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2.1 Follow-up of the First Known Interstellar Object

Karen Meech – Invited Speaker

On October 19, 2017 the Pan-STARRS1 telescope discovered a rapidly moving object. Additional astrometry obtained with pre-discovery observations on October 18 through data obtained with the Canada-France-Hawaii-Telescope on October 22 showed that the object had the highest hyperbolic eccentricity ever detected, confirming that this object clearly originated from outside the solar system. By October 30, the orbital eccentricity was 1.1956±0.006 – a 100-sigma confirmation of the hyperbolic nature and was given the designation 1I/2017 U1, and the official name of 'Oumuamua, meaning visitor from the distant past, was approved by the IAU. Beginning on October 22 there was an intense effort to secure observing resources to characterize the object. 1I/2017 U1 passed perihelion on September 9, 2017 and had made its Earth close approach at 63 lunar radii on October 14. Because it was receding rapidly from the Earth and Sun, within a week of discovery the brightness had dropped by a factor of 10 and in less than a month it had dropped by a factor of 100. Thus, there was a period of just over a week where the target could be relatively easily characterized. Deep images of 'Oumuamua showed no hint of cometary activity, with limits on the amount of dust that could be present at less than 7-8 orders of magnitude that of a typical comet at similar distances. Light curve observations showed that the object was rotating with an instantaneous rotation period of 7.34 hours, and a light curve range of 2.5 magnitudes, implying an extremely elongated axis ratio perhaps as large as 10:1. Assuming a low albedo typical of comets (4%) this implies a size of 800x80x80 m. However, as more time series data were obtained, it was evident that 'Oumuamua was in an excited spin state with the long axis precessing around the total angular momentum vector with an average period of 8.67±0.34 hr. The timescale for damping an excited spin in a body this size is very long, so the spin state may reflect the violent process of ejection of 'Oumuamua from its host planetary system. The color of 'Oumuamua was found to be quite red with a spectral slope of 23%±3% per 100 nm, consistent with comet surfaces, the dark side of Iapetus, and other minerals.

Our final experiment was to combine position measurements obtained from the Hubble Space Telescope with ground based measurements to do a detailed study of the orbit. Our analysis of 207 astrometric positions showed that the orbit cannot be fit by a purely gravity-only trajectory, but are well matched (at the 30-sigma level) by the addition of a radial acceleration. We explored several explanations for the non-gravitational motion, and found that cometary outgassing is the most physically plausible, but requires that 'Oumuamua has a somewhat different nature from solar system comets. In this talk I will present the discovery and initial characterization of 'Oumuamua and present some of the latest results about its acceleration. Support for this work was obtained from NSF grants AST-1617015 and AST-1413736

2.2 Gemini Observations of Active Asteroid 354P/LINEAR (2010 A2)

Invited Speaker – Yoonyoung Kim

Active asteroids are a population of small solar system bodies that show comet-like dust emission but orbit in the main asteroid belt. We conducted Gemini/GMOS-N observations of active asteroid 354P/LINEAR (2010 A2) when it made its closest approach to Earth (i.e., the geocentric distance of 1.06 AU on 2017 January 27-28). Taking advantage of the best observing geometry since the discovery, we obtained the first evidence for the rotational status of the largest fragment (~120 m in diameter), which was slowly rotating, that is, the rotational period of 11.36 hours. In addition, we succeed in direct imaging of 10 sub-fragments (~20 m in diameter or larger). Based on these new observational results, we conjecture that this active asteroid was created as a result of catastrophic collision among unknown asteroids. This work was supported by the K-GMT Science Program (PID: GN-2016B-Q-14) of the Korea Astronomy and Space Science Institute (KASI).

2.3 High-Resolution Imaging with 'Alopeke's Wide Field Mode

Elliott Horch

'Alopeke is a two-channel speckle imaging system recently completed and installed at GCAL port of the Gemini-North Telescope. Its design is based on a similar instrument, the NASA Exoplanet Star and Speckle Imager (NESSI), which was previously commissioned at the WIYN telescope. In addition to a standard, narrow field-of-view speckle mode, both instruments also have a wide-field mode that has a full-frame field of view of approximately one arc minute squared. An initial assessment of the high-resolution capabilities of the 'Alopeke instrument in its wide field mode will be given. In particular, although 'Alopeke undersamples speckles in the wide field mode, we have developed the use of speckle-related analysis techniques that allow for resolution down to nearly Nyquist sampling rates (0.16 arcseconds). These techniques result in astrometry and photometry that are particularly useful in crowded stellar fields. The algorithms can also be extended to obtain an increase in the contrast of surface features on extended objects. Some examples will be discussed, and comments on the science enabled by this mode will be given.

2.4 z-Band Photometry Reveals Three Distinct TNO Surface Types

Invited Speaker – Rosemary Pike

Several different classes of trans-Neptunian objects (TNOs) have been identified based on their optical and near-infrared colors. As part of the Colours of the Outer Solar System Origins Survey (Col-OSSOS), we have obtained g-, r-, and z-band photometry of 26 TNOs using Subaru and Gemini Observatories. Previous color surveys have not utilized z-band reflectance, and the inclusion of this band reveals significant surface reflectance variations between sub-populations. The colors of TNOs in $g - r$ and $r - z$ show obvious structure, and appear consistent with the previously measured bi-modality in $g - r$. The distribution of colors of the two dynamically excited surface types can be modeled using the two-component mixing models from Fraser & Brown. With the combination of $g - r$ and $r - z$, the dynamically excited classes can be separated cleanly into red and neutral surface classes. In $g - r$ and $r - z$, the two dynamically excited surface groups are also clearly distinct from the cold classical TNO surfaces, which are red, with $g - r > 0.85$ and $r - z < 0.6$, while all dynamically excited objects with similar $g - r$ colors exhibit redder $r - z$ colors. The z-band photometry makes it possible for the first time to differentiate the red excited TNO surfaces from the red cold classical TNO surfaces. The discovery of different $r - z$ colors for these cold classical TNOs makes it possible to search for cold classical surfaces in other regions of the Kuiper Belt and to completely separate population, which overlaps in orbital parameter space. The discovery of different $r - z$ colors for these cold classical TNOs makes it possible to search for cold classical surfaces in other regions of the Kuiper Belt and to completely separate cold classical TNOs from the dynamically excited population, which overlaps in orbital parameter space.

3 Review of GPI Science and Possible Upgrades

3.1 State of the GPIES Survey

Bruce Macintosh

The Gemini Planet Imager (GPI), a coronagraphic adaptive optics instrument designed for spectroscopy of extrasolar planets, had first light in 2013. After five years, GPI has resulted in 46 papers. The core GPI program is the GPI Exoplanet Survey (GPIES), a 600-star survey of young nearby stars to detect self-luminous extrasolar planets and constrain their occurrence rates, and to observe circumstellar debris disks. I will review the status of the GPIES project and preliminary conclusions on the occurrence rate of giant (2-13 MJ) planets in wide (10-100 AU) orbits. Based on the GPIES data, I will present a summary of on-sky GPI performance and lessons learned. The two most significant factors determining bright star contrast performance are atmospheric coherence time and the presence of dome seeing. With a possible move to Gemini North, we are planning potential upgrades including a pyramid-sensor based AO system with predictive control; we will summarize upgrade options and the science they would enable.

3.2 Characterizing 51 Eri b from 1 to 5 _m: A Partly Cloudy Exoplanet

Invited Speaker – Laurent Pueyo

We first discuss the capabilities of the Gemini Planet Imager instrument for exoplanet spectroscopy, and we highlight its ability to deliver a uniform and self-consistent family portrait of the atmospheric composition of nearby young Jovian and sub-Jovian exoplanets. We then discuss in more details the spectro-photometry spanning 1-5 µm of 51 Eridani b, a 2-10 MJup planet discovered by the Gemini Planet Imager Exoplanet Survey. 51 Eri b photometry is redder than field brown dwarfs as well as known young T-dwarfs with similar spectral type (between T4-T8) and we propose that 51 Eri b might be in the process of undergoing the transition from L-type to T-type. We used two complementary atmosphere model grids including either deep iron/silicate clouds or sulfide/salt clouds in the photosphere, spanning a range of cloud properties, including fully cloudy, cloud free and patchy/intermediate opacity clouds. Model fits suggest that 51 Eri b has an effective temperature ranging between 605-737 K, a solar metallicity, a surface gravity of log(g) = 3.5-4.0 dex, and the atmosphere requires a patchy cloud atmosphere to model the SED. From the model atmospheres, we infer a luminosity for the planet of -5.83 to -5.93 (logL/L$\odot$), leaving 51 Eri b in the unique position as being one of the only directly imaged planet consistent with having formed via cold-start scenario. Comparisons of the planet SED against warm-start models indicates that the planet luminosity is best reproduced by a planet formed via core accretion with a core mass between 15 and 127 M$\oplus$.

3.3 Direct Imaging of Alpha Centauri A and B with the Gemini Planet Imager

Rusian Belikov

We present the results of observing Alpha Centauri A and B with the Gemini Planet Imager (GPI) in Y-band. Because of its unusual proximity to the Sun (the next Sun-like star is 2.4 times farther away), Alpha Centauri is a favorable outlier that presents a possibly unique opportunity to image planets and disks in reflected light with an instrument like GPI, as well as to do so in the habitable zone of both A and B stars. We observed in Y-band in order to have an easier expected planet-star contrast ratio, because models predict higher albedos in Y-band than at longer wavelengths for giant planets. We also used differential polarimetry mode on aCen B, both to gain extra sensitivity (at least for polarized planets and disks) as well as to study the polarizations of any found planets and disks. In addition, the high brightness of Alpha Centauri is expected to enable deeper contrast performance after post-processing. The combination of our observing mode and high brightness of Alpha Centauri is expected to enable imaging of Jupiter-size planets in the habitable zones of both stars, or even Neptune size planets if they are 50% polarized. Although radial velocity non-detections imply that Jupiter-mass planets probably cannot exist around Alpha Centauri, low-density Jupiter radius planets are still possible. We will describe the progress of our

program to date, including science results as well as an analysis of systematics and performance enhancements enabled by brighter stars.

3.4 Results from LP Program Characterizing Dusty Debris Disks with the Gemini Planet Imager

Invited Speaker – Christine Chen

Some exoplanetary systems contain not only planets but also minor body belts, analogous to the asteroid and Kuiper belts in our Solar System. Planets in these systems gravitationally perturb minor bodies, placing them on crossing orbits where they collide, creating debris dust. Detailed studies of the scattered light from the debris dust can constrain the size and porosity of the grains and therefore the mechanisms by which the dust and parent bodies are processed. The Gemini Planet Imager (GPI) has provided high Signal-to-Noise Ratio (SNR) spectroscopic and polarimetric observations of predominantly bright, highly inclined debris disks. These observations enable detailed measurements of the total intensity and polarization fraction phase functions and the near-infrared reflected light spectrum. We present some recent results using GPI to constrain the properties of circumstellar dust in debris disks from the Gemini Large and Long Program "Characterizing Dusty Debris in Exoplanetary Systems".

3.5 GPI Large Program: Scattered Light Imaging of Young Stellar Objects

Invited Speaker – John Monnier

Abstract Text: The discovery of transition disks around young stars has provided the opportunity to study planet formation in situ when giant planet formation and growth are most vigorous. We know young circumstellar disks disappear on a few million year timescale and we see strong spatial variations in dust and gas around such young stars, presumably directly related to the planet formation process. Using the Gemini Planet Imager (GPI) in differential polarimetry mode, we are carrying out a survey to characterize a statistically-significant sample of young disks at each major stage of planet formation, from the youngest “full disk” stage and through pre-transition and transition disk stages. GPI is ideal for this survey due to its unprecedented sensitivity to scattered light emitted between 20-150 AU from the star, a region of the protoplanetary disk where giant planet formation is known to occur. The diffraction-limited resolution of Gemini South will allow disk features to be imaged with ~6 AU resolution for the first time, including possible gaps, cavities, puffed-up dust “walls,” asymmetries or spiral density waves. We are currently about half way through our data collection phase of the survey work and I will present some early imaging and modeling results.

3.6 Debris Disk Campaign Results from the Gemini Planet Imager Exoplanet Survey

Tom Esposito

We summarize results from the debris disk imaging campaign of the Gemini Planet Imager Exoplanet Survey (GPIES) as it nears completion. This survey uses GPI's polarimetric and spectroscopic modes to detect circumstellar debris disks in dust-scattered near-IR light and has produced 25 detections out of 80 nearby young stars selected for disk observations since 2013. With the high angular resolution provided by the Gemini South telescope and GPI's high-order adaptive optics, we are probing the ~10--100 au regions of these planetary systems down to < 1 au scales for the closest stars. Thus, our data inform us about regions known to host planets; for instance, the predominance of forward-scattering particles among our detections (implied by their high average inclination) suggests a particular range of sizes and material compositions for the debris. We will show detections of disks in the GPIES sample, including several disks for which we achieved the first scattered-light and/or polarized intensity detections. We will also briefly describe our target sample, observing procedure, and data reduction process. Finally, we will discuss preliminary estimates of our survey's sensitivity to scattered-light disks and statistics gleaned from our sample that provide broader understanding of the debris disk stage of planetary system evolution.

4 Invited Session – Strategic Plan for Gemini in the 2020s

4.1 Gemini in the LSST Era

Eric Bellm

Gemini's large aperture, versatile instrument suite, and flexible observing modes make it an ideal facility for followup observations of targets identified by the Large Synoptic Survey Telescope (LSST) in the 2020s. I will provide an overview the LSST surveys and data products most relevant to the Gemini community.

4.2 Building a Time Domain Follow-up Network for the LSST Era

Todd Boroson

The world-public alert stream from LSST will have the potential to enable breakthroughs in many areas of study, including supernovae, TDEs, exoplanets, AGN physics, solar system objects, and diverse phenomena in stars and stellar systems. However, much of this opportunity will be lost unless the research community is prepared to follow up relevant discoveries in an organized and efficient way. Las Cumbres Observatory (LCO) is working with other observatories to build the infrastructure that will make this possible. One part of this is the extension and enhancement of LCO's existing global network of small telescopes through the collaborative participation of larger telescopes with relevant capabilities. Another part is the development of software tools that will enable researchers to gather and manipulate data associated with large samples of specific types of objects and to trigger requests for the needed follow-up observations on any telescope in the network. In this talk, I will present the current characteristics and capabilities of the LCO network, and I will describe the efforts under way to extend this into a capable time domain follow-up network for the LSST era.

