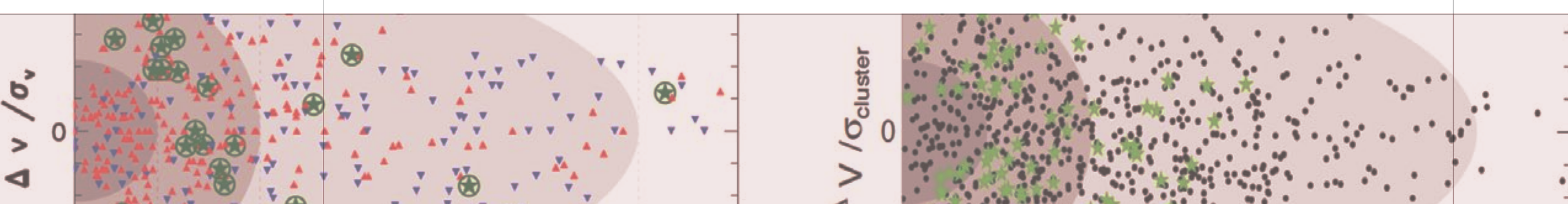
GeminiFocus

Publication of the Gemini Observatory | January 2015

Gemini*Focus*



The cover of this issue is a striking new image from Gemini that peers into the heart of a galaxy group known as VV 166. The image brings clarity and definition to the different morphological types in VV 166 despite its great distance of about 300 million light-years. One of its most fascinating features is a perfect alignment of three disparate galaxies in a precise equilateral triangle, including the giant blue spiral NGC 70 at top. Despite the apparent diversity of galaxy types in VV 166, the relative proportions of morphologies that we see in it may represent the distribution of galactic types throughout the universe.

Gemini*Focus January 2015*

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Markus Kissler-Patig

Director's Message

2014: A Successful Year — 2015: Exciting Prospects

As the end of 2014 nears we can proudly look back at a very productive and successful year for Gemini. In 2014, we brought our users several innovative programs, including a highly oversubscribed first round of Large and Long programs and the associated Priority Visitor mode (***viewable here***). The latter is working well and has now expanded into all of Gemini's regular programs. Gemini North cruised through the year with its four instruments and one adaptive optics system (almost making us forget about the unfortunate dome shutter failure events). Meanwhile, Gemini South caught up to its twin's full suite of four instruments by adding the Gemini Planet Imager to regular operations. This completes the telescope's four-instrument suite, in addition to the GeMS Multi-Conjugate Adaptive Optics System.

Gemini also introduced some subtle changes during 2014. For instance, for the U.S. user community, Phase II of the proposal preparation process is now supported by Gemini staff, rather than the National Optical Astronomy Observatory staff. We also started subsidizing students accompanying senior observers in the "Bring One, Get One" scheme (***viewable here***). Additionally, Gemini users can now exchange code, tips, and tricks through our new Data Reduction User Forum (***view here***).

In 2014, we also welcomed our first limited-term partner: the Republic of Korea, through the Korea Astronomy and Space Science Institute. Australia, which is not able to remain a full partner beyond 2015, also signed a limited-term partnership agreement (via Australia Astronomy Limited) to remain with Gemini as a limited-term partner through 2016.

Overall, we realized a welcome net gain in our user community in 2014.

But Wait…
See What 2015 Will Bring!

Starting in January, the long-awaited, and unique to Gemini, Fast Turnaround program begins (***view here***). For the first six months, we will test this mode with 10 percent of Gemini North's time. Once the program is well established, the plan is to expand the mode by offering it at both telescopes. Fast Turnaround programs will allow our users to submit proposals every month and receive data as early as six weeks after proposal submission. We very much look forward to the impact that this innovative mode will have on our users around the world!

In 2015, you, our users, will also have the opportunity to contribute directly to the future of Gemini. We encourage you to attend the "Future & Science of Gemini Observatory" meeting in Toronto (Ontario, Canada), from June 14th-18th. In addition to science presenta-tions, we are planning multiple discussions about Gemini's future and will present the results of the feasibility studies for our next facility-class instrument. Don't miss this op-portunity to be heard.

Invitations for the second round of Large and Long programs will also be solicited in 2015. Letters of Intent are due in early February, so watch the Gemini homepage for an announcement, or be sure to get the latest news by subscribing to Gemini's monthly e-newscast for users ***here***. Both priority visitor observing, as well as the "Bring One, Get One" scheme, will continue to be offered in 2015 — for Large and Long programs, as well as for regular ones.

We also look forward to expanding our range of instruments. In particular, we are delighted to offer high-resolution spectroscopy again in 2015B. Tests with GRACES (Gemini Remote Access to CFHT ESPaDOnS Spectrograph, our demonstrator link to the Canada-France-Hawaii Telescope's high-resolution spectrograph) were successful, and, in the Mauna Kea collaborative spirit, we came to an agreement with CFHT to access ESPaDOnS via our 300-meter fiber. (***See details here***.)

This being said, progress on our new high-resolution spectrograph, GHOST, is moving rapidly forward; with its preliminary design study concluded in the week of December 15th, it is expected to arrive at Gemini by the end of 2016. Furthermore, the Principal Investigators of our two visiting instruments in 2014 — the Differential Speckle Survey Instrument, and the Texas Echelon Cross Echelle Spectrograph — announced interest in returning; their in-struments will significantly enhance the capabilities we can offer to our users.

Finally, Gemini is not only "Exploring the Universe" but also "Sharing its Wonders." Our flagship annual local outreach program in Chile, Viaje al Universo, concluded a very successful week of activities in October, with thousands of residents, teachers, and students in attendance. Preparations for the long-running Hawai'i version, Journey through the Universe, are now ramping up for its 11th year. If you are in Hilo during the week of March 2nd, please contact Janice Harvey (***jharvey@gemini.edu***) and find out how you can participate.

Not only are we looking back at a productive year 2014, but we are very excited about all the remarkable things to come in 2015!

Markus Kissler-Patig is Gemini's Director. He can be reached at: mkissler@gemini.edu

Adam Muzzin

Why Do Galaxies Stop Forming Stars in Massive Clusters?

Why galaxies in massive clusters stop forming stars has remained an unsolved problem for decades. Now, results from the Gemini CLuster Astrophysics Spectroscopic Survey (GCLASS) is providing a clearer picture of the events leading up to the quenching process.

It's not a complete mystery that several processes can occur to "quench" star formation in cluster galaxies. We know that galaxy clusters are filled with very hot, dense, X-ray emitting gas, and that as galaxies orbit the cluster, they pass through this medium. We also know that the pressure created can strip out the galaxies' own gas, which is needed to fuel their star formation; hence, if it is stripped, star formation ceases. We can even directly observe this process in action in some nearby cluster galaxies. But the details of exactly how this happens are sketchy at best.

Galaxies themselves are filled with hot diffuse gas throughout their dark matter halos. This gas is continually cooling to ultimately provide the cold molecular gas that ends up in their spiral disks to form stars. How this gas is stripped in galaxy clusters largely remains a mystery, however. The process may be strong enough to remove only the loosely bound gas in a galaxy's hot diffuse halo. If so, it will very slowly truncate the galaxy's gas supply; most disks contain enough cold gas to continue forming stars for an additional ~ 1 - 2 billion years (Gyr), if not replenished at all. Then again, the gas stripping process could be more violent and able to remove both the diffuse halo as well as the disk's dense cold gas, and truncate star formation nearly instantaneously. At some level both are likely to happen, but it has been very challenging to prove convincingly that one process is more common than the other.

Figure 1.
Left panel: The velocity of galaxies within the 10 GCLASS clusters relative to the velocity dispersion of each cluster versus the position of each galaxy relative to the virial radius. Quiescent galaxies are plotted as red triangles, star-forming galaxies as inverted blue triangles, and post-starburst galaxies as encircled green stars. Strikingly, the post-starbust galaxies form a "ring" structure at high velocities and intermediate radius. Right panel: Galaxies in a simulated set of clusters (black points). Green stars show galaxies that are "quenched" in the simulation on a timescale of 0.1 — 0.5 Gyr after they first cross about half the virial radius. The distribution of the simulated quenched galaxies is statistically consistent with the observed post-starburst population suggesting this is where and when cluster galaxies are first quenched.

The GCLASS Survey at z ~ 1

One additional challenge in observing this quenching process in action is that until very recently we've only been able to collect data on fairly nearby clusters. Locally, the average star-forming galaxy is only converting a few solar masses of gas into stars per year. That's a pretty low level of activity. Therefore, the difference between a recently quenched local galaxy and one that has normal star-formation activity is fairly marginal. One nice solution would be to look at galaxies at higher redshifts. The average star-forming galaxy at $z \sim 1$ is 10 times more active than locally, so if the quenching process is violent, it would be much easier to identify one that has recently been stripped of its gas.

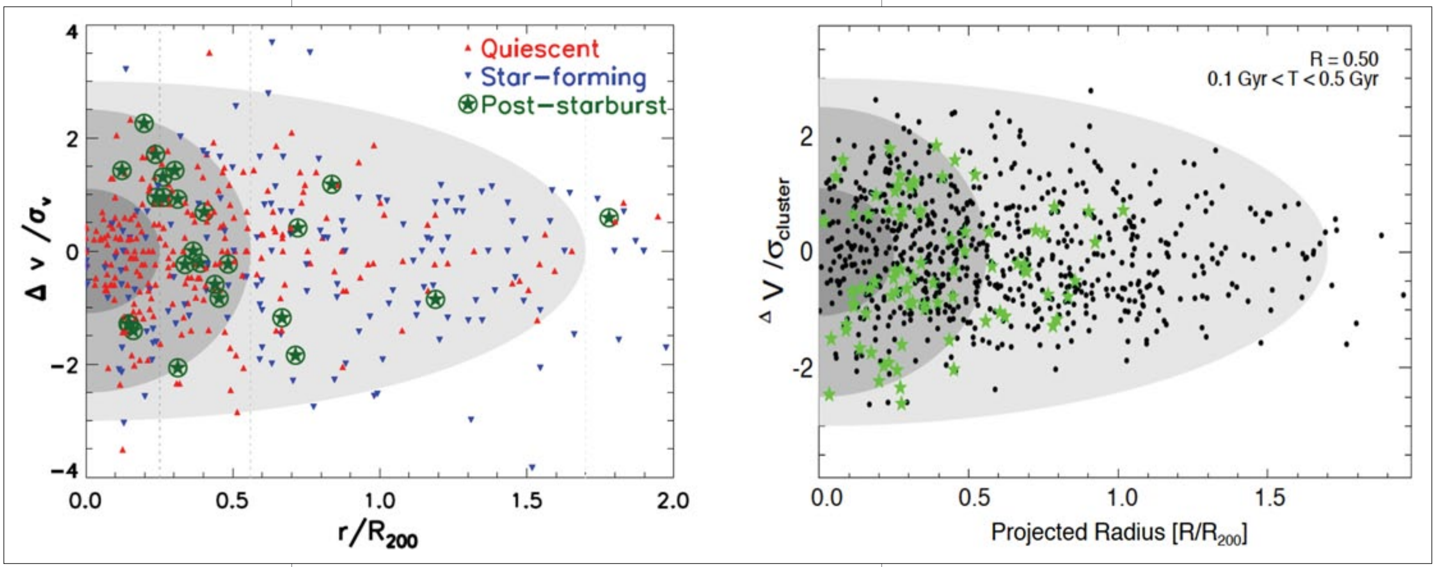
From 2009 - 2011 we carried out a large spectroscopic survey with the Gemini Multi-Object Spectrograph of 10 massive clusters at $z \sim 1$. This program, the Gemini CLuster Astrophysics Spectroscopic Survey (GCLASS) — one of the largest surveys ever carried out on the Gemini North and South telescopes — required about 220 hours of observations, but has provided spectra for ~500 cluster galaxies at $z \sim 1$. GCLASS marked about a 10-fold increase in the number of spectra for cluster galaxies compared to any previous cluster survey at this redshift.

GCLASS had numerous scientific goals. One was to measure how the central galaxies in clusters grow over cosmic time (Lidman *et al.*, 2012 and 2013), as well as how the stars are distributed in high-redshift clusters — both on the galaxy scale (van der Burg *et al.,* 2013) and in the global cluster scale (van der Burg *et al.,* 2014). In addition, it also looked critically at the stellar populations of cluster galaxies at $z \sim 1$ in Muzzin *et al.* (2012).

New Insights

More recently we've attacked the problem of linking cluster galaxy dynamics to the quenching process. This has led to some interesting new insights about the quenching process (*e.g.*, Noble *et al.*, 2013; Muzzin *et al.*, 2014).

One of the most striking revelations from the GCLASS data is that there appears to be a correlation between the stellar populations of the galaxies and their dynamical state within the cluster. The left panel of Figure 1 plots the GCLASS cluster galaxies relative to "typical" velocities of all galaxies (the velocity dispersion) against their distance from the cluster's center (which has been normalized to the virial radius of each cluster). Galaxies have been color-coded based on their stel-



lar populations: quenched galaxies are plotted as red triangles, and star-forming galaxies appear as inverted blue triangles. These two populations are distinctly different, with quenched galaxies tending to be found near the cluster's center and moving at slower velocities. Star-forming galaxies are found throughout the cluster and tend to be moving at higher velocities.

This had been seen before in lower-redshift clusters (*e.g.*, Biviano *et al.*, 2002; Poggianti *et al.*, 2004). It can be explained naturally by the quenched galaxies having been accreted into the cluster earlier (presumably when they were still star-forming galaxies). Most likely they experienced dynamical friction and lost kinetic energy, gradually slipping into orbits well within the clusters' gravitational potential wells. Star-forming galaxies are likely to be more recently accreted and hence have higher velocities, as they are on their first passage through the clusters.

Our team also looked at galaxies that had spectral signatures indicating recent quenching. These "post-starburst" galaxies are shown as the encircled green stars in the left panel of Figure 1. These high-velocity objects had quite a striking distribution in this Figure, as they tend to lie roughly in a "ring" structure at intermediate radius. In particular, they very clearly avoid both the cluster core region, which is dominated by quenched galaxies, and the large radius region dominated by star-forming galaxies.

This signature has never been seen before, so modeling it seemed an obvious way to try to understand more about the quenching process. We were most interested in getting some quantitative measurements of both how long it takes for galaxies to quench (once the process begins) and where in the cluster it starts to happen. In particular, the latter measurement is unprecedented. We employed some high-resolution dark-matter-only simulations of clusters to see if we could input these numbers and reproduce the observed distribution of the post-starbursts in the right panel of Figure 1.

In the simulations, we followed galaxies as they first fell into the cluster. We then simulated quenching at different locations and with different timescales. These models easily ruled out many locations and specific timescales; the details of this can be found in Muzzin *et al.* (2014). What worked best in reproducing the distribution of the post-starbursts was if we quenched galaxies after they first passed roughly half the virial radius ($R \sim 0.5R_{200}$) on a timescale of ~ 0.1 - 0.5 Gyr. The resulting distribution of post-starburst galaxies is shown as the right panel of Figure 1, and is statistically a good match to the observation.

This was the first time that simultaneous constraints had been set on both the duration of the quenching process and where it happens. We were concerned that our findings depended heavily on a simulation, so we also used the stellar populations of the galaxies to test the model. Figure 2 shows the average spectra of both the typical star-forming galaxy in the cluster (top blue) and the average spectra of the post-starburst galaxies (bottom green). These spectra were fit to a range of models, with the best-fit star-formation history shown in the bottom left panel.

Basically, this test showed that star-forming galaxies continue forming stars for several Gyr within the cluster before they quench — and that process needs to be rapid in order to create the stellar populations seen in the post-starburst galaxies. Not only is this consistent with what we derived from our dynamical modeling, but also remarkable because these two constraints (the spectra, as well as the dynamical modeling) are completely independent indictors of what is happening.

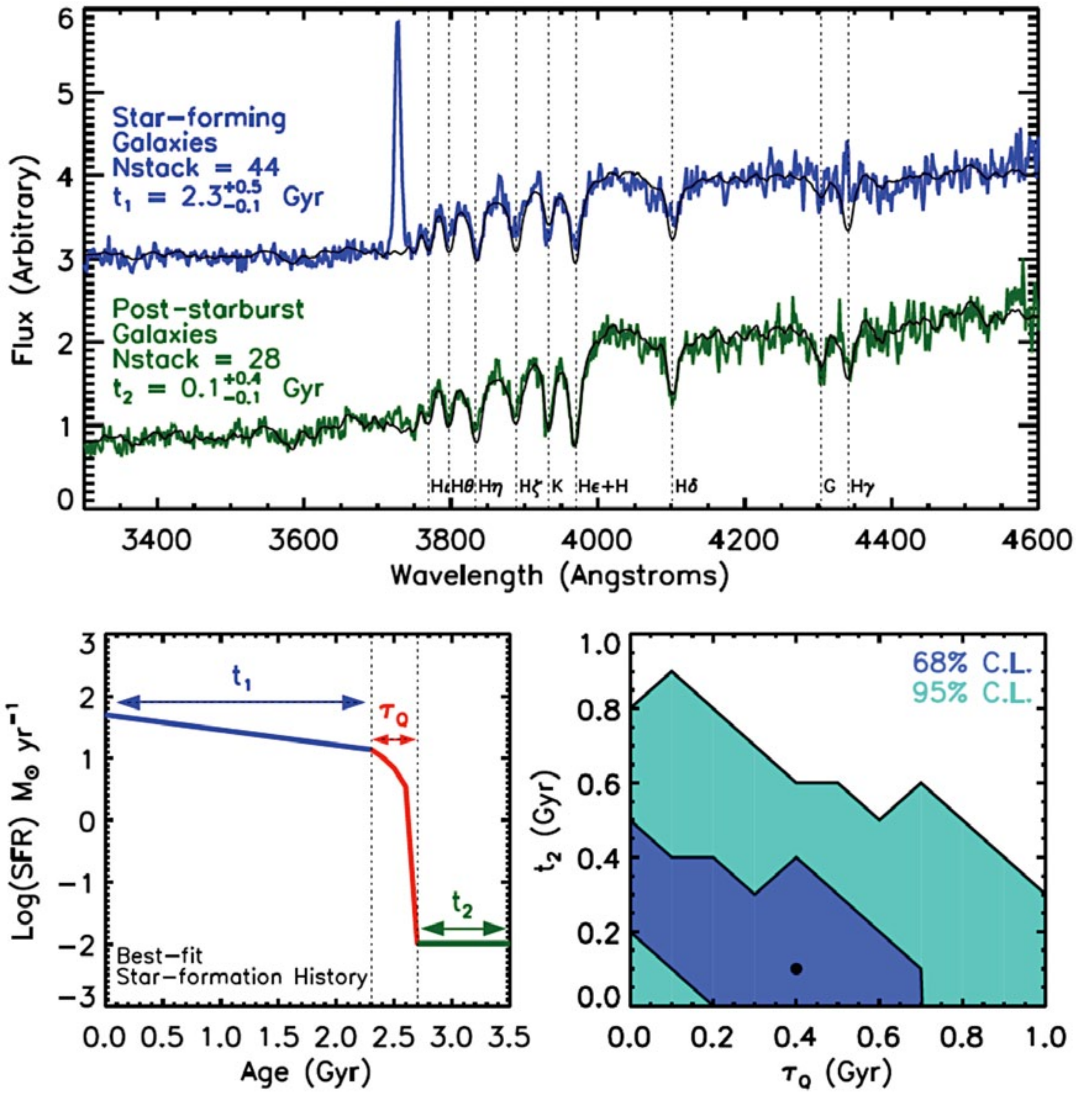


Figure 2.

Top Panel: The average spectra of star-forming (blue) and post-starburst galaxies (green) in the GCLASS clusters. The black lines are the best-fit spectra for both types based on the star-formation history in the lower-left panel. Lower-left panel: The best-fit star-formation history of the post-starburst galaxies under the assumption that the star-forming galaxies are their progenitors. This suggests that the average post-starburst spends ~ 2.3 Gyr forming stars before it is quenched on a timescale of ~ 0.1 ± 0.4 Gyr. This is fully consistent with the quenching model derived from dynamics of the galaxy populations in Figure 1.

Towards a Physical Model of Satellite Quenching

The overall picture that emerges from this analysis is that when star-forming galaxies fall into clusters they continue forming stars for 0.5 - 1.5 Gyr — about the time it takes to fall far enough into the cluster to cross about half of the virial radius. Once this happens, the quenching process begins, and it is quite rapid, perhaps even violent. Despite having concrete numbers to work with, there are still challenges in understanding exactly what is happening.

For instance, because the quenching process appears to be so rapid, it's tempting to believe that all gas — both hot and cold — is being removed from the galaxy. But that may not be the full story. Galaxies at $z \sim 1$ are forming stars at a much higher rate than those at $z \sim 0$. If only the hot gas was removed, the higher-redshift galaxies would consume most of their cold gas quite quickly, on a timescale of ~ 0.5 Gyr, which is the upper limit of what the models permit.

So, there is clearly still work to do. Since we know that the cold gas consumption time-scales move to longer values at lower redshift, measuring any evolution in the quenching time-scale with redshift is crucial for breaking this degeneracy. Some studies have been done at lower-redshift, and they tend to indicate slightly longer timescales than we measured at $z \sim 1$ (*e.g.*, Wetzel *et al.*, 2013; Haines *et al.*, 2013). This would implicate hot gas stripping, but the analysis was done in a quite different way, so the jury is still out.

The Next Steps: Hubble and the GOGREEN Survey

Our team is taking steps to better understand the quenching process in distant clusters. We have recently been awarded time to take H-alpha images of the GCLASS clusters with the Hubble Space Telescope (HST). With HST's resolution in the near-infrared we should be able to not only resolve the star-forming disks in cluster galaxies, but also see if they really have been stripped by the intracluster gas.

Even more exciting is the recent start of the GOGREEN (Gemini Observations of Galaxies in Rich Early ENvironments) survey. This 440 hour program is one of the new Gemini Large and Long programs and will obtain spectra for ~1000 cluster and group galaxies at $1.0 < z < 1.5$ using the recently-upgraded Hamamatsu chips on both GMOS South and soon on GMOS North. GOGREEN will go much deeper than GCLASS and allow us to access higher-redshift clusters, as well as much lower-mass galaxies. This should allow us to better understand how galaxies of different masses are affected by their environments, as well as whether the whole process changes over cosmic time. GOGREEN observations are slated for completion in 2017, and we look forward to summarizing those results in a future *Gemini*Focus article.

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Nancy A. Levenson and Rachel Mason

Science Highlights

Gemini's users continued to produce great science through the year. Among the results featured in this latest sampling are critical measurements of stellar motions in spiral galaxies, new perspectives on the epoch of reionization of the early universe, and a look at the origins of massive field stars in the Milky Way's center.

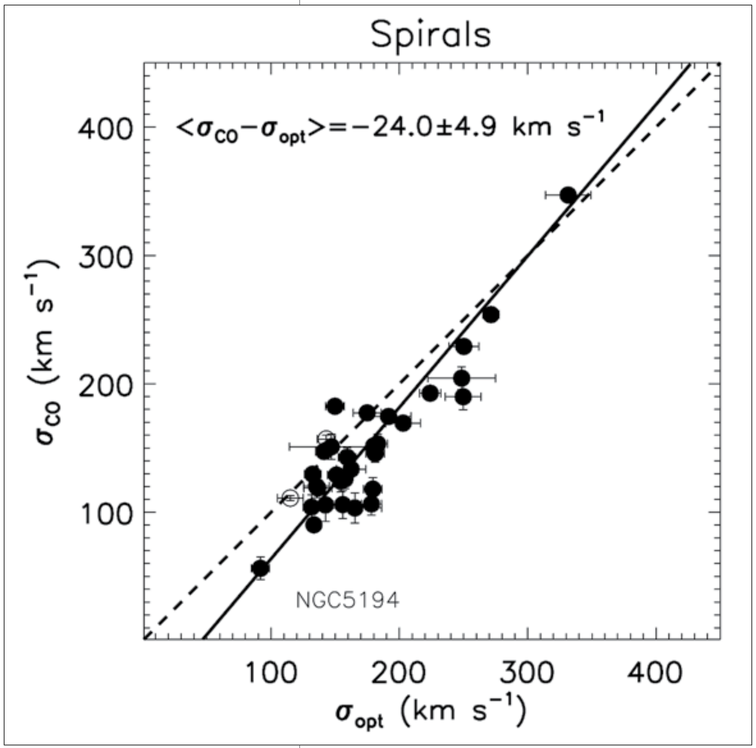

Figure 1. *The stellar velocity dispersions measured using CO and the calcium triplet are significantly different in spiral galaxies. The solid line is a fit to the data; the dashed line shows the one-to-one relationship.*

Discrepant Measurements of Stellar Motions in Spiral Galaxies

The bulge stars and central supermassive black holes of galaxies are fundamentally related to each other, and, empirically, measurements of their masses are correlated. Determination of stellar velocity dispersion (σ) conveniently provides the value for stars, allowing derivation of the black hole mass, which is otherwise difficult to measure directly. Observing nearby spiral galaxies, however, an international team reports that the values of σ they measure in the near-infrared are systematically different from shorter wavelength measurements.

The team, led by Rogemar A. Riffel (Universidade Federal de Santa Maria, Brazil), used the Gemini Near-Infrared Spectrograph (GNIRS) on Gemini North, comparing the stellar absorption lines of the CO band heads around 2.3 microns and the 0.85 micron calcium triplet. In elliptical galaxies, sigma values derived from the two sets of lines agree well. However, in ultraluminous infrared galaxies (ULIRGs) and merger remnant galaxies, σ_{CO} tends

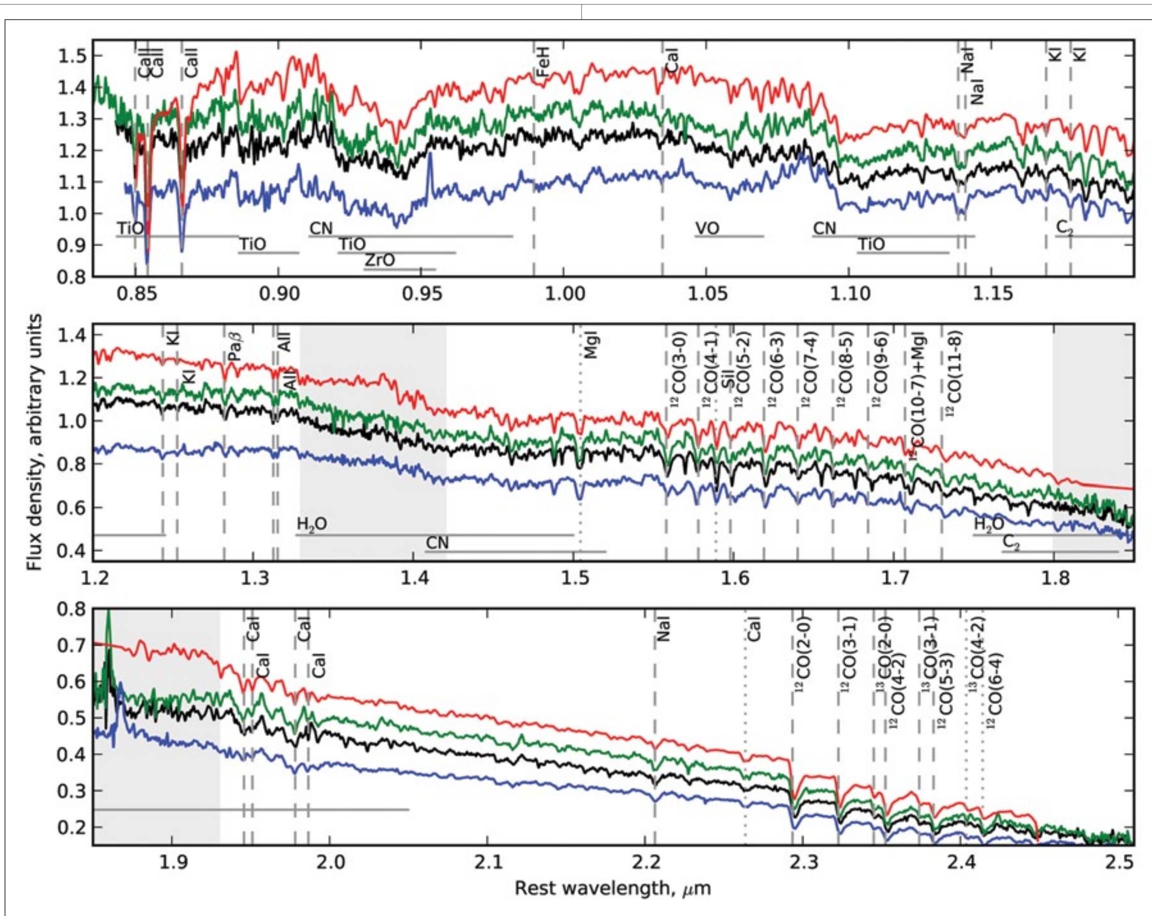

Figure 2.

Three of the GNIRS galaxy spectra from the Mason et al. *paper, showing the wavelengths of the calcium triplet, CO band heads, and numerous other atomic and molecular features. The blue, black, and green lines are observed spectra while the red line is a combination of empirical stellar spectra. The close resemblance between the stellar and galaxy data shows that most of the structure in the galaxy spectra is composed of real, weak absorption lines.*

to be smaller than σ_{CaT}. The so-called "sigma-discrepancy" has implications for our understanding of galaxy evolution; masses derived from σ_{CaT} imply that ULIRGS could evolve into giant elliptical galaxies, whereas σ_{CO} would imply them to be the ancestors of much smaller galaxies.

Members of the team wondered whether the sigma-discrepancy would also be observed in the cores of spiral galaxies. Their measurements show that although a statistically significant discrepancy is present, it is much smaller than that observed in the ULIRGS and merger remnants (Figure 1). The lower σ_{CO} indicates that a dynamically cold stellar population is present in the spiral galaxies. Based on the fact that small velocity dispersions and young stellar populations have been observed to be spatially related in IFU spectra of a handful of galaxies, Riffel *et al.* speculate that the sigma-discrepancy is evidence of recent nuclear star formation in these spiral galaxies.

This work used a set of 50 new GNIRS cross-dispersed spectra of nearby galaxy centers (Figure 2). With wide wavelength coverage and generally good signal-to-noise ratio, the spectra are also being used to investigate several topics related to weakly active galaxies and their stellar populations. A sizable international collaboration is now further examining the data to model the stellar features and emission lines and exploring the properties of the active galactic nuclei, as well as other areas of study.

Full results from the current work are in press in *Monthly Notices of the Royal Astronomical Society* ***(view here)*** and a preprint is available ***here***. The paper presenting the data and giving access to the reduced spectra, led by Rachel Mason (Gemini Observatory), has been submitted to *The Astrophysical Journal Supplement Series.*

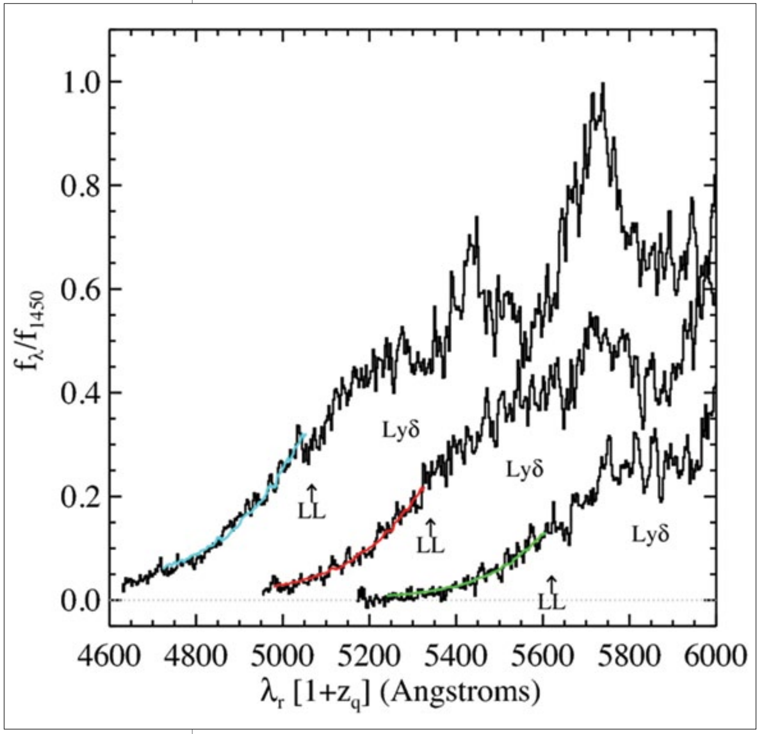

Figure 3.
Quasar spectra averaged over the redshift intervals [4.4, 4.7], [4.7, 5.0], and [5.0, 5.5] (top to bottom). The onset of the Lyman limit is marked in each case (LL). The model intrinsic quasar emission is overplotted in color.

Evolution of the Ionized Universe

The epoch of reionization in the early universe and the subsequent evolution of ionized material is fundamentally related to cosmological evolution. New work measures the mean free path of ionizing photons at redshifts $z > 4.4$ and shows strong evolution in the ionized structures.

Gábor Worseck (Max-Planck-Institut für Astronomie and University of California Santa Cruz) and collaborators base these results on a multi-semester, multi-partner study that obtained observations of quasars using both Gemini Multi-Object Spectrographs (Figure 3). Quasars serve as bright background continuum sources and are therefore sensitive to absorption by neutral hydrogen along the line of sight. Specifically, they measured the mean free path of photons at the Lyman limit (λ_{mfp}^{912}).

In this first large set of such high-redshift quasars (numbering 163 targets), the team divided the sample into redshift bins and measured the evolution of λ_{mfp}^{912} over time. They found $\lambda_{mfp}^{912} \propto (1 + z)^{-5.4}$, which is significantly steeper than that due to cosmic expansion alone [$\propto (1 + z)^{-3}$]. The team interprets these results as due to large-scale structures of the universe. The density and neutral fraction of these filaments decreases with time, accounting for the short distances Lyman continuum photons could pass freely before absorption in the early universe.

The smooth evolution observed supports the expected result that the universe was substantially ionized by $z = 5.2$, which is the highest redshift examined in this study. Thus, this work does not probe the epoch of reionization directly. Approaching this period, however, it does set an important constraint on models of reionization, and this work rules out several models of absorbing systems in the early universe.

The paper is published in *Monthly Notices of the Royal Astronomical Society* ***(viewable here)*** and reduced quasar spectra are available ***here***.

The Origins of Massive Field Stars in the Galactic Center

The existence of massive field stars in the extreme environment of the Galactic center raises fundamental questions about their origin. The challenge is to form these short-lived stars that are not presently located in sites of obvious recent stellar birth, such as molecular clouds (which would offer the raw materials) or clusters (which would show the effects of concentrated star formation).

New work by Hui Dong (National Optical Astronomy Observatory) and collaborators provides accurate kinematic measurements of massive stars and their nearby gas regions. This work suggests some scenarios for the origin of these massive stars, finding evidence for both ejection from clusters and *in situ* formation in different examples.

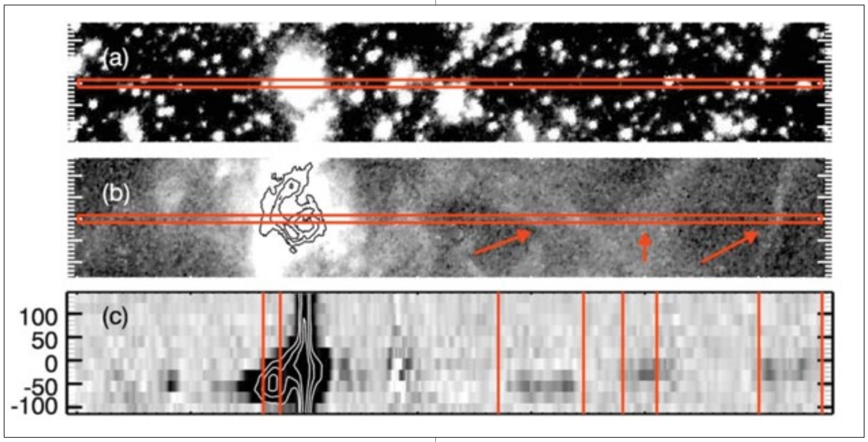

Figure 4.

Upper panels show near-infrared continuum and Paschen α images of target P35 and its associated HII region. The position-velocity plot (c) around the wavelength of Brackett γ is extracted from the GNIRS longslit spectrum (whose location is marked with horizontal lines in the upper panels). Low surface brightness features marked with arrows in (b) are evident in the position-velocity plot.

The sample of eight stars was selected on the basis of Paschen α emission, characteristic of massive stars. Observations using the Gemini Near-Infrared Spectrograph (GNIRS) and Near-infrared Integral Field Spectrometer (NIFS), both on the Gemini North telescope, provide spectroscopy with a resolution of around 50 kilometers per second.

Sample stars located near the Arches cluster are similar to the cluster population (in terms of age, mass, and spectral characteristics), suggesting that they were originally cluster members. The massive field stars could have been dynamically ejected from the cluster, especially through three-body interactions.

Two examples show velocities that are similar to those of nearby molecular and ionized gas clouds, which implies a physical association with these neighboring star-forming regions. The researchers suggest that one of these in particular, dubbed P35 (Figure 4), may have formed at this site. In contrast, other stars show differences in motion compared with nearby gaseous regions, which suggests that the stars are only passing by and were not formed originally at these locations.

In addition, the new spectroscopy confirms main sequence masses exceeding 50 M_{Sun} in all cases and enables additional spectral classification; Dong *et al.* also report the identification of a new O If+ star. Complete results appear in *Monthly Notices of the Royal Astronomical Society* ***(view here)*** and a pre-print is available ***here***.

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Contributions by Gemini staff

News for Users

Gemini continues to focus its attention on users' needs, as well as instrument maintenance and upgrades. Among the top news, Gemini has created a new department for user support intended to (among other things) improve the post-observation science process, Priority Visitor Runs have begun, and the Gemini Planet Imager Campaign has officially started!

Science User Support Department

Formed in mid-2014, the Science User Support Department (SUSD) is intended to provide sustained attention to post-observing support. The new department is largely a reorganization and will consolidate effort that has been distributed around Gemini, including data reduction software development, National Gemini Office interactions, helpdesk, data-reduction-forum stewardship, and archive coordination.

Joanna Thomas-Osip manages the new department, having transitioned from a Science Operations Specialist to the post on September 15^{th}. Joanna has a Ph.D. in astronomy from the University of Florida, as well as postdoctoral research and project management experience at both MIT and Las Campanas Observatory/Giant Magellan Telescope. Joanna's vision for SUSD is to create a collaborative community of users and staff by "encouraging interactions that induce constructive interference in our feedback cycle." In other words, feedback and solutions should flow back-and-forth between users in a cycle that fosters constant improvements.

For issues relating to user support, please feel free to contact Joanna at *jthomas@gemini.edu*, or look for her at the January Gemini Users Meeting in Toronto (Ontario, Canada).

Update on FLAMINGOS-2

As reported in the October 2014 issue of *Gemini*Focus, FLAMINGOS-2 is back on sky with image quality now good over the entire 6-arcminute field-of-view. The instrument remains in imaging- and long-slit modes only, pending commissioning of the Multiple Object Spectrograph mode, which may become possible in 2015. Spectroscopic resolution is quite close to the original specifications, but optical modeling has been done to see whether it can be improved. Considering this, we now believe that FLAMINGOS-2 spectroscopy has reached its full potential. The problem with high background reported in October will be addressed during a short shutdown in February 2015, see Figures 1 and 2.

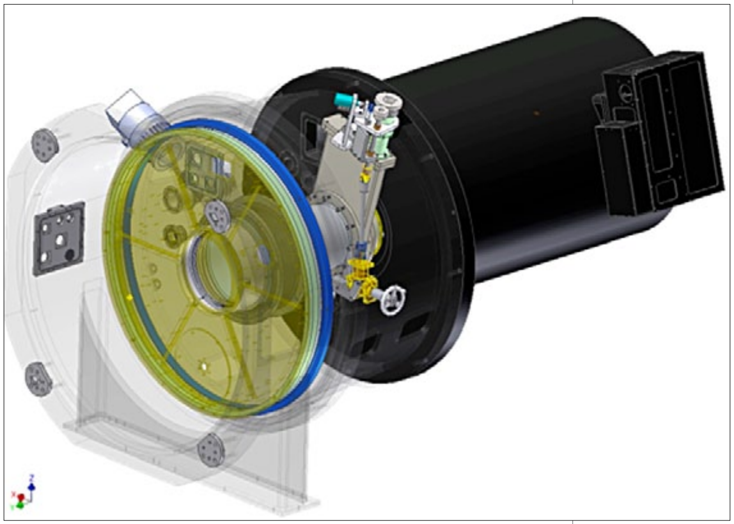


Figure 1.
The FLAMINGOS-2 gate valve mechanism, situated in the tunnel between the two halves of the cryostat. The front, temperature-cyclable part houses the MOS wheel, and the rear includes the camera optics and detector.

GPI Campaign Commencement

With the Gemini Planet Imager (GPI) now entering regular operations, the GPI Exoplanet Campaign has officially kicked off. With a total allocation of about 890 hours, the campaign is expected to take at least three years to complete. The Campaign is using GPI to produce the first-ever census of giant planet populations between 5 and 50 astronomical units from their host stars, allowing us to better understand the formation of Jovian planets, and how they migrate to-and-fro within their parent solar systems. It will also help unmask how they interact with disks and belts of debris. Finally, the results of the Campaign should bridge the gap be-

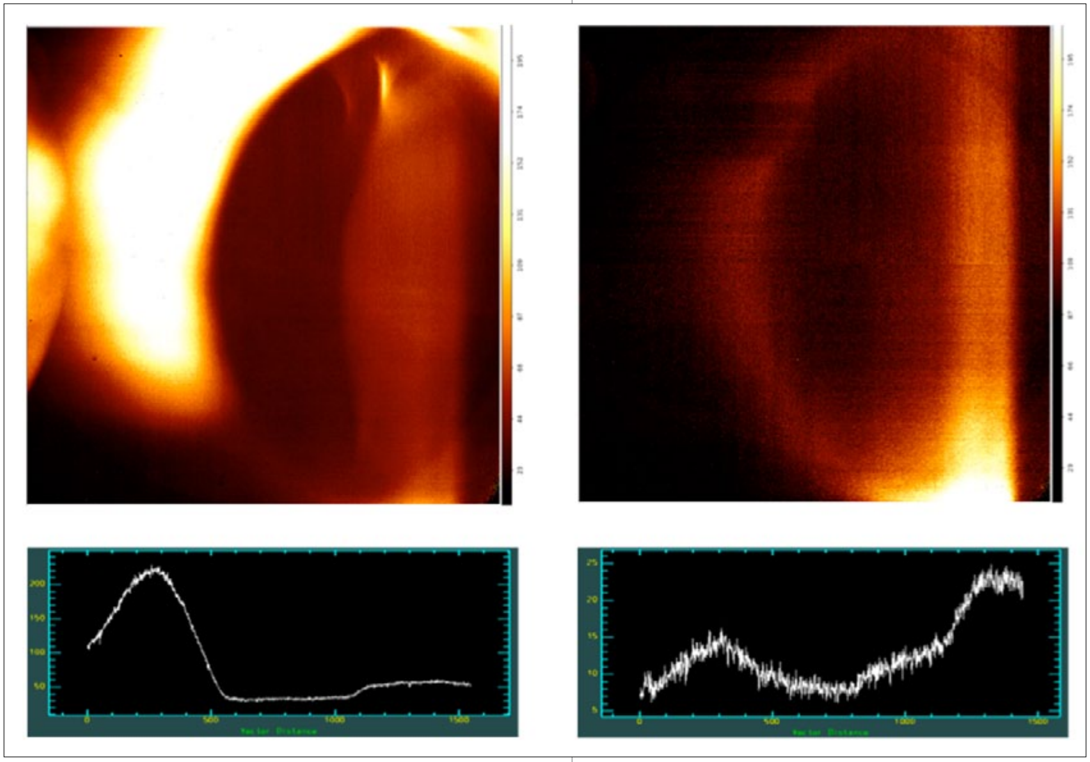


Figure 2.
The effect of the gate valve baffle not going into place properly. Radiation from the warm gate valve mechanism is "seen" in the rear cryostat. The figure shows the HK spectral range, the setup most affected by the fault. We will address this in an engineering period for FLAMINGOS-2 in February.

tween Jupiter and the brown dwarfs with the first examples of cool low-gravity planetary atmospheres.

The first night of Campaign observations occurred on November 8, 2014, with the first of a five-night block undertaken by the instrument team and Gemini staff. The first night was inauspicious, plagued by poor seeing varying and high winds, but the Campaign has some observations which can stand poorer conditions, and several Campaign targets were observed even on that first night. By the end of the block a good haul of Campaign targets had been observed.

GPI Queue

GPI has been in the queue since the start of Semester 14B, in scheduled blocks. Unfortunately, the weather has not been cooperating; out of six scheduled nights, we have only completed three hours of observations. Principal Investigators that have been affected have been contacted to add new targets for those that have set.

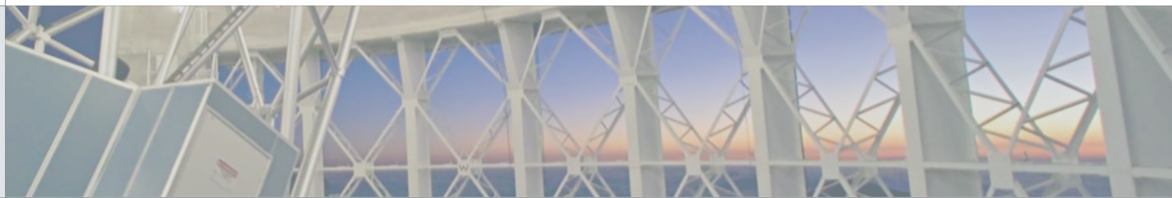
Priority Visitor Runs Begin!

Principal Investigators of Large and Long programs are becoming familiar with the "Priority Visiting" mode, in which the observing program's staff are placed at the summit for an extended visit. A PI with an allocation of 40 hours might, for example, come for a total stay of six nights, within which they can choose when to execute their observations (possibly even choosing to observe in better conditions than they formally requested).

During 2014B we have had a number of these runs, both North and South. The first was undertaken by Wes Fraser (Herzberg Institute of Astrophysics, National Research Council of Canada) and collaborators (including one taking advantage of "Bring One, Get One") in August 2014, covering between them a nine-night summit block (see article in the October issue of *Gemini*Focus). The run went very well and featured a night on which three of the big Mauna Kea telescopes were trained on the same object at the same time! We're keeping notes on what works and what doesn't during the course of these runs, because in the longer term, as the teams become more experienced, we expect to reduce the level of astronomer support at the summit. Priority Visitor (PV) mode was announced as a general possibility in the 2015A Call for Proposals, and we are currently scheduling more such PV runs for 2015A.

Fast Turnaround Program Launched!

Early in the new year (January 2, 2015) we were pleased to announce the release of the first call for Fast Turnaround proposals. This pilot program, running at Gemini North, gives users the opportunity to apply for telescope time every month. Proposals are reviewed by the PI (or a co-Investigator) of other proposals submitted during the same round, and successful programs can be observed starting one month after the proposal deadline. See the ***Fast Turnaround web pages*** for full details about this innovative program.



Contributions by Gemini staff

On the Horizon

Instrument development at Gemini continues. Users may have access to GRACES as early as 2015B, proposals for the next facility instrument are being evaluated, and the GHOST project successfully passed its Preliminary Design Stage Review.

GRACES: Gemini User Access to High-resolution Optical Spectroscopy Nears

After successful testing, Gemini and CFHT have now agreed on a way to offer GRACES (Gemini Remote Access to CFHT ESPaDOnS Spectrograph) to Gemini users in regularly scheduled blocks of time starting as early as 2015B. Meanwhile, some additional work will further im-

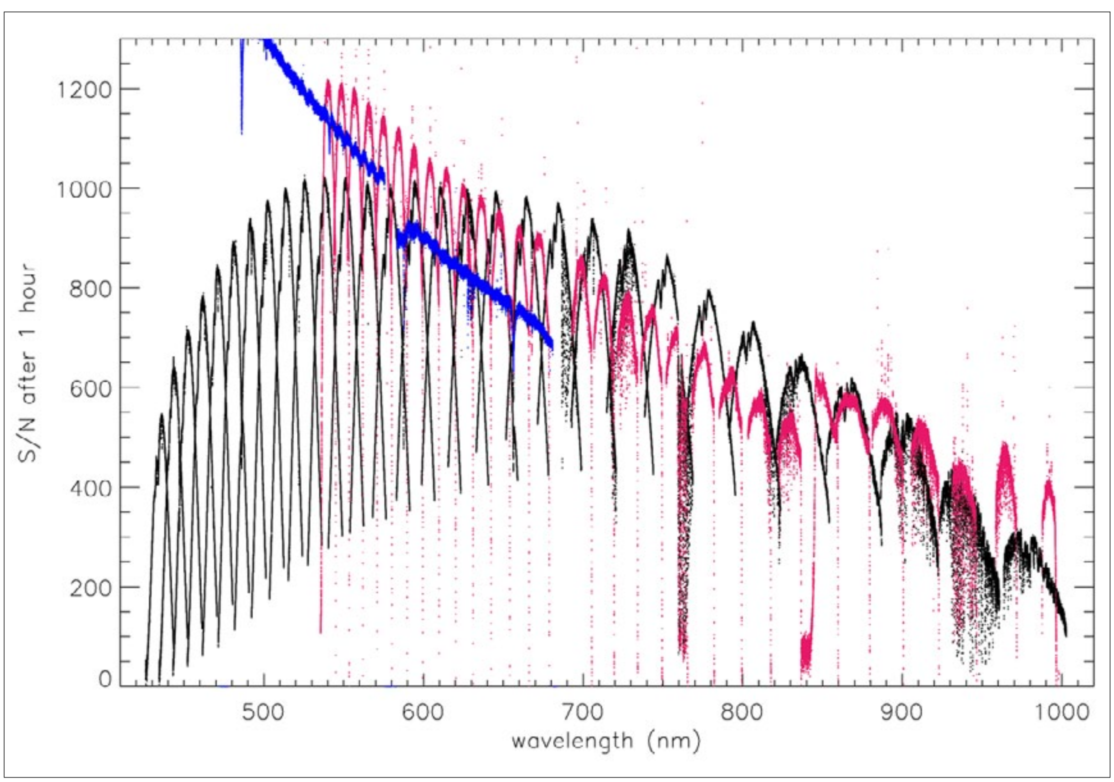


Figure 1.
Comparison of a one-hour exposure on the star Feige 66 observed with GRACES (black), Keck's High Resolution Echelle Spectrometer (HIRES; red), and ESO's Ultraviolet and Visual Echelle Spectrograph (UVES; blue). All the spectra are binned into their resolution element for fair comparisons.
Figure credits: André-Nicolas Chené, Scott Dahm (Keck), and Isabelle Percheron (ESO).

prove GRACES' performance and make it operate more efficiently. The expected sensitivity is already impressive, as illustrated in Figure 1. Since its 270-meter fiber, which connects Gemini to the CFHT ESPaDOnS spectrograph, has a high transmission between 500 and 900 nanometers, GRACES' performance will rival that of other high-resolution spectrographs on other 8-10 meter telescopes. GRACES will operate in two modes: One offering an average resolution power of R=40,000, and another delivering R=68,000.

Additional information can be found on the GRACES webpage **[here](#)** .

GIFS Moves Ahead

The Gemini Instrument Feasibility Study (GIFS) proposal deadline passed on December 15th with eight proposals received. GIFS will provide science cases and instrument ideas that could be used for the next facility instrument (Gen4#3). Gemini will now evaluate the proposals for selection in January, 2015. There's still time, however, to provide input for Gen4#3 at the Gemini Future and Science meeting in June. (Information about the meeting is available at ***this website***). The latest information on GIFS can be viewed ***here***.

GHOST Materializing

During the third week of December 2014, the Gemini High-resolution Optical SpecTrograph (GHOST) project held its Preliminary Design Review (PDR) in Hilo, Hawai'i (Figure 2). Attending were the Review Committee and several members from the partnership: Gemini Observatory, Australian Astronomical Observatory, Australian National University, and Canada's National Research Council–Herzberg.

The PDR Committee was pleased to see the progress achieved, acknowledging the extraordinary effort of the GHOST team in achieving the PDR's passage and has recommended that the project proceed into the Critical Design Stage. The Committee also made numerous recommendations to help the team ensure success. Watch for future updates as the Critical Design Review approaches by the end of 2015; we still plan on

Figure 2.
The GHOST team (consisting of members from AAO, NRC-H, ANU, and Gemini)successfully passed their Preliminary Design Stage Review at Gemini North Hilo headquarters on Wednesday. A team of dedicated experts, external and internal to Gemini, supported the review and made some very good suggestions to help keep the project on track. The entire team was happy and relieved on completion of this major project milestone.

Figure 3.
The Gemini South laser propagates into the southern sky during a GeMS run in 2014

bringing GHOST to one of the Gemini telescopes in 2017, though which one has yet to be determined.

Laser Guide Star Facility (LGSF) Upgrade: Next Generation Laser Guide Star for Gemini South

Given reliability issues experienced with the existing laser guide star system at Gemini South, Gemini is investigating procuring a new laser. The current generation of laser systems are much more reliable than our existing laser, which is difficult to maintain at full power, making its use operationally both costly and technically challenging.

In early 2015, we will explore the feasibility of integrating a current generation laser with the rest of our laser guide star system. If this integration is feasible and the new solution meets our power, reliability, delivery time, and cost requirements, we will strongly consider moving forward with procurement.

GMOS: CCD Update at Gemini North

With new red-sensitive Hamamatsu detectors installed and commissioned in the Gemini Multi-Object Spectrograph (GMOS) at Gemini South, and with the CCDs providing good science data, it's now Gemini North's turn to have its GMOS upgraded. The new Hamamatsu detectors should arrive at Gemini North in early 2015. After assembling and testing the new CCDs in the lab, we'll be ready to install them in July 2015, pending operational resources being available. Details and updates are available ***here***.


Peter Michaud and Maria-Antonieta García

Viaje al Universso

Sharing the universe with the public in Chile, and art with staff

Each year, Gemini's Viaje al Universo program engages thousands of local Chilean students, teachers, and families in a week full of education and fun. In 2014, the event carried on this tradition, growing for the fifth consecutive year as we added several new partners from the local community, including the University of La Serena, City Hall of La Serena and Coquimbo, and Chile's National Tourism Service (SERNATUR). Many Gemini staff also gave generously of their time and shared their passion for the exploration of the universe. This year we recognized 10 teachers and their school's principals for their continued support and participation in Gemini's outreach programs. The images that follow convey the essence of the week's diverse events.

The University of La Serena, overlooking the city of La Serena, was the setting for the opening ceremony of this year's Viaje al Universo. Over 100 people attended, including the Mayor of La Serena Roberto Jacob Jure, and Gemini South's Deputy Director Nancy Levenson. Also participating were local representatives from Chile's National Tourism Service, City Hall of La Serena and Coquimbo, and University of La Serena. Science staff from the Association of Universities for Research in Astronomy and Las Campanas Observatory also joined in the fun.

Gemini South volunteer Viviana Bianchi (from Argentina) uses chocolate cookies to teach girls from Colegio Germán Riesco in La Serena about Moon phases.

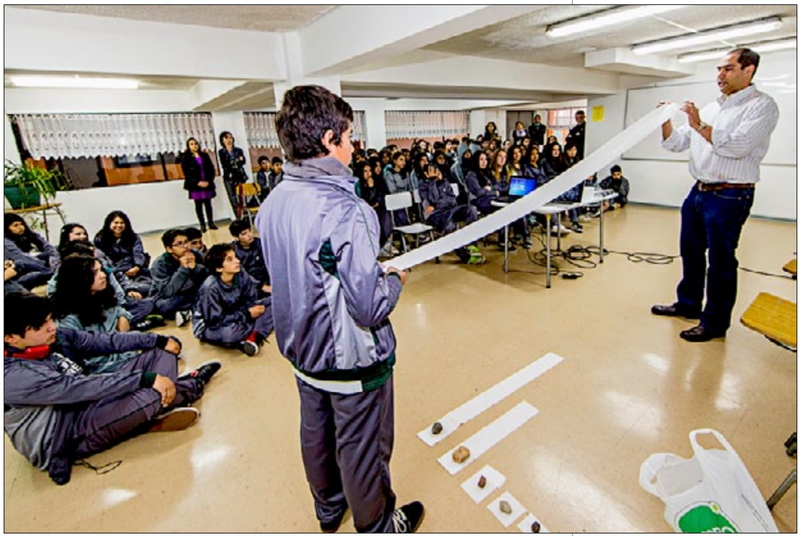
Over 100 children from Leonardo da Vinci school in Vicuña, Colegio Español Coquimbo, and a local language school, gather at the Alfa Aldea planetarium in Vicuña to listen to science talks provided by the University of La Serena and Gemini.

Staff from both Gemini and the Cerro Tololo Inter-American Observatory presented concurrent portable planetarium programs. Here, 3rd graders prepare to enter one of the domes.

At the public library in the Mall Plaza La Serena, teachers had the opportunity to assemble and use a "Galileoscope." Here, educator Jorge Muñoz and a few of the participating teachers turn their recently assembled telescopes on the sky.

Gemini's career brochure was distributed to more than 3,000 students during their Viaje al Universo week. Here a girl and her classmates read about the variety of career opportunities available at astronomical observatories.

Gemini South science staff's Juan Madrid leads an interactive session at Colegio San Joaquín on "A Journey into Stellar Clusters" for 7th and 8th grade students and teachers.



Oh, and There Was Art Too!

As Viaje al Universo wrapped up, Gemini South's Artist in Residency Colleen McLaughlin Barlow arrived from Vancouver (British Columbia, Canada) to share her creativity. For the entire month of November (and a few days of October and December) Colleen immersed herself with Gemini's staff to gain inspiration for her photos, paintings, and Japanese prