Toronto 2015 FUTURE & SCIENCE OF GEMINI OBSERVATORY

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SPEAKER ABSTRACTS

Table of Contents

1 Introduction

1.1 Welcome, State of the Observatory

Markus Kissler-Patig

1.2 Board Perspectives and Future Vision

Michael Balogh – Invited Speaker

1.3 Title: Science Highlights

Nancy Levenson

1.4 Gemini's Fast Turnaround Program

Rachel Mason

The Fast Turnaround program, launched at Gemini North in January 2015, allows users to submit observing proposals every month. This poster will outline how the scheme works and also show some of the data we have collected to measure how well the pilot program is going. We would very much like to hear your thoughts about how the FT program could be optimized; please stop by and let us know!

2 Solar System

2.1 Gemini Observatory Adaptive Optics contributions to Planetary Science

Franck Marchis – Invited Speaker

I will discuss the contribution of high angular resolution imaging and spectroscopy made using the Gemini Observatory Adaptive Optics systems (ALTAIR, NICI and GPI) and the potential of GeMS for the study of multiple asteroid systems, the volcanism of Io and more interesting bodies in the solar system.

2.2 It Takes Two: Simultaneous Exploration of the Outer Solar System with CFHT and Gemini

Michele Bannister – Invited Speaker

We use the Queue flexibility of both Gemini and CFHT for innovative simultaneous colour measurements of trans-Neptunian objects. The resonant populations beyond Neptune offer unique tracers of the early architectural rearrangements of the giant planets of the Solar System. The Outer Solar System Origins Survey (OSSOS), the highest-ranked Large Program on CFHT, is creating a ~500-object sample of the trans-Neptunian region, focussed on resonant populations. This fully debiased sample allows study of the surface properties of trans-Neptunian objects through their broad-band colours. However, these objects show rotational variability on less than half-day timescales.

Complementing the Gemini Large Program "Colours of OSSOS" on bright m_r < 23.5 OSSOS discoveries, we are simultaneously observing the same objects in u' with CFHT, exploring the little-measured features in the ultraviolet of the surfaces of trans-Neptunian objects. The square-degree field of view of CFHT MegaPrime allows us to extend the u' survey to proximate discoveries in the OSSOS sample, at lower SNR. After the first semester some thirty objects have been observed in u', as many measurements as exist in the literature.

2.3 Colours of the Outer Solar System Origins Survey

Wesley Fraser – Invited Speaker

The surfaces of trans-Neptunian objects (TNOs) have for a long time been poorly understood. Only recently has concrete knowledge of the colour distribution, and reasonable theories for the mechanism which produced that distribution, become available. The two leading theories have vastly different consequences for our interpretation of the structure of the protoplanetary disk, with one suggesting the disk was largely stratified, being cut with many separate ice lines, and the other suggesting the disk was thoroughly mixed. It has also been shown that the TNO surface properties strongly correlate with their orbital class, leading to the tantalizing possibility that the combined orbital-colour distribution can be used

as a probe of the relative TNO formation locations with the protoplanetary disc.
The large program, Colours of the Outer Solar System Origins Survey, or ColOSSOS is designed around these ideas. The primary goal of ColOSSOS is to produce the first ever compositional-dynamical map of the outer Solar System. Operating simultaneously with the CFHT ColOSSOS will acquire extremely precise (SNR>25 in all bands) u, g', r', and J photometry of a r'<23.5, brightness limited sample. With ~140 targets extracted from the well calibrated OSSOS survey, the ColOSSOS sample will be the first ever colours sample to have fully characterized discovery-to-characterization biases.
I will present an overview of the ColOSSOS program and demonstrate how colours can be used as dynamical probes of the Solar System's formation. I will also present the first data acquired for the program, and the techniques we are using for the reductions. Finally, I will comment on the additional science enabled by the ColOSSOS program, including resolved binaries work, and lightcurves work at the Subaru telescope.

2.4 The 5:1 Neptune Resonance: Dynamics and Population

Rosemary Pike

Based on 4 objects detected with semi-major axes near the 5:1 external resonance with Neptune, we estimate a substantial and previously unrecognized population of objects, perhaps more significant than the 3:2 (Plutino) resonance population. These external resonances are largely unexplored in both observations and dynamical simulations. However, understanding the characteristics and trapping history for objects in these populations is critical for constraining the dynamical history of the solar system. The 4 objects detected in the Canada-France Ecliptic Plane Survey (CFEPS) were classified using dynamical integrations. Three are resonant, and the last appears to be a resonant diffusion object. The 3 objects are taken to be representative of the population, so by using these detections and the CFEPS characterization (pointings and detection limits) we calculate a population estimate for this resonance at ~1900(+3300 -1400) objects with Hg<8. This is at least as large as the Plutinos (3:2 resonance) at 90% confidence. The small number of detected objects results in such a large population estimate due to the numerous biases against detecting objects with semimajor axes at ?88AU. Based on the dynamical behavior of the known objects, the trapping mechanism for the 5:1 resonance appears to be resonance sticking from the scattering objects. A population could be maintained through periodic scattering object capture, but the efficiency appears to low for a steady-state. The significance of the different capture methods for external resonances can be constrained using multi-band photometry, soon to be measured for similar resonant objects in our Gemini Large Program ColOSSOS.

3 Partner Highlights and Perspectives

3.1 Argentina

Sergio Cellone

An overview of the use of Gemini along recent years by the scientific community in Argentina is presented, showing the strong impact that Gemini had on astronomy in this country. This is quantified by different indicators, including number of refereed papers, international collaborations, PhD Theses, etc. Based on ongoing projects, a summary of our goals for the future is also given.

3.2 Australia

Stuart Ryder

3.3 Brazil

Eduardo Cypriano

3.4 Canada

Craig Heinke

An overview of how Canada uses Gemini (including a few selected science highlights), and of the Canadian community's goals for Gemini.

3.5 Chile
Franz Bauer

3.6 University of Hawaii
Roy Gal

3.7 KASI
Narae Hwang

3.8 United States
Letizia Stanghellini

4 Future Instrumentation

4.1 Development Program and Instrument Procurement Update
Scot Kleinman

4.2 Instrumentation Upgrades: Small Projects
Ruben Diaz

Gemini desire to keep their instrumentation suite competitive. In addition to requesting new and visiting instrumentation, Gemini are investing funds into upgrading their existing instruments. Beginning in 2015 and assisted by the Science Technology Advisory Committee (STAC), Gemini will start this process by launching a Request for Proposals and asking the community to respond to requested instrument upgrade studies and small projects. Here we present the latest status of this activity which will include a prioritized list of candidate upgrade projects and feasibility studies for larger projects.