4.3 Building the Infrastructure for Time-Domain Science

Tom Matheson

The revolution in time-domain astronomy is occurring right now. The Zwicky Transient Facility is producing hundreds of thousands of time-domain alerts every night. With the start of Large Synoptic Survey Telescope operations, the numbers will approach ten million alerts per night. This volume of alerts is well beyond the amount that individuals can handle on their own. To take advantage of the tremendous opportunities in time-domain science provided by these (and other) surveys, astronomers will need to develop a whole new time-domain ecosystem to enable discovery. I will describe the pieces of the ecosystem, focusing on the ANTARES project. ANTARES is a joint effort between NOAO and the University of Arizona to build a software system that can process the vast numbers of time-domain alerts and sort them into subsets that astronomers can then exploit.

4.4 Gemini in a Time Domain Follow-up Network

Bryan Miller

Gemini Observatory, Gemini South in particular, will be an important facility for following up time-domain discoveries. Queue observing via a variety of proposal routes allows Gemini to easily execute target-of-opportunity (TOO) observations and this capability will be very important for time-domain follow-up. However, additional automation will be needed to handle the expected increase in the number of TOO triggers and other time-domain observations. Changes being considered to the operations model and software will be presented. Finally, we will preview how Gemini could be incorporated into the developing time-domain follow-up network.

4.5 Gemini Strategic Plan

John Blakeslee

I will provide an update on the development of Gemini's multi-faceted Strategic Plan for the 2020s. The Plan is a work in progress, and input from Gemini user community at this meeting will be incorporated into the final version, targeted for completion by the end of this year.

5 Extrasolar Planets

5.1 Population Properties of Brown Dwarf Analogs to Exoplanets

Invited Speaker – Jacqueline Faherty

In recent years, several research teams have used kinematics paired with spectral and photometric peculiarities to identify seemingly field brown dwarfs that belong to young moving groups. This sample of warm (1200 - 2200 K) but extremely low mass (5 - 30 MJup) objects defines an intriguing bridge between giant exoplanets and substellar mass objects. Since 2012, we have been collecting uniform medium resolution (3000 - 6000) spectra of the population of so-called isolated super Jupiters in groups that range from 5 - 300 Myr. Using parallaxes and an abundance of observed data we create spectral energy distributions and derive semi-empirical effective temperatures. The vast collection of medium resolution data we have accumulated contains a wealth of detailed spectral information. In this talk I will show trends in molecular absorption and alkali line features identified as a function of effective temperature rather than spectral type. Binning the sample by age and effective temperature, I speculate that the diversity seen in the features results from variations in atmosphere conditions.

5.2 Revealing the Fundamental Properties of Exoplanets and their Host Stars with 'Alopeke

Steve Howell

Our team has built and delivered 'Alopeke, a new high-resolution imaging instrument, to Gemini North. 'Alopeke is permanently mounted at the GCAL port and while based on our previous visiting speckle imager (DSSI), it provides far more features and observing modes and easier operation.

This talk will focus on our long-term exoplanet characterization program in which we study the host star environment and its effect on exoplanet properties. Using 'Alopeke + Gemini-N, we obtain the highest resolution images available today (on any single telescope) allowing us to peer deep into stellar systems. We will discuss measurements of the distribution in brightness and separation of exoplanet host star systems as well as characterization of the radii and densities of small, rocky exoplanets. We find that the majority of bound companions in exoplanet host star systems, similar to that of field stars, orbit with stellar separations of less than 0.2", typically <10 AUs. Such observations are essentially impossible by any other means thereby making "Alopeke+Gemini-N the only game in town. We will discuss our observational program and the information it provides on stellar parameters, exoplanet validation, true exoplanet size distributions and occurrence rates, and planet formation scenarios.

5.3 Signatures of Rocky Planet Engulfment in HAT-P-4. Implications for Chemical Tagging Studies

Invited Speaker – Carlos Saffe

The detection of a possible chemical signature of planet formation in the photosphere of a star is a challenge for the current observational techniques. It requires a careful selection of the targets, obtain spectra with the highest possible quality (S/N), and a detailed analysis using the so-called full differential technique. I will start this talk by reviewing the statistical trends of metallicity for stars with and without exoplanets, for both main-sequence and giant stars. We will compare the chemical solar pattern with similar stars of the solar neighborhood i.e. solar-twins and solar-analogs, showing that our Sun do present a lack of refractory elements. Then, I will focus on the study of binary stars with similar components, which allow to increase the precision in the derivation of stellar parameters and chemical abundances, by applying the differential technique.

Finally, I will present the results for the remarkable binary system HAT-P-4, with observations acquired through Gemini + GRACES (Gemini Remote Access to CFHT ESPaDOnS Spectrograph) under a fast-turnaround (FT) observing mode. Notably, the exoplanet host star HAT-P-4 is ~0.1 dex more metal rich than its companion, its Lithium content is greater by ~0.3 dex, and is enhanced in refractory elements relative to volatile. We propose a scenario where at the time of planet formation, the star HAT-P-4 locked the inner refractory material in planetesimals and rocky planets, and formed the outer gas giant planet at

a greater distance. The inner rocky material (at least 10 MEarth) where then accreted, resulting the notable chemical pattern that we observe today in this binary system.

6 Galactic Astronomy

6.1 Discovery of a Group of Coherently Receding Variable Halo Stars

Invited Speaker – Sukanya Chakrabarti

We present results from spectroscopic observations of a trio of Cepheid candidates identified from K band light curves toward Norma. The Flamingos-2 spectra show that these stars are moving with a large and similar radial velocity—the heliocentric velocities are 171 ± 32 km/s, 164 ± 37 km/s, and 173 ± 20 km/s. The average radial velocity is 169 km/s, which is large and distinct from typical stars in the Galaxy's stellar disk. Given the radial velocities and associated 1? error, we find that the combined probability that these three stars are foreground Milky Way disk stars is 7 × 10^-4%, and the probability that these are large-amplitude spotted stars in a binary is 10^-5%. These objects at l ~ 333° and b ~ -1° are therefore associated with the stellar halo. The identification of these sources as Type I Cepheids is not certain, and thus the distances of these sources are not yet well established. Assuming the 3.6 ?m period-luminosity relation of Type I Cepheids gives a distance of 78 kpc for these sources.

6.2 GRACES spectroscopy of metal-poor stars

Invited Speaker – Kim Venn

The Gemini Remote Access to CFHT ESPaDOnS Spectrograph (GRACES) delivers high resolution spectroscopy (R~ 67,000) across the optical region (400 to 1000 nm) for stars as faint as V~19, although brighter objects are necessary to reach high SNR, especially at wavelengths > 500 nm.

We have used GRACES to follow-up on known metal-poor stars; these have ranged from stars in the UFD galaxy Triangulum II (Venn et al. 2017), to outer halo stars passing through the solar neighbourhood (Monty et al. 2018), to unusually young alpha-rich stars found in the APOGEE survey (Yong et al. 2016), and most recently the very metal-poor stars found in the CFHT/MegaCam Pristine survey (Keilty et al. 2018).

In all cases, the high resolution spectra are required to determine detailed chemical abundances and measure precision radial velocities to explore the origins and evolution of these stars in terms of the formation and evolution of our Galaxy. This includes the search for chemical signatures that can be associated with the early and/or rapid chemical evolution, or changes in the initial mass function, e.g., carbon enrichments, high [alpha/Fe] ratios or alpha-challenged stars, and details in the neutron capture element ratios. We can also use these data to explore binary characteristics, find escaped stars from globluar clusters, and search for other unusual chemical signatures indicative of formation in rare environments (e.g., Li and K enhancements).

Overall, GRACES has proven to be a very successful collaboration between the Gemini Observatory, Canada-France-Hawaii Telescope, and NRC-Herzberg (Canada).

6.3 Deep GeMS Imaging of Obscured Bulge Globular Clusters

Doug Geisler

The innermost Galactic globular clusters (GGCs) of the Milky Way have been systematically excluded from optical GGC studies due to severe total and differential extinction, despite their importance for studying this independent GC system, which likely includes the oldest object in the Galaxy for which we can derive an accurate age. We have obtained GeMS+GSAOI imaging for a number of inner bulge GGCs spanning a large range in metallicity. By exploiting the unique capabilities of GeMS+GSAOI@Gemini, we can finally begin to place our understanding of bulge GGCs on par with their optically well-studied halo counterparts. We image cluster members in these GGC cores down to the lower main sequence. Combined with homogeneous multi-element abundances we are deriving from APOGEE spectra and theoretical

isochrones, this allows us to self-consistently measure their ages for the first time, with vast implications for the formation history of our Galaxy and its bulge.

6.4 Quenching or bursting? Physical processes in green valley galaxies and the star formation acceleration

Thiago Gonçalves

One of the main open questions in contemporary astrophysics is how galaxies quench star formation. The observed color bimodality is a strong indication that galaxies do not passively exhaust their gas reservoirs, instead requiring an active process that shuts down star formation over short timescales. In this talk I will show recent results by our group measuring quenching timescales of galaxies in different epochs and of different types, supporting the idea that some processes are more efficient for quenching star formation, including a dependence of quenching efficiencies on galaxy morphology. I will also present a new technique combining spectroscopic and photometric indices that allows for a measurement of the time derivative of the star-formation rate, i.e. the star formation acceleration. This new measurement has strong potential for impact on studies of galaxy evolution, comparing for example the quenching timescales of galaxies with and without AGN activity. Nevertheless, it depends strongly on high signal-to-noise spectra of the continuum in nearby and distant galaxies. In that context, I will discuss the need for deep spectroscopic surveys from large telescopes such as Gemini, and future synergies with 30-m class observatories.

6.5 Cosmic Survivors: Symbiotic X-ray Binaries

Invited Speaker – Ken Hinkle

'Symbiotic Stars' describe a group of mass-transfer binary systems consisting of a red giant and a white dwarf or neutron star. These systems are identified in the optical and ultraviolet by the presence in their spectra of both nebular emission lines and late-type giant absorption features. The emission lines result from mass transfer from the late-type star onto the compact secondary. The infrared is largely free of the emission lines and allows the late-type star to be studied. Gemini/Phoenix spectra have been used to determine the orbits and abundances for the late-type star in about thirty symbiotic binaries, about ten percent of the currently known systems. Of particular interest are the systems containing a neutron star. The neutron star binaries are X-ray sources and most of the neutron stars are X-ray pulsars. Neutron star symbiotic binary systems are remarkable in having survived a supernova explosion. I will explore what this survival story tells us.

7 Invited Session – Observatory Synergies

7.1 Plans for the National Center for Optical/IR Astronomy

Beth Willman

7.2 Subaru Telescope: Current Status and Future

Michitoshi Yoshida

The current status and future prospect of the Subaru Telescope are presented. The Subaru Telescope has a unique capability of very wide field observation. A wide field imager, Hyper Suprime-Cam (HSC), whose field-of-view reaches 1.75 square degrees with a spatial resolution of 0.4 arcsec, is operating very well, and a large survey project using HSC, HSC-SSP (Subaru Strategic Program), is in progress. About 70 % of this 300 nights project has been done so far. The on-site assembly and commissioning of the next wide field instrument, Prime Focus Spectrograph (PFS), started in this year. The Metrology Camera was delivered to Hawaii as the first component of PFS in this April and its commissioning is progressing. The science operation of PFS will start in 2021. Recently, early phase of the commissioning of InfraRed Doppler spectrograph (IRD) has been completed. IRD will be partly open to the community in a shared-risk mode

from this August. These Subaru capabilities are complementary to Gemini. I also talk about the status and accomplishment so far of the observation time exchange program between Gemini and Subaru.

7.3 ESO in 2018

Rob Ivison

The European Southern Observatory (ESO) is conducting an ambitious programme, building and operating world-class astronomical observatories on the ground and fostering cooperation in astronomy. In this presentation I will provide an update on recent progress in the various ESO programmes.

7.4 CFHT Status Report and Future Plans

Doug Simons

An update of progress made on many fronts at CFHT over the past few years is provided with a particular emphasis on SPIRou, the latest instrument to arrive at CFHT. Future plans based upon evolving operations and instrumentation, as well as MSE, will be summarized. Thoughts about the challenges to and future of Hawaii astronomy in the 21st century will also be presented.

8 Instrument Development

8.1 Gemini Instrumentation and AO Development Activities

Scot Kleinman

Gemini's instrumentation and adaptive optics development efforts continue to grow. We run an active upgrade program for existing instruments, a facility program to bring new instruments to the Observatory, and a visitor program that allows teams to bring their own instruments to Gemini for their own and general community science. On the upgrade front, we have finished installing new CCDs into both our GMOS instruments; improved the capabilities of our multi-conjugate adaptive optics system at Gemini South, GeMS; and replaced the lasers in the adaptive optics systems at both our telescopes. GHOST, our new high-resolution optical spectrograph is nearing completion for 2019 delivery and our new 8-band, optical to infrared imager and spectrograph, SCORPIO, is in its Critical Design Stage.

Our visiting instruments continue to grow in both number and complexity and we are developing a path to transition selected instruments from our visitor program to become full facility instruments.

Future plans include some additional upgrade, exciting visitor instruments and a focus on AO at Gemini North.

8.2 GHOST Overview

Steve Margheim

The Gemini High-Resolution Optical Spectrograph (GHOST) is a bench-mounted echelle spectrograph to be delivered to Gemini South in 2019. I will present an overview of the instrument design and specifications, give an overview and update of the development and commissioning progress, and discuss some of the exciting science expected to be done with our next facility instrument.

8.3 An Overview of SCORPIO

Massimo Robberto

I present an overview of SCORPIO (Spectrograph and Camera for Observations of Rapid Phenomena in the Infrared and Optical), the facility instrument for Gemini South designed for LSST-transients follow-up and high-efficiency multi-band imaging and spectroscopy. SCORPIO covers the wavelength range 385-2350 nanometers with long slit spectroscopy at R~4000 and simultaneously imaging capability in the {\sl grizYJHK} bands. Thanks to the use of frame-transfer CCDs, it can monitor variable sources with time-resolution of about 50ms.

The project is in CDR phase and is on schedule to be commissioned at the time of the LSST first light.

8.4 GeMS 2.0 begins: results of a successful new laser commissioning and beyond

Gaetano Sivo

Adaptive Optics (AO) systems aim at detecting and correcting for optical distortions induced by atmospheric turbulences. The Gemini Multi Conjugated AO System GeMS is operational and regularly used for science observations since 2013 delivering close to diffraction limit resolution over a large field of view. GeMS entered this year into a new era. The laser system has been upgraded from the old 50W Lockheed Martin Coherent Technologies (LMCT) pulsed laser to Toptica 20/2W CW SodiumStar laser. The laser has been successfully commissioned and is now used regularly in operation.
In this presentation, I will give an overview of the status of our AO operations and developments at Gemini. I will be focusing on GeMS and the science/performance obtained with the instrument. I will go then into the details of the commissioning of the Toptica laser and show the improvements obtained in term of acquisition, stability, reliability and performance. I will also show preliminary results we obtained on our on-sky study of the comparison of our two laser facilities (the toptica and the LMCT). Finally, I will present the first outcomes of our study of moving forward to relocate GeMS to Gemini North.

9 Nearby Galaxies

9.1 Direct Evidence of Hierarchical Assembly of Low Masses From Isolated Galaxy Groups

Invited Speaker – Sabrina Stierwalt

A key prediction of the Lambda Cold Dark Matter paradigm is that the merging of smaller galaxies to form larger ones should also occur at lower mass scales, but direct observational evidence has remained elusive. We present an example of hierarchical structure formation at low mass scales caught in action: the discovery of the first compact, bound groups of galaxies that contain only low mass, dwarf galaxy members. The seven dwarf groups were discovered in the systematically-selected TiNy Titans (TNT) survey of interacting dwarf galaxy pairs which enables a statistical comparison to predictions from cosmological simulations. Within the galaxy mass range to which TNT is complete, our observations of dwarf multiples match predictions of the frequency of such systems from the Illustris Simulation.

9.2 Multiple component kinematical analysis on the SDSSJ0838 'green pea' starburst galaxy: strong outflows and a hidden rotating disk.

Guillermo Bosch

Compact, low mass starburst galaxies, dubbed as Green Peas, have been identified as good local analogs of low metallicity galaxies at high redshift. While their integrated properties have been extensively studied, the spatially-resolved gas-phase kinematics and its relation with their star formation activity, ionization and metallicity properties is still not completely understood. Single Gaussian component analysis on IFU spectroscopy of similar objects has found a mixed sample of both rotating disks and pressure supported systems, but high dispersion spectroscopy (both in long-slit and IFU) revealed a more complex emission line profiles, suggesting various distinct kinematic components. In this contribution, we present deep medium resolution (R~4000) GMOS IFU spectroscopy of the green pea galaxy J0838. We perform a multiple Gaussian fit on a spaxel-by-spaxel basis to the Halpha+[NII] profiles, which allows us to detect the kinematical signature of a rotating disk with relatively low velocity dispersion, otherwise concealed by the presence of strong broad emission components. The broad, low-surface brightness component is spatially extended and suggest the presence of strong outflows (expansion velocities up to 100 km/s) induced by the young, violent star formation activity. These results provide interesting constraints to the mechanisms regulating star formation activity and the escape of ionizing photons from these systems.

9.3 Galaxies and their Central Black Holes

Invited Speaker – Jonelle Walsh

Over the past 15 years it has become increasingly clear that supermassive black holes are essential components of galaxies, as demonstrated by the empirical correlations connecting black hole masses and large-scale galaxy properties. Although about 100 dynamical black hole mass measurements have been made to date, the local black hole mass census is highly incomplete. Gaining a more complete picture of black hole demographics and a deeper understanding of the mechanisms that drive black hole/galaxy evolution requires the measurement of black holes in a wider range of galaxy types with varied evolutionary histories. In this talk, I will discuss on-going efforts to expand the diversity of host galaxies with robust dynamical black hole mass measurements, including progress made through a Gemini Large and Long Program utilizing NIFS assisted by laser guide star adaptive optics.

9.4 Insights from stellar kinematics of early-type galaxies from the MASSIVE survey

Irina Ene

Using spectroscopic observations from the GMOS-N IFU and the Mitchell wide-field IFU, we report on kinematics and kinemetry results for a selection of galaxies from the MASSIVE survey with M*>10^11.5 solar masses. By parameterizing the line-of-sight velocity distributions using the standard Gauss-Hermite series, we explore the radial behavior of the first 4 kinematic moments of the studied galaxies. Using kinemetry, we quantify local features found on these velocity maps and we determine the amount of misalignment between the kinematic and photometric axes. High-resolution stellar kinematics that resolve the sphere of influence of supermassive black holes are a crucial ingredient in dynamical modeling of the black hole's mass. Combined with wide-field kinematics that can constrain the dark matter halo mass, we can gain insight into the structure of very massive early-type galaxies.

9.5 The past and the present of NGC 1316 through Gemini + GMOS

Favio Faifer

We present here the results obtained from a photometric and spectroscopic study of the CG system of the early type galaxy NGC 1316 (Fornax A), based on observations obtained with Gemini + GMOS. The photometric properties of this system and of the galaxy are analyzed, confirming the presence of different sub-populations of CGs, in which a remarkable subpopulation of bright and intermediate colors objects stands out. Our data are analyzed in conjunction with Vr data published by other authors. In particular, ages and metallicities of a sample of 35 CGs confirmed by deep GMOS spectroscopy are presented, finding that this sample is dominated by a set of young metal rich CGs. These results are compared with other data, also obtained with GMOS, belonging to other early-type galaxies which show no evidence of recent star formation. The data set is analyzed and an attempt is made to give clues about the past of NGC 1316. We conclude that these pieces of evidence could indicate that this galaxy has cannibalized one or more gas-rich galaxies, where the last fusion event took place around 2 Gyr ago.

9.6 Low Surface Brightness Galaxies: Challenging Gemini Observational Limits?

Analía Smith-Castelli

The very faint end of the early-type galaxy population is defined by dwarf spheroidal (dSph) galaxies, which are extended objects displaying extremely low-surface brightnesses (mu_g > 24 mag arcsec^{-2}) and no evidence of star formation. Originally identified in the Local Group (LG), the number of studies of this type of galaxies beyond the Local Volume has increased significantly in the last years. The interest in the identification of new examples of such extremely faint galaxies resides in the fact that they can be used as test-beds to constrain models predictions. For example, are they formed in-situ, or are they structures kinematically decoupled and gravitationally bound that arise from the interaction of massive galaxies? In this context I will present the progress in the study of low surface brightness galaxies in different environments, carried out by the research group on "Extragalactic Stellar Systems and their Cosmological Context" of Instituto de Astrofisica de La Plata (Argentina, http://seecc.fcaglp.unlp.edu.ar/). Our results are based on deep optical images obtained with the Gemini telescopes.

9.7 Deep IFS View of Nuclei of Galaxies survey: first results

Roberto Bertoldo Menezes

We are conducting the Deep IFS View of Nuclei of Galaxies (DIVING3D) survey of bright galaxies in the Southern hemisphere. The purpose of this project is to observe the nuclear regions of all galaxies in the Southern hemisphere brighter than B = 12.0. The sample has a total of 170 objects. Most of the observations are being taken with the Integral Field Unit (IFU) of the Gemini Multi-Object Spectrograph (GMOS), at the Gemini South telescope. The main goals of this survey are to study the nuclear emission-line properties, the circumnuclear emission-line properties, the stellar and gas kinematics, and also the stellar archeology in the central regions of the objects in the sample. Here we present the first statistical results of the nuclear emission-line properties of the sample.

10 Visitor Instruments

10.1 Gemini Infrared Multi-Object Spectrograph

Suresh Sivanandam

The Gemini Infrared Multi-Object Spectrograph (GIRMOS) is a powerful new instrument being designed for the Gemini telescope that takes advantage of the latest developments in adaptive optics (AO) and integral field spectrographs. GIRMOS will carry out simultaneous high-angular-resolution, spatially-resolved, infrared (1-2.4 µm) spectroscopy of four objects (each 3”x3”) within a two-arcminute field of regard by taking advantage of GeMS and multi-object AO (MOAO). This capability does not currently exist anywhere in the world and offers significant gains over a very broad range of scientific topics in astronomical research. For example, current scientific programs for high redshift galaxies are pushing the limits of what is possible with infrared spectroscopy at 8-10-meter class facilities by requiring several hours of observing time per target. Multiplexing several objects simultaneously with MOAO is absolutely necessary to make effective use of telescope time and obtain statistically significant samples for high redshift science. With an expected commissioning date of 2023, GIRMOS’s capabilities will also make it a key follow-up instrument for the James Webb Space Telescope when it is launched next year, as well as a true scientific and technical pathfinder for future Thirty Meter Telescope (TMT) multi-object integral field spectroscopic instrumentation.

10.2 BATMAN@Gemini, a Visiting DMD-based Spectro-Imager: Instrumentation and Science Cases

Frederic Zamkotsian

We are proposing a new generation spectro-imager called BATMAN as a Visiting Instrument on Gemini. Next-generation astronomical instrumentation could be based on MOEMS programmable slit masks for multi-object spectroscopy (MOS). MOS is used extensively to investigate astronomical objects optimizing the Signal-to-Noise Ratio (SNR): high precision spectra are obtained and the problem of spectral confusion and background level occurring in slitless spectroscopy is cancelled. Fainter limiting fluxes are reached and the scientific return is maximized both in cosmology, in galaxies formation and evolution, in stellar physics and in solar system small bodies characterization.

We are developing a 2048x1080 Digital-Micromirror-Device-based (DMD) MOS instrument. A two-arm instrument has been designed for providing in parallel imaging and spectroscopic capabilities. In a high spatial resolution mode, well-suited to be mounted behind GeMS, the field of view (FOV) is 1.5 arcmin x 0.8 arcmin with a plate scale of 0.05 arcsec per micromirror and per detector pixel. The wavelength range is in the visible and the spectral resolution is R=1000 for 0.1 arcsec object. The instrument will have two 2k x 4k CCD detectors. Thanks to its compact design, high throughput is expected. The two arms with F/4 on the DMD are mounted on a common bench, and an upper bench supports the detectors thanks to two independent hexapods. The stiffness of the instrument is guaranteed thanks to a box architecture linking both benches. The volume of BATMAN is 1.4x1.2x0.75 m3, with a total mass of 400kg.

Mounting of all sub-systems has been done and integration of the individual arms is under way. This instrument will be placed initially on the 3.6m Telescopio Nazionale Galileo in the Canarias Islands at the end-2018. BATMAN on the sky is of prime importance for characterizing the actual performance of this new family of MOS instruments, as well as investigating the new operational procedures on astronomical objects (combining MOS and IFU modes, different spatial and spectral resolutions in the same FOV, absolute (spectro)photometry by combining imaging and spectroscopy in the same instrument, automatic detection of transients …). The schedule is to move this optimized instrument on Gemini in 2020-21 to benefit from a larger telescope diameter as well as unique abilities of its Adaptive Optics System.
Science cases for BATMAN@Gemini, as well as first simulations, will be finally presented.

10.3 MAROON-X: An Earth-Finder Spectrograph for the Gemini Observatory

Jacob Bean

Exoplanet surveys have recently progressed to the point of discovering small, potentially terrestrial planets orbiting in circumstellar habitable zones. Assessing the true degree of habitability of these worlds requires gaining knowledge of both their bulk and atmospheric properties. In this talk I will summarize the development of MAROON-X, which is a high precision radial velocity spectrograph that is scheduled to be commissioned at Gemini North as a visitor instrument in early 2019. MAROON-X is designed to measure the masses, and thus constrain the densities of potentially Earth-like worlds around late M dwarfs. I will describe how MAROON-X will be used in conjunction with facilities like TESS, JWST, and the ELTs to make the first credible searches for habitable environments beyond our Solar System.

10.4 ‘Alopeke - Evolution of an instrument line and capabilities

Nicholas Scott

`Alopeke is a new speckle imager built at NASA's Ames Research Center for community use at Gemini-N. It is a dual channel instrument operating in the visual with both speckle and wide-field modes. The speckle mode has a FoV of 6.7" while the wide-field mode has a FoV of 60". The instrument is functionally similar to the NESSI instrument installed at the WIYN telescope at KPNO; both instruments have evolved from the DSSI instrument previously used at Gemini North and South. A primary role of these instruments is exoplanet validation for the Kepler, K2, TESS, and many RV programs. The diffraction-limited imaging available through speckle effectively eliminates distortions due to the presence of Earth's atmosphere by `freezing out' changes in the atmosphere by taking extremely short exposures and combining the resultant speckles in Fourier space. This technique enables angular resolutions at the diffraction limit. Our instruments provide the highest spatial resolution available today on any single telescope. Contrast ratios of 6 or more magnitudes are easily obtained with the instrument's two emCCD cameras. Simultaneous dual-color speckle observations down to 17th magnitude can help characterize detected companions. The wide field imaging mode enables fast time-series and traditional photometry with narrow band or SDSS filters.

10.5 The First IGRINS Visit to Gemini Observatory

Hwihyun Kim

The Immersion Grating Infrared Spectrometer (IGRINS) is a high resolution (R=45,000) spectrometer with a broad wavelength coverage in H and K bands (1.45-2.50 microns). After it was first commissioned on the 2.7m Harlan J. Smith Telescope at McDonald Observatory in Spring 2014, IGRINS was used for more than 350 nights in the first two years there. Due to its fixed format echellogram and the compact cryostat with no cryogenic mechanisms, IGRINS is highly adaptable to various facilities. In 2018A IGRINS was offered as a visiting instrument at Gemini South. This allowed the Gemini community to have an access to this revolutionary new instrument and the IGRINS science community to observe fainter targets and southern-sky targets. IGRINS was the most demanded instrument at Gemini South in the 2018A call for proposals. In total 50 nights were awarded to the 21 IGRINS programs investigating young stellar systems and their

protoplanetary disk evolution, exoplanet candidates, properties of low-mass stars, and the interstellar medium.

11 Cosmic Explosions

11.1 The Gemini Perspective on Neutron Star Mergers

Invited Speaker – Ryan Chornock

11.2 DES Supernova Cosmology Results

Invited Speaker – Ryan Foley

The Dark Energy Survey is a 6-year NOAO survey program with a primary goal to study the nature of dark energy through multiple probes, including measuring the expansion history of the Universe using Type Ia supernovae (SNe Ia). Through the first 3 years of the survey, we have obtained over 200 cosmological useful, spectroscopically confirmed SNe Ia to a redshift of 0.85. With this sample, our preliminary results are consistent with a Lambda CDM Universe with the dark-energy equation-of-state parameter consistent with -1 with a 6% uncertainty. Gemini spectroscopy has been key to increasing the number of spectroscopically confirmed SNe Ia in our cosmology sample, especially at the highest redshifts. These spectra also provide additional information about the SN explosions, including the velocity of the ejecta. The ejecta velocity has been shown to correlate with the intrinsic color of a SN Ia, and evolution with redshift could cause a systematic bias in our cosmological inference. The Gemini sample, with its large redshift reach, is critical for constraining SN evolution and biases.

11.3 The Kepler Supernova Experiment

Steve Margheim

The early light curves of supernovae contain important information on the nature of these systems and their progenitor systems. Traditional, ground-based, supernovae surveys typically detect supernova days after the initial explosion and have sparse data for the earliest times after explosion. Very few well-studied supernovae have both the early-detection and cadence necessary to detect these early-time features. The Kepler/K2 mission provides a continuous 30-minute cadence and crucial observations of the early rise time, previously inaccessible to other studies. This early information, combined with the exquisite photometric accuracy available from a space-based observatory, allows us, for the first time, to compare theoretical models and progenitor system signatures to observations. Kepler/K2 Campaigns 16 and 17 were dedicated to monitoring ~20,000 galaxies in order to provide a statistical sample of the best light curves ever obtained. Gemini/GMOS spectroscopy at part of a Large and Long Program was crucial in the classification and confirmation of our supernovae candidates, in addition to the wealth of information observed at facilities worldwide. Here we will present an overview of the Kepler Supernova Experiment and share early results.

11.4 Using Gemini/GMOS to Understand One Massive Lensing Cluster and One QSO Host Galaxy

Brenda Frye

We present results from two different projects using Gemini/GMOS data: one pertaining to a galaxy cluster and another to a QSO host galaxy. First, we undertook a Gemini/GMOS redshift census of galaxies in the field of the massive lensing cluster PLCK G165.7+67.0 (G165) at z=0.351 (PI: Frye, GN-2016A-Q-30). We reduce and analyze the data using both the IRAF/Gemini pipeline and a custom-built code in IDL. Based on a total of 17 cluster redshifts, we measure a dynamical mass that is a factor of 3-4 higher than the lensing mass within 250 kpc. We also discover a hint of a radial velocity gradient across the cluster which has the implication that the cluster is not spherically-symmetric. We infer that the non-spherical arrangement of mass may be responsible for inflating the value for the dynamical mass. Secondly, we set out to measure the redshift of the emitting gas in the projected vicinity of the luminous QSO PG1543+489 (z=0.40). Although QSO hosts are historically studied using HST imaging, thanks to the availability of an

optical IFU on Gemini/GMOS we were able to get spectroscopic information of the region surrounding the QSO from the ground. In the course of the data reduction, we encountered the obstacle that the IRAF/Gemini supported pipeline stops short of supplying 3D co-addition and 3D viewing software. This motivated us to write our own IDL Widget. We find that even on aggressive binning of the data, we were unable to detect spectral features above the noise limit at any redshift. This curious lack of emission line features may be a result of the gas being partially-ionized or even ablated from this satellite object of the QSO.

12 Active Galactic Nuclei

12.1 Gas inflows and outflows around nearby AGN mapped with Gemini IFUs

Invited Speaker – Thaisa Storchi Bergmann

Our group AGNIFS - AGN Integral Field Spectroscopy - has been mapping the gas and stellar kinematics of nearby active galaxies using the Gemini instruments NIFS and GMOS-IFU. I will discuss the main results of our search of non-circular motions -- inflows and outflows in ionized and molecular gas, used to gauge the mass budget of the AGN feeding and the impact of the outflows on the host galaxy. Outflows are common, but are unexpectedly seen, in many cases, perpendicularly to the ionization axis, and, when seen along this axis, are much less extended (few 100 pc) than the region ionized by the AGN (kpc's). The latter includes gas rotating in the plane of the galaxy beyond the outflow. Inflows have been observed along nuclear spirals and bars (within few 100 pc from the nucleus), both in ionized and molecular gas, with the molecular gas usually having a lower velocity dispersion, indicating a "colder" kinematics consistent with being more "confined" in a compact (~100 pc's) thin disk in the plane of the galaxy.

12.2 The first 62 AGN observed with MaNGA : gas excitation & surface mass density distribution

Janaina do Nascimento

We present maps for the ionized gas flux distributions, excitation and surface mass density for the first 62 Active Galactic Nuclei (AGN) observed with SDSS-IV MaNGA, and compare them with those of a control sample of non-active galaxies. We find that, for the early-type AGN, the ionized gas is more concentrated in the nuclear region, when compared with the controls, while for the late-type galaxies the gas distribution is similar to that in the controls, being spread throughout the galaxies. The total ionized gas mass ranges from $\approx 10^5$ Msun to $\approx 10^8$ Msun , with a distribution of values with a median just slightly larger for the AGN (1.7×10^6 Msun) than for the controls (0.9×10^6 Msun) but with a standard deviation larger than the difference between the two. The main difference between the AGN and controls is on the ionized gas mass surface density within 0.2Re (effective radius) that is larger for the AGN than for the controls, with a larger difference observed for the early-type than for the late-type galaxies. This difference between the AGN and controls is highest for the highest luminosity AGN and becomes lower as the AGN luminosity decreases. We calculated average profiles of the gas surface mass density and show that they are steeper in AGN than in the controls within the inner 0.4Re for the highest luminosity AGN ($L([OIII]\lambda 5007) \geq 3.8 \times 10^{40}$ erg s^{-1}), being similar to those of the controls beyond this radius and for lower luminosity AGN.

13 Distant Galaxies and Cosmology

13.1 Gemini Observations of Galaxies in Rich Early Environments (GOGREEN Survey)

Invited Speaker – Michael Balogh

GOGREEN is a Large and Long Program on Gemini to study the evolution of low-mass galaxies at $1.0 < z < 1.5$, a time when the interplay between galaxies and their host dark matter haloes is expect to be very different from today. By simultaneously tracing the growth of those haloes over cosmic time with changes in the stellar populations and star formation rates of the galaxies, we will answer fundamental questions

about how galaxies acquire, consume and expel their gas as they evolve. The spectroscopic survey is about 65% complete, and the corresponding imaging campaign is also nearing completion. I will present the survey design and status, as well as early results on the growth of the quiescent galaxy population in the galaxy cluster sample.

13.2 The SPT-GMOS Spectroscopic Survey: Velocity Dispersions and Velocity Segregation of ~100 Massive Galaxy Clusters

Matt Bayliss

I will present results from SPT-GMOS, a spectroscopic survey with Gemini/GMOS-South targeting Sunyaev Zel'dovich-selected galaxy clusters identified by the South Pole Telescope. Our full spectroscopic sample includes 2868 cluster member galaxies spanning 0.3 < z < 1.1, all of which we classify as passive, post starburst, or star-forming using well-established spectral indices. These data yield velocity dispersion estimates for nearly 20% of the full SPT-SZ galaxy cluster sample, contributing to the calibration of the mass function and cosmology. We also use the full cluster member spectroscopic sample to study the ensemble phase space properties of SPT galaxy clusters. There are clear differences between the velocity distributions of cluster member galaxy populations as a function of spectral type and luminosity at high confidence out to z=1.1. Star-forming cluster galaxies tend to have larger peculiar velocities than passive/post starburst galaxies, and the most luminous cluster galaxies (m < m* - 0.5) have significantly smaller peculiar velocities than fainter cluster members, a signature of dynamical friction. We compare these results to simulations, finding good agreement in the cluster galaxy velocity distributions segregated by spectral type, but find that simulated galaxy clusters do not exhibit the same strong velocity segregation with luminosity that we see in the data. Finally, we investigate a new method of using velocity segregation comparisons between data and simulations to measure the effective velocity bias in our data. Measuring velocity bias in this way suggests that large spectroscopic surveys can improve dispersion-based mass-observable scaling relations for cosmology even in the face of velocity biases, by quantifying and calibrating them out.

13.3 The Massive and Distant Clusters of WISE Survey (MaDCoWS)

Invited Speaker – Mark Brodwin

The Massive and Distant Clusters of WISE Survey (MaDCoWS) is a comprehensive program to detect and characterize the most massive galaxy clusters in the Universe at z ~ 1, and is the only all-sky survey sensitive to galaxy clusters at this epoch. The foundation for this program is data from the NASA Wide-field Infrared Survey Explorer (WISE). The primary goal is to study the evolution of massive galaxies in the most overdense environments at z > 1 when star formation and AGN activity may be peaking in these structures. Spitzer follow-up imaging of 2000 MaDCoWS clusters has allowed us to select the richest and/or most distant clusters for detailed study. To date we have spectroscopically confirmed over 40 MaDCoWS clusters at 0.8 < z < 1.5, the majority via Gemini GO and LLP observations. These clusters span a wide range of halo masses (1-10 x 10^14 Msun), and include the discovery of the most massive z > 1.15 cluster found to date, as well as a cluster at z = 1.23 cluster that is lensing a z = 2.22 supernova Ia. I will describe the MaDCoWS Gemini LLP program, a key part of the ongoing multiwavelength follow-up of these distant clusters, and briefly describe upcoming studies of galaxy evolution in rich cluster environments at z > 1.

13.4 Discoveries and Properties of High-redshift Quasars with IMS

Invited Speaker – Yongjung Kim

High-redshift quasars are remarkable sample to understand the early universe. Based on the wide field surveys, hundreds of quasars have been discovered at high redshift (z > 5). But most of them are biased toward luminous ones, and it is only recently that faint quasars (M1450 > -24 mag) have been identified. Since faint quasars are thought to occupy a large portion of high-redshift quasars, research on them is

required to see the nature of the whole population. In this talk, we will present our result from the Infrared Medium-deep Survey (IMS), the near-infrared imaging survey covering 120 square degree are on the sky with the depths of J ~ 23 AB magnitudes. Combining the archive optical imaging data, we identified about 200 candidates for high-redshift quasar, and the number has been narrowed down to dozens of highly promising candidates with additional medium-band observations. Until now, about 10 faint quasars at z~5 and 6 have been spectroscopically identified with Gemini and Magellan telescopes. Our result so far suggests that the number of faint quasars may not be high enough to fully account for the cosmic reionization. Furthermore, we obtained a deep NIR spectrum of one of the faint quasars for the first time. This shows a very interesting result that IMS J2204+0112 contains a central black hole as massive as a billion solar mass, corresponding to the low Eddington ratio of 0.1. This low value is distinguishable from those of other luminous quasars at high redshift, implying two possible scenarios for the black hole growth in the early universe.

13.5 Optical followup of the SPT2349-56 protocluster at z=4.3

Scott Chapman

We present deep GMOS spectroscopy and imaging, and Flamingos2 K-band imaging towards the densest protocluster system discovered so far, SPT2349-56 at z=4.3 (Miller et al. 2018, Nature). This system has been recently confirmed, using ALMA in cycle-4, having 15 ULIRGs/SMGs detected in dust-continuum, CO(4-3) and C+ lines within 20" (integrated SFR of ~10^4 Msun/yr). Since it was found in a blind 1.4-mm SPT survey of 2500 deg^2, it is unlikely there are many other systems like these in the entire sky. These observations provide an essential, unbiased, and coherent census of galaxy population in this truly unique protocluster field. We have (i) characterized the environment, by identifying Lyman break galaxies, and (ii) probed the stellar masses of both the ULIRGs and the LBGs in the protocluster through deep Ks-band and Spitzer-IRAC imaging.

14 Tuesday's "Under the Hood" Talks

14.1 Col-OSSOS: discoveries, implications, and the practicalities of observing Solar System objects

Rosemary Pike

The Col-OSSOS LP was designed to acquire a magnitude limited sample of Trans-Neptunian objects (TNOs) discovered in a characterized survey. The sample completeness is particularly critical, as it allows the team to investigate the properties of the intrinsic distribution of TNOs. There were several major challenges for acquiring these observations including object brightness variability (due to rotation) and object motion relative to background stars. Col-OSSOS prioritized custom photometry software development and used priority visitor observing to maximize observations in unbroken blocks. The team also successfully leveraged the Gemini LP award for observing time on CFHT and Subaru, which resulted in a survey with much broader photometric coverage than originally envisioned and increased the program's impact.

14.2 An Overview of Gemini/NIFS Data Reduction

Jonelle Walsh

Our Gemini Large and Long Program address a bias in the types of galaxies for which dynamical black hole mass measurements have been made, exploiting the power of NIFS assisted by laser guide star adaptive optics. To analyze the NIFS data, we have developed a reduction pipeline. In this talk, we will review the main steps involved in NIFS data reduction, and discuss the improvements we have made beyond the standard processing scripts available on the instrument website. The pipeline and documentation will be made publicly available on GitHub.

14.3 Distant Galaxy Cluster Imaging and Spectroscopy with Gemini

Mark Brodwin

We are conducting a Gemini program focused on identifying massive galaxy clusters at z ~ 1 to 1.5 selected from WISE and Pan-STARRs data. The primary goal is spectroscopic confirmation of as many such clusters as possible, within our given time allocation. We will discuss the way we choose WISE-selected clusters to target with GMOS r and z-band pre-imaging, identify likely cluster members from these images, and then design masks to carry out spectroscopy with GMOS.

14.4 DES Supernova Cosmology with Gemini

Yen-Chen Pan

Type Ia Supernovae are exceptionally bright explosions, and their calibrateable brightness make them useful tools in probing the cosmic expansion. However, they are currently limited by the poorly constrained redshift evolution of SN Ia intrinsic colors, which could introduce uncertainties in their use in cosmology. Previous studies have shown that the SN ejecta velocity is highly correlated with its intrinsic color, but uncorrelated with other properties such as luminosity. Since 2015, we have been awarded total 223 hours (including 154 hours from LLP programs) to measure the ejecta velocity of a large sample of high-z SN Ia with Gemini GMOS spectroscopy and constrain any potential evolution in intrinsic color. The SNe Ia were all discovered by the Dark Energy Survey (DES), the only currently running high-z SN survey, and we have successfully obtained the spectra of ~100 high-z events with well-observed multi-color light curves from the Dark Energy Camera (DECam). In this talk, I will focus on more practical aspects of our Gemini programs, including observation scheduling, strategy, and data reduction.

14.5 Seeking the Poisson limit with GMOS

Michael Balogh

GOGREEN is attempting spectroscopy of very faint galaxies (zmag=24.25) through multiple observations totalling up to 15h of integration. Maximizing success from this survey requires reaching the Poisson limit in spectral extraction. In this session we will briefly discuss some of the issues that need to be addressed in data reduction to achieve this limit, with a focus on the charge diffusion effects that are prominent at long wavelengths (>850nm).