B-star Exoplanet Abundance Study**

Abstract: "Direct imaging surveys have proven that substellar companions on wide orbits are rare, but seem to be more common with increasing host stellar mass. However, the more massive B-type stars (>3MSun) have not been studied to the same level of scrutiny as AFGKM types, and it is not clear whether this trend holds for the most massive stars or there is an overturn, as suggested by the indirect methods at short separations. To address this issue, the B-star Exoplanet Abundance Study (BEAST) survey has started with the goal of detecting giant planets, brown dwarfs and disks around 83 B-type stars in Scorpius Centaurus with SPHERE. Here, we describe the layout of the survey and the current results of the observations. We also present the first companion yielded by BEAST, the discovery of a ~20 Mjup circumbinary brown dwarf in Upper Scorpius. We will discuss the spectral properties of this object and the importance of common proper motion when claiming physical association."

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Invited talk
11/22/2019, 10:50 - 11:30

Misato Fukagawa
(NAOJ)

Title: **Star Formation Science with Subaru**

Abstract: This review will cover a wide variety of topics on star formation investigated with the Subaru Telescope, from the initial mass function to the characterization of young stellar objects such as about age measurements, multiplicity, jets, and circumstellar disks. The prospects in optical and infrared will also be discussed based on the recent progress with ALMA.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Invited talk
11/22/2019, 11:30 - 12:10

Olivier Guyon
(Subaru Telescope)

Title: **Imaging Giant Exoplanets with SCExAO and Habitable Planets on TMT**

Abstract: Subaru Telescope has provided powerful exoplanet imaging capabilities with AO-fed high contrast imaging instrumentation. Its current extreme-AO instrument, the Subaru Coronagraphic Extreme Adaptive Optics (SCExAO) system, feeds several optical and near-IR instrument modules, including the CHARIS near-IR integral field spectrograph and the VAMPIRES visible imager/polarimeter. SCExAO users are making major contributions in exoplanet science with observations of disks and young giant planets.
Major upcoming upgrades in Subaru adaptive optics instrumentation, along with new SCExAO instrumentation deployment, will further augment contrast performance and provide additional modes including high resolution spectroscopy and near-IR polarization differential imaging. The SCExAO platform is also a prototype for imaging and spectroscopy of habitable planets around nearby M-type stars with the Thirty Meter Telescope. The scientific and technical evolution path toward this ambitious goal is poised to make Subaru Telescope a world-leading exoplanet observation facility over the next decade.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution poster
Poster ID: P30

Yasunori Hori
(Astrobiology Center)

Title: **Do the TRAPPIST-1 Planets Have Primordial or Secondary Atmospheres?**

Abstract: Recently, seven Earth-sized planets orbiting an ultra cool red dwarf TRAPPIST-1 were reported, three of which dwell in the habitable zone. Low densities of the TRAPPIST-1 planets may conceal volatile content, e.g., water and atmospheres. In fact, atmospheric spectroscopy of the TRAPPIST-1 planets suggests that six of them may have atmospheres. We have investigated whether the TRAPPIST-1 planets acquired substantial amounts of primordial atmospheres from the ambient disk gas and can retain some of them under a hostile environment such as stellar intense irradiations. In this talk, we discuss expected atmospheric properties of the TRAPPIST-1 planets, which are closely related to their habitability, in the context of formation histories.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution poster
Poster ID: P31

Masashi Omiya
(Astrobiology Center (ABC/NINS))

Title: **Precise radial velocity survey of late-M dwarfs in IRD-SSP : Observation status**

Abstract: In IRD-SSP, we are carrying out a precise radial velocity (RV) survey of late-M dwarf stars to search for Earth-like planets around late-M dwarfs using the IRD and the Subaru telescope since S19A. Goals of our survey are to detect Earth-like planets in the habitable zone and understand property of planetary systems around low-mass stars.

In the first phase of the survey observation, we aim to select good targets suitable for very precise RV measurements with IRD from our ~150 sample stars pre-selected using stellar parameters in literatures and our low-resolution spectroscopy. Many late-M dwarfs are active and rapidly rotating, and then such properties of the stars disturb precise RV measurements with precisions of ~2m/s to be needed to detect Earth-mass planets around low mass stars. The stars with double lines caused by close companions are also excluded in the screening observation.

So far, we have observed more than 40 pre-sample stars several times until May 2019 and will observe the 60 stars for the RV measurements in IRD-SSP survey from S19B intensively. In this poster, we report the current observation status of the IRD-SSP survey.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution poster
Poster ID: P32

Mayuko Ozawa
(Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo)

Title: **N-body simulations of accretion of ice giant cores in mean motion resonances with gas giants**

Abstract: Recent exoplanet surveys have detected more Neptune-size planets beyond the snow line than planet formation theories predict. However, even for such planets in the Solar System, namely Uranus and Neptune, the planetary accretion processes remain uncertain. Standard in-situ growth of the cores of Uranus and Neptune via planetesimal accretion is theoretically too slow to be completed before gas disk dispersal. In this study, as a possible rapid growth process, we consider the accretion of planetesimals trapped in mean motion resonances (MMRs) with inner giant planets such as Jupiter and Saturn. If MMRs could accelerate planetary accretion, the timescale problem of the cores of Uranus and Neptune could be alleviated. The previous study that studied the core accretion of Saturn in MMRs considered only a 2-dimensional system. In this study, we have performed high-resolution N-body simulations of planetary accretion in a 3-dimensional system to investigate the effect of MMRs on planetary accretion.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution poster
Poster ID: P33

Yuhei Takagi
(Subaru Telescope)

Title: **High-resolution optical and near-infrared spectroscopy of FU Ori type star V960 Mon**

Abstract: We present the result of the high-resolution optical and near-infrared spectroscopy of FU Ori type star V960 Mon. Spectroscopic variation of an FU Orionis type star will provide valuable information of its physical nature and the disk evolution. From our previous results of two-years mid-resolution optical spectroscopic monitoring of V960 Mon since its outburst on Nov. 2014, we found that the equivalent width of neutral atomic lines increased, while those of ionized line decreased. This equivalent width change corresponds to a decrease in effective temperature and an increase in surface gravity. To investigate the cause of this change, we obtained the high-resolution optical and near-infrared spectra. While line profiles of the neutral lines were broad during the early phase of the outburst, those in the spectrum taken in Jan. 2018 show triple-peaked profile. The central structure of the absorption line is likely to be which indicate that the spectrum of the central star is appearing as the V960 Mon luminosity fades. The H-alpha line, Ca triplet, NaD, and K lines also show profile change, corresponding to the evolution of the outflow and accretion. We discuss the relationship between the profile change and the evolution of FU Ori star.

"Past 20 Years and Future of Subaru's Role in Observations of Exoplanets and Disks"
Contribution poster
Poster ID: P34

Taichi Uyama
(NExScI, Caltech/IPAC)

Title: **Search for Hα from Accreting Protoplanets with SCExAO+VAMPIRES**

Abstract: The Visible Aperture Masking Polarimetric Interferometer for Resolving Exoplanetary Signatures (VAMPIRES) has newly started operation with Subaru/SCExAO. This instrument enables variety of imaging modes of polarization differential imaging (PDI), aperture masking, and spectral differential imaging with a Hα filter (SDI). The main purpose of the instrument is high– resolution imaging of circumstellar disks but the Hα SDI mode can provide another aspect of high –contrast imaging; accretion signatures. As reported accreting protoplanet candidates around LkCa 15 or PDS 70 hydrogen emissions from protoplanets will directly benefit discussion of planet formation mechanisms. We introduce Hα high– contrast imaging observation and reduction schematics in the presentation.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Invited talk
11/19/2019, 9:00 - 9:25

Ivo Labbe
(Swinburne University of Technology)

Title: **The first billion years of galaxy formation**

Abstract: The formation of the first galaxies is one of the most exciting frontiers in studies of galaxy evolution. We can now observe galaxies when the universe was only a few percent of its current age, and trace their rapid growth with time. Yet significant questions and challenges remain. When did the first galaxies form? What are the properties of the galaxy stellar populations, their capability to produce ionizing photons, and their role in reionizing the intergalactic medium? I will review results from deep observations with ground- and space-based telescopes, highlighting recent advances from the final mission of the Spitzer Space Telescope and the Atacama Large Millimeter Array. Informed by these, I will look ahead as we prepare for the launch of the forthcoming James Webb Space Telescope.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 9:25 - 9:40

Daichi Kashino
(ETH Zurich)

Title: **Exploring the end tail of cosmic reionization with Subaru/HSC**

Abstract: Measurements of the effective optical depth (tau_eff) of the Lyman-alpha forest have established the increase in the average HI opacity of the IGM back to z~6, the end epoch of reionization. Interestingly, the observed dispersion in tau_eff increases dramatically at z>5.5 and very large opaque regions have been discovered even though the Universe was largely reionized by then. Two major scenarios have been proposed to reproduce the observed tau_eff distribution, which invoke large fluctuations either in the ionizing background or IGM temperature, and predict contradictory correlation between tau_eff and large-scale matter density. In order to distinguish these scenarios, we have been carrying out galaxy surveys in the redshift range 5.5<~z<~6.0 using Subaru/HSC in the fields where tau_eff measurements are available from z>6 quasar spectra. The wide-field imaging enables us to construct the galaxy density maps and correlate the galaxy surface density with the opacity measurement in each redshift slice and line of sight. In this presentation, we present our first results and discuss which scenario is preferred.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 9:40 - 9:55

Satoshi Yamanaka
(Waseda University)

Title: **CHORUS: Candidates of Lyman continuum galaxies at z=3.3 and 4.9 selected from CHORUS narrow-band data**

Abstract: We report the candidates of Lyman continuum galaxies (LCGs) at z=3.3 and 4.9 selected from the narrow-band images which are observed as a part of Cosmic HydrOgen Reionization Unveiled with Subaru (CHORUS; PI: A.K. Inoue) project. In order to understand the dominant sources of cosmic reionization, the fraction of ionizing photons (Lyman continuum; LyC) which escape from galaxies into the surrounding intergalactic medium is one of the most important physical quantities of star-forming galaxies. The wide area and deep narrow-band imaging survey with Subaru/Hyper Suprime-Cam is a powerful and efficient way to search for the high-z LCGs and to constrain the escape fraction of LyC. We investigate the LyC from the Lyman alpha emitter candidates at z=3.3 and 4.9 by using the unique narrow-band filters of Subaru/NB0387, NB0527, and NB0718. As a result, we find some possible candidates of LCGs at z=3.3 and 4.9. When the LyC from the LCGs at z=4.9 is confirmed, it is the highest-z LCGs so far. We show the details of our LCG candidates, and discuss the escape fraction and the possibility of the foreground contamination.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 9:55 - 10:10

Shotaro Kikuchihara
(University of Tokyo)

Title: **Early Low-Mass Galaxies and Star-Cluster Candidates at z~6-9**

Abstract: We present very faint dropout galaxies at z~6-9 with a stellar mass M* down to M*~10^6Mo that are found in the Hubble Frontier Fields (HFF) program in conjunction with the deep Spitzer images and lensing effects. We investigate stellar populations of the galaxies with the optical/NIR photometry and BEAGLE (stellar population synthesis + photoionization) models, identifying 357 galaxies with M*~10^6-10^9Mo. We derive the galaxy stellar mass functions (GSMFs) at z~6-9 that extend a stellar mass limit to M*~10^6Mo. Comparing M* of the galaxies with the effective radii R_e on the source plane, we have pinpointed two objects with low stellar masses (M*<=10^7Mo) and very compact morphologies (R_e<=40pc) that are comparable with those of globular clusters (GCs) in the Milky Way today. These objects are candidates of star clusters that should be a part or a dominant component of high-redshift low-mass galaxy, some of which may be related to GCs today. We discuss future spectroscopic observations for the high-redshift GC candidates with the Subaru Telescope.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"

Invited talk

11/19/2019, 10:25 - 10:50

Catlin Casey

(UT Austin)

Title: **Rare galaxies in the early Universe**

Abstract: I will present some of the difficulties and challenges in identifying some of the most rare galaxy populations -- like submillimeter luminous galaxies and luminous AGN -- beyond z>4. These galaxies represent the Universe's first massive galaxies, and likely sit at the nodes of the cosmic web, linking together dense filaments tracing out protocluster environments. Our techniques used to identify these galaxies has tremendous impact on how we interpret their importance.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 10:50 - 11:05

Ken-ichi Tadaki
(NAOJ)

Title: **A sub-kiloparsec-view of the most massive star-forming galaxies at z>4**

Abstract: Submillimeter galaxies at z>4 are the most likely progenitors of compact quiescent galaxies at z=1-3. They are building up their central cores through compact starbursts with an effective radius of 1-2 kpc. ALMA 0.08-arcsec resolution observations reveal off-center gas clumps in a submillimeter galaxy at z=4.3 as well as a rotation-dominated disk. Exploiting the kinematic properties and the spatial distribution of molecular gas mass surface density, we find that the starburst disk is gravitationally unstable, implying that the self-gravity of gas overcomes the internal pressure by stellar feedback. This result is consistent with a scenario that in-situ clumps are formed through disk instability. On the other hand, we find an evidence for an ex-situ clump that does not corotate with the starburst disk. The accretion of such a non-corotating clump could stimulate violent disk instability, driving gas inflows into the central regions of the galaxy. Our results suggest that compact cores are formed through an extreme starburst due to a gravitational instability, triggered by non-corotating clumps. New laser tomography AO experiments on Subaru (ULTIMATE-START) will provide high-resolution K-band images, which are essential for characterizing the stellar component of in-situ/ex-situ gas clumps at z=4.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 11:05 - 11:20

Seiji Fujimoto
(U. Waseda)

Title: **First Identification of 10-kpc Scale [CII] 158um Halos around Star-Forming Galaxies at z=5-7**

Abstract: We report the discovery of 10-kpc scale [CII] 158um halos surrounding star-forming galaxies in the early Universe. We choose deep ALMA data of 18 galaxies each with a star-formation rate of ~ 10-70 Msun with no signature of AGN whose [CII] lines are individually detected at z=5.153-7.142, and conduct stacking of the [CII] lines and dust-continuum in the uv-visibility plane. The radial profiles of the surface brightnesses show a 10-kpc scale [CII] halo at the 9.2sigma level significantly extended more than the HST stellar continuum data by a factor of ~5 on the exponential-profile scale length basis, as well as the dust continuum. We also compare the radial profiles of [CII] and Lya halos universally found in star-forming galaxies at this epoch, and find that the scale lengths agree within the 1sigma level. The existence of the extended [CII] halo is the evidence of outflow remnants in the early galaxies and suggest that the outflows may be dominated by cold-mode outflows, which challenges current galaxy evolution models.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 11:20 - 11:35

Ryota Kakuma
(The University of Tokyo, ICRR)

Title: **Cross-Correlation Lyα Intensity Mapping with Star-Forming Galaxies at z = 5.7 and 6.6**

Abstract: We present results of the cross-correlation Lya intensity mapping with Subaru/HSC ultra-deep narrowband images and LAEs at z=5.7 and 6.6 in a total area of 4 square degrees. Although overwhelming amount of data quality controls have been performed for the narrowband images and the LAE samples, we further conduct extensive analysis evaluating systematics. Removing the systematics, we carefully calculate cross-correlations between Lya intensity of the narrowband images and the LAEs.

We identify very diffuse Lya emission with the 3σ (2σ) significance at $>$ 150 ckpc far from the LAEs at z=5.7 (6.6), beyond a virial radius of star-forming galaxies with M_h ~ 10^11 M$\odot$. The diffuse Lya emission possibly extends up to 1,000 ckpc with the surface brightness of 10^−20−10^−19 erg s^−1 cm^−2 arcsec^−2. We confirm that the small-scale ($<$ 150 ckpc) Lya radial profiles of LAEs in our Lya intensity maps are consistent with those obtained by recent MUSE observations. Comparisons with numerical simulations suggest that the large-scale (~ 150−1,000 ckpc) Lya emission are not explained by unresolved faint sources of neighboring galaxies including satellites, but by a combination of Lya photons emitted from the central LAE and other unknown sources, such as a cold-gas stream and galactic outflow.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Invited talk
11/19/2019, 13:30 - 13:55

Taddy Kodama
(Astronomical Institute, Tohoku University)

Title: **Past 20 years of panoramic studies of distant clusters with Subaru and the Future**

Abstract: Since the first open-use science operation of Subaru in 2000, we have been targeting distant clusters of galaxies, taking the unique advantages of wide-field observation capabilities of Subaru both in optical and near-infrared.
Our original PISCES project mapped out large-scale structures in and around clusters at $0.4<z<1.3$ on 30Mpc co-moving scale. The next Mahalo-Subaru project has extended the survey back to $z=2.5$. Using narrow-band filters, we have been mapping star-forming line emitters in and around clusters and porto-clusters, and revealing the inside-out quenching of star formation activities from cluster cores to the surrounding regions as time progresses.
In the dense cores of a cluster at the cosmic noon ($z=2.5$), we see an enhancement of star forming activities, which are likely driven by ample gas that is supplied by massive gas inflow through the filamentary structures. It is consistent with strong Lya line attenuations with respect to the Ha emission lines as indicated by dual narrow-band imaging (Lya and Ha), and also with higher molecular gas mass fraction as observed with ALMA (Gracias-ALMA project). Together with other results in the literature, we argue that the gas accretion mode may be changed from the cold accretion mode accompanied by high star formation activity, to the hot mode where gas cooling and thus accretion to galaxies become inefficient, resulting in the quenching of the cluster cores.
We are now extending the Subaru cluster survey to even much larger areas with HSC by the project named HSC^2. By combining the red-sequence technique and the narrow-band imaging technique, we can construct more representative samples of galaxy clusters by mitigating the selection bias. We plan to follow-up those unique cluster samples with PFS, in order to characterize galaxy properties, and to investigate environmental effects and quenching histories over the cosmic times.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 13:55 - 14:10

Satoshi Kikuta
(Sokendai / NAOJ)

Title: **Lyman-alpha view around a z = 2.84 hyperluminous QSO at a node of the cosmic web**

Abstract: We report on the results of deep and wide-field (1.1 deg^2) narrow-band observations with HSC of a field around a hyperluminous QSO (HLQSO), HS1549+1919, residing in a protocluster at z = 2.84, to map the large-scale structure of Lyα emitters (LAEs). One HSC pointing enables us to detect 3490 LAEs and 76 extended Lyα blobs (LABs), probing diverse environments from voids to protoclusters. The HLQSO is found to be near the center of the protocluster, which corresponds to the intersection of ~100 comoving Mpc-scale structures of LAEs. LABs are basically distributed along the large-scale structure, with larger ones particularly clustering around the HLQSO, confirming a previously noted tendency of LABs to prefer denser environments. Moreover, the shapes of LABs near the HLQSO appear to be aligned with the large-scale structure. Finally, a deep Lyα image reveals a diffuse Lyα nebula along a filamentary structure with no luminous UV/sub-mm counterpart, which may be due to a cold filament with high clumping factor illuminated by the QSO, with the required high clumpiness provided by unresolved residing halos of mass $\leq 10^{9-10} M_\odot$. Dependence of Lyα halos of LAEs on photometric properties are also probed through stacking analysis.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 14:10 - 14:25

Michael Rich
(UCLA)

Title: **Extended Lyman Alpha Nebulae associated with Radio Overdensities at z~3**

Abstract: We have imaged the fields of radio source overdensities at z~3 and find 7 cases of extended Lyman alpha nebulae (LAN). We find that the LAN are extended on scales of >100 kpc. In one case, there appears to be three sites of emission adjacent to what appears to be emission associated with the galaxy cluster, which is consistent with models of cosmological cold flows. In contrast with LAN at z>4, we do not find clear sources of photoionization, such as a nearby QSO.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 14:25 - 14:40