4.3 An Update on the Gemini High Resolution Optical Spectrograph (GHOST)
Andrew Sheinis

The Gemini High-Resolution Optical SpecTrograph (GHOST) is the newest instrument being developed for the Gemini telescopes, in a collaboration between the Australian Astronomical Observatory (AAO), the NRC - Herzberg in Canada and the Australian National University (ANU). GHOST has completed its Preliminary Design Phase and is now in the Critical Design Phase. We describe the status of the design, and development of this new instrument as well as describe the unique scientific role this instrument will have in an international context, from exoplanets through to the distant Universe.

5 Active Galactic Nuclei

5.1 Mapping Feeding and Feedback Processes of Supermassive Black Holes with Gemini Integral Field Spectrographs
Thaisa Storchi Bergmann – Invited Speaker

A fundamental role is attributed to supermassive black holes (SMBH) and the feedback they generate in the evolution of galaxies. Cosmological models that do not consider these feedback effects end up producing over-massive galaxies. I will discuss Gemini observations of feeding and feedback processes around SMBHs that occur when the SMBH is being fed in Active Galactic Nuclei (AGN). The observations comprise integral field spectroscopy obtained with the instruments GMOS-IFU and NIFS of the inner kiloparsec of nearby AGN hosts at spatial resolution ranging from tens to hundred of pc scales. Feeding is found in the form of gas inflows observed along nuclear spirals and rotation in compact disks. Mass inflow rates are estimated to be ~ 2-3 orders of magnitude larger than the AGN accretion rate, suggesting that the excess gas is depleted via formation of new stars. Young stars are indeed observed in a few cases and

can be interpreted as signatures of co-evolution of the host galaxy and its AGN. Gas outflows are prevalent around the most luminous AGN, with varying geometries, velocities ranging from a few 100 km/s up to ~1000 km/s and mass outflow rates of a few tenths to a few solar masses per year.

5.2 Gas kinematics in the inner kiloparsec of NGC 1386 and NGC 1365: bipolar outflows, rotation and...an equatorial outflow!?

Davide Lena

We used the GMOS integral field unit on the Gemini South telescope to investigate the kinematics of the circum-nuclear ionized gas in two active galaxies: NGC 1386, a Seyfert 2, and NGC 1365, a Seyfert 1. The study is part of a larger program aiming to investigate outflows in low-luminosity AGNs, and the mechanisms channeling gas (the supermassive black hole fuel) from the inner kiloparsec down to few tens of parsecs from the supermassive black hole. We found that the dominant kinematic components can be explained as a combination of rotation in the large-scale galactic disk and compact outflows along the axis of the AGN “radiation cone”. However, in the case of NGC 1386, there is also compelling evidence for an equatorial outflow, which provides a new clue to the physical processes operating in AGNs.

5.3 Observations of quasar feedback

Nadia Zakamska – Invited Speaker

Quasars are now thought to have made critical impact on galaxy formation. In particular, feedback from accretion onto supermassive black holes is implicated in establishing the black hole mass vs galaxy bulge correlations and in limiting the maximal mass of galaxies. Theoretical models predict that both radiative output of the accreting black hole and the relativistic outflows (jets) can make strong impact on the surrounding galaxy, but direct observations of feedback phenomena have been surprisingly difficult to come by. In this talk, I will review the indirect evidence for quasar feedback as required by galaxy formation models. I will then present recent multi-wavelength observations providing direct evidence of powerful quasar-driven winds and outflows on galaxy-wide scales. Much of this progress is enabled by integral field unit observations with Gemini.

5.4 The near-infrared stellar populations of galaxies: models constraints from observations of active galaxies

Rogério Riffel

Studying the unresolved stellar content of galaxies generally involves disentangling the various components contributing to the spectral energy distribution (SED), fitting a combination of simple stellar populations (SSPs) to derive information about age, metallicity, and star formation history. In the near-infrared (NIR, 0.85-2.5μm), the thermally pulsing asymptotic giant branch (TP-AGB) phase -- the last stage of the evolution of intermediate mass stars (M$\lesssim$6M$\odot$) -- is a particularly important component of the SSP models. These stars may be able to dominate the emission of stellar populations with ages $\sim$0.2 - 2 Gyr being responsible for roughly half of the luminosity in the K-band. In addition, when trying to describe the continuum observed in active galactic nuclei, the signatures of the central engine and from the dusty torus cannot be ignored. Over the last years we developed a method to disentangle these three components. Our synthesis shows significant differences between Seyferts\,1 (Sy~1) and Seyferts\,2 (Sy~2) galaxies: the hot dust component is required to fit the K-band spectra of $\sim$90\% of the Sy\,1 galaxies, and only of $\sim$25\% of the Sy\,2; about 50\% of the Sy\,2 galaxies require a FC component contribution $\gtrsim$20\%, while this fraction increases to about 60\% in the Sy\,1; also, in about 50\% of the Sy2, the combined FC and young components
contribute with more than 20\%, while this occurs in 90\% of the Sy1, suggesting recent star formation in the central region. The central few hundred parsecs of our galaxy sample contain a substantial fraction of intermediate-age SPs with a mean metallicity near solar. Two-dimensional mapping of the near-infrared stellar population of the nuclear region of active galaxies suggests that there is a spatial correlation

between the intermediate-age stellar population and a partial ring of low stellar velocity dispersion ($\sigma \star$). Such age is consistent with a scenario in which the origin of the low-$\sigma \star$ rings is a past event which triggered an inflow of gas and formed stars which still keep the colder kinematics of the gas from which they have formed. Besides, we will also discuss the presence fingerprints of features attributed to TP-AGB stars in the spectra of the nuclear region of nearby galaxies.

5.5 Feeding vs. Feedback in AGNs probed with Near-IR Integral Field Spectroscopy

Rogemar Riffel

Abstract Text: We have been observing Active Galactic Nuclei (AGN) using near-infrared (Near-IR) integral field spectroscopy (IFS) for about 10 years. Most of these observations were done with the Gemini's Near-IR Integral Field Spectrograph (NIFS) with adaptive optics at spatial resolutions of tens of parsecs and covering the inner few hundreds of parsecs of the galaxies. So far, we were able to map mass inflow and outflow rates, the ages of the stellar populations and the flux distributions for ionized and molecular emission lines of about a dozen of galaxies. One of the main result is that the molecular and ionized gas have distinct flux distributions and kinematics, with the former being more restricted to the plane of the galaxy - showing inflows in some cases, and the latter extends to high latitudes above the galaxy plane, attributed to emission of gas in outflows from the nucleus. In this work we show a summary of the project, as well as results for galaxies recently observed.

5.6 Discovery of two nuclei in the process of merging in the OH Megamaser Galaxy IRAS17526+3253

Dinalva Sales

Abstract Text: OH Megamaser galaxies (OHMG) comprise roughly 20% of luminous and ultraluminous infrared galaxies (ULIRGs) radiating bright OH masers lines at 1667 and 1665 MHz. (U)LIRGs that host OHMs are predominantly merging systems with a preference for the most far-infrared luminous, suggesting that the presence of OHM require exceptionally high concentrations of dense molecular gas, perhaps associated with a temporal spike in tidally driven gas inflow. We present a two-dimensional analysis of the gaseous excitation and kinematics of the OHMG IRAS17526+3253 obtained with the Gemini Multi-Object Spectrograph Integral Field Unit (GMOS-IFU) on the Gemini North telescope. This merger system is classified as a double Starburst nucleus and is also in an advanced merger stage separated by ?8 kpc, which are each associated with compact (but resolved) radio sources. We centered the GMOS-IFU field-of-view at the brightest 1.49GHz radio emission, corresponding to the southern nucleus. The GMOS-IFU data reveals that this nucleus is actually double, with two sources, appearing both in the continuum and in gas emission, and separated by ~835 pc. These two nuclei have associated extended gas emission distributed over the whole field-of-view (~1.7 x 2.5 kpc), with one system observed in blueshift (coming towards us) and the other in redshift (moving away from us). Our observations thus show that this OH Megamaser system is actually the result of the merger of three galaxies.

5.7 Quasar ionization echos

Mischa Shirmer

Abstract Text: Green bean galaxies feature 30-100 kpc extended emission line regions. They are amongst the most luminous type-2 AGN known at a redshift of 0.3. I will present first results from our deep IFU, imaging and Chandra observing campaigns, highlighting the extraordinary properties of these peculiar galaxies. One of the most intriguing results is that the AGN in Green Bean galaxies appear to have shut down very recently, while the ionizing radiation from the nucleus is still propagating through the gas. We can use these ionization echos to reconstruct the last 100,000 years for individual AGN, obtaining direct observational constraints for the growth of supermassive black holes.

6 Cosmic Explosions

6.1 Title: Gemini: Cosmology from Type II Supernovae

Mario Hamuy – Invited Speaker

Understanding the nature of dark energy arguably constitutes one of the most important current scientific questions and entails a formidable theoretical, observational, and statistical challenge. The answer to this question will require a coordinated effort involving different techniques, each one with its own merits and systematics. Thus, it will be important to identify as many independent observational methods. Here I present novel methods to measure luminosity distances based on Type II SN, particularly those involving solely photometric information, as will be the case of future massive wide field surveys.

6.2 Supernova flash spectroscopy: a new observational window into stellar death

Avishay Gal-Yam – Invited Speaker

We present the technique of flash spectroscopy: rapid spectroscopic observation of supernovae, shortly (hours) after they explode. Strong shock breakout radiation flash-ionizes any surrounding circumstellar material (CSM) distributed around the exploding star, and the resulting recombination emission lines enable a direct measurement of the CSM composition. As the ejecta expand they sweep up the CSM, so a series of spectra tracking the emission line evolution will allow to constrain the physical distribution of gas around each event. The CSM around massive stars is a probe of their evolution during the final year prior to explosion, a critical period not easily accessible till now. We demonstrate the efficacy of this technique with recent studies from the iPTF survey that can regularly detect SNe hours after they explode.

6.3 Recent Gemini results on X-ray Binaries

Craig Heinke

Recent work with Gemini has identified exotic new X-ray binaries, and constrained the masses of neutron stars and black holes. These exotic systems include donor stars that are brown dwarfs, M dwarfs, red giants, and even carbon stars. Gemini radial velocities and/or multiband lightcurve fitting have enabled mass measurements, including the first measurement of the black hole mass in an ultraluminous X-ray source. Finally, Gemini spectroscopy has uncovered a hidden population of accreting X-ray binaries in the Galactic Bulge Survey, an X-ray/optical/IR survey designed to understand the population of quiescent Galactic X-ray binaries.

6.4 Spectrophotometric Evolution of Eta Carinae's Great Eruption

Armin Rest

Eta Carinae is one of the most massive binaries in the Milky Way, and its expanding circumstellar nebula has been studied in detail. It was seen as the second brightest star in the sky during its 1800s ``Great Eruption'', but only visual estimates of its brightness were recorded. We discovered light echoes of the Great Eruption, which allowed us to obtain a spectrum of this event now with modern instrumentation, 150 years after it was first observed. I will present our Gemini follow-up observations with which we have started to retrace Eta Car's 3D spectrophotometric evolution during and before the Great Eruption.

6.5 Studying Dust Formation in Core-Collapse Supernovae with Gemini/GMOS

Geoffrey Clayton – Invited speaker

Recent detections of large amounts of dust in high redshift galaxies suggest that core collapse supernovae (CCSNe) may play an important role in the dust budget of the universe. In these high-z galaxies, with ages less than 1 Gyr, there has not been enough time for low-mass AGB stars to form, so much of the dust may come from high-mass stars in SN explosions. For the past decade, we have been following numerous, nearby CCSNe with Gemini, HST, and Spitzer to look for indications of dust formation, which appear within the first few years of explosion. In particular, I will discuss the results of spectroscopic and imaging

obtained with Gemini/GMOS. I will discuss these results and their implications for SNe as major dust contributors in the universe.

6.6 An X-ray Transient Goes Bump in the Night

Franz Bauer

A fast X-ray transient was discovered by Chandra in the Chandra Deep Field-South field on 2014 October 01. The transient lasted only a few ks in duration, reaching a 0.5-8 keV luminosity of at least ~1e45 erg/s (assuming z_phot > 0.3 from nearest galaxy). Surprisingly, no optical or radio transient was found between ~0.05 to 90 days after discovery to deep limits, thereby ruling out many types of phenomenon. I will discuss what possibilities remain and what may imply for future transient surveys.

6.7 Declining Ultraviolet Emission From a Newborn Type Ia Supernova

Yi Cao

One of the leading progenitor scenarios is the single degenerate channel in which a white dwarf accretes mass from a companion star and the resulting increase in its central pressure and temperature ignites thermonuclear explosion. In this talk, I will present our recent discovery of declining ultraviolet emission from a Type Ia supernova within four days of its explosion. This emission is consistent with radiation expected from interaction between the supernova ejecta and a companion star. Our observation evidently supports that some Type Ia supernovae are produced in the single degenerate channel.

7 Current Partnerships

7.1 Current Gemini Partnerships

Markus Kissler-Patig

7.2 Future Plans of Subaru for Operations and Instruments

Nobuo Arimoto

Future plans of Subaru Telescope for operations and instruments in the context of Gemini (complementary use, joint efforts etc.) and the scientific strategy of Subaru for the era of ELT's will be presented. Subaru's scientific achievements in 2013-2015 will also be briefly introduced.

7.3 Keck Observatory: Current Status and Future Plans

Hilton Lewis

This talk describes the status and plans of the W. M. Keck Observatory in Hawaii. It will cover an overview of the facility, the planning process, upgrades to instrumentation and infrastructure and broad strategic themes identified at the recent Keck science strategic planning workshop.

8 Exoplanets

8.1 Science with the Gemini Planet Imager

Bruce Macintosh – Invited Speaker

The Gemini Planet Imager (GPI) is a new high-contrast instrument on Gemini South, combining high-performance AO, a diffraction-controlling coronagraph, and a near-IR integral field spectrograph/polarimeter. I will present early science results from GPI, discuss its capabilities, and discuss the large-scale Gemini Planet Imager Exoplanet Survey (GPIES)

8.2 The Gemini Planet Imager Exoplanet Survey

Jeffrey Chilcote

The Gemini Planet Imager (GPI) is a next-generation coronagraph constructed for the Gemini Observatory. It combines a very high-order adaptive optics system, a diffraction-suppressing coronagraph, and an integral field spectrograph with low spectral resolution but high spatial resolution. Our team has been

selected by the Gemini Observatory to carry out an 890-hour program - the GPI Exoplanet Survey (GPIES) campaign from 2014-2017. By the end of the survey will have observed 600 stars spanning spectral types A-M. Including approximately 60 which will be looked at using GPI's polarization capabilities. The range of separations studied by GPI is completely inaccessible to Doppler and transit techniques. We are using GPI to produce the first-ever robust census of giant planet populations in the 5-50 AU range, allowing us to: 1) illuminate the formation pathways of Jovian planets; 2) reconstruct the early dynamical evolution of systems, including migration mechanisms and the interaction with disks and belts of debris; and 3) bridge the gap between Jupiter and the brown dwarfs with the first examples of cool low- gravity planetary atmospheres. Simulations predict this survey will discover approximately 50 exoplanets, increasing the number of exoplanet images by an order of magnitude, enough for statistical investigation. The GPIES campaign started in November 2014, and we have investigated approximately 110 stars. We present an overview of the exoplanet survey including the current status of the spectral and polarization results and early science results as part of the GPI verification and commissioning.

8.3 Brown Dwarf & Exoplanet Science with Gemini

Chris Tinney – Invited Speaker

Our team has been using Gemini in recent years to explore the properties of Y dwarfs - the coldest brown dwarfs known, and the best directly observable analogues we have for the properties of cold (i.e. < 400K) exoplanets. I'll report on results to date on the binary statistics and astrometry of a sample of cold brown dwarfs, as well as looking at future opportunities in the field.

8.4 Probing transiting exoplanet atmospheres with Gemini/GMOS

Jean-Michel Désert – Invited Speaker

The study of representative exoplanet atmospheres is the next important step for constraining planetary formation and evolution, and for improving our knowledge of exoplanetary physics. In particular, the wide diversity of exoplanet atmospheres discovered so far remains to be explored and explained. In this context, the investigation of transiting planet atmospheres using ground-based telescopes equipped with multi-object spectrographs (MOS) is a very important component of exoplanet characterization.

During the last few years, cutting-edge observational programs conducted with Gemini/GMOS have advanced our knowledge of this field. Noteworthy, the first multi-semester survey program dedicated to characterize transiting exoplanetary systems through observations of their atmospheres using a ground-based MOS has been conducted with GMOS. The purpose of this 3.5 year survey is to obtain exo-atmospheric transmission spectra at high spectrophotometric precision, and to reliably estimate the uncertainties.

I review the state of the art of transiting exoplanet atmospheric characterization with GMOS and discuss the main findings in the context of atmospheric science. I then present the challenges faced by these experiments and the lessons learnt for future observations and instruments. With precisions equal or superseding space-based observations, Gemini/GMOS is paving the way for future exoplanet characterization with ground-based MOS.

8.5 Astrometric Limits from GeMS on the Presence of Exoplanets in the Luhman 16AB System

Mark Ammons

We present new astrometric limits from GeMS on the presence of an exoplanet orbiting either component of Luhman 16AB, the nearest brown dwarf binary known. As opposed to traditional adaptive optics systems, GeMS' wide field of view provides numerous reference stars for calibrating rotation and plate scale, producing a more precise measurement of the binary separation (sigma = 0.2 mas single-axis per epoch) that improves the literature measurements by more than a factor of 20. We obtained seven epochs of astrometry over a period of 13 months in 2014. Using a Markov Chain Monte Carlo fitting scheme, we find that a mutual Keplerian orbit with no perturbing planets fits the binary separation to

within the measurement errors, ruling out companions down to 14 Earth masses for certain orbits. Precision astrometry enables a broad new range of investigation, including discovery of exoplanets orbiting low mass stars, confirmation and mass measurement of giant planets discovered through direct imaging, and sensitive mass measurement of binaries. I discuss the path forward for astrometry with GeMS, taking into account today's performance limitations and the potential for improvement with a new Laser Guide Star and hardware upgrades that realize fainter Natural Guide Star limits. GeMS's long lifetime and access to faint IR sources will be advantages relative to space-based competition, but sky coverage and observation setup time must be improved for usability.

8.6 Characterizing Imaged Exoplanetary Systems with Gemini

Thayne Currie

The Gemini Observatory has played a leading role in direct imaging, yielding the first images of extrasolar planets (HR 8799; Marois et al. 2008), supporting the Gemini NICI planet-finding campaign (Liu et al. 2008), and now supporting the Gemini Planet Imager and accompanying science programs. In this talk, I discuss what we have learned about *characterizing* young exoplanetary systems with Gemini. Gemini/NICI has yielded valuable information on the atmosphere of the young, benchmark imaged planet beta Pic b (Currie et al. 2013), placed and new constraints on known planet-sculpted debris disks, and provided the first independently-confirmed protoplanet, HD 100546 b (Currie et al. 2014). Early GPI observations further clarified the properties of young planets beta Pic b and HD 95086 b. Time permitting, I will present new results, reporting the first discovery of a new object with GPI and describe future efforts to characterize planetary systems with GPI.

9 Additional Topics

9.1 The Future of Gemini Adaptive Optics

Chad Trujillo

The Gemini telescopes were designed from the outset with Adaptive Optics (AO) in mind, with a location at each telescope dedicated to a Facility AO system which can feed any instrument with an AO corrected beam. Altair in the North and the Gemini Multi-Conjugate AO System (GeMS) in the South are both in routine operation and are available for Laser AO every semester. In addition, the Gemini Planet Imager (GPI), a stand-alone AO system, has been recently integrated into queue operations. The operation of such advanced systems has uncovered new and previously unnoticed issues with image quality, such as the optical quality of Gemini's mirrors and the stability of the telescope's optomechanical system to sub-arcsecond vibrations. Altair, GeMS and GPI have all produced astonishing science already, but the future of Gemini's AO program requires these AO systems and the telescope itself to be improved in terms of image quality, robustness of operation, ease of science use and the addition of additional observing modes. Our recent challenges and successes will be discussed along with future plans for the next year out to the next decade.

9.2 The Large Synoptic Survey Telescope

Steven Kahn

The Large Synoptic Survey Telescope (LSST) is a large aperture, wide-field, ground-based optical telescope designed to provide a deep time-domain survey of the entire southern hemisphere in six color bands covering the wavelength range 320 - 1050 nm. Every piece of the southern sky will be "visited" by LSST ~ 1000 times over the ten-year duration of the mission. The resulting database will enable a diverse array of in-depth investigations ranging from studies of moving small bodies in the solar system to the structure and evolution of the universe as a whole. I will review the basic design of the LSST, and provide a brief tour of some of the exciting science that we expect to come from this major new Facility. I will also discuss some of the areas that would benefit from a coordinated follow-up program with Gemini and other major

facilities.

9.3 Follow-up of low-albedo NEOWISE discoveries with Gemini-South/GMOS-S

Joseph Masiero

The NEOWISE all-sky infrared survey is a three-year mission to scan the sky at 3.4 and 4.6 microns, searching for low-albedo near-Earth objects that other surveys have trouble discovering. Once an object is discovered by NEOWISE, ground-based follow-up is critical to ensuring the orbit is known sufficiently well to rule out future impact probability. We use Gemini-South/GMOS-S to fill a critical hole in global follow-up capability, recovering the faintest targets that other telescopes cannot. I will present our follow-up efforts to date, and highlight some of the successes that would not have been possible without our Gemini LLP.

10 Galactic Astronomy

10.1 A high resolution view of resolved stellar populations with the Gemini Observatories

Alan McConnachie – Invited Speaker

High spatial resolution studies of the nearby Univierse are essential for resolving our neighbours into individual stars. These studies allow us to use the many individual stars to help estimate the age and metallicity distribution of the parent population. In the case of multi-epoch imaging studies, proper motions may also be measured that provide critical dynamical information that can be used in conjunction with spectroscopic measurements of the radial velocities. Here, I will discuss application of some of these techniques to two of our nearest neighbours using instrumentation on Gemini; GMOS studies of the M31 satellite system, and GeMS/GSAOI studies of the MW globular clusters.

10.2 Probing the dark halo of the Milky Way with GeMS/GSAOI

Tobias Fritz

Many properties of the Milky Way halo, like its mass, are not well known. One major limitation to the current radial velocity data sets is the mass-anisotropy degeneracy, which can only be broken with proper motions. These proper motions are also necessary to determine the orbits of dwarf galaxies and globular clusters, which then provide insight into the origins of the baryonic halo.

With the advent of GeMS/GSAOI on Gemini-South, it is now possible to obtain ground-based meaningful proper motions in the outer halo with a time base line of only two years that are competitive with space-based techniques.

In our Gemini large program we target stars in the Sagittarius stream, five globular clusters and four dwarf galaxies.We present analysis of the first epoch AO imaging, concentrating on the astrometric errors, both statistical and systematic in origin. The results of this analysis are useful for any future project using GeMS/GSAOI to determine absolute proper motions.

Further, we separate our objects into foreground stars, target object stars and background galaxies using morphology and colors. To demonstrate the usefulness of proper motions for dynamics we present the case of the globular cluster Palomar 5. We have already determined its proper motion from large field seeing limited images and have achieved an accuracy of 0.20 mas/yr over a 15 year time baseline.

10.3 The ELM Survey: Searching for the Shortest Period Binary White Dwarfs

Mukremin Kilic – Invited Speaker

Our targeted survey of extremely low mass (ELM) white dwarfs has discovered a significant number of compact binaries in the last 4 years. Some of these systems are strong gravitational wave sources and potential progenitors of underluminous or type Ia supernovae and AM CVn systems. I will present the most recent highlights from the ELM Survey including the latest Pdot measurements for J0651, the discovery of a new 20-min system, and the first ever discovery of a millisecond pulsar + pulsating white dwarf binary.

10.4 Using Gemini poor-weather time to search for binary systems among faint Galactic WN stars

Ana Elisa Collado

We present a spectroscopic monitoring of a sample of faint Galactic Wolf-Rayet stars of WN-type aiming at discovery of new binary systems. The observations are being carried out from the low-resolution spectrographs available at CASLEO and CTIO, but some targets are being followed using “poor-weather time” at Gemini. In this presentation, we describe some results obtained from the GMOS-S spectra. Among them, we remark the discovery of a new WN+O system, WR35a.

11 Gemini Instrument Feasibility Studies (GIFS)

11.1 MOVIES: A combined optimized target of opportunity and workhorse large wavelength coverage spectrograph for the Gemini telescopes

Alan McConnachie

MOVIES (the Montréal-Ohio-VIctoria Échelle Spectrograph) is a broad bandwidth, moderate resolution (R3 – 10K) dual arm optical and near infrared (NIR) echelle spectrograph that simultaneously covers 0.36 – 2.45?m (requirement/optimized for: 0.4 – 2.4?m). It is supported by a rapid acquisition camera operating simultaneously in the optical and NIR. MOVIES is designed for obtaining spectra of the faint Universe with high throughput, high efficiency, high reliability and rapid exposure start. MOVIES uses an optimized, low-risk, design with a minimum number of elements and mechanisms to ensure ease of calibration and high stability on long and short timescales. It will be a “go-to” long slit spectrograph for the rapid follow-up of faint objects from future facilities such as LSST, DESI and WFIRST, and will be a valuable feeder instrument for the ELTs. We will present the key science drivers, the design choices to support the science and the current status of the feasibility study.

11.2 OCTOCAM: A fast optical/NIR multi-channel imager and spectrograph

Antonio de Ugarte

OCTOCAM is a multi-channel imager and spectrograph that is being proposed as part of the Gemini Instrument Feasibility Studies (GIFS). OCTOCAM's is based on the use of high efficiency dichroics to divide the light into eight different arms, four optical, and four near-infrared. It has the advantage of simultaneity, as it is capable of observing at the same time in g, r, i, z, Y, J, H and Ks bands, with a field of view of 3’x3’. With its spectroscopic mode it will be capable of obtaining a full spectrum from 370 to 2,400 nm in a single shot. Using standard long slit observations, OCTOCAM will provide spectral resolutions of ~3,000-4,000. With echelle grisms that we are currently developing, the resolution could be increased to ~10,000. We are also studying options for obtaining full-Stokes spectropolarimetry to study geometry and magnetic fields of astrophysical phenomena in part of the wavelength range. As an add-on, the instrument will be equipped with a mini-IFU (Integral Field Unit). Thanks to the use of state of the art detectors, it will be able to reach high readout speeds, allowing science cases aimed at high time-resolution. This will also mean that OCTOCAM will virtually eliminate dead times in most observing modes, allowing duty cycles of roughly 100%. In this way, OCTOCAM will cover a region of the (spectral-resolution)-(spectral-coverage)-(temporal-resolution) diagram that is not occupied by any other single instrument in the world.

11.3 GMOX: A wide-bandwidth, moderate-resolution, MEMS-based multi-object spectrograph

Massimo Robberto

GMOX is a wide-bandwidth, moderate-resolution, MEMS-based multi-object spectrograph under feasibility study as the next Gemini facility instrument (Gen4#3). GMOX is designed to operate at the Multi-Conjugate AO system of Gemini South (GeMs), which delivers a 90"x90" AO corrected field of view with Strehl ratio as high as 0.3 in the K-band. GMOX uses two dichroics to split the field in three modules (Blue, Red, and IR) covering the full spectral range from U to K. Each module is equipped with a Digital

Micromirror Devices (DMDs) of the latest generation providing 1.1 million randomly addressable slits. Each DMD feeds a spectroscopic channel at R=4000 and a parallel imaging channel for slit alignment, monitoring and ancillary science. Exploiting the exquisit optical quality of GeMs, GMOX reaches unparalleled sensitivity and spatial resolution in crowded fields.

11.4 GEONIS: Gemini Efficient Optical and Near-infrared Imager and Spectrograph

Nicholas Konidaris

Gemini is undertaking a study of its next generation instrument through the Gemini Instrument Feasibility (GIFS) program. As part of the GIFS program, we describe the Gemini Efficient Optical and Near-infrared Imager and Spectrograph (GEONIS).

GEONIS is a high observing efficiency spectrograph system designed for efficient observations of single objects discovered by a variety of ground- and space-based observatories. To determine the science requirements of GEONIS, we look to a variety of diverse science cases, including near-earth asteroids, extrasolar planets, and transients. The science requirements are tied to the context of the Large Synoptic Survey Telescope, advanced Laser Interferometry Gravity Wave Observatory, and James Webb Space telescope.

This presentation provides a status update and plans forward for GEONIS.

12 Nearby Universe

12.1 The universal mass-metallicity relation for Local Group dwarf galaxies

Denise Gonçalves – Invited Speaker

Along the last 10 years we have derived the nebular chemical abundances of planetary nebulae and H II regions of Local Group (LG) dwarf galaxies. Taking our own results and those in the literature, we collected together the chemical properties --oxygen abundance, O/H-- of a significant sample (14) LG dwarf galaxies, either irregulars (dIrr) or spheroidals (dSph). This sample is analysed in an effort to establish the PN luminosity- and mass-metallicity relations (LZR and MZR) for these galaxies. Previous attempts to obtain such relations failed to provide correct conclusions because were based on too limited samples. As far as we are able to compare stellar with nebular metallicities, our MZR is in very good agreement with the slope of the MZR recently obtained for LG dwarf galaxies using spectroscopic stellar metallicities. Interestingly enough, we actually found that both dIrr and dSph galaxies follow the same MZR, at variance with the differences claimed in the past. And, moreover, our MZR is also consistent with the global MZR of star-forming galaxies, which span a wider stellar mass range (~10^6 -10^11 solar masses).

12.2 Tracing the history of merger remnant early-type galaxies

Myung Gyoon Lee – Invited Speaker

Galaxies grow via mergers. Merger remnant early-type galaxies are considered to be in the transition phase to massive elliptical galaxies so that they are an ideal target to study the growing phase of massive galaxies. They show various features of merger remnants in the morphology, structures, stellar populations, and kinematics, and these have been used to investigate their merging processes. When and how merging happened in these galaxies are key issues to reveal the merging history. Star clusters are a powerful probe for tracing the history of the merger remnant galaxies in the local universe. I will give an overview of current status of our understanding of the local merger remnants and present a case study of M85, a well-known merger remnant S0 in Virgo, based on star clusters.

12.3 The molecular H2 emission and the stellar kinematics in the nuclear region of the Sombrero galaxy

Roberto Bertoldo Menezes

We analyze the molecular H2 emission and the stellar kinematics in a data cube of the nuclear region of M104, the Sombrero galaxy, obtained with NIFS on the Gemini-North telescope. After a careful

subtraction of the stellar continuum, the only emission line we detected in the data cube was H2 21218. An analysis of this emission revealed the existence of a rotating molecular torus/disk, aproximately co-planar with a dusty structure detected by us in a previous work. We interpret these two structures as being associated with the same obscuring torus/disk. The kinematic maps provided by the Penalized Pixel Fitting method revealed that the stellar kinematics in the nuclear region of M104 appears to be the result of the superposition of a "cold" rotating disk and a "hot" bulge. Using a model of a thin eccentric disk, we reproduced the main properties of the maps of the stellar radial velocity and of the stellar velocity dispersion, specially within a distance of 0.2" from the kinematic axis (in regions at larger distances, the limitations of a model of a thin rotating disk become more visible). The general behavior of the h3 map, which is significantly noisier than the other maps, was also reproduced by our model (although the discrepancies, in this case, are considerably higher). With our model, we obtained a mass of (9.0 +/- 1.5) x 10^8 Msun for the supermassive black hole of M104, which is compatible, at 1-sigma or 2-sigma levels, with the values obtained by previous studies. We also obtained an eccentricity of e = 0.12 +/- 0.05 for the stellar disk around the nucleus.

12.4 The extremely populated globular cluster system of the lenticular galaxy NGC6861

Carlos Escudero

The study of globular cluster systems (GCSs) provides important clues about the star formation history and chemical enrichment of galaxies. Using the Gemini/GMOS instrument, we present a photometric study of the GCS associated to the galaxy NGC6861. This lenticular galaxy, located in low density environment, poses a challenge in understanding of their origin and evolution.

Analysing colour-colour and color-magnitude diagramas of NGC6861, we found a large number of GC candidates, and estimates a total population of 3000+/-300 clusters. This translate in a high specific frequency of Sn~10.

Besides the known blue and red subpopulations, the colour distribution shows signs of the possible existence of a third subpopulation with intermediate colours. This, together with non-concentric isophotes presented by the galaxy, could be interpreted as evidence of a past interaction or merger event.

12.5 The near-IR spectral properties of nearby galaxy nuclei

Rachel Mason

We have recently published a compilation of GNIRS spectra of the nuclei of 50 nearby galaxies. Most of the galaxies host an AGN, but in many of them the AGN line and continuum emission is so weak that we have a detailed view of the underlying stellar population: the good S/N and wide (0.85 - 2.5 um) wavelength coverage of the spectra reveal a wealth of atomic and molecular stellar absorption features. We are using these spectra to investigate the signatures of various stellar populations, including the thermally-pulsing AGB stars that currently cause considerable uncertainty in our understanding of high-redshift galaxies. The data set can be used to address several other questions about galaxies and AGN, and we have made the reduced spectra and reduction tools available to the public. I will discuss the results we have obtained so far, and point out other noteworthy aspects of the data.

12.6 Dark matter and globular cluster systems of isolated ellipticals

Ricardo Salinas

As tracers of star formation, galaxy assembly and mass distribution, globular clusters have provided important clues to our understanding of early-type galaxies. But its study has been mostly constrained to galaxy groups and clusters where early type galaxies dominate, leaving the properties of the globular cluster systems (GCSs) of isolated ellipticals as a mostly uncharted territory. We present observations of ~10 isolated elliptical galaxies. Photometry of their GCSs reveals clear color bimodality in most of the cases. All the studied GCSs are rather poor with a mean specific frequency S_N~1.5, independently of the parent galaxy luminosity. Considering also previous work, it is clear that bimodality and especially the

presence of a significant, even dominant, population of blue clusters occurs at even the most isolated systems, casting doubts on a possible accreted origin of metal-poor clusters as suggested by some models.

12.7 Multiconjugate Fluctuations: Measuring Surface Brightness Fluctuations with GeMS

John Blakeslee

The surface brightness fluctuations (SBF) technique provides a powerful tool for measuring the mean brightness of the constituent stars in a distant, unresolved stellar system. It is one of the most precise extragalactic distance indicators and has been used extensively with HST to distances of 100 Mpc and beyond. The distance to which the method can be applied depends sensitively on the spatial resolution of the data, while the accuracy of the results depends on how well the PSF can be characterized. We have a program to test and calibrate the SBF method with the GeMS/GSAOI system on Gemini-South. The wide field of view and excellent spatial resolution of GeMS/GSAOI makes it possible to measure the SBF signal much more efficiently than with seeing-limited imagers. I will review the SBF method, provide an update on our current GSAOI program, and discuss future prospects.

13 Distant Galaxies

13.1 Where Accretion Meets Feedback: The Large Gaseous Halos Around Galaxies

Jessica Werk – Invited Speaker

Galaxies evolve by maintaining an elaborate balancing act among gas supply, consumption, and removal. Many of the baryons involved in this cycle are in a phase that is exceedingly difficult to observe directly via emission -- i.e. diffuse, highly-ionized gas in the extended halos of galaxies known as the circumgalactic medium. Thus, experiments using quasars as illuminating background sources have become the gold standard for probing this elusive medium. In this talk, I will present observations of circumgalactic gas made with HST/COS in conjunction with ground-based optical spectroscopic data. These observations have had tremendous success in solving long-standing problems in galaxy formation and in confirming the predictions of hydrodynamical simulations for the importance of recycled accretion in building a galaxy's observed stellar content. I will discuss several ongoing challenges in developing a consistent physical picture of the gas in the circumgalactic medium and will focus on three open and pressing questions about the role gas flows play in shaping galaxies throughout cosmic time. Finally, I will present a new galaxy redshift survey in the fields of well-studied quasars, which we are carrying out with the Gemini Telescopes. These data will not only address the outstanding questions related to the circumgalactic medium but will ultimately enable a more complete picture of galaxies and the cosmic web in which they reside.

13.2 Eppur si muove'

Roberto Abraham

Star-forming galaxies at high-redshift are known for their clumpy morphologies and high velocity dispersion 'turbulent disks'. But what causes the evolution from these primordial structures to the regular grand design spirals and/or smooth elliptical galaxies today? For an individual system this can be explained by a Toomre-instability due to the system being rich in molecular gas. However I will present a new discovery, based on deep AO and GMOS IFU data of clumpy disks galaxies kinematics backed up by simple physical arguments, that the ultimate cause of this is the evolution of the specific angular momentum of disk systems in a cosmological context.

13.3 The Stellar Properties of Turbulent Disks at z~1 Using GMOS-IFS

Robert Bassett

I will present research from my PhD thesis (completion expected this year) which focuses on extremely gas-rich and turbulent disk galaxies at 0.07 < z < 0.14. These massive (Mstar > 10^10 Msolar) disks have strikingly similar properties to clumpy galaxies near the peak of cosmic star formation such as those observed in the SINS survey. The work I will be presenting is concerned with deep integral field

spectroscopy observations of these galaxies (the so called DYNAMO sample) using the Gemini Multi-Object Spectrograph (GMOS) with the goal of measuring stellar properties from absorption features in the continuum. Our sample is comprised of 14 galaxies observed between 2012 and 2015 with 8-9 hours per object. These observations have revealed the stellar light to be dominated by young stellar populations (~500 Myr) with couple stellar and ionized gas kinematics. We suggest that such objects represent galaxies in the throws of thick disk formation, a process typically occurring at much higher redshift. Because the measurement of these stellar properties at high redshift is currently impossible,

DYNAMO galaxies represent the best known laboratories for performing detailed studies of early disk formation.

13.4 Dead galaxies not so dead – galaxy evolution over the last 8-9 Gyr

Inger Jørgensen

Sin and its extension, which aims to map the evolution of bulge-dominated galaxies in rich clusters from redshift two to the present. Our high signal-to-noise spectra obtained with Gemini combined with HST imaging make it possible to study individual galaxies in these clusters with masses as low as 10^10.3 solar masses at redshift 1.3 (our current sample limit). In rich clusters out to z=1.3 we find no size evolution of these galaxies. Further, the epoch of last star formation, as mapped by the M/L ratios, depends on the galaxy masses. At redshift 1.3 in the Lynx W cluster our data support a cluster-wide star formation episode only 1-2 Gyr prior, consistent with the epoch of last star formation found from the M/L ratios. However, other aspects of our results question the simple picture of passive evolution of the bulge-dominated galaxies resulting in low redshift galaxies as observed in, e.g., the Coma cluster. Specifically, we find cluster-to-cluster variations in the metallicities and the abundance ratios of the galaxies. We are currently analyzing data of more clusters at redshifts 0.2-0.5 to investigate if such variations between clusters are common.

13.5 A Gemini Large and Long Program for Dark Energy Survey Strong Lensing and Photometric Redshift Spectroscopic Follow-Up

Huan Lin

We report on a Gemini Large and Long Program that we are carrying out using Gemini-South/GMOS-S for spectroscopy of strong lensing and photometric redshift targets from the Dark Energy Survey (DES). The DES is an ongoing 5-band optical imaging survey of 5000 sq. deg. of the southern sky and will discover many strongly lensed galaxies and quasars. Spectroscopic redshift confirmation of these strong lensing systems will be essential in using these systems for cosmology and galaxy evolution studies. Moreover, additional secondary galaxy targets are also observed and will provide a large spectroscopic sample to improve photometric redshift calibrations for DES. We will describe details of our program and the results of our successful first semester of spectroscopic observations, including strong lensing systems with confirmed redshifts and our photo-z calibration redshift sample.

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

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). We have confirmed, in part on the basis of Gemini imaging and spectroscopy, MaDCoWS clusters over a wise range of masses (2-10 x 10^14 Msun) out to z=1.3. A large Spitzer Snapshot program targeting the 2000 WISE-richest MaDCoWS clusters over the full extragalactic sky is currently underway. Over the next few semesters, the Gemini Observatory will be the premiere facility with which to spectroscopically confirm and characterize most massive of these in both hemispheres. The ultimate

goals of the program include (1) the investigation of the evolution of massive galaxies in the most overdense environments, (2) unbiased calibration of scaling relations for cluster mass observables, and (3) identification of extremely massive clusters that can be used for the fgas cosmological test and as constraints on primordial non?Gaussianity.

13.7 The Gemini Cluster Astrophysics Spectroscopic Survey (GCLASS)

Adam Muzzin

The GCLASS survey was a large program conducted with GMOS (220 hours) that obtained high-quality spectra of ~ 800 galaxies at 0.85 < z < 1.35 in the fields of 10 rich galaxy clusters. This is significantly more spectra than any previous cluster survey in this redshift range, and has opened up a new window for studying distant clusters. The data have allowed us to measure how brightest cluster galaxies assemble themselves over half the age of the universe, as well as given us a detailed picture of the evolution of cluster galaxies. In particular, they highlight significant differences between the population of galaxies that live in clusters versus the general field at z ~ 1, and show that environment is a key property affecting galaxy evolution, even when the universe is only half its current age. The data have also allowed us to make the first measurements of where and when galaxies cease forming stars in high-density regions such as clusters, and this has been key information for understanding the complicated physics behind the quenching process. Intriguingly, they also show that the overall structure of galaxy clusters has changed significantly since z ~ 1, a result which conflicts with the predictions of cosmological models of structure formation, and as of yet remains to be explained. I will present an overview of the survey as well as summarize these recent results.

13.8 An adaptive optics view of the morphological evolution of galaxies during 1 < z < 2

Sarah Sweet

While local galaxies fall into two dominant populations (passive, red, pressure-supported spheroids, and blue, star-forming disks), these familiar Hubble-type classifications do not apply as readily to high-redshift galaxies, the most massive of which are compact and red. Logically, these high-z galaxies likely become the elliptical population at z=0, but they must grow by 3-5 times in size in the interim. It is proposed that the size evolution of galaxies either occurs by accretion of smaller galaxies, whereby the compact core remains, or by adiabatic expansion due to mass-loss winds, whereby the entire galaxy expands. The key to distinguishing between these two scenarios is the accurate measurement of the size-mass relation. This requires sufficient resolution to measure effective radii and Sersic indices of the most compact galaxies over a wide field of view, at rest-frame optical wavelengths to avoid bias due to small-scale localised star-formation.

In this talk I will describe our project using the Gemini South Adaptive Optics Imager, with its unique capability of diffraction-limited near-infrared wide-field imaging, to image the cores of galaxy clusters over the redshift interval 1 < z < 2. I will present our results from the first galaxy cluster, as well as our methodology for processing the complex data from this new instrument (including successful correction for the quasi-static off-axis distortion, varying PSF and image ghosting).