Hideki Umehata
(RIKEN)

Title: **Gas filaments connecting galaxies and supermassive black holes in a proto-cluster**

Abstract: A generic prediction in a cold dark matter universe is the presence of a network of filaments within which galaxies form and evolve. However, the faintness of the emission from the intergalactic gas in these filaments had prevented us from testing this picture. We report the detection of Lyα radiation from multiple filaments connecting galaxies within a z=3.1 proto-cluster using VLT/MUSE and Subaru/Suprime-Cam. Together with spectroscopy using ALMA and Keck/MOSFIRE, intense star formation and supermassive black-hole activity is also found to occur within the galaxies embedded in this structure, which are the likely sources of the elevated ionizing radiation powering the observed Lyα emission. The network of filaments is believed to be responsible for powering star formation and black hole growth in one of the most active galaxy populations at z~3, in line with predictions of modern cosmological simulations.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 14:40 - 14:55

Andrew Newman
(Carnegie Observatories)

Title: **LATIS: Mapping the IGM and Galaxy Environments at z~2.5 with Magellan**

Abstract: I will introduce LATIS, the Lyman-alpha Tomography IMACS Survey, a 56-night project using the IMACS spectrograph at Magellan to produce the largest high-resolution three-dimensional maps of the intergalactic medium at z=2.2-2.8 to date. We are mapping the large-scale structure at ~1 pMpc resolution by observing the Lyman-alpha forest in deep spectra of ~3000 luminous Lyman-break galaxies. LATIS will ultimately cover a 1.7 deg^2 area, of which we have completed 0.6 deg^2 in the COSMOS and CFHT Legacy Survey fields. I will motivate the technique of Lyman-alpha tomography, introduce the design of the survey, and present our initial maps along with mock surveys performed in simulations. LATIS will provide environmental information for all galaxies within a 10^7 cMpc^3 volume using a technique that is independent of galaxy tracers and closely connected to the underlying matter density field. The LATIS data set will therefore be a powerful resource for studying environment-dependent galaxy evolution at cosmic noon, as well as a preview of larger tomography surveys that can be undertaken with PFS or the ELTs.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 15:30 - 15:45

Tomoko Suzuki
(Tohoku Univ./NAOJ)

Title: **Dissecting star-forming region within galaxies in a proto-cluster at z=2.53 with Subaru/IRCS+AO188**

Abstract: It still remains unclear if the structural growth of star-forming galaxies can differ depending on their surrounding environments. To trace how galaxies are building-up their structures, direct observations of on-going star formation within the galaxies are necessary. We conducted the Adaptive Optics (AO)-assisted imaging observations for star-forming galaxies in a dense proto-cluster core at z = 2.53 with Subaru/IRCS+AO188. We obtained the images of Halpha-emitting region as well as stellar continuum with an angular resolution of 0.2 arcsec by using the narrow-band filter. Based on the stacking analyses, we investigated the spatial extent of the star-forming region traced by Halpha and compared it to that of the stellar component. We found that the star-forming region is more extended than the stellar distribution for the massive star-forming galaxies (logM*>10), suggesting the inside-out growth of the structure. Our group has found a similar trend for star-forming galaxies at z~2-2.5 in general fields with the same observational technique. Our results suggest that the structural growth of star-forming galaxies at z~2-2.5 is dominated by the internal secular processes rather than the external processes irrespective to the surrounding environments.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 15:45 - 16:00

Tao Wang
(University of Tokyo)

Title: **Environmental effects on massive galaxy formation from the most distant X-ray clusters**

Abstract: The role of local environment in massive galaxy formation remains debated. While it has been known that massive ellipticals are preferentially located in dense environments, the early assembly of these galaxies makes it difficult to explore what is the role of environment during their formation/quenching. Here we combine multiwavelength observations with Subaru, VLT, VLA, and ALMA towards the most distant known X-ray cluster at z=2.51, to reveal a key formation phase of massive clusters, in which clear evidence of environmental dependence on galaxy star formation and gas properties has been observed. This provides direct evidence on the environmental dependence of massive galaxy formation at their peak formation epoch.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 16:00 - 16:15

Shigeru Namiki
(SOKENDAI)

Title: **The environmental impacts on the mass-metallicity relation at z=1.52.**

Abstract: We present the results of our near-infrared (NIR) spectroscopic observations of a rich cluster candidate around a radio galaxy at z = 1.52 (4C65.22) with Subaru/MOIRCS and LBT/LUCI. We observed 71 galaxies mostly on the star-forming main sequence selected by our previous broadband (photo-z) and narrow-band Hα imaging observation with Subaru in this cluster environment. We successfully confirmed the redshifts of 39 galaxies, and conclude that this is a gravitationally bound, real cluster at z = 1.517. Our spectroscopic data also suggest a hint of large-scale filaments or sheet-like three-dimensional structures crossing at the highest-density cluster core. By stacking the spectra to derive their average interstellar medium (ISM) gas-phase metallicity based on the [N II]/Hα emission line flux ratio, we find that the mass-metallicity relation (MZR) in the 4C65.22 cluster environment is consistent with that of Hα- selected field galaxies at similar redshifts. Our results suggest that the environmental impact on the MZR is small at high redshifts, but chemical evolution in the high-z cluster is still under debate and there is only less than ten cluster sample. We believe that PFS and ULTIMATE Subaru would enable us to perform the discussion with a large number of deep spectroscopic data.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 16:15 - 16:30

Masao Hayashi
(NAOJ)

Title: **Probing large-scale structures at z<1.6 by HSC wide-field survey**

Abstract: Subaru HSC is a powerful instrument to reveal the large-scale structures over several tens Mpc scale and its redshift evolution, which is essential to better understand the structure formation and evolution in Universe. We demonstrated that the already-known supercluster CL1604 at z~0.9 is a part of the more extended structures and thus the tip of the iceberg. A set of narrow-band (NB) filters also makes HSC unique. Using the HSC-SSP DR1 data, we revealed the large-scale structures of star-forming galaxies on about 50 comoving Mpc scale including galaxy clusters, filaments, and voids. Now, the NB data available from the HSC-SSP DR2 and CHORUS surveys allow us to expand our previous study in terms of denser redshift slices and wider/deeper survey than the DR1. We proceed to conduct follow-up spectroscopy of more than one thousand NB emitters using 2dF+AAOmega at AAT, and then confirm them at a high success rate. The combination of wide-field imaging and multi-fiber spectroscopy is a pilot study for the synergy of HSC and PFS. We will present a unique ability of HSC in revealing the large-scale structures at z<1.6 and then discuss how the galaxies have evolved along the structures by combining with the spectroscopic data.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 16:30 - 16:45

Mike Hudson
(University of Waterloo)

Title: **First weak lensing results from the UNION Survey**

Abstract: Gravitational lensing is a powerful method of mapping the distribution of matter around galaxies, clusters, voids and filaments in the cosmic web. I will review recent results from weak lensing surveys, including the first map of dark matter dominated filaments between galaxies in the cosmic web, and the link between galaxies and their host halos: dependence on redshift, stellar mass, colour, and galaxy size. Finally I will present the first weak lensing results from the Ultraviolet Near-Infrared Optical Northern Survey (UNIONS): a survey whose goal is 5000 square degrees of pan-chromatic data from CFHT, Pan-STARRS and Subaru.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/19/2019, 16:45 - 17:00

Takashi Kojima
(University of Tokyo)

Title: **Extremely Metal-poor Galaxies Probed with Subaru/HSC Deep Imaging and Optical Spectroscopy**

Abstract: Early-epoch galaxies are expected to have primordial characteristics such as very low metallicity (<10% Zsun), low stellar mass (10^6 Msun), and young stellar age (<30 Myr). Galaxies with such characteristics have been discovered in the local universe, which are called extremely metal-poor emission-line galaxies (EMPGs). EMPGs provide us a nearby laboratory helpful to understand the very early-phase of star formation.
In this study, we search for EMPGs in the local universe (z<0.02) from deep imaging data of Subaru/HSC-SSP as well as wide-field imaging data of SDSS. We have successfully selected ~70 EMPG candidates over a wide range of i=17–24 mag thanks to the combination of the HSC and SDSS data. Recently, we have identified 10 real EMPGs in our pilot optical spectroscopy with Keck/DEIMOS, Subaru/FOCAS, and Magellan/LDSS3+MagE. In this talk, we report results of the pilot spectroscopy and discovery of one of the most metal-deficit galaxies discovered ever (~2% Zsun). We discuss the existence of very hot star population in EMPGs suggested by high-ionization lines and elemental abundances.

“KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity”
Contribution poster
11/19/2019, 17:00 - 17:15

Tetsuya Hashimoto
(National Tsing Hua University)

Title: **A young galaxy cluster in the old Universe**

Abstract: "Galaxies evolve from a blue star-forming phase into red quiescent one by quenching their star-forming activity. In high density environments, this galaxy evolution proceeds earlier and more efficiently. Therefore, local galaxy clusters are dominated by well-evolved red, elliptical galaxies. Here we report a discovery of a "blue cluster", that is a local galaxy cluster with an unprecedentedly high fraction of blue star-forming galaxies yet hosted by a massive dark matter halo. The blue fraction is 0.57 that is 4.0 sigma higher than those of the other comparison clusters under the same selection and identification criteria. The velocity dispersion of the member galaxies is 510 km/s, which corresponds to a dark matter halo mass of $2.0^{+1.9}_{-1.0} \times 10^{14}$ Msun. The blue fraction of the cluster is more than 4.7 sigma beyond the standard theoretical predictions including semi-analytic models of galaxy formation. The probability to find such a high blue fraction is only 0.003%, which challenges the current standard frameworks of the galaxy formation and evolution in the Lambda CDM Universe. The galaxy distribution suggests the existence of filamentary cold gas streams in the massive halo even in the local Universe, which has already disappeared in the theoretically simulated local Universes. "

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Invited talk
11/21/2019, 9:00 - 9:25

Gwen Rudie
(Carnegie Observatories)

Title: **The Circumgalactic Medium of Star-Forming Galaxies at 2<z<3**

Abstract: The exchange of baryons between galaxies and their surrounding intergalactic medium (IGM) is a crucial but poorly-constrained aspect of galaxy formation and evolution. I will present results from the Keck Baryonic Structure Survey (KBSS), a unique spectroscopic survey designed to explore both the physical properties of high-redshift galaxies and the connection between these galaxies and their surrounding intergalactic baryons. The KBSS is optimized to trace the cosmic peak of star formation (z~2-3), combining high-resolution spectra of hyperluminous QSOs with densely-sampled galaxy redshift surveys surrounding each QSO sightline. I will present new detailed studies of metal-enriched absorbing gas in the high-z CGM, highlighting the gas kinematics and thermal properties and the diversity of physical conditions found close to galaxies. I will also present new measurements of the evolution of hydrogen and carbon-bearing gas within the CGM from z~2.3 to z~0.2 which exhibit surprising trends. Collectively, these data constrain the nature and sphere of influence of galaxy-scale outflows, intergalactic accretion, and their evolution as a function of time.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/21/2019, 9:25 - 9:40

Yuma Sugahara
(ICRR, UTokyo)

Title: **Fast Outflows Identified in Early Star-Forming Galaxies at z = 5–6**

Abstract: We present velocities of galactic-scale outflows in seven star-forming galaxies at z=5-6 with a stellar mass of M*~10^{10.1} Mo. We make use of the ALMA [CII]158 um emission lines and the deep Keck/DEIMOS spectra of the galaxies at z=5-6 available to date, to obtain the precise systemic velocities and metal absorption lines, respectively. We fit outflow-line profiles to the SiII1260, CII1335, and SiIV1394,1403 absorption lines in a composite Keck spectrum. The measured maximum outflow velocity at z~5-6 is vmax=810^{+140}_{-160} km/s on average, which is higher than those at z=0 by a factor of 3.5 and comparable to z=2, at M*~10^{10.1} Mo. Interestingly, vmax shows a clear positive correlation with vcir, the halo circular velocity estimated from the stellar masses, for galaxies with M*=10^{10.0-10.8} Mo over z=0-6 with ~0.1 dex scatters. This positive correlation suggests that the outflow velocity is physically related to the halo circular velocity. The redshift evolution of vmax at M*~10^{10.1} Mo is explained by the increase of vcir toward high redshift.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Invited talk
11/21/2019, 9:40 - 10:05

Annalisa Pillepich
(MPIA)

Title: **Universe(s) in a box: insights from the TNG simulations and needed steps forward**

Abstract: Contemporary cosmological hydrodynamical simulations are reaching unprecedented levels of sophistication and complexity. Numerical programs like IllustrisTNG are allowing us to model reasonably realistic populations of galaxies across an ever wider range of masses, environments, evolutionary stages and cosmic epochs. There we resolve and model the structural details of thousands of galaxies together with the large-scale cosmic web by solving the equations of gravity and magnetohydrodynamics and by including prescriptions for star formation, stellar evolution, metal enrichment, cooling and heating of the gas, galactic outflows and feedback from the supermassive black holes, all within the LCDM paradigm. In the talk, I will give examples of the insights and quantitative characterizations that the IllustrisTNG simulations, and particularly the new TNG50 run, are suggesting us about the evolution and interplay of all matter components within and around galaxies. I will also discuss some of the future steps that are required to further improve the theoretical modeling, to enhance the discovery potential of astronomy data, and to augment the sophistication and veracity of the comparison between observed and simulated data.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Invited talk
11/21/2019, 10:20 - 10:45

Camilla Pacifici
(STScI)

Title: **Synergy between galaxy models and observations to unveil the high-redshift Universe**

Abstract: In the past years, ground-based and space telescopes have given us inestimable information about the Universe we leave in. We can now study the physical properties of galaxies from the present day, up to 13 billion years ago. However, the interpretation of high-resolution data, both in terms of spatial and spectral resolution, is becoming very challenging or even impossible without proper tools and comprehensive models. With the help of existing data, we need to develop and test new approaches that will allow us to deal with the amount of information we will receive in the future.
I will present how we can generate libraries of galaxy spectra where all components are computed in a consistent manner, using detailed star formation and chemical enrichment histories from cosmological simulations, state-of-the-art spectral models including nebular emission, and different treatments for dust attenuation. With such model spectra, we can simultaneously interpret spectral features and broadband photometry, from large scales to small regions inside a galaxy.
I will show how this approach is being applied to current observations from photometric and spectroscopic surveys and how it will be used for future observations to derive constraints on the stellar, dust, and metal content of high-redshift galaxies.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/21/2019, 10:45 - 11:00

Ken Mawatari
(Institute for Cosmic Ray Research, University of Tokyo)

Title: **Balmer Break Galaxy candidates in the Reionization Epoch: Hint on Star-Formation Activity at z > 10**

Abstract: We report a new sample of high-z passive galaxy candidates in the COSMOS field. We photometrically identify three candidate galaxies with the strong Balmer breaks (Balmer Break Galaxies; BBGs) at $5 < z < 8$ down to [3.6] ~ 24mag in the 0.41 deg^2 effective area. Follow-up observations with the Atacama Large Millimeter/submillimeter Array (ALMA) reveal that they are not detected in their dust emission. Comprehensive template fitting analysis of the observed spectral energy distributions (SEDs) reveals that galaxies as massive as ~ 5 x 10^10 Msun in stellar mass dominated by old stars already exist at z ~ 6, although contamination from exotic AGNs or ultra-luminous LBGs at z ~ 20 cannot be completely ruled out. While these BBGs make a small contribution to the cosmic stellar mass density in the z ~ 6 Universe, their stars should be formed at much higher redshift, $z > 10$. We estimate star-formation rate density (SFRD) owed by the BBG progenitors. Our estimate supporting smooth SFRD evolution beyond z ~ 8 will serve as a guide for future surveys aiming at direct identification of first galaxies.

“KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity”
Contribution talk
11/21/2019, 11:00 - 11:15

Tomo Goto
(National Tsing Hua University)

Title: **Revealing cosmic star formation history and black hole accretion history with AKARI and the HSC**

Abstract: Understanding infrared (IR) luminosity is fundamental to understanding the cosmic star formation history and AGN evolution. In the AKARI NEP wide field, AKARI has obtained deep images in the mid-infrared (IR), covering 5.4 sq.deg. However, our previous work was limited to the central area of 0.25 sq.deg due to the lack of deep optical coverage. To rectify the situation, we used the newly advent Subaru telescope's Hyper Suprime-Cam to obtain deep optical images over the entire 5.4 sq.deg of the AKARI NEP wide field. With this deep and wide optical data, we, for the first time, can use the entire AKARI NEP wide data to construct restframe 8um, 12um, and total infrared (TIR) luminosity functions (LFs) at $0.15<z<2.2$. A continuous 9-band filter coverage in the mid-IR wavelength (2.4, 3.2, 4.1, 7, 9, 11, 15, 18, and 24um) by the AKARI satellite allowed us to estimate restframe 8um and 12um luminosities without using a large extrapolation based on a SED fit, which was the largest uncertainty in previous work. By combining the AKARI and HSC data, we report dust-hidden cosmic star formation history and AGN evolution from $z=0$ to $z=2.2$.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/21/2019, 11:15 - 11:30

Andrea Silva
(NAOJ)

Title: **The star formation properties of merging galaxies at 0.3<z<2.5**

Abstract: We present a study of the influence of galaxy mergers on star formation at 0.3 < z < 2.5. Major mergers are selected from the CANDELS/3D-HST catalog using a peak-finding algorithm. Mergers have projected galaxy nucleus separation of their members between 3 and 15 kpc. We compare the star formation activity in merging and nonmerging galaxies and find no significant differences. We find that only 12% of the galaxies in major mergers are starbursting. The low fraction of starbursting merging galaxies in this sample suggests that at galaxy nucleus separations of 3-15 kpc merging galaxies are still in an early stage and are yet to reach the maximum level of star formation activity. Furthermore, the level of star formation enhancement and its duration could be arguably reduced compared to local mergers, as shown by simulations of high-z mergers, and might also depend on the physical properties (such as stellar mass and gas fraction) of the merging galaxies.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/21/2019, 11:30 - 11:45

Erin Kado-Fong
(Princeton University)

Title: **Integrated Light Tidal Features Across the Mass Spectrum: Results from HSC-SSP**

Abstract: Observations of tidal features around external galaxies provide a window into the infall orbit, mass, and stellar populations of the satellite progenitors that form these extended features. Given its exquisite sensitivity, area, and seeing, HSC offers an unprecedented view of the low surface brightness universe that is complementary to deep, targeted observations of nearby galaxies. Building on previous work in which we developed a method to automatically detect tidal features around galaxies and generated one of the largest such samples to date (Kado-Fong et al. 2018), I will examine the formation mechanism of such tidal debris around massive galaxies as a function of the present-day morphology of the tidal feature system, and consider the correlation between the tidal feature morphology and the properties of its host galaxy. I will then present a sample of dwarf-dwarf mergers in the field, and examine the progression of star formation throughout the dwarf-dwarf merger sequence.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Invited talk
11/21/2019, 13:30 - 13:55

Sirio Belli
(MPE / CfA)

Title: **The Star Formation Histories of Massive Quiescent Galaxies at z~2**

Abstract: Why do massive galaxies stop forming stars at high redshift? The nature of this quenching process is one of the most important missing pieces in the puzzle of galaxy formation.
Using deep Keck spectroscopy of massive quiescent galaxies at z~2, we were able to infer the star formation histories and measure the stellar ages for these systems. We found that, in order to reproduce simultaneously the observed age distribution and the number density evolution of quiescent galaxies, both a fast (~100 Myr) and a slow (~1 Gyr) quenching channels are needed. These measurements offer new, powerful constraints on the physical mechanisms responsible for galaxy quenching.

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Contribution talk
11/21/2019, 13:55 - 14:10

Danilo Marchesini
(Tufts University)

Title: **A Complete and Unbiased Photometric View of Ultra-massive Galaxies in the First 2 Gyr of Cosmic History**

Abstract: One of the most controversial questions regarding the formation and evolution of galaxies is when and how today's most massive galaxies form. At z=0, elliptical galaxies with Mstar>1012Msun are known to exist. These galaxies host the largest SMBHs and often live in clusters as BCGs. But what are their progenitors at z>3? What are their properties? At what epoch do they assemble? Are they always found in over-dense environments or do they also form in isolation? How often do they host AGNs? Do they all become BCGs by the present day? One surprising initial finding is that the number density of ultra-massive galaxies (UMGs; Mstar>3x10^11 Msun) evolves very little between z=4 to z=1.5. The formation of these massive galaxies so early in the Universe's history puts very tight constraints on models of galaxy formation and evolution. I will present the characterization of the stellar population properties, number density, AGN incidence, and environments of the largest sample, to-date, of UMGs at z>3 constructed from state-of-the-art photometric catalogs over ~8 deg^2 in XMM and CDFS. This sample (~60 UMGs; K<23.5 AB) is the first representative stellar-mass complete sample of UMGs in the first 2 Gyr of cosmic history, including both quiescent and dusty star-forming galaxies.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/21/2019, 14:10 - 14:25

Masayuki Tanaka
(NAOJ)

Title: **Stellar velocity dispersion of a massive galaxy with suppressed star formation at z=4.01**

Abstract: We present a measurement of stellar velocity dispersion of the most distant, massive quiescent galaxy spectroscopically confirmed to date. Using deep multiwavelength data in UDS, we have constructed a photometric sample of massive (~10^11 Msun) galaxies with suppressed star formation rates at z~4. We carried out a spectroscopic follow-up observation of the brightest galaxy in the sample with Keck/MOSFIRE. The 7 hour MOSFIRE spectrum reveals 4 prominent Balmer lines and we confirmed the galaxy at z=4.01. This is the most distant galaxy with suppressed star formation rate confirmed to date. Thanks to the high S/N of the spectrum, we successfully measured its stellar velocity dispersion, sigma_* = 288 +- 61 km/s. This is consistent with the velocity dispersion of nearby massive galaxies, which indicates that the stellar velocity dispersion does not evolve significantly since z=4. Using the physical size of this galaxy measured from the deep HSC data, which is consistent with the typical size of massive quiescent galaxies at z~4 in the rest-frame optical from Kubo et al. (2018), we find that the stellar mass inferred from photometry is consistent with the dynamical mass, which excludes exotic IMF models. We discuss future prospects for JWST.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/21/2019, 14:25 - 14:40

Francesco Valentino
(Cosmic Dawn Center - Niels Bohr Institute)

Title: **Quiescent galaxies at z~4: formation and evolution**

Abstract: We present our spectroscopic study of quenching/quiescent galaxies at z~4, resulted in the detection of 3 systems with Keck/MOSFIRE and VLT/X-Shooter. The absence of nebular emission lines and far-infrared detections confirms a suppressed star formation. From the joint modeling of the spectrum and the SED, we derive stellar masses of log(M⋆/Msun)~11, placing these galaxies >1-2 dex below the main sequence. Such modeling suggests that these sources experienced a strong (SFR~1200-1600 Msun/yr) and short (~50-150 Myr) burst of star formation in their past, properties reminiscent of the population of sub-mm galaxies (SMGs) generally indicated as candidate progenitors. We thus compare the comoving number densities and the expected properties of the progenitors with observations of z>4 SMGs, finding a fair agreement with the deepest surveys detecting not only the most extreme starbursts, but also more normal galaxies. Exploring the Illustris-TNG simulation, we do retrieve populations of quiescent galaxies at z~3-4 and SMGs at z~4-5, with number densities and properties in rough agreement with the observations at z~3, but in increasing tension at higher redshift. We find that not all the progenitors of z~4 quiescent galaxies shine as bright SMGs in their past and, conversely, not all bright SMGs quench by z~3.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution talk
11/21/2019, 14:40 - 14:55

Kate Whitaker
(UConn)

Title: **The REQUIEM Survey: REsolving QUIEscent Magnified Galaxies**

Abstract: Understanding the formation and quenching of massive quiescent galaxies at cosmic noon (z~2) remains a major problem in galaxy formation theory. While clues to their formation will be imprinted on the stellar populations in their inner cores, such analyses are beyond the capabilities of current technology. Here, we present some preliminary results from a unique upcoming survey leveraging the Hubble Space Telescope WFC3/G141 grism spectroscopy and ALMA dust continuum imaging of a unique sample of gravitationally lensed massive quiescent galaxies from z=1.5 to 3. The boost in spatial resolution and signal that strong gravitational lensing affords gives us the rare opportunity to perform spatially resolved age measurements at 0.5 kpc resolution and improved sensitivity to measure their gas content.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Invited talk
11/21/2019, 15:30 - 15:55

Takahiro Morishita
(STScI)

Title: **Probing evolution and quenching histories of massive galaxies at high redshift**

Abstract: Formation histories of early-type galaxies have been a long-standing question. The main conclusion from previous studies of local fossil records is that many of them have completed their star formation activity by z ~ 2. Recent findings of quenched galaxies at high redshift independently support this. Their formation histories at earlier times, and the primary driver for quenching, are still unclear.
In this talk, I will first present our latest work on massive, quenched galaxies at z ~ 2. Our new SED modeling, in combination with legacy HST spectroscopic + photometric data, reveals evolution histories of these galaxies with no functional assumption on the form of their star formation histories. Based on the results, I will discuss possible problems in SED modeling concerned with assumptions in star formation histories.
I will then present future plans with JWST/NIRSPEC and NIRISS. High-sensitivity/spectral resolution data at 1–5 μ m wavelength will push the current limit to higher redshifts, and possibly provide clues to the formation and death of the first generation of massive galaxies. I will highlight aspects that will be, and will not be, revealed by JWST, the latter of which has to wait for the advent of 30 m-class telescopes.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Invited talk
11/21/2019, 15:55 - 16:20

David Sanders
(University of Hawaii, Institute for Astronomy)

Title: **The Hawaii Two-0 Survey: The Evolution of Massive Galaxies at $3 < z < 7$**

Abstract: The Hawaii 20 sq.deg. Deep Survey (H20) of the North Ecliptic Pole (NEP) and Chandra Deep Field South (CDFS) - the 2 major calibration fields for Euclid and WFIRST - is combining nearly 6000 Hrs. of "warm-Spitzer" imaging and 40 nights of Subaru-HSC imaging and Keck-DEIMOS spectroscopy to provide the first definitive constraints on the evolution of the massive galaxies, $\log(M^*/M_{sun}) > 10.5$, at $3 < z < 7$, estimates of their dark matter halos via clustering measurements, and identification of rare "Rosetta stone" objects that may be re-ionizing the universe at $z > 7$. I will review current state-of-the-art measurements of the galaxy mass function at $z > 3$, and show the improvements that will result from the Hawaii Two-0 Survey.

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Contribution talk
11/21/2019, 16:20 - 16:35

Po-Feng Wu
(Max Planck Institute for Astronomy)

Title: **Multiple paths from star-forming to quiescence: tracing galaxy formation with deep spectroscopic survey**

Abstract: The stellar populations record the trajectories of formation of galaxies. The LEGA-C spectroscopic survey dedicates 100 nights with VLT/VIMOS in obtaining high S/N continuum spectra of high-redshift galaxies. For the first time, we can access information on the stellar populations of $z>0.5$ galaxies for a representative sample. I will show the variety of formation histories as inferred from the spectra of over 1,000 galaxies at $z\sim1$. Together with the high-resolution images taken by the Hubble Space Telescope, I will demonstrate that galaxies follow multiple pathways evolving from star-forming to quiescent. On one hand, we see evidence for a process that slowly shuts off star formation and transforms star-forming galaxies to quiescent galaxies without necessarily changing their structures. On the other hand, there is likely another mechanism that rapidly quenches galaxies, an event that coincides with dramatic structural evolution. This complex behavior can only be revealed by a large sample of galaxies with high-quality spectra. Future multi-object spectrographs with high multiplicity on large telescopes will open up new opportunities in extra-galactic archeology.

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Contribution talk
11/21/2019, 16:35 - 16:50

Pieter Van Dokkum
(Yale University)

Title: **The sizes of massive galaxies in COSMOS-DASH**

Abstract: Wide area surveys of the distant Universe have been hampered by the lack of high resolution imaging in the near-infrared. To address this, we have executed COSMOS-DASH, a 0.6 square degree survey in the COSMOS field with the WFC3/IR camera on HST. This was possible thanks to an innovative technique that increased the near-IR mapping speed of Hubble by a factor of 8. We measured the size-mass relation of massive galaxies with these data, finding that the relation is not a powerlaw but shows an upturn at high masses. Furthermore, we find that the size-mass relation has the same form as the stellar mass-halo mass relation, for a simple conversion between the virial radius and r_80, the radius containing 80% of the light. The talk will also discuss prospects for improving size and total luminosity measurements of galaxies using low surface brightness-optimized telescopes, and the synergy between wide field optical and near-IR surveys from space and the ground.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution poster
Poster ID: P35

Shiro Mukae
(Univ. Tokyo)

Title: **HETDEX-HSC: Wide-Field Imaging Survey for Hobby-Eberly Telescope Dark Energy Experiment**

Abstract: We present our wide-field HSC survey for an emission line survey of Hobby-Eberly Telescope Dark Energy Experiment (HETDEX). We carry out the deep r-band imaging (10 σ depth of r = 25.1) over the ~ 300 deg2 field where HETDEX now conducts a blind survey to identify one million LAEs at z = 1.9-3.5 with the ~35,000 fiber-fed IFU instrument, VIRUS on the 10m Hobby-Eberly Telescope. Our imaging data is essential to the HETDEX survey for distinguishing high-z LAEs and low-z [OII] emitters by the equivalent width discrimination and machine learning techniques. In the conference, we will discuss the synergy between HSC and HETDEX along with the progress of the HETDEX survey.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution poster
Poster ID: P36

Akio Inoue
(Waseda University)

Title: **CHORUS: Cosmic HydrOgen Reionization Unveiled with Subaru**

Abstract: I will present an overview of the CHORUS project, a Subaru intensive program. This is a deep multiple narrowband imaging survey in the COSMOS field. The observations are already completed last year and I will present the latest status of the data analyses as well as some initial science results including LyA luminosity functions at z=2--7 and Lyman continuum galaxy candidates at z=3--5.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution poster
Poster ID: P37

Kazuyuki Ogura
(Bunkyo University)

Title: **Semi-analytic examination for the cosmic variance on the H-alpha emitter distribution**

Abstract: The New Numerical Galaxy Catalog (nu^2GC) is a semi-analytic model for the galaxy formation, which is successful to reproduce various statistical properties of galaxies at 0<z<6 by combining the state-of-the-art N-body simulation and phenomenological model. A remarkable aspect of the nu^2GC is a large comoving volume up to ~1 Gpc^3 with sufficient mass resolution, which enables us to examine various properties of galaxies obtained by wide field surveys such as the Subaru Strategic Program survey with Hyper Suprime-Cam (HSC-SSP).

As a pilot study, we construct a model of H-alpha emitters (HAEs) with nu^2GC, resulting that it well reproduces H-alpha luminosity function (LF) at z=0.4 obtained by HSC-SSP observations. Based on the model, we have found that (1) HAEs are good tracer for the structure such as cosmic filaments, (2) the H-alpha luminosity function within ~2 deg^2 area show significant field variance up to ~1dex, and (3) >15 deg^2 surveys are required to converge the luminosity function.

We present the current status of our HAE model and future prospects of the model for comparing it with the PFS wide field survey.

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Contribution poster
Poster ID: P38

Yongming Liang
(SOKENDAI / NAOJ)

Title: **Correlation between galaxy and IGM at z~2.2 based on Subaru/HSC MAMMOTH overdensities and SDSS/(e)BOSS quasar spectra**

Abstract: The correlation on distribution between HI in the intergalactic medium (IGM) and galaxies now attracts great interests. In the MAMMOTH project, Cai+2016 found that Coherently Strong Lyman-alpha Absorption Systems (CoSLAs) can be ideal tracers for massive overdensities. We performed deep narrowband imaging using the Hyper Suprime-Cam (HSC) on the 8.2-m Subaru Telescope to probe Lyman Alpha Emitters (LAEs) at z~2.2 in the fields traced by such extreme groups of HI absorbers. The CoSLAs are selected from quasar spectra of the complete SDSS/(e)BOSS database covering over 10,000 deg^2, equivalent to a survey volume of ~1 cGpc^3, which is one order of magnitude larger than current z>2 galaxy surveys. Here we show our results that massive large scale structures are found in the four observed HSC fields. We also find a hint of the direct positive correlation between our LAE overdensity sample and the optical depth of Lyman-alpha absorption in (e)BOSS background quasar spectra, which is also supported by a cross-correlation analysis for the distribution of LAEs and LoSs with low/high optical depth subsamples. Such results help us to constrain the different mass assembly history for galaxies and neutral intergalactic gas during the epoch of Cosmic Noon.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution poster
Poster ID: P39

Masanori Iye
(NAOJ)

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.

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Contribution poster
Poster ID: P40

Hisanori Furusawa
(NAOJ)

Title: **A study of bright star-forming galaxies at redshift 7 using Subaru Telescope**

Abstract: We present a campaign of searching for bright star-forming galaxies at redshift 7 using Subaru Telescope. Our previous intensive program perform z-band deep integration (z>~26.5) with Suprime-Cam on two fields (COSMOS and SXDS) , and find 18 candidates of UV-bright Lyman-break galaxies (MUV<-21.75), combined with the public NIR data (UltraVISTA and UKIDSS/UDS).
Followup spectroscopy with FOCAS reveals a LyA emitter (LAE) at z=7.168 with small rest-frame EW (3.7A). We estimate a fraction of bright LAEs with large EW is less than 0.23 at z~7. This implies that a growth of the LAE fraction possibly levels off and even falls between z=6 and 7. LAEs with strong LyA may be more common in bright galaxies than in fainter ones.
The Hyper Suprime-Cam (HSC) survey allows to extend the survey volume. We perform a bright LAE search at z~7 using HSC-SSP data. From S16A NB0921 detection, we select 48 bright LAE candidates (NB921<~24), and 10 LAEs are spectroscopically confirmed. We further conduct MOIRCS NIR spectroscopy on two LAEs that show very large EW (>200A). No significant evidence of a large AGN contribution or Pop III components has been detected in the NIR spectra.
We will report the sample and project status.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution poster
Poster ID: P41

Nozomu Tamada
(Ehime University)

Title: **Hunting optical counterparts of high-z DLAs with Subaru/HSC**

Abstract: It is important to understand the total picture of the galaxy evolution, but galaxies in the early phase of their evolution is not well understood because their gas fraction is so high that their stellar emission is very faint generally. In this study, we focus on the Damped Lyman-alpha Absorption (DLA) system (quasar absorption-line system with log N_HI >= 20.3 cm-2). Though high-z DLAs are interesting objects to assess the early phase of the galaxy evolution, only a small number of optical DLA counterparts at z>2 have been identified so far (<20). Thus statistical properties of optical counterparts of high-z DLAs are not fully understood.
In this study, we used optical data taken through the Subaru HSC-SSP survey for identifying optical counterparts of high-z DLAs (z>2). Specifically, we selected photometric candidates of galaxies at $2 < z < 3$ using our dedicated color-selection criteria, and investigated the average number count of those galaxies around high-z DLAs. As a result, we found that the number density of z=2-3 galaxies at 2-3 arcsec from DLAs shows a significant number excess (~27%) with respect to that in comparison fields.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution poster
Poster ID: P42

Yasunori Terao
(University of Tokyo)

Title: **H alpha emitters at z~2.1－2.5: selection from broad-band photometry**

Abstract: Investigating properties of star forming galaxies (SFGs) over cosmic time is essential to understand galaxy evolution. Therefore various narrow-band (NB) surveys have been conducted targeting the H alpha emission line from high-z SFGs. However, NB surveys need large survey areas to construct large samples due to narrow redshift windows. In this presentation, we introduce our method to derive the H alpha fluxes of galaxies at z~2.1－2.5 from broad-band data using ZFOURGE multi-band catalog. We have performed SED fitting with emission lines to accurately estimate stellar continuum fluxes and identified ~2000 H alpha emitters by excesses from the continuum in the Ks-band. Their luminosity function shows an excess in the bright-end compared to the result of a NB survey (HiZELS; Sobral et al. 2013), which can be mostly explained by the fact that more massive galaxies have larger H alpha sizes. Regardless of the excess, an increase in derived cosmic star formation rate density is small and still consistent with previous results. We will also discuss the application of our method to different lines such as [OIII] and how our analysis is improved by wide-field surveys with medium-band filters, like SWIMS-18.

“KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity”
Contribution poster
Poster ID: P43

Naoaki Yamamoto
(Tohoku University)

Title: **Various evolutionary stages of galaxy clusters at high redshifts**

Abstract: It is important to study the properties of the galaxies and their environmental dependence at high redshift. However there are not so many statical studies of high-z clusters because high-z galaxy clusters are rare and member galaxies are very faint. Then we used HSC-SSP data which have larger field of view and deeper than previous surveys and we tried to construct a large sample of galaxy clusters at z = 0.5~1.2. We carried out two surveys. At first, we conducted “Blue cloud survey”, in which we found over-density regions of star-formation galaxies by using narrow band filter to capture [O II] or [OIII] emission. Secondary, we conducted ""Red sequence survey”, in which we found over-density regions of red sequence galaxies by using broad band filter. We named these two survey as ""HSC-HSC , which stands for Hybrid Search for Clusters with HSC. We found a lot of galaxy cluster candidates. Especially in "Blue cloud survey", the candidates dominated by emission line galaxies were found. We studied properties of these cluster candidates by using color-magnitude diagram, luminosity function and so on. We confirmed "down sizing". Our results suggest that they may be corresponding to a younger stage of galaxy cluster formation.

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Contribution poster
Poster ID: P44

Makoto Ando
(The University of Tokyo)

Title: **Exploring Galaxy Proto-Cluster Cores at z~2**

Abstract: Many properties of galaxies depend on the environment they are located in. Galaxy clusters are the densest regions in the universe, and their member galaxies are known to have different properties from field galaxies at least at z<1: a more top-heavy stellar mass function (SMF), a higher passive fraction, etc. To reveal when and how such differences arise, their progenitors called proto-clusters should be researched. A proto-cluster is split into a number of dark matter halos (DMHs) and an unbound region. In this study, among those structures, we focus on the most massive DMH, or a proto-cluster "core", where environmental dependence is likely to be strongest. We search for such cores at cosmic noon with expected halo masses of >~ 10^13 Msun. Using the COSMOS2015 galaxy catalog by Laigle+16, we identify more than 100 core candidates at z~2. Clustering analysis shows that these candidates are indeed hosted by DMHs with the targeted mass range. We find that core member galaxies have a more top-heavy SMF and a higher passive fraction than field galaxies, indicating that differences in these properties seen in local clusters have already appeared in cores at z~2.

"KAIA•HÖ•KÜ: Towards Understanding the origin of the Complexity and Diversity"
Contribution poster
Poster ID: P45

Umi Kobayash
(NAOJ/SOKENDAI)

Title: **Influence of galaxy mergers on AGN activities**

Abstract: In the cold dark matter model, galaxy interactions and mergers are one of the primary mode of galaxy growth. We occasionally observe active galactic nuclei (AGNs) at the center of galaxies, and one may expect that galaxy interactions drive the gas inflow to the center and trigger the AGN activity. However,previous work does not seem to show a clear connection between galaxy interactions and AGNs. We tackle this issue using high quality data from the HSC survey. Our sample is constructed from SDSS DR14 within a redshift range of $0.01 \leqq z \leqq 0.2$. A test sample consists of several thousand galaxies. We visually classified the galaxies using the HSC images, which have a much higher quality than, e.g., SDSS, and identified galaxies with irregular/disturbed morphologies. After that, we adopted Convolution Neural Network (CNN) using above galaxies as the training sample to improve our statistics. In our poster, we discuss the differences in AGN fraction, color distribution, and environment between merger and non-merger galaxies with respect to each of the two methods, visual classification and CNN

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Contribution poster
Poster ID: P56

Sadman Ali
(Subaru Telescope)

Title: **Characteristics and evolution of the UV upturn phenomenon in cluster early-type galaxies**

Abstract: The UV upturn is a rise in the spectra of early-type galaxies (ETGs) below 2500Å. Both theoretical considerations and observational evidence point towards hot horizontal branch (HB) stars being the main source of the UV output in old ETGs, while the optical part of their spectra is dominated by MS and RGB stars.
By combining GALEX and UVOT data below 3000Å, we generated for the first time comparatively detailed UV SEDs for Coma cluster ETGs. Fitting these SEDs with a two-component SSP+blackbody models show a range of temperatures between 10000 – 21000K for the UV upturn population, and the strength of the upturn is found to be roughly correlated with galaxy mass. We also find the UV-optical colours of Coma red sequence galaxies to be identical to those of Fornax, Perseus and 20 other low redshift clusters ($z<0.1$) from the 2dF survey, which strongly indicates that the upturn is a ubiquitous feature in all cluster early-type galaxies at low redshift. Furthermore, the upturn strength is found to be completely independent of the cluster environment in which the galaxies reside. We then extended the study of the upturn in cluster red sequence galaxies at $z = 0.2, 0.3, 0.55$ & 0.7 using their UV-optical colours – in each case probing beyond the L* point. From this analysis, the incidence and strength of the upturn is found to remain constant from $z = 0$ to 0.55, but this strength is significantly diminished in the $z = 0.7$ cluster, implying that the stellar population responsible for the upturn in a typical red sequence galaxy is only just developing at this redshift and is essentially fully-developed by ~1-2 Gyrs later. This evolutionary behaviour is most consistent with Helium-enhancement being the key driver of the hot HB stars. By comparing our results with the predictions made by the YEPS Helium-enhanced spectrophotometic models, we find that a solar metallicity hot HB sub-population that displays a consistent upturn between $0 < z < 0.55$ but then fades by $z = 0.7$ would require a Helium abundance of $Y \geq 0.45$, if formed at $zf = 4$. This also plausibly sets a lower limit of 1010Msun to the in situ stellar mass of L* galaxies at this redshift.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Invited talk
11/19/2019, 9:00 - 9:35

Michael Rich
(UCLA)

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 mult-modal abundance distributions at $|b|<6$ deg, with indications of bimdality 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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 9:35 - 9:55

Noriyuki Matsunaga
(The University of Tokyo)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 9:55 - 10:15

Daisuke Suzuki
(ISAS / JAXA)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 10:15 - 10:35

Wenbo Wu
(National Astronomical Observatories, CAS)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 11:00 - 11:20

Haining Li
(National Astronomical Observatories, CAS)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 11:20 - 11:40

Wako Aoki
(National Astronomical Observatory of Japan)

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 nucleosyntheis 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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 11:40 - 12:00

Tadafumi Matsuno
(NAOJ/SOKENDAI)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 13:30 - 13:50

Miho N. Ishigaki
(Tohoku University)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 13:50 - 14:10

Takanobu Kirihara
(Chiba University)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Invited talk
11/19/2019, 14:10 - 14:45

Kim Venn
(University of Victoria)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 14:45 - 15:05

Evan Kirby
(Caltech)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 15:35 - 15:55

Kohei Hayashi
(ICRR, The University of Tokyo)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Invited talk
11/19/2019, 16:10 - 16:45

Masashi Chiba
(Tohoku University)

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).

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/19/2019, 16:45 - 17:05

Rosemary Wyse
(Johns Hopkins University)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 9:00 - 9:20

Yutaka Komiyama
(NAOJ)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Invited talk
11/21/2019, 9:20 - 9:55

Karoline Gilbert
(Space Telescope Science Institute)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 9:55 - 10:15

Ivanna Escala
(Caltech)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 10:45 - 11:05

Jennifer Wojno
(Johns Hopkins University)

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 Å-1), we propose a method to derive [Fe/H] and [α/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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 11:05 - 11:25

Masayuki Tanaka
(NAOJ)

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 sattelite problem: more than an order of magnitude shortage of the observed number of dwarf sattelite 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~-9.5mag. 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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Invited talk
11/21/2019, 11:25 - 12:00

Eric Peng
(Peking University)

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~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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 13:30 - 13:50

Jin Koda
(Stony Brook University)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Invited talk
11/21/2019, 13:50 - 14:25

Laura Ferrarese
(National Research Council of Canada)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 14:25 - 14:45

Aaron Romanowsky
(San Jose State University / University of California Observatories)

Title: **Chemodynamics and dark matter in galaxies beyond the Local Group**

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 14:45 - 15:05

Zehao Zhong
(National Astronomical Observatories, Chinese Academy of Sciences)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 15:35 - 15:55

Raja GuhaThakurta
(University of California Santa Cruz)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Invited talk
11/21/2019, 15:55 - 16:30

Brent Tully
(University of Hawaii)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 16:30 - 16:50

Nobuo Arimoto
(National Astronomical Observatory of Japan)

Title: **An HSC View of M81 Group of Galaxies**

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 16:50 - 17:10

Shany Danieli
(Yale University)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution talk
11/21/2019, 17:10 - 17:30

Scott Carlsten
(Princeton University)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution poster
Poster ID: P46

Kumiko Morihana
(Nagoya University)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution poster
Poster ID: P47

Kana Morokuma
(The University of Tokyo)

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).

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution poster
Poster ID: P48

Rie Miura, E.
(NAOJ)

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.

"Wide-field-surveys of the Local Group and Nearby Galaxies"
Contribution poster
Poster ID: P49

Ichi Tanaka
(Subaru Telescope)

Title: **A Hidden Past of NGC 720 as Revealed from the Deep HSC Imaging**

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.

"Progress and Perspective of Solar System Science using Subaru"
Invited talk
11/21/2019, 13:30 - 14:00

Fumi Yoshida
(Planetary Exploration Research Center, Chiba Institute of Technology)

Title: **Solar System sciences with Subaru telescope**

Abstract: We will review the achievement in the solar system conducted with the Subaru Telescope. We will discuss what has been achieved as well as what should be achieved in the future.

"Progress and Perspective of Solar System Science using Subaru"
Invited talk
11/21/2019, 14:00 - 14:30

Hideyo Kawakita
(Kyoto Sangyo University Koyama Astronomical Observatory)

Title: **Cometary Science from the Subaru Telescope**

Abstract: The Subaru Telescope has been used for the observations of comets in these 20 years. Not only HDS but also IRCS and other instruments have been used for achieving various scientific goals. Here we concentrate on the high-resolution spectroscopic observations in optical and near-infrared wavelength regions.

Nuclear spin isomers (ortho and para) ratio of ammonia in comet has been derived at the first time in comet C/1999 S4 (LINEAR) in 2000. The ratio could be used to infer the formation conditions of cometary molecules. Many comets have been observed to derive the ortho-to-para ratio of ammonia in comet until now. We summarize our survey for OPR of cometary ammonia in collaboration with VLT/UVES and discuss about their meaning based on recent laboratory studies. The survey for isotropic ratio of nitrogen (14N/15N) in cometary ammonia is also conducted in collaboration with VLT/UVES since 2014. We also report the latest results and discuss about the relationship between solar system materials and the interstellar matters. Finally, we also present some other results in cometary science, derived from the Subaru Telescope.

"Progress and Perspective of Solar System Science using Subaru"
Invited talk
11/21/2019, 14:30 - 15:00

Takafumi Otsubo
(ISAS/JAXA)

Title: **Mid-infrared observations and mineralogy of comet dust grains with Subaru/COMICS**

Abstract: A silicate feature is often observed in comet spectra as a 10-μm resonant feature. In most cases, the feature shows the existence of crystalline silicates together with amorphous silicates. Since the crystalline silicate grains generally require high processing temperatures above 800K, it is believed that they formed in the warm inner regions, and there should have been radial transportation of the materials in the proto-solar disk. Comets are believed to be the remnant of the planetesimals swept away by the giant planet migration, and dust grains in comets preserve the information on the physical condition around the giant planet formation region in the early solar nebula.
From this point of view, we have made efforts to increase mid-infrared observational samples of comets with Subaru+COMICS, mainly for studying the crystalline fraction in silicate grains, which may be a clue to the efficiency of the radial transportation and the birthplace of the individual comets. In this talk, we summarize the COMICS observations of about 20 comets. We will show the results of comet dust properties, including size distribution, mineralogy, and the crystalline fraction in silicate grains, and discuss the differences between two dynamical groups: Oort cloud comets and Jupiter-family comets.

"Progress and Perspective of Solar System Science using Subaru"
Invited talk
11/21/2019, 15:30 - 16:00

JJ Kavelaars
(National Research Council of Canada)

Title: **Observing the distant solar system with Subaru and the New Horizons spacecraft.**

Abstract: On 1-January-2019 the New Horizons spacecraft had an historic and flawless encounter with the outer solar system object 2014 MU69. This encounter was achieved by bringing together preparatory observations from telescopes around the world and in space. First with efforts to discover a target that New Horizons could reach for a close encounter and then the intensive effort to determine the orbit and physical characteristics of the encounter target. Along the way many new TNOs, not encounterable but observable from New Horizons, were discovered and tracked, enabling the first ever measurement of large phase-angle observations of these members of the distant solar system. The discovery of many of these distant KBOs was achieved using the Subaru SuprimeCam and HyperSuprimeCam. New Horizons observations, of both the close encounter target 2014 MU69 and the more distantly observed KBOs, are transforming our understanding of the primordial solar system and the physics at work during planetesimal formation.

I will review the road that led to the discovery and tracking of these distant Kuiper belt objects and the transformative information that their observation from New Horizons is revealing. In particular I will focus on knowledge gained from the comparison between the phase functions of the different distant KBOs that have been observed and on the cratering frequency observed on the surface of 2014 MU69.

"Progress and Perspective of Solar System Science using Subaru"
Invited talk
11/21/2019, 16:00 - 16:30

Glenn Orton
(Jet Propulsion Laboratory, California Institute of Technology)

Title: **Ground-Based Thermal-Infrared Investigations of Planetary Atmospheres**

Abstract: Insightful investigations of planetary atmospheres have been made by a combination of instruments on interplanetary spacecraft, spaceborne Earth-proximal instruments and ground-based telescopes. This presentation will concentrate on spatially resolved thermal-infrared observations from ground-based observatories, among which the Subaru COMICS instrument has provided outstanding contributions. These observations map the temperature, cloud and compositional fields across planetary atmospheres that is a unique capability of the 5-25 μm spectral region. Both by themselves and in conjunction with interplanetary spacecraft data, they have yielded unexpected insights into atmospheric processes, both internal and in response to external forces, including impacts by both icy and rocky bodies. Ground-based observations determined that the Galileo probe descended into a very anomalous region of Jupiter, forming one of the motivations for the current Juno mission. Other investigations include verification and expansion of results from the Cassini mission showing the effects of a spectacular storm reaching into Saturn's stratosphere. Long-term studies have revealed long-term non-seasonal quasi-periodic structure in both Jupiter and Saturn. One current challenge is the determination of long-term trends in the atmospheres of Uranus and Neptune in preparation for JWST observations and future missions to these icy giants.

"Progress and Perspective of Solar System Science using Subaru"
Invited talk
11/21/2019, 16:30 - 17:00

Ruobing Dong
(University of Victoria)

Title: **Observing the Formation of Solar System Planet Analogs**

Abstract: Planets form in gaseous protoplanetary disks surrounding newborn stars. As they form, they gravitationally perturb the disk, and produce structures. A fleet of new instruments with unprecedented resolving power, such as Subaru/HiCIAO/SCExAO and ALMA, have come online in the past decade. They have discovered rich structures in disks, such as gaps and spiral arms, which are most likely associated with embedded (unseen) planets. By comparing observations with theoretical models of planet-disk interactions, the properties of the still forming planets may be constrained. Such studies help us understand how planets form. Specifically, some of the structures produced by the formation of solar system planet analogs in nearby protoplanetary disks are already detectable using current instruments, and some more will become detectable in the next decade. By searching for and observing those structures, we will be able to witness and study the birth of solar system analogs.

"Progress and Perspective of Solar System Science using Subaru"
Invited talk
11/22/2019, 9:00 - 9:30

Rosemary Pike
(ASIAA)

Title: **Mapping Surface Colors of TNOs through Large Surveys**

Abstract: The Outer Solar System Origins Survey (OSSOS) and its companion surveys discovered approximately 1000 TNOs. We have measured the surface properties of more than 100 of these objects through the Colours of the Outer Solar System (Col-OSSOS) survey and discovered that TNO surfaces can be classified based on g-r and r-z colors. This inspired observations dedicated to mapping the fraction of each of the three surface types throughout the Kuiper belt, to provide constraints on Neptune's migration. The distribution of surface colors of TNOs and Jovian Trojans (JTs) is a key component of our proposed large survey (Formation of the Outer Solar System: an Icy Legacy, FOSSIL). This survey is designed to illuminate how our Solar System formed and evolved, by using the unique capabilities of Subaru's Hyper Suprime-Cam to survey ~1.5 magnitudes deeper than all previous efforts. By incorporating surface color measurements, we will be able to understand the intrinsic distribution of surface properties of TNOs and JTs. The FOSSIL sample is predicted to be 2-4 times the current sample and will enable significant insight into the surface property distribution of small bodies and other unsolved questions about the formation and evolution of the Solar System.

"Progress and Perspective of Solar System Science using Subaru"
Contribution talk
11/22/2019, 9:30 - 10:00

Shuya Tan
(Earth-Life Science Institute, Tokyo Institute of Technology)

Title: **Observations of Europa's surface materials with Subaru/IRCS and its comparison with laboratory experiments**

Abstract: The Jovian icy satellite, Europa possesses an interior ocean that is believed to be one of the most habitable environments beyond Earth. Reflectance spectra of those materials using Keck and VLT at wavelengths of 1.5–2.5 μm suggest the existence of Na/Mg hydrochlorides on Europa's geologically-active regions. Although those salts would reflect the chemical compositions of the ocean, they could experience oxidation to form oxychlorine, such as chlorate and perchlorate, triggered by high-energy irradiation. If oxychlorine is generated on Europa and provided into the interior ocean, this would be important oxidants to provide redox disequilibrium energy for life. Given the low eutectic temperatures of oxychlorines, such as perchlorate, this would also play a key role in tectonics of Europa's icy crust, Here, we conduct high-spectral resolution observations for Europa's surface in wavelength of 0.95－1.5 μm with Subaru/AO188+IRCS. This provides further information on the salt compositions and formation of oxychlorines. We also perform laboratory experiments to simulate oxidation of surface hydrochlorides. By irradiations of electron onto hydrochlorides, we examine oxidation processes of hydrochlorides on Europa's surface. Comparing the telescope observations and laboratory experiments, we interpret the oxidation processes on Europa's surface.

"Progress and Perspective of Solar System Science using Subaru"
Invited talk
11/22/2019, 10:00 - 10:30

Dave Tholen
(University of Hawaii)

Title: **Asteroids Near and Far**

Abstract: The availability of wide-field imaging instruments on Subaru has enabled searches for a variety of different asteroid orbital types. One of my earliest surveys involved the use of Suprime-Cam to look for asteroids with orbits entirely interior to Earth's orbit. The geometry constrained the observations to an hour or two after evening twilight or before morning twilight, with the telescope pointed at low altitudes. Perhaps the most famous discovery to result from this effort is 2004 XZ130, which at the time held the record for smallest semimajor axis of 0.617 AU.

Beyond the classical Kuiper belt, Subaru/HSC has added a northern hemisphere component to a search for objects in the Inner Oort Cloud (IOC) region started by colleagues Scott Sheppard and Chad Trujillo on the Blanco telescope with DECam. The first few discoveries have revealed a curious alignment of orbital major axes, leading to the suggestion that a massive object is lurking somewhere in fringes of the solar system, its gravitational pull shepherding these smaller objects into aligned orbits. Ongoing search efforts allow us to potentially find both additional extreme objects as well as the proposed massive body. The status of this effort will be presented at the conference.

"Progress and Perspective of Solar System Science using Subaru"
Contribution talk
11/22/2019, 10:30 - 11:00

Stefanie Milam
(NASA/GSFC)

Title: **Detailed Studies on Small Bodies in the Solar System with Subaru and WFIRST synergies**

Abstract: Solar System observations with astrophysics facilities offers not only advancement in the field and planetary science and solar system evolution, but also considerable public outreach. Here we investigate the contribution to small body science from joint efforts with WFIRST and Subaru. The combination of WFIRST and HSC SSP data will provide significant data including orbit solutions, spectral gradients at visible wavelengths, and evaluation of surface H2O ice for a number of faint Trans-Neptunian Objects (TNOs) with diameters between 100-1000 km. The results will significantly to our understanding of the origin, dynamical history, and chemical evolution of primordial small bodies in the outer solar system.

A further benefit of using these two facilities in conjunction is for following up observations of serendipitously detected small bodies in the WFIRST surveys, including new minor bodies (e.g. Near-Earth Asteroids, main-belt asteroids, hyperbolic asteroids, comets, active asteroids, Jupiter Trojans, Centaurs, etc.) and irregular satellites of the giant planets (see Holler et al. 2018). Subaru follow-up can help further constrain the orbits and measure optical colors.

"Supermassive Black Holes" and "Time Domain" Joint Session
Invited talk
11/19/2019, 9:00 - 9:40

Shigeru Yoshida
(Chiba University)

Title: **Multi-messenger astronomy with high energy neutrinos**

Abstract: The high energy neutrino astronomy has been blooming. The realtime neutrino alert stream implemented by IceCube Neutrino Observatory has been launched and realized the rapid followup observations which led to the first identification of a likely source accelerating cosmic rays to at least energies beyond PeV. In this talk, we discuss the multi-messenger astronomy prompted by high energy neutrino detection and how it resolves one of the long standing mysteries in astrophysics - origin of the high energy cosmic rays.

"Supermassive Black Holes" and "Time Domain" Joint Session
Contribution talk
11/19/2019, 9:40 - 10:00

Haoning He
(RIKEN)

Title: **Neutrinos from Choked Jets Accompanied by Type-II Supernovae**

Abstract: The origin of the IceCube neutrinos is still an open question. Upper limits from diffuse gamma-ray observations suggest that the neutrino sources are either distant or hidden from gamma-ray observations. It is possible that the neutrinos are produced in jets that are formed in core-collapsing massive stars and fail to break out, the so-called choked jets. We explain the IceCube observed diffuse neutrino flux as neutrinos from the jets choked in the hydrogen envelopes of red supergiant stars. Furthermore, we predict that a newly born jet-driven type-II supernova may be observed to be associated with a neutrino burst detected by IceCube. The future observations on a newly born type-II supernova following the IceCube events by Subaru HST and other telescope will help to constrain our model.

"Supermassive Black Holes" and "Time Domain" Joint Session
Contribution talk
11/19/2019, 10:00 - 10:20

Tomoki Morokuma
(The University of Tokyo)

Title: **Subaru+Gemini follow-up for IceCube high-energy neutrinos**

Abstract: Origin of high-energy TeV-PeV neutrinos detected by the IceCube experiment is still unclear and more observational constraints are desired. For the 290 TeV event IceCube-170922A, an apparently bright blazar (BL Lac), TXS 0506+056 ($g¥sim15$ mag), turned out to be the likely counterpart and high signal-to-noise ratio data were taken over the full range of electromagnetic emission in addition to high-energy neutrino. On the other hand, another hypothesis, a peculiar supernova with failed jet, survives as a strong candidate of high-energy neutrino sources in general but almost no observational constraints have been obtained. We here show our trial to search for supernovae with Subaru/Hyper Suprime-Cam in the error region of IceCube-170922A in addition to our observations with 1m-class and Gemini telescopes for TXS 0506+056. We also discuss future prospects once 30m-class telescopes are available.

"Supermassive Black Holes" and "Time Domain" Joint Session
Contribution talk
11/19/2019, 10:20 - 10:40

Mitsuru Kokubo
(Tohoku University)

Title: **Properties of variability-selected AGNs in the HSC SSP Transient Survey in COSMOS**

Abstract: Using time-domain dataset from the Subaru HSC SSP Transient Survey in COSMOS, we selected about 1000 AGNs purely based on the variability information. This variability-selected AGN sample contains low-luminosity (host-dominated) AGNs and red AGNs, which are missed by color selection techniques. Cross-matching with the Chandra X-ray COSMOS-Legacy Survey point source catalog reveals that a large fraction of the variability-selected AGNs is not detected in the X-ray band, indicating that our variability-based AGN search achieves higher sensitivity to faint AGNs than the deep X-ray AGN survey. In this talk I will discuss statistical properties of the variability-selected AGNs, and show some interesting objects with peculiar SEDs found in the variability-selected AGN catalog.

"Supermassive Black Holes" and "Time Domain" Joint Session
Contribution talk
11/19/2019, 11:00 - 11:20

Shintaro Koshida
(Subaru PFS Instrument Research Specialist)

Title: **Searching for hot dust surrounding SMBH with HSC transient survey catalog**

Abstract: HSC transient survey is one of the deepest surveys of variable object based on the data observed in Subaru Strategic Program for HSC. The project built a database of variable object detected in the survey employing a differential photometry method. It provides more than 40,000 set of light curves of transient objects in wavelength from HSC-g to HSC-Y band. We applied a reverberation mapping method named JAVELIN (e.g. Zu et al. 2011) to the light curves of AGNs from the database and detected hot dust component in several objects varying with time lags from the accretion disc flux variations. The time lags follow the lag luminosity relation of the hot dust surrounding super massive black holes (e.g. Koshida et al. 2014). The hot dust detection with the large catalog of HSC survey expands the lag luminosity relation to further universe.

"Supermassive Black Holes" and "Time Domain" Joint Session
Contribution talk
11/19/2019, 11:20 - 11:40

Shunsuke Onishi
(The University of Tokyo, ISAS/JAXA)

Title: **The line-of-sight velocity variation of CO ro-vibrational lines in the ULIRG IRAS 08572+3915**

Abstract: According to the unified model of Active Galactic Nuclei (AGNs), supermassive black holes are surrounded by a geometrically thick structure named "molecular torus", whose inclination angle makes a difference to AGN types (Antonucci et al. 1993). Gas forms a thin disk in a simple gravitationally-bound system. Hence, understanding the kinetic process to maintain the thickness of a torus is essential. However, its inner structure has not been directly observed due to its tiny size (~pc). Then, we attempted to determine whether the velocity field in a torus is Keplerian or turbulent by observing the time variation of the line-of-sight velocity of CO ro-vibrational absorption lines (v=1-0, ¥Delta{J}=¥pm{1}, ¥lambda~4.7 ¥mu{m}) toward the ultra-luminous infrared galaxy IRAS 08572+3915.

We compared spectra obtained with Subaru Infrared Camera and Spectrograph (IRCS) in three epochs: 2004, 2010 (¥Delta{V}~60 km s^{-1}), and 2019 (¥Delta{V}~30 km s^{-1}). As a result, we found that some lines (v=1-0, J_{¥mathrm{lower}}=4-8) showed deceleration of ~40 km s^{-1} from 2004 to 2010 and acceleration of ~40 km s^{-1} from 2010 to 2019 even if we consider systematic errors of the wavelength calibration. This irregular velocity variation suggests that the velocity field in the molecular torus is not Keplerian but turbulent.

"Supermassive Black Holes" and "Time Domain" Joint Session
Contribution talk
11/19/2019, 11:40 - 12:00

Chien-Hsiu Lee
(NOAO)

Title: **ANTARES: a community broker for ZTF and LSST**

Abstract: With the avalanche of alerts delivered by LSST and the limited resources for follow-up, we will need brokers to select intriguing alerts that warrant follow-ups in a timely manner. At NOAO and University of Arizona, we are developing the Arizona-NOAO Temporal Analysis and Response to Events System (ANTARES), to hunt for the rarest of the rare event in the time-domain. In this talk we will give an overview of the ANTARES system, how we use ZTF as a training set, and the way forwards to LSST.

"Supermassive Black Holes" and "Time Domain" Joint Session
Contribution talk
11/19/2019, 12:00 - 12:20

Toru Yamada
(ISAS/JAXA)

Title: **Variability Search for Faint AGN using the HSC SSP-Survey Data: Variability properties of the low-luminosity AGN in the COSMOS field**

Abstract: We present the results of the multi-band deep variability survey for faint AGN in the COSMOS field using the data obtained for HSC-SSP Ultradeep Survey. It reaches to the depth i(AB)~24, which is significantly deeper than previous variability search covering ~deg^2 area. We adopted the method using the fixed-aperture photometry and introduce the procedure to treat the photometry over the intervals with various different depth, which is inevitable for the facility not dedicated for time-domain observations. In this presentation, we focus on the most robust sample of the 500 variable objects, yet including the objects which are too faint to be detected in the deepest X-ray data of the Chandra Legacy Survey whose detection limit is ~5x10-16 erg/s/cm2. The X-ray limit corresponds to Lx~1042 erg/s at z=1, or BH mass of 107Msun for the Eddington ratio of 0.1. Thus our survey (even with the most robust sample) may include very low-mass BH. Our stacking analysis of the individually X-ray undetected sources shows that they are indeed AGN with lower luminosity, likely to be BH with ~106Msun. So our work presents the utility of the variability to detect and identify very low-mass BH which are very difficult to be detected by other methods.
We discuss the variability properties, i.e., dependence on wavelength and luminosity for these sources using the structure function analysis and also for the properties of the host galaxies.

"Demographics of Supermassive Black Holes across the Universe"

Invited talk

11/19/2019, 13:30 - 14:00

Jenny Greene

(Princeton)

Title: **Mergers, Black Hole Binaries, and PFS**

Abstract: I will discuss our ongoing quest to understand the role of mergers in the evolution of supermassive black holes, from triggering to black hole pairing, to gravitational wave detection. I will end with exciting prospects for the upcoming PFS survey.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/19/2019, 14:00 - 14:20

Maria Charisi
(Caltech)

Title: **Searching for sub-parsec supermassive black hole binaries**

Abstract: Supermassive black hole binaries (SMBHBs) should form frequently, as a result of galaxy mergers. However, they remain elusive, especially at small sub-parsec separations. A promising method to identify SMBHBs is to search for quasars with periodic variability. I will describe the emerging population of candidates from systematic searches in time-domain surveys, as well as multi-wavelength studies to uncover additional evidence for the binary nature of the candidates (e.g., relativistic Doppler boost). I will also discuss the prospects of multi-messenger inference with Pulsar Timing Arrays.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/19/2019, 14:20 - 14:40

Malte Schramm
(NAOJ)

Title: **A potential high-z dwarf galaxy discovered by ALMA and SUBARU/IRCS**

Abstract: We report the discovery of a potential dwarf galaxy in our ALMA follow-up observations of a luminous quasar at z=3. The galaxy has been detected through its CO emission in ALMA band 3. The galaxy appears to be very compact and shows a rotating CO disk. The dynamical mass estimate of 10^9 Msun will put this galaxy into the dwarf regime. We have also identified a compact counterpart in our IRCS AO supported K-band imaging. Through further follow-up observations in optical bands we also confirmed that the galaxy is indeed very faint with i-band mag=23.5. We will discuss several possible scenarios including the possibility for this galaxy to host an AGN located at the same redshift as our main quasar at z=3 by constraining the redshift of the source through the detected CO line and SED modeling. This dwarf galaxy could be one of the lowest mass galaxies observed with ALMA at high-z hosting an AGN.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/19/2019, 14:40 - 15:00

Tetsuya Hashimoto
(National Tsing Hua University)

Title: **One step toward understanding cosmic re-ionization: absorption tests with a new QSO we discovered at z=6.6**

Abstract: Investigating the Gunn-Peterson trough of high redshift quasars (QSOs) is a powerful way to reveal the cosmic reionization. As one of such attempts, we perform a series of absorption tests with one of the highest redshift QSOs, PSO J006.1240+39.2219 at z = 6.62 we previously discovered. Using the Subaru telescope, we obtained medium-resolution spectra with a total exposure time of 7.5 hours. We calculate the Lya transmission in different redshift bins to determine the near zone radius and the optical depth (tau). We find a sudden change in the Lya transmission at 5.71<z<5.86, which indicates the end of the reionization. However, at z>6, we have detected flux. Thus, tau is lower than previously measured. Due to the improved depths and resolution of the spectra, we possibly detect faint flux previous work missed. The near zone radius of the QSO is 5.79±0.09 pMpc, which is consistent with the decreasing near zone size at higher redshift. We also analyze the dark gap distributions to probe the neutral hydrogen fractions beyond the saturation limit of the Gunn-Peterson trough. We find the median of the dark gap width becomes larger with increasing redshift. In contrast to these three analyses, we perform a model free analysis by counting dark pixels, to find the upper limit of x_i<0.6 (0.8) at z<6 (z>6). All four analyses based on this QSO show increasingly neutral hydrogen towards higher redshifts, adding precious measurements at z>6.5. Using the deep near-infrared (NIR) spectrum we obtained with Gemini/GNIRS, we explore the early growth of supermassive black holes (SMBHs). This NIR (rest-frame UV) spectrum shows blue continuum slope and rich metal emission lines in addition to Lya line. We utilize the [MgII] line width and the rest frame luminosity L3000Å to find the MBH to be 10^8Msun, making this one of the lowest mass QSOs at z>6. The power-law slope of the continuum emission is 2.94±0.03, significantly bluer than the slope of -7/3 predicted from standard thin disc models. We fit the spectral energy distribution (SED) using a model which can fit local SMBH, which includes warm and hot comptonisation

powered by the accretion flow as well as an outer standard disc. The result shows that the very blue slope is probably produced by a small radial (230Rg) extent of the standard accretion disc. All the SED fits require that the source is super-Eddington (Lbol/LEdd>9), so the apparently small disc may simply be the inner funnel of a puffed up flow, but clearly the SMBH in this QSO is in a rapid growth phase.

"Demographics of Supermassive Black Holes across the Universe"
Invited talk
11/19/2019, 15:30 - 16:00

Chris Harrison
(European Southern Observatory)

Title: **AGN Outflows and Feedback Across Cosmic Time**

Abstract: Over the last two decades there has been a huge amount of observational and theoretical work that aims to establish the connection between the growth of supermassive black holes (i.e., Active Galactic Nuclei; AGN) and the growth of their host galaxies. This is largely driven by the fact that cosmological models cannot reproduce realistic galaxy populations unless the energy released by AGN regulates star formation in the host galaxies. I will summarise our campaigns to constrain the role of AGN in galaxy evolution. Firstly, I will present our systematic multi-wavelength observational survey (e.g., using ALMA, MUSE, VLA, eMERLIN, Chandra...) of z~0.1 quasars which is: (1) providing high spatial resolution measurements of galactic outflows; (2) establishing the role of radio jets in driving these outflows and; (3) determining what impact these processess have on the host galaxy's star-formation and gas supply. Secondly, I will present a statistical assessment of the impact of AGN on star formation in the population as a whole over cosmic time using a combination of observations (e.g., ALMA) and predictions from cosmological simulations.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/19/2019, 16:00 - 16:20

Toru Misawa
(Shinshu University)

Title: **Properties of Narrow Absorption Line Systems in AGN Outflow**

Abstract: AGN outflows, one of the most important key ingredients for the formation/evolution of quasars and their host galaxies, are usually studied through quasar absorption lines. They are classified by their line widths into broad absorption lines (BALs; > 2,000 km/s) and narrow absorption lines (NALs). In addition to BALs, a substantial fraction of NALs are also thought to be intrinsic to the quasars (i.e., intrinsic NALs) rather than intervening objects like foreground galaxies and the IGM. The study of intrinsic NALs complements that of BALs because the corresponding absorbers reside in different regions of the outflow.
For more than 10 years, we have been monitoring intrinsic NALs in spectra of optically bright quasars taken with Subaru/HDS, Keck/HIRES, and VLT/UVES, and discovered several important properties: a) there is no discernible changes in strength/profile of intrinsic NALs, while BALs are frequently variable, b) there is no velocity shift despite the fact that acceleration often assumes to be a key physical property of the outflow, and c) there exists an internal structure/fluctuation in intrinsic NAL absorbers with a scale of <10^-3 pc. We discuss a possible geometry of the outflowing wind based on these results.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/19/2019, 16:20 - 16:40

Tohru Nagao
(Ehime University)

Title: **High-z narrow-line regions in AGNs**

Abstract: It is now widely recognized that the ISM property in star-forming galaxies depends significantly on the redshift; the ISM in higher-z galaxies is characterized by a lower-metallicity and higher-ionization than lower-z galaxies. However it is not well understood how the ISM property in AGNs depends on the redshift. In this contribution, we report our studies on the narrow-line region (NLR) in some AGNs at z>3 through spectroscopic observations using Subaru and VLT. The detailed comparison between the spectroscopic data and photoionization models revealed that the high-z NLR is characterized by moderately high metallicity and very high gas density.

"Demographics of Supermassive Black Holes across the Universe"
Invited talk
11/21/2019, 9:00 - 9:30

Silvia Mateos Ibáñez
(Instituto de Física de Cantabria (CSIC-UC))

Title: **Uncovering highly obscured SMBH growth**

Abstract: Despite extensive observational efforts, a significant fraction of Active Galactic Nuclei (AGN) activity in highly obscured environments still evades our census. Mid-IR surveys with the Wide-field Infrared Survey Explorer could uncover, at least in part, the elusive highly obscured SMBH growth in the most extreme luminous AGN. Although several studies have already presented results from follow-up campaigns of WISE-based AGN samples, they typically lack the X-ray depth necessary to reveal the true nature of many of the IR-selected AGN candidates.

I will present the results of a detailed analysis of the properties of a complete, mid-IR flux-limited sample, of ~100 luminous AGN candidates selected with WISE. To date 95 per cent of the objects have spectroscopic redshifts and optical classifications. Moreover, the full 6 deg2 survey area has very deep X-ray coverage from XMM-Newton observations, allowing us to directly measure the accretion luminosity and nuclear absorption in the 76 per cent of the sample with X-ray detections and to put robust constrains on the nuclear absorption in the 24 per cent of the sources that have escaped X-ray detection. Thus, this unique dataset will allow us to robustly evaluate how AGN selection at mid-IR wavelengths can help us to complete our census of highly obscured AGN activity.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 9:30 - 9:50

Masatoshi Imanishi
(NAOJ)

Title: **Luminous buried AGNs in merging ultraluminous infrared galaxies revealed with Subaru and ALMA**

Abstract: We present our Subaru infrared and ALMA (sub)millimeter observations of nearby merging ultraluminous infrared galaxies (ULIRGs) to investigate luminous buried AGNs, by distinguishing from starbursts. Scrutinizing such luminous AGNs deeply buried in dust and dense molecular gas in merging ULIRGs is of particular importance to understand how supermassive black holes (SMBH) grow in mass during gas-rich galaxy mergers in our universe. Observations at the wavelengths of low dust extinction are crucial. We observed >100 nearby ULIRGs in the infrared (spectroscopy and imaging) and discovered optically elusive, deeply buried luminous AGNs in roughly half of observed ULIRGs with no optical AGN signatures, suggesting that such luminous buried AGNs are common in ULIRGs, as predicted by theories. We also found that SMBHs in the progenitors of more massive galaxies are more actively mass-accreting, supporting theoretical models that AGN feedback is stronger in such galaxies (Imanishi+10 ApJ 721 1233; Imanishi & Saito 14 ApJ 780 106; Imanishi+19 in prep). Our recent ALMA (sub)millimeter spectroscopy has started to detect optically- and even infrared-elusive extremely deeply buried luminous AGNs, thanks to almost negligible dust extinction (Imanishi+18 ApJ 856 143; Imanishi+19 ApJS 241 19).

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 9:50 - 10:10

Yoshiki Toba
(Kyoto University)

Title: **Multi-wavelength view of dust-obscured galaxies**

Abstract: We review the physical and statistical properties of infrared (IR)-bright dust-obscured galaxies (DOGs) with i - [22] > 7.0 in AB magnitude and with flux density at 22 μm > 1.0 mJy. IR-bright DOGs are a subset of high-redshift (z~1-3) optically-faint luminous IR galaxies (such as ULIRGs and HyLIRGs). A hydrodynamic simulation has indicated that black holes in IR-bright DOGs are expected to show the highest accretion rate during a major merger event, suggesting that IR-bright DOGs are expected to harbor the black holes in the growing phase. Therefore, IR-bright DOGs may constitute a key population for understanding the co-evolution of galaxies and supermassive black holes. However, these IR-bright DOGs are spatially rare, so wide-area surveys with optical and IR are strongly required to detect these bright but spatially rare populations.
So far, we have performed a systematic search for IR-bright DOGs and investigated their statistical and physical properties based on multi-wavelength data, such as SDSS, Subaru/HSC, WISE, AKARI, ALMA, and NuSTAR. In this presentation, we particularly focus on the following properties of IR-bright DOGs: (i) luminosity function and luminosity density, (ii) clustering properties, (iii) ionized and molecular gas properties, (iv) host properties.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 10:10 - 10:30

Akatoki Noboriguchi
(Ehime University)

Title: **Discovery of blue-excess dust-obscured galaxies viewed with Subaru Hyper Suprime-Cam**

Abstract: In this presentation, we report our discovery of "blue-excess" dust-obscured galaxies (BluDOGs) viewed with Subaru Hyper Suprime-Cam. Dust-obscured galaxies (DOGs) are faint in the i-band (optical) but very bright 22 micron band (mid-infrared: mid-IR), which are thought to be powered by active star-formation or AGN, or both. DOGs are believed to be a candidate population that are evolving into quasars from gas-rich major merger.
In this work, we found 8 DOGs with optically blue excess (BluDOGs; Noboriguchi et al. 2019) in our 571 DOGs discovered by combining three multi wavelength catalogues of optical (Subaru HSC), near-IR (VIKING), and mid-IR (ALLWISE). The BluDOGs shows that those optical color is very blue as the optical color of quasars, while those color between the optical band and mid-IR band is very red. We suggest that the BluDOGs are in transient phase between DOGs and quasars. By assuming the lifetime of DOGs is about 100 Myr, we can estimate the lifetime of BluDOGs to be a few Myr. If the blue-excess comes from the leaked AGN light, the lifetime of BluDOGs corresponds to the timescale of the blowing-out event.

"Demographics of Supermassive Black Holes across the Universe"
Invited talk
11/21/2019, 10:50 - 11:20

Kohei Ichikawa
(Tohoku University)

Title: **Obscured SMBH assembly using multi-wavelength and wide-field surveys**

Abstract: Most of the accretion onto SMBHs is highly obscured and the number density of such obscured AGN is quite smaller than galaxies. Therefore, multi-wavelength and wide-field surveys are crucial to assemble such obscured AGN. In my talk I will review our two ongoing projects covering multi-wavelength view. One is BASS survey: multi-wavelength study of a large sample of local (z~0.05) AGN selected in the hard X-ray band (14-195 KeV), where obscuration does not play a strong role. The other is WERGS project: optically-faint radio galaxies revealed by the cross-matching of shallow but wide VLA/FIRST and deep and wide Subaru/HSC SSP survey down to g~26, opening the new parameter space of extremely radio-loud AGN with radio-loudness parameter of R= f(1.4GHz)/f_g > 10^4.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 11:20 - 11:40

Takuji Yamashita
(NAOJ)

Title: **Wide and Deep Exploration of Radio Galaxies with Subaru HSC (WERGS)**

Abstract: We present the initial results of our on-going project, "Wide and Deep Exploration of Radio Galaxies (RGs) with Subaru HSC (WERGS)", which is aimed at studying high-z RGs using the Subaru HSC-SSP catalog and archive radio catalogs. RGs represent a key population for understanding the evolution and formation of massive galaxies, because radio-mode AGN feedback can regulate star formation in galaxies.
We identified ~3600 HSC counterparts of VLA FIRST radio sources in a 156 square degree field (Yamashita et al. 2018). RGs at photo-z > 1 are found in an optically faint regime (i > 21). The multiwavelength SED fitting analysis shows these optically faint and high-z RGs have higher SFR and AGN luminosity than optically bright and low-z ones (Toba et al. 2019). These results suggest a different picture of RGs from our perception in the local Universe. For RGs at higher-z, we are searching for them using the Lyman break technique. In a pilot study, we found a z=4.7 RG, which has a massive stellar mass (logM*/Msun = 11.4) and non-ultra-steep radio spectral index. This discovery demonstrates the power of HSC-SSP to explore high-z RGs.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 11:40 - 12:00

Kianhong Lee
(University of Tokyo)

Title: **The radio-loud fraction and the mean radio-loudness of high-z low-luminosity HSC quasars**

Abstract: To constrain the radio-loud fraction and the mean radio-loudness of accreting SMBHs in the early universe, we conduct new radio observations of 22 low-luminosity (rest-frame ultraviolet luminosity M_1450 > -25 mag) quasars at z~6 with the Karl G. Jansky Very Large Array (JVLA) at 1.4 GHz. Our quasar sample is discovered with Subaru/HSC, lying at the faint-end of quasar luminosity function at z~6. The sensitivity of our observations (1 sigma~10-50 uJy) is about 3-10 times deeper than that of the VLA-FIRST survey. The radio luminosity (rest-frame 5 GHz) of 22 quasars are all lower than 10^25.5 W/Hz and we constrain the radio-loudness of 20 quasars to R=f_5GHz/f_4400 < 100. The median stacking image (1 sigma~5 uJy) constrains the mean radio-loudness of our sample to R < 11, which is inconsistent with the redshift-evolution trend suggested by lower-redshift studies of quasars. This implies that the radio-loud fraction of low-luminosity quasars appears to be lower than that of luminous ones, which is consistent with previous studies, but the mean radio-loudness does not follow the evolution trend at lower redshifts.

"Demographics of Supermassive Black Holes across the Universe"
Invited talk
11/21/2019, 13:30 - 14:00

Stephanie LaMassa
(Space Telescope Science Institute)

Title: **Demographics of X-ray and Mid-Infrared Selected AGN from the Wide-Area Stripe 82X Survey**

Abstract: Stripe 82X is a wide-area (31 deg^2) X-ray survey designed to uncover obscured high luminosity AGN missed from our optical census of black hole growth. A special SDSS-IV eBOSS program observed 37 deg^2 of Stripe 82, ~15.5 deg^2 of which covered the largest contiguous portion of Stripe 82X, to spectroscopically target X-ray selected and WISE W1-W2 selected AGN. The combined X-ray and WISE AGN sample is 82% spectroscopically complete to r~22, with a median redshift of z~1. We find that 20% of the X-ray AGN are optically obscured (i.e., lack broad lines in their optical spectra) and 30% of the WISE AGN are obscured. A proper census of the obscured AGN population at high luminosities require population synthesis modeling that accounts for the X-ray and mid-infrared selection functions and survey flux limits, so these observed fractions represent a lower limit of obscured black hole growth in this parameter space. We find that 50% of the WISE AGN at $z < 0.5$ have emission line ratios consistent with star-formation rather than AGN photoionization: whether they are heavily buried AGN or star-forming galaxy contaminants is currently unclear. We also find that X-ray AGN not detected by WISE tend to be at high X-ray luminosity, challenging the conventional wisdom that mid-infrared selection recovers all luminous AGN. Conversely, we do not find that the WISE AGN undetected by X-rays have redder W1-W2 colors, indicating that they are not preferentially more obscured than the X-ray and WISE selected AGN.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 14:00 - 14:20

Hyewon Suh
(Subaru Telescope)

Title: **The most obscured phase of accreting black holes at high redshift: First accreting black hole candidates**

Abstract: The existence of SMBHs at z>7 challenges models of the formation and growth of SMBHs, suggesting that black holes undergo very efficient and rapid accretion of gas within the first billion years after the Big Bang. The direct collapse of primordial gas clouds would be among the most interesting scenarios to form such massive black holes at high redshift, but there is no confirmed detection of early SMBH progenitors so far.
We present the newly discovered X-ray sources without any optical/NIR counterparts in the COSMOS field, which have been undetected in any Subaru/HSC grizy, UltraVISTA Y,J, and/or H, Ks bands. Our sources are detected only in the X-ray and the infrared bands (Spitzer/MIPS 24um), consistent with the predicted SED model of direct collapse black hole.This is possibly the first population of accreting black holes, or heavily obscured AGNs at high redshift. Our study will be an important preparation for the future JWST, WFIRST science.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 14:20 - 14:40

Masafusa Onoue
(MPIA)

Title: **Probing the early SMBH evolution at the frontiers: deep NIR observations of z=6-7 quasars**

Abstract: Luminous quasars during the reionization epoch have been identified since the 2000's, showing that the central SMBHs accrete at near Eddington limit. The rest-frame UV spectra of those highest-redshift quasars are reminiscent of those of low-redshift quasars, which implicates slow or perhaps no redshift evolution of broad-line region metallicity up to z=7. Recently, there have been a lot of efforts to explore the observational frontiers of early SMBH studies, which either probe down the quasar luminosity function or focus on z>7 quasars. In this talk, I will present results from deep near-infrared observations of z=6-7 quasars aiming at one of the two directions above. More specifically, I will show the Eddington ratio distribution for z=6 low-luminosity quasars, as well as the BH mass and metallicity measurements of the most distant quasar known at z=7.5. I will also discuss the expectations toward the next generation telescopes/instruments such as JWST, Euclid and TMT.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 14:40 - 15:00

Nanako Kato
(Ehime University)

Title: **A search for high-z red quasars with the Subaru HSC and WISE data**

Abstract: Red quasars are thought be in the phase of transition from hidden accretion (obscured BH growing phase) to unobscured radiation (traditional quasar), i.e. "blowout" phase. As such, this population is an useful probe to understand the formation and evolution of quasars and their host galaxies. Recently, more than 80 new high-z ($z > 5.7$) quasars have been discovered by the Subaru High-z Exploration of Low-Luminosity Quasars (SHELLQs) project, based on the Subaru Hyper Suprime-Cam (HSC) SSP survey. We are using this sample to reveal whether red quasars prevail in the early universe. The candidates of red quasars were selected with a combination of the HSC and WISE data, which yielded four candidates with WISE detection so far. We constructed broadband SED of each candidate and derived the color excess E(B -V). We will present the preliminary results from this analysis, including identification of two promising candidates.

"Demographics of Supermassive Black Holes across the Universe"
Invited talk
11/21/2019, 15:30 - 16:00

Luis Ho
(Kavli Institute for Astronomy and Astrophysics, Peking University)

Title: **Fundamental Physical Properties of Quasar Host Galaxies**

Abstract: The basic properties of the host galaxies of quasars are extraordinarily difficulties to measure because of the adverse of influence of the bright nucleus and their generally large distances. Yet, it is imperative that we measure them as accurately as possible in order to understand the lifecycle of supermassive black holes and their impact on galaxy evolution. I describe recent efforts to measure some fundamental parameters of quasar host galaxies, including their morphology, environment, stellar mass, star formation rate, gas content, and dynamical mass.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 16:00 - 16:20

Toru Ishino
(Ehime University)

Title: **Subaru Hyper Suprime-Cam View of Quasar Host Galaxies at z < 1**

Abstract: It is well known that there is a tight correlation between the mass of supermassive black holes and mass of their host bulges, suggesting that they coevolve. As a driver of the coevolution, AGN feedback is proposed, which suppresses star formation activity in their host galaxies. However, the actual impacts of AGNs on their host galaxies is still unclear. To understand this, it is important to investigate the properties of AGN host galaxies accurately.

In this study, we used Hyper Suprime-Cam Subaru Strategic Program survey images. We investigated the host properties of 859 quasars at z < 1, extracted from the SDSS DR7 quasar catalog. We fitted the observed radial profiles with a combination of the PSF and the Sersic model to decompose into quasar nuclei and host galaxies. By comparing the properties of the quasar hosts and non-AGN galaxies, we found that quasar host galaxies are mostly located on the green valley. This trend is consistent with a scenario in which star formation of the host galaxies is suppressed by AGN feedback, and galaxies migrate from the blue cloud to the red sequence.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 16:20 - 16:40

Yuya Saeda
(Ehime University)

Title: **Stacking analysis of quasar host galaxies at z > 1 with Subaru HSC**

Abstract: When and how AGN activity is ignited is still unclear. In this respect, it is crucial to reveal which types of galaxies make supermassive black holes more active, by investigating quasar host colors. In particular, observations of quasar host galaxies located at z > 1 are crucial to understand the relation between AGN activity and the host galaxies in the first half of the history of the universe. However, it is difficult to observe quasar host galaxies at z > 1 individually, because of the high brightness of quasar nuclei.

In this study, by analysing the Hyper Suprime-Cam Subaru Strategic Program imaging data, we investigated the property of 3,527 quasar host galaxies at z > 1 selected from the SDSS quasar catalog. We subtracted AGN component based on PSF profile from the HSC imaging data, and stacked residual host galaxy component in several redshift bins, in order to get the mean flux of host galaxy component in the five HSC bands (g, r, i, z, y). We carried out aperture photometry on the stacked images and the SED fitting with CIGALE, which allowed us to investigate the color of host galaxies. We will report the latest results.

"Demographics of Supermassive Black Holes across the Universe"
Contribution talk
11/21/2019, 16:40 - 17:00

John Silverman
(Kavli IPMU)

Title: **The growth of supermassive black holes and their host galaxies from HST to HSC**

Abstract: The evolution (or not) of the ratio between the mass of supermassive black holes and that of their host galaxies is an important observable to establish, particularly since strong AGN feedback mechanisms are invoked in hydrodynamic simulations and semi-empirical models of galaxy formation. We will report on our new measurements of this ratio at $z \sim 1.5$ using HST and FMOS-COSMOS for black hole mass estimates. To bridge the redshift divide with local values, the Subaru HSC Strategic Survey Program is proving exquisite optical imaging over 1k deg2 to measure this ratio at $z < 1$ for a large sample of known SDSS quasars. To further interpret our results, we compare the observations to theoretical models and address whether AGN feedback provides a link between supermassive black holes and galaxies.

"Demographics of Supermassive Black Holes across the Universe"
Contribution Poster
Poster ID: P50

Kazuma Joh
(Ehime University)

Title: **Influence of the AGN activity on ionized gas clouds in narrow-line regions of AGNs**

Abstract: The radiation-driven fountain model is a theoretical model that naturally explains the formation and maintenance of the nuclear torus structure (Wada+12, Wada+18). In this model, it is expected that high-density gas clouds are supplied from the inner part to outer narrow-line regions (NLRs) through outflows. For examining this theoretical expectation observationally, we systematically investigated the ionized gas in NLRs based on 127,000 objects taken from Sloan Digital Sky Survey (SDSS). For this data, we measured the electron density as a function of the location in the so-called BPT diagram. We found that the NLR in AGNs is denser than the HII region in star-forming galaxies. Furthermore, NLRs with a higher AGN activity are characterized by a higher electron density. In addition, the velocity dispersion of [OIII]5007 shows a positive correlation with the AGN activity. These results are consistent with the radiation-driven fountain model. Also, in some LINERs and composite objects, NLRs with a notably high electron density were seen. For these objects, the effects of shocks may be important.

"Demographics of Supermassive Black Holes across the Universe"
Contribution Poster
Poster ID: P51

Daisuke Itoh
(Shinshu U.)

Title: **Estimating a distance of intrinsic NAL absorbers**

Abstract: In addition to broad absorption lines (BALs; FWHM > 2000 km/s), a substantial fraction of narrow absorption lines (NALs; FWHM < 500 km/s) in quasar spectra have recently been suggested to physically associated to the quasars (i.e., intrinsic NALs) rather than foreground galaxies and/or the IGM. There are two possible origins of intrinsic NALs; quasar driven outflow in central region and those smashing into ISM and/or CGM at large distance.
To determine the origin of intrinsic NALs, we examine pairs of stable/meta-stable lines such as CII1335 / CII*1336 and SiII1260 / SiII*1265 to measure electron density, which can be used to calculate their distance from the center in photoionization models.
We searched BAL quasar spectra taken with VLT/UVES from the ESO archive and found 2 quasars hosting intrinsic NAL systems with fine-structure lines, of which one (detected in SDSS J121549.80-003432.1) possesses clear fine-structure lines, with photoionization modeling possible. For the quasar we calculated a distance of intrinsic NAL absorber following the procedure above and confirmed it is comparable to the size of the host galaxy's CGM. We discuss the origin of intrinsic NALs based on our calculations for these quasars.

“Demographics of Supermassive Black Holes across the Universe”
Contribution Poster
Poster ID: P52

Shenli Tang
(Kavil IPMU / University of Tokyo)

Title: **The study of dual QSOs as tracers of galaxy mergers**

Abstract: Galaxy mergers are thought to play an important role in galaxy evolution and the growth of SMBHs. In particular, they can trigger starbursts and AGNs. Now the study of mergers, including an early stochastic phase, is promoted and also a number of simulation studies have been carried out. But studies still lack reliable observational samples of the merger stage with separation < 10 kpc, in which dual AGNs are excepted to exist. In this work, we match the SDSS QSO catalog and HSC imaging to identify on possible dual QSO candidates with separations 0.6~4” (3 - 30 kpc) as tracers of an on-going merger event at redshift < 4. To further confirm our candidates, we have acquired follow-up spectroscopic observations using Keck/LRIS. For this poster, I will show both the SDSS and HSC images and some spectral analysis of the ISM properties of several of our dual QSO samples.

“Demographics of Supermassive Black Holes across the Universe”
Contribution Poster
Poster ID: P53

Kohei Iwashita
(Ehime University)

Title: **CHORUS: A new search for type-2 AGNs at high-z by focusing on dual-NB emitters with HSC-SSP and CHORUS**

Abstract: We report the initial results of our new search for high-z type-2 AGNs by utilizing the HSC NBs data. It is important to study SMBHs and their evolution for understanding the evolutionary link between SMBHs and galaxies. It is crucial to carry out AGN surveys with a high completeness. However, optical broad-band colorselection and variability-based selection are incomplete for obscured type-2 AGNs.

Here we would like to propose that a combination of two NB filters, NB718 and NB921 equipped in HSC, can be powerful to search for high-z type-2 AGNs systematically, because these filters can detect Ly_alpha1216 and CIV1549 of emission-line galaxies at z~4.9. The strong CIV emission is not seen in star-forming galaxies, so we can search for AGNs at z~4.9 by selecting objects that show flux excesses in both NB718 and NB921.

We selected some objects which show NB718 and NB921 flux excesses simultaneously (hereafter "dual emitters") by combining the catalogs of the HSC-SSP and CHORUS projects. In this poster presentation, we report the detailed method and properties of the dual emitters.

"Time-Domain Astronomy in the Multi-Messenger Era"
Invited talk
11/21/2019, 9:00 - 9:40

Marcelle Soares-Santos
(Brandeis University)

Title: **Cosmology in the era of multi-messenger astronomy with gravitational waves**

Abstract: Motivated by the exciting prospect of a new wealth of information arising from the first observations of gravitational and electromagnetic radiation from the same astrophysical phenomena, the Dark Energy Survey (DES) has established a search and discovery program for the optical transients associated with LIGO/Virgo events (DESGW). Using the Dark Energy Camera (DECam), DESGW has contributed to the discovery of the optical transient associated with the neutron star merger GW170817, and produced the first cosmological measurements using gravitational wave events as standard sirens. We now pursue new results during the third, and ongoing, observing campaign. In this talk, I present an overview of our results, and discuss its implications for the emerging field of multi-messenger cosmology with gravitational waves and optical data.

“Time-Domain Astronomy in the Multi-Messenger Era”
Contribution talk
11/21/2019, 9:40 - 10:00

Masaomi Tanaka
(Tohoku University)

Title: **Optical/infrared counterparts of gravitational wave sources**

Abstract: The first gravitational wave (GW) observation from a neutron star merger was successfully performed in 2017 (GW170817). The detection triggered electromagnetic (EM) wave observations over the entire wavelength range, which enabled the first identification of an EM counterpart of a GW source. In optical and infrared wavelengths, the counterpart shows characteristic properties of "kilonova", EM emission powered by radioactive decays of newly synthesized r-process elements. I summarize current understanding of kilonova emission by focusing on recent progress in atomic opacity calculations, and discuss what we can learn from optical/infrared observations of kilonova. Then, I highlight open questions and future prospects toward understanding the origin of r-process elements in the Universe.

"Time-Domain Astronomy in the Multi-Messenger Era"
Contribution talk
11/21/2019, 10:00 - 10:20

Mahito Sasada
(Hiroshima University)

Title: **J-GEM Optical and NIR Follow-Up in Gravitational-Wave Third Observing Run**

Abstract: Gravitational-wave (GW) astronomy has been opened since detecting astronomical events of GW by LIGO in 2015. In August 2017, a merger of a binary neutron star (BNS) has been detected as GW170817, from which an electro-magnetic (EM) emission was detected by many telescopes and satellites from radio to gamma-ray regimes. The optical and near-infrared (NIR) lights were emitted from a kilonova, which was energized by radioactive decay through the rapid neutron-capture process (r-process). Optical and NIR observations can reveal a process of nuclear synthesis in a merger of BNS. J-GEM (Japanese collaboration for Gravitational-wave Electro-Magnetic follow-up) aims to firstly detect and observe a GW EM counterpart using Japanese optical and NIR telescopes including Subaru telescope.
Since April 2019, the 3rd observing run (O3) of LIGO/Virgo GW telescope has been carried out. LIGO/Virgo have detected over 10 GW events including several events having a neutron star. The EM surveyed observations were performed in entire wavelengths to find a EM candidate of the GW source, including Subaru and other Japanese optical and NIR telescopes in J-GEM. We also performed follow up observations for candidates of GW EM objects with imaging and spectroscopy. I would present our strategy and follow ups of detected GW events in O3.

"Time-Domain Astronomy in the Multi-Messenger Era"
Contribution talk
11/21/2019, 10:20 - 10:40

Takayuki Ohgami
(Konan University)

Title: **Subaru/Hyper Suprime-Cam survey for finding gravitational wave counterpart**

Abstract: Advanced LIGO and Advanced Virgo detected the gravitational wave from a binary neutron star on 17th August 2017. This gravitational wave event was named GW170817. J-GEM (Japanese collaboration for Gravitational wave Electro-Magnetic follow-up) has conducted the follow up survey using the Subaru/Hyper Suprime-Cam (HSC) that aimed to identify an optical counterpart to the gravitational wave source. As a result, we find 60 candidate extragalactic transients, including J-GEM17btc (also known as SSS17a/DLT17ck). Evaluating the probabilities that they are located within the 3D skymap, we conclude that J-GEM17btc is the most likely and distinguished candidate to be the optical counterpart of GW170817. The 3rd observing run called O3 started from 1st April 2019. Three of events including a neutron star are reported by 15th June.We have conducted the follow up survey using the HSC for one of them (GW190510). Moreover we plan for using the Thirty-Meter Telescope (TMT) which is the next generation large telescope in the future. In this talk, I will report the detail of our observations (for GW170817 and GW190510) and importance of Subaru and TMT for the follow-up observations of GW events.

"Time-Domain Astronomy in the Multi-Messenger Era"
Invited talk
11/21/2019, 11:00 - 11:40

Francisco Forster
(University of Chile)

Title: **High cadence surveys and the future ecosystem of time domain astronomy**

Abstract: A new generation of high etendue telescopes is allowing us to explore large volumes of the Universe with fast cadences. This has led to the discovery of new populations of events or the new phases of evolution of known populations of events. In order to take advantage of these new discoveries several new tools are required. Among them are high performance image processing tools, fast machine learning aided discovery and classification algorithms, interoperable tools that allow an effective communication between the different astronomical infrastructure, new models which allows interpreting new regions of the parameter space, and new tools to extract the most physical knowledge from these observations. In this talk I will review some examples of high cadence surveys, their tools and scientific results, in particular concerning our experience with the High cadence Transient Survey (HiTS). I will also discuss the future ecosystem of time domain astronomy in the era of high cadence observations, where a new layer of astronomical alert brokers and target and observation managers will be required to connect survey and follow-up telescopes. In particular, I will discuss the challenges and opportunities found while developing the ALeRCE astronomical broker and its implications for the future of multi messenger astronomy.

"Time-Domain Astronomy in the Multi-Messenger Era"
Invited talk
11/22/2019, 9:00 - 9:40

Takashi Moriya
(NAOJ)

Title: **High-redshift supernova surveys with Subaru**

Abstract: I will introduce high-redshift supernova surveys with Subaru/HSC and discuss their discoveries, focusing on high-redshift superluminous supernovae.

“Time-Domain Astronomy in the Multi-Messenger Era”
Contribution talk
11/22/2019, 9:40 - 10:00

Ji-an Jiang
(Kavli IPMU)

Title: **Unveiling the Nature of Type Ia Supernovae with Early-phase Information Obtained from Subaru Deep Imaging Surveys**

Abstract: Type Ia supernovae (SNe Ia) have been used as "standard candles" to demonstrate the accelerating expansion of the Universe though their progenitor systems and explosion physics are still under debate. Photometric information of SNe Ia within a few days of their explosions (early-phase SNe Ia) plays an irreplaceable role in solving such long-standing issues of SNe Ia, and the systematical study of early-phase SNe Ia is now carrying out with the Subaru Hyper Suprime-Cam (HSC). In this talk, I will introduce an abnormal early-phase SN Ia, MUSSES1604D (SN 2016jhr) discovered in the first observing run of the "MUltiband Subaru Survey for Early-phase SNe Ia" (MUSSES) that robustly supports the so-called He-shell detonation scenario and the multiple origins of peculiar early light-curve behavior of SNe Ia for the first time. Then, I will present new findings by investigating early-phase SNe Ia discovered by the ongoing HSC SSP transient survey.

"Time-Domain Astronomy in the Multi-Messenger Era"
Contribution talk
11/22/2019, 10:00 - 10:20

Sei Saito
(Tohoku University)

Title: **Spectropolarimetry of Superluminous Supernova**

Abstract: In recent years, many superluminous supernovae which are ten to hundred times more luminous than normal supernovae have been discovered. However, their explosion mechanism is not yet clear. Because in the case of some models of mechanisms, it is expected that the shape of the explosion considerably deviates from spherical symmetry, it is important to study the multi-dimensional shapes of superluminous supernova. Since all extragalactic supernovae cannot be spatially resolved, polarimetric observation is one of the most powerful tool to study their morphology.

We performed spectropolarimetric observation of a superluminous supernova, SN 2017egm (Type I SLSN) about 200 days after the maximum light, using FOCAS of Subaru Telescope. The degree of interstellar polarization estimated in this study is consistent with that of polarization that is supposed to originate from the supernova in a previous study. In other words, SN 2017egm does not have a large intrinsic polarization in the early epoch. It shows that the outer layer of the supernova is almost spherical. Whereas, in the late epoch, it shows polarization originating from the supernova and it indicates that the inner part of the supernova is aspherical. Hence, we conclude that the inner ejecta of superluminous supernovae are more aspherical.

“Time-Domain Astronomy in the Multi-Messenger Era”
Contribution talk
11/22/2019, 10:20 - 10:40

Masahiro Matsuda
(Tohoku university)

Title: **Luminous Supernovae from Subaru HSC**

Abstract: Core-collapse supernovae (CCSNe) have a wide variety in the peak luminosity.While CCSNe have only -16 ~ -18 mag at peak, superluminous supernovae (SLSNe) reach -21 ~ -23 mag. There maybe a gap between SNe and SLSNe in the luminosity distribution, but the intrinsic luminosity distribution is not yet clear.We carried out a transient survey with Hyper Suprime-Cam Subaru Strategic Program (HSC-SSP) from April 2016 to November 2017. This survey covered the COSMOS field (Ultra-Deep layer 1.77 deg2, Deep layer 5.78 deg2) for about half a year with a depth of about 26 mag. The data are suitable to unbiasedly study the luminosity distribution of SNe. We identified SNe more luminous than -19.5 mag with reliable redshifts and studied properties of their light curves. Using this sample, we present the event rate and luminosity distribution of luminous SNe.

"Time-Domain Astronomy in the Multi-Messenger Era"
Contribution talk
11/22/2019, 11:00 - 11:20

Ichiro Takahashi
(Kavli IPMU)

Title: **Photometric Classification of the HSC Transients through Machine Learning**

Abstract: The progress of observation technology in recent years has brought the rapid increase in the number of discovered supernovae. More than 1,800 supernova candidates were discovered in transient survey of the COSMOS field with the Subaru Hyper Suprime-Cam (HSC) (Yasuda et al. 2019), and it is estimated that tens of thousands of supernovae will be discovered each year in the Large Synoptic Survey Telescope (LSST) era. In order to select follow-up candidates efficiently among these numerous supernovae, we study type classification of supernovae using machine learning technologies. Our classifier using Deep Neural Network enables classification in a short time after observation by learning with simulated data before observation and directly inputting photometric information. We tried this classifier to select candidates for the follow-up observations together with conventional template fitting in the HSC transient survey from 2016 to 2018. We present the performance of the classifier and how we classified supernovae type using machine in actual supernova survey.

"Time-Domain Astronomy in the Multi-Messenger Era"
Contribution talk
11/22/2019, 11:20 - 11:40

Nozomu Tominaga
(Konan University)

Title: **High-cadence transient surveys with Subaru/Hyper Suprime-Cam**

Abstract: We perform high-cadence transient surveys with Subaru/Hyper Suprime-Cam (HSC) with time intervals of about one hour. We find five rapidly rising transients at z = 0.384-0.821 and a rapidly declining blue transient at z=0.4229 in the two-successive-nights observation with an image subtraction technique. Their absolute rates of brightness change are faster than 1 mag per day. The rapidly rising transients are consistent with early emission from core-collapse supernovae, e.g., the cooling envelope emission from the explosion of red supergiants or the shock breakout from a dense wind. On the other hand, the rapidly declining blue transient is consistent with none of the transients or variables observed so far. Comparisons with theoretical models demonstrate that a shock breakout at the stellar surface of an explosion of red supergiant star with the low-energy explosion energy of $< 0.4 \times 10^{51}$ erg reproduces its multicolor light curve. These discoveries show that the high-cadence multicolor optical transient survey with intervals of about one hour and continuous and immediate follow-up observations is important for studies of normal core-collapse supernovae at high redshifts.

"Time-Domain Astronomy in the Multi-Messenger Era"
Contribution talk
11/22/2019, 11:40 - 12:00

Nao Suzuki
(Kavli IPMU, Univ of Tokyo)

Title: **Progress Report on HSC SNIa Cosmology Program**

Abstract: We report the status of ongoing Type Ia Cosmology program in the framework of Subaru Hyper-Suprime Cam SSP. The second season of SSP Ultra Deep Field (SXDS) is being observed and supernovae are being discovered as we speak. Infrared photometric follow-up by Hubble Space Telescope is triggered on the best / highest redshift supernovae and followed by spectroscopic observations by Keck, VLT, Gemini, GTC and AAT. We aim to achieve the best constraint on dark energy and introduce live supernova as well as our challenges on calibration and systematic errors.

"Time-Domain Astronomy in the Multi-Messenger Era"
Contribution Poster
Poster ID: P54

Yen-Chen Pan

(NAOJ)

Title: **Probing the Progenitor Metallicity of SNe Ia with Ultraviolet Spectra**

Abstract: Ultraviolet (UV) observations of Type Ia supernovae (SNe Ia) are useful tools for understanding progenitor systems and explosion physics. In particular, UV spectra of SNe Ia, which probe the outermost layers, are strongly affected by the progenitor metallicity. Theory suggests that SN Ia progenitor metallicity is correlated with its peak luminosity, but not its light-curve shape. This effect should lead to an increased Hubble scatter, reducing the precision with which we measure distances. If the mean progenitor metallicity changes with redshift, cosmological measurements could be biased. Models also indicate that changing progenitor metallicity will have little effect on the appearance of optical SN data, but significantly alter UV spectra. Here we use the largest UV spectroscopic sample of SNe Ia to date to study the metallicity effect. With this sample, we confirm theoretical predictions that SN Ia UV spectra are strong metallicity indicators. Our findings show that UV spectra are promising tools to further our understanding of SN Ia while directly improving the utility of SN Ia for cosmology.

"Time-Domain Astronomy in the Multi-Messenger Era"
Contribution Poster
Poster ID: P55

Kengo Takagi
(Hiroshima University)

Title: **Structure of circumstellar matter in helium nova V445 Puppis and its time evolution**

Abstract: V445 Pup (Nova Puppis 2000) is known as the first helium nova. Its stellar system would consist of a massive white dwarf and a helium star, and could be a strong candidate for a Type Ia supernova progenitor. To explore the structure of the stellar system and its evolutional stage, we performed optical and near-infrared observations, including one epoch Subaru/FOCAS photometry and spectroscopy.

Our spectropolarimetry during the outburst stage suggests that the bipolar outflow found by near-infrared AO imaging >4 years after the outburst already blew even at the outburst phase and that there were pre-existing scattering clouds along the circumstellar disk only the earliest stage of the outburst. The optical spectrum at 11 years is dominated by [O III], [O II] and He I lines, suggesting the hydrogen-poor circumstellar matter ionized by the nova remnant is seen and the possible helium star is obscured. At 18 years, the optical and near-infrared light is still about 3 mag fainter than that before explosion, but, in recent 3 years, the optical light is gradually brightening while the near-infrared light is almost stable or slightly faded, which cannot be explained by a simple clear up of the dusty circumstellar matter.

Instruments and Software session
Poster ID: P01

Naoyuki Tamura
(Kavli Institute for the Physics and Mathematics of the Universe, the University of Tokyo)

Title: **Prime Focus Spectrograph (PFS): Overview of the instrumentation and its current status**

Abstract: PFS (Prime Focus Spectrograph), a next generation facility instruments on the Subaru telescope, is a very wide-field, massively multiplexed, and optical & near-infrared spectrograph. Exploiting the Subaru prime focus, 2400 reconfigurable fibers will be distributed in the 1.3 degree-diameter field of view. The spectrograph system has been designed with 3 arms of blue, red, and near-infrared cameras to simultaneously deliver spectra from 380nm to 1260nm in one exposure. The instrumentation has been promoted by the international collaboration under the initiative of Kavli IPMU. The team are actively integrating and testing the hardware and software of the subsystems. Last year in 2018, we managed to deliver one of them, Metrology Camera System, to the observatory at the summit of Maunakea, and subsequently tested it on the telescope in the nighttime. The development of the other subsystems is steadily progressing, aiming at starting engineering observation in 2020, and science operation from 2022. We are also making substantial simulation efforts to develop a survey plan in the framework of Subaru Strategic Program (SSP). In this presentation, we will give an overview of the instrumentation, current status and future perspectives.

Instruments and Software session
Poster ID: P02

Shiang-Yu Wang
(ASIAA)

Title: **Prime Focus Spectrograph (PFS): The metrology camera system**

Abstract: The metrology camera system (MCS) serves as the optical encoder of the fiber motors for the configuring of fibers in PFS. MCS provides the fiber positions within a 5 microns error over the 45 cm focal plane. The information from MCS is fed into the fiber positioner control system for the closed loop control. MCS locates at the Cassegrain focus of Subaru telescope in order to cover the whole focal plane with one 50M pixel Canon CMOS camera. It is a 380mm Schmidt type telescope which generates a uniform spot size with a ~10 micron FWHM across the field for reasonable sampling of the point spread function. The positions of all fibers can be obtained within 0.5s after the readout of the frame. This enables the overall fiber configuration to be less than 2 minutes. The system was completed in early 2018 and delivered to Subaru telescope in April 2018.
In this report, we will present the major components for MCS and the latest test results of MCS during the engineering run with Subaru telescope.

Instruments and Software session

Poster ID: P03

Shiang-Yu Wang

(ASIAA)

Title: **Prime Focus Spectrograph (PFS): The status of integration and testing of Prime Focus Instrument**

Abstract: The prime focus unit of PFS called Prime Focus Instrument (PFI) provides the interface with the top structure of Subaru telescope and also accommodates the optical bench in which Cobra fiber positioners are located. In addition, the acquisition and guiding cameras (AGCs), the optical fiber positioner system, the cable wrapper, the fiducial fibers, illuminator, and viewer, the field element, and the telemetry system are located inside the PFI. The mechanical structure of the PFI was designed with special care such that its deflections sufficiently match those of the HSC's Wide Field Corrector (WFC) so the fibers will stay on targets over the course of the observations within the required accuracy. The PFI structure and component was delivered in 2017 and the integration of PFI started in 2018. The integration of the Cobra modules started in 2019. In this report, the latest status of PFI development will be given including the procedure of the PFI integration, the integration and testing results.

Instruments and Software session

Poster ID: P04

Daniel Reiley

(Caltech)

Title: **Prime Focus Spectrograph (PFS): Delivery of subassemblies from Caltech**

Abstract: The team in Pasadena, including Caltech, JPL ,and LNA, have completed all assemblies for the Prime Focus Instrument (PFI) subsystem of Prime Focus Spectrograph (PFS). These items include mechanical, electrical, and optical subassemblies and subsystems. By far the largest task was the delivery of 44 Cobra modules, each of which integrates 57 fibers, microlenses, and positioners, as well as mechanical support and electrical drive electronics. Quality of these assemblies was controlled via detailed work instructions and was monitored via metrology of many performance characteristics. One of these characteristics, beam angle, is shown in detail.

Instruments and Software session
Poster ID: P05

Brent Belland
(California Institute of Technology)

Title: **Prime Focus Spectrograph (PFS): FRD testing of individual Cobras and Cobra modules**

Abstract: Focal ratio degradation (FRD) is a degradation in angular distribution of light exiting an optical fiber, relative to its angular distribution at the fiber's input. This effect is important to the Subaru PFS because it affects the point spread function in the spectrographs, thereby affecting the fidelity of sky subtraction. Caltech has completed detailed studies on FRD in fibers, with precise measurements on the fiber level, detailed system-level simulations, and preparation for module-level measurement in production.

Instruments and Software session

Poster ID: P06

David Le Mignant

(Laboratoire d'Astrophysique de Marseille (LAM, Aix-Marseille Université, CNRS))

Title: **Prime Focus Spectrograph (PFS): integration and performance tests of the spectrograph modules**

Abstract: The spectrograph modules for the Prime Focus Instrument are now in the phase of assembly, integration and tests, fully verified first in France, then at Subaru telescope in Hawaii. In this poster, we report on the assembly, integration and tests of the first two spectrograph modules at Laboratoire d'Astrophysique de Marseille (LAM, Marseille, France). We briefly present the hardware configuration, the functional performance and alignment procedures. We then present and discuss the image quality results (ensquared energy, spectral resolution, scattered light, etc.). The 2019-2021 schedule for the integration & tests for the 4 spectrograph modules, leading to the Subaru spectrograph readiness is also presented.

Instruments and Software session

Poster ID: P07

Ligia Souza de Oliveira

(Laboratorio Nacional de Astrofisica - Brazil)

Title: **Prime Focus Spectrograph (PFS): Fiber Optics System**

Abstract: The fiber optic system to be used in the PFS project was divided into three parts being called; Cable A, Cable B, and Cable C. When A, B, and C cables are connected they will form a cable with a 65-meter cable. We have chosen two types of optical fiber manufacturer, Fujikura, and Polymicro so we could get better performance. Each of these parts makes a connection using connectors that have been developed to connect 651 optical fibers at once time. The fibers start at Cable C where we have the light input, it passes through the connectors, Cable B, and ends in the slit, Cable A, where we have the light output being analyzed by 4 spectrographs in the total of 2394 fibers. We describe and show how each of these parts is assembled. Also, we describe the type of polish for optical fibers and the assembly of fibers terminations.

Instruments and Software session
Poster ID: P08

Graham J. Murray
(Durham University)

Title: **Fibre Cables from FMOS to PFS and beyond - Development of a Unique Fibre Cable Manufacturing Process for Subaru MOS Projects.**

Abstract: For integral-field and multi-object astronomical spectroscopy, fibres offer unique flexibility by enabling spectrographs to be located remotely from the telescope focal plane. Photon-starved observations demand optimum optical efficiency, so fibre losses must be minimised. In addition to intrinsic absorption in the fibre, another loss mechanism, so-called “focal ratio degradation” (FRD) must be considered. A fundamental cause of FRD is stress, therefore low stress cables that impart minimum fibre FRD are essential. FMOS for Subaru Telescope employed a highly effective cabling solution developed at Durham University in collaboration with the company PPC Broadband Fiber Ltd. The manufacturing process has been improved and reapplied for PFS, thus maintaining a long and productive relationship between Durham and NAOJ Subaru Telescope. The methods have subsequently found wider application in DESI and are likely to feature in MSE, ELT-HiRES and several large format IFU schemes. The process, planetary stranding, is adapted from the manufacture of marine telecommunications cables. Fibre bundles describe helical paths through the cable, incorporating additional fibre per unit length. As a consequence fibre stress from tension and bending is minimised. This poster describes the stranding principles and the manufacturing process, incorporating the latest test data from the PFS science cables.

Instruments and Software session
Poster ID: P09

Neven Caplar
(Princeton University)

Title: **Prime Focus Spectrograph (PFS): Development of the 2D sky subtraction algorithm**

Abstract: Sky subtraction in 2D offers natural advantage over the subtraction in 1D as it able to account for the full complexity of the PSF, some of which is always lost when simplifying a PSF to a 1D problem. The main factors that need to be known to model individual PSFs are the optical aberrations and the illumination of the spectrograph camera. This final illumination of the camera depends on the properties of individual fibers and the vignetting at the entrance to the fiber. We have been developing an algorithm which will be
able to predict the 2D PSF at any position on the detector plane and under various vignetting angles. Drawing from our experience from the HSC project, we have been analyzing the strongly defocused arc data taken at the optical bench in order to precisely characterize optical aberrations across the whole detector plane. Use of defocused images also allows us to decouple the influence of the focal-ratio degradation in the fiber and the optical aberrations on the final PSF. We plan to use this algorithm to remove the wings of the bright sky lines. We show some preliminary results demonstrating the quality of the subtraction.

Instruments and Software session
Poster ID: P10

Takuji Yamashita
(NAOJ)

Title: **Prime Focus Spectrograph (PFS): Development in flux calibration and sky subtraction**

Abstract: We report the current status of our software development on flux calibration and sky subtraction for the Subaru Prime Focus Spectrograph (PFS) data. PFS, a next generation instrument, is a very wide-field multi-object spectrograph in optical and near-infrared wavelength. PFS simultaneously observes 2394 spectra of 380-1260 nm wavelength using fibers distributed over the 1.3 deg diameter field of view. We are developing software modules for flux calibration and sky subtraction in a data reduction pipeline, taking part in an international collaboration.
The flux calibration is performed using F-type stars which are pre-selected from broad-band colors (e.g., HSC-SSP). We use the AMBRE stellar model templates to type observed spectra into stellar sub-groups and produce the flux calibration vectors. In our sky-subtraction module, we adopt a 1D algorithm in contrast to the 2D algorithm being developed for the main data reduction. We presume that our module will be useful in quick analysis if we make the 1D algorithm faster than the 2D one.

Instruments and Software session

Poster ID: P11

Vincent Le Brun

(Laboratoire d'Astrophysique de Marseille)

Title: **Prime Focus Spectrograph (PFS) : An overview of the automatic redshift measurement and spectral analysis pipeline**

Abstract: The PFS consortium will propose a large scientific program shared between 3 large spectroscopic surveys that will gather hundreds thousands of galaxy/QSO spectra in various redshift ranges. It is therefore necessary to develop an automated redshift estimation and spectral analysis pipeline, that will also deliver a reliability level of the measurement, as well as basic spectral parameters (line fluxes, equivalent widths).
This poster describes the methods we use, as well as preliminary results on the first simulated data.

Instruments and Software session

Poster ID: P12

Maximilian Fabricius

(Max-Planck for Extraterrestrial Physics)

Title: **Prime Focus Spectrograph (PFS): Fiber assignment and Survey Planning**

Abstract: The galaxy evolution and galactic archeology components of the PFS survey will target the same patch of sky from several dozens to 100 times. The problem of allocating PFS' 2394 fibers to objects over many visits of a field is a highly non-trivial optimization problem that we solve though linear programming. Our new network flow approach models the fiber allocation as a generalized network min-cost/max-flow problem inspired by SDSS, but extends this to address the variety of conditions and requirements of the the PFS survey. It offers a clear sense of an optimal solution; while it may not find a globally optimal solution in finite computational time, it generally provides a very good solution in reasonable amounts of time and gives a clear quantitative measure of just “how good it is”. Our approach generally yields higher total number of observed science objects per given number of observations than “greedy” allocation algorithms and respects constraints like the minimal number of allocated calibration fibers, and the completion of already started objects. Finally, collisions are taken into account in an iterative manner by interfacing to a python reimplementation of the fiber collision simulation code.

Instruments and Software session
Poster ID: P13

Kiyoto Yabe
(Kavli IPMU)

Title: **Prime Focus Spectrograph (PFS): the SSP survey plan and simulations**

Abstract: A large spectroscopic survey using Prime Focus Spectrograph (PFS) in the framework of the Subaru Strategic Program (SSP) is now under planning. The survey, which consists of 3 science topics (cosmology, galactic archaeology, and galaxy/AGN evolution), has various conditions, for instance, (1) there are different target fields widely, (2) there are targets with different exposure time and scientific priority in the same field, (3) there may be requirements on the observation season and cadence. Considering this complexity, one of the important tasks is to make one coherent survey plan maximizing the entire scientific outputs.

We are now planning a detailed survey design conducting many simulations with the survey simulator in development. The survey simulator provides the optimal observation schedule for a given list of target fields and the required observing time. We also conduct detailed end-to-end simulations by simulating the entire process from the target selection to the data quality assurance, in which software we use in the actual operation such as fiber allocation software is partly implemented. In this presentation, we report the current status of the survey design and the survey simulations in detail.

Instruments and Software session

Poster ID: P14

Kiyoto Yabe

(Kavli IPMU)

Title: **Prime Focus Spectrograph (PFS): the expected performance**

Abstract: Prime Focus Spectrograph (PFS) on Subaru Telescope has a power of conducting large spectroscopic surveys thanks to its wide field-of-view, multiplicity, and wide spectral range. The expected performance of the instrument should be defined beforehand to plan the survey design and carry out the feasibility study of targets in interest.

PFS project office presents the expected performance partly using the actual throughput measurement of some instrument components and provides some tools such as the exposure time calculator (ETC) and the spectral simulator. In this poster, we present the latest performance that we expect, showing an example of simulated spectra.

The sky subtraction capability is also critical to the performance for especially faint targets at higher redshift. We examine the possible uncertainty of the sky subtraction utilizing the ETC assuming several possible cases of the sky subtraction residual. We also examine the effect of fiber aperture by using the optical model of the telescope and instrument. In this poster, we also present the recent progress of these studies and discuss a possible impact on the scientific performance.

Instruments and Software session

Poster ID: P15

Masayuki Tanaka

(NAOJ)

Title: **Prime Focus Spectrograph (PFS): Science Database**

Abstract: Prime Focus Spectrograph (PFS) is going to deliver a large number of spectra with a wealth of information about emission and absorption lines of objects. In order to handle and explore the massive data efficiently, National Astronomical Observatory of Japan (NAOJ) and the Johns Hopkins University (JHU) are building a data analysis environment for PFS that serves both HSC imaging data and PFS spectroscopic data. The combination of these data sets makes it difficult to carry out science in a classic 'download-data-and-analyze-locally' way; the total data volume is too big (over several hundred TBytes) to be transferred over the network. We provide a Jupyter Notebook environment, where users can login and analyze data on a remote server, thus eliminating massive data transfer. We combine the SciServer environment developed by JHU and a number of data analysis tools developed by NAOJ to build this Jupyter Notebook environment. We are prototyping a system and iterating with science users to make the system ready for science by the time PFS starts science operation. We describe the current status and discuss future development plans.

Instruments and Software session
Poster ID: P16

Junko Furusawa
(Astronomy Data Center, NAOJ)

Title: **Current Status of SMOKA**

Abstract: SMOKA (Subaru-Mitaka-Okayama-Kiso Archive system, URL: https://smoka.nao.ac.jp) provides to general users with public data observed with the Subaru Telescope and several optical and infrared telescopes operated by Japanese institutes. SMOKA not only promotes further utilization of observational data for research and educational activities, but also enables verification of research results. The system has been in operation since June 2001. The data size of 33TB are downloaded from SMOKA, and 14 academic papers based on the archived data came out in the last fiscal year. One of the biggest changes of the service recently made is hosting Hyper Suprime-Cam (HSC) raw data, which was started in February 2014. In particular, we have been successfully providing the raw data from the Subaru Strategic Program with HSC, synchronously with its public data releases (February 2017 and May 2019). We report developments and usage status of the SMOKA system in the past year, and discuss our future scheme of operation and improvements.

Instruments and Software session

Poster ID: P17

Hisanori Furusawa

(NAOJ)

Title: **Hyper Suprime-Cam SSP Public Data Release 2**

Abstract: The Subaru Strategic Program (SSP) with Hyper Suprime-Cam (HSC) is a wide-field imaging survey for covering 1400 square degree fields by five optical wavebands (g, r, i, z, y), which is cooperated by an international collaboration of Japan, Princeton University, and the Taiwan community. The project involves development of pipeline, data processing, and construction of a data archive service for products. In May 2019, we launched the second public data release (PDR2). This release includes processed images and catalogs for over 300 square degrees of multi-waveband data (March 2014 through January 2018). The data set comprises Wide (r~26) and Deep+UltraDeep (D+UD) data (r~27.5-28). The D+UD data are covered by four narrow-band (NB387, 816, 921, 1010) as well as the five broad bands. The products involves several new important features including a bug fix in PSF modeling, sky-background subtraction using a global pattern across field-of-view, scattered light subtraction in the y band, and improvement in a coaddition and source detection. The archive service provides users with useful functions to retrieve necessary data, such as catalog search, image cut-out, an interactive viewer. We will discuss the project status and plan for the future releases.

Instruments and Software session

Poster ID: P18

Stephen Gwyn

(Canadian Astronomy Data Centre)

Title: **Stacking the Suprime-Cam image archive at the CADC**

Abstract: To increase the legacy value of the Suprime-Cam data, the CADC is calibrating and stacking the entire archive. The individual raw images are detrended (bias-subtracted and flat-fielded) using the sdfred2 software package. The images are astrometrically calibrated using GAIA and photometrically calibrated using Pan-STARRS. The individual images are then resampled and stacked using SWarp on to a grid of tiles covering the sky.

Instruments and Software session
Poster ID: P19

Masayuki Kuzuhara
(Astrobiology Center, NINS / NAOJ)

Title: **Instrument, Software, and Operation Status of the InfraRed Doppler Spectrograph (IRD)**

Abstract: InfraRed Doppler (IRD) is the high-dispersion (R ~ 70,000) spectrograph that works on the Subaru Telescope mainly to find and characterize exoplanets based on precision radial velocity (RV) measurements in the near-infrared. Laser frequency comb (LFC) that ranges from about 1 to 1.7 um calibrate IRD's RV measurements, enabling the efficient RV sampling for cool objects like late-M dwarfs. The adaptive optics system, AO188, corrects the wavefront error of object light, which is then injected into optical fibers through fiber injection module and transferred to the spectrograph. IRD employs several mode-scramblers to suppress modal noise of multi-mode fibers. In future, the extreme AO system, SCExAO, can be used with IRD, allowing us to optimize the use of single mode fibers. IRD has been available for science observations since 2018, and it is now running for the Subaru Strategic Program (SSP) and open-use observations. Here, we report the latest status of IRD's instrument, and its software for observation operation and data reduction. Our report includes the stability of our RV measurements that have been tested from our on-sky observations.

Instruments and Software session

Poster ID: P20

Kentaro Motohara

(University of Tokyo)

Title: **Performance of New NIR Imager/MOS Spectrograph SWIMS on the Subaru Telescope**

Abstract: SWIMS, a simultaneous-color wide-field infrared multi-object spectrograph, is one of the first generation instrument for the University of Tokyo Atacama Observatory 6.5m telescope, which is no under construction at Chile. For an initial test and performance verification, we have installed SWIMS on the Cassegrain focus of Subaru telescope and successfully carried out two engineering runs. By the data obtained, we have verified that the performances of SWIMS is as good as designed, and is capable of carrying out science observations. In this presentation, we will introduce the design and performances of SWIMS and show the future plan of its operation.

Instruments and Software session

Poster ID: P21

Sebastien Vievard

(Subaru Telescope - Observatoire de Paris - Astrobiology Center)

Title: **FIRST instrument at Subaru - Status and upgrades**

Abstract: FIRST, the Fibered Imager foR a Single Telescope instrument, is an ultra-high angular resolution spectro-imager, able to deliver calibrated images and measurements beyond the telescope diffraction limit, a regime that is out of reach for conventional AO imaging.

FIRST achieves sensitivity and accuracy by coupling the full telescope to an array of single mode fibers. Interferometric fringes are spectrally dispersed and imaged on an EMCCD. An 18-Fiber FIRST setup is currently installed on the Subaru Coronographic Extreme Adaptive Optics instrument at Subaru telescope. It is being exploited for binary star system study. In 2020 it will be upgraded with delay lines and an active LiNb03 photonic beam-combining chip allowing phase modulation to nanometer accuracy at MHz.

On-sky results at Subaru Telescope have demonstrated that, thanks to the ExAO system stabilizing the visible light wavefront, FIRST can acquire long exposure and operate on significantly fainter sources than previously possible. A similar approach on a larger telescope would therefore offer unique scientific opportunities for galactic (stellar physics, close companions) and extragalactic observations at ultra-high angular resolution.

Instruments and Software session

Poster ID: P22

Malte Schramm

(NAOJ)

Title: **A second generation astro-comb for SUBARU/HDS**

Abstract: We have developed a new astro-comb operating in the visible wavelength regime for installation at SUBARU-HDS. The astro-comb with its mode spacing of 30 GHz will provide a precise wavelength calibrator for HDS to allow precision spectroscopy over a wide wavelength range covering 350-830 nm in three broadband windows. We will give an overview of the instrument and show first performance results based on an extensive test in summer 2019 at the Okayama observatory where the comb is tested on the HIDES spectrograph mounted at the 1.88m telescope.

Instruments and Software session
Poster ID: P23

Koki Terao
(Tohoku University)

Title: **ULTIMATE-START I: Subaru Tomography Adaptive optics Research experimenT overview**

Abstract: We present the current states of ULTIMATE-START (Subaru Tomography Adaptive optics Research experimenT) project, which is a laser tomography adaptive optics experiment modifying the current AO188 laser guide star system. Main goal of the project is to improve the LGS AO performance and achieve AO correction in the shorter wavelength range down to 650 nm. In a single laser guide star (LGS) system, there is a "cone effect" problem that an LGS cannot cover the whole cylindrical light path of a science object. Thus, the accuracy of wavefront measurement and performance of the current LGS-AO is limited. As a method of reducing the cone effect, it has been proposed to cover the cylindrical region with multiple LGSs. Besides, the wavefront correction is performed in high precision by breaking the atmospheric turbulence in altitude direction using the tomography technique. Our LTAO system will be operated by four Shack–Hartmann wavefront sensors (WFS) and four LGSs. We are making the design of WFS systems and optimizing by numerical simulations.

Instruments and Software session

Poster ID: P24

Yoshito Ono

(Subaru Telescope)

Title: **ULTIMATE-START II : Performance evaluation with AO simulations**

Abstract: The ULTIMATE-START (Subaru Tomography Adaptive optics Research experimenT) is a project led by Tohoku University in Japan to install a laser-tomography adaptive optics (LTAO) mode into AO188, which is a facility SCAO system operating at the Subaru telescope. The goal of this project is to improve the AO performance especially in visible wavelength and to demonstrate technologies for the future ULTIMATE-Subaru GLAO system. We will use 4 laser-guide stars (LGSs) and 4 Shack-Hartmann wavefront sensors (SH-WFSs) for the high-order tomographic wavefront measurement. The low-order mode is measured with one natural guide star (NGS) observed by the 2x2 SH-WFS in AO188, and the DM in AO188 applies the LTAO correction. In this presentation, we will present our performance evaluation for the LTAO system based on numerical simulations, including influences from brightness and angular distance of NGS and comparison with the current AO188 SCAO mode, under various of observation conditions and wavelengths.

Instruments and Software session
Poster ID: P25

Hajime Ogane
(Tohoku University)

Title: **ULTIMATE-START III : Atmospheric turbulence profiling for a tomography AO**

Abstract: We are developing a new laser tomography adaptive optics system for the Subaru telescope. In this system, tomographic estimation of atmospheric turbulence with 4 laser guide stars is going to be used in order to measure the effect of turbulence and to realize high Strehl Ratio observation in short wavelength range. The angle between two laser guide stars is only a few ten arcseconds, which makes the tomographic estimation an ill-posed inverse problem. Then, it is essential to get low resolution atmospheric turbulence profile as a prior information for tomographic estimation. In order to obtain the atmospheric turbulence profile, we are proposing to use Shack-Hartmann wavefront sensor scintillation information as a MASS(Multi Aperture Scintillation Sensor; Tokovinin 1998) measurement. The merit of the approach is the wavefront sensors in AO system can be used, and the atmospheric turbulence information in the same direction to the target can be obtained in real time. In this poster, we will report the detail of this method and current development status.

Instruments and Software session
Poster ID: P26

Yosuke Minowa
(Subaru Telescope)

Title: **ULTIMATE-Subaru: Project overview and current status**

Abstract: ULTIMATE-Subaru is a Subaru's next facility instrument project, which will provide wide-field near-infrared survey capability in late 2020s. ULTIMATE-Subaru will be equipped with a Ground-Layer Adaptive Optics (GLAO) system, which uniformly improves image quality over a wide field of view by correcting for the turbulence at the ground layer of the Earth's atmosphere. The GLAO system consists of an adaptive secondary mirror, laser guide star facility, and wavefront sensor systems at Nasmyth IR (NsIR) and Cassegrain (Cs) foci. The telescope will be modified to have maximum FoV at Cs (~20') and NsIR (~14'). We have successfully passed a conceptual design review of the GLAO system in 2018. Currently, preliminary design studies for GLAO and conceptual design studies for WFI and MOIRCS upgrade with GLAO are ongoing, as well as GLAO key subsystem prototyping and on-sky demonstration. In this presentation, we will provide ULTIMATE project overview and timeline. We will also introduce our current activities on the instrument design and the key technology development.

Instruments and Software session
Poster ID: P27

Yusei Koyama
(Subaru Telescope)

Title: **ULTIMATE-Subaru: science overview**

Abstract: We present an overview of the science goals of ULTIMATE-Subaru project - the development of ground layer adaptive optics (GLAO) on Subaru. The improved image quality (0.2" at K-band in the median conditions) over the wide FoV (~20-arcmin in diameter) will bring strong impacts on a wide variety of science fields in astronomy from studies of the very high-redshift universe to the present-day universe (including our Galaxy). In my poster, based on the extensive discussion within the ULTIMATE-Subaru science team over the last few years, we will summarize our key science goals, survey design, and the expected outcome of ULTIMATE-Subaru, including its great synergy with the other Subaru facility instruments (HSC/PFS), as well as the future space missions (JWST/WFIRST/Euclid). We hope to share the science capabilities of ULTIMATE-Subaru with all participants in the conference (including scientists from outside the current Subaru community), and to promote discussion on the wide-field strategy of Subaru during the conference.

Instruments and Software session

Poster ID: P28

Kentaro Motohara

(University of Tokyo)

Title: **ULTIMATE-WFI : Wide Field Imager with 200 square arcmin FoV**

Abstract: ULTIMATE Wide Field Imager (WFI) is a near-infrared wide field imager for Subaru GLAO system, now under conceptual design phase. WFI will be installed on the Cassegrain focus and cover FoV of 14arcmin on a side with image quality less than 0.1arcsec, to sample the 0.2arcmin image quality over 20 arcmin diameter of the GLAO system. As the diameter of the FoV is over 600mm, the optics is divided into four barrels with square field lenses under room temperature, with gaps less than 1arcmin. Each barrel has at least two filter wheels, one for broad/medium-band filters and the other for narrow-bands, and be imaged with a HAWAII-4RG 15um array. Preliminary design study of the optics shows good image quality of spot size less than 0.1arcsec over whole FoV, proving the feasibility of WFI. In this poster, we will introduce the WFI concept and its current design.

Instruments and Software session
Poster ID: P29

Etsuko Mieda
(Subaru Telescope)

Title: **Laser Guide Star Facility upgrade for ULTIMATE: SCAO, LTAO, and GLAO at Subaru**

Abstract: Since its first light with 36 elements in 2002 and with 188 elements in 2006, Subaru's AO facility has been providing excellent corrected seeing for many kinds of science for the past 17 years. In 2011, our AO system was further improved by the addition of a laser guide star facility (LGSF) which increased the sky coverage by a factor of three. In the next decade at Subaru, our AO system will step forward into the next scale by introducing laser-tomography (LT) and ground-layer (GL) AO modes, whose project names are ULTIMATE-START and ULTIMATE-Subaru. ULTIMATE-START is a milestone project toward ULTIMATE-Subaru to demonstrate a multi-laser system at Subaru where we also enhance the AO correction for observations in the visible. ULTIMATE-Subaru will develop a next facility-class GLAO system at Subaru with an adaptive secondary to strengthen the extremely wide-field capability of Subaru Telescope.

In this presentation, we focus on a LGSF upgrade aspect of ULTIMATE project for the upcoming LTAO and GLAO systems at Subaru. We expect to install the TOPTICA laser in a single-beam configuration for SCAO in 2020, a four-beam configuration for LTAO in 2022, and a wide-asterism configuration for GLAO in 2025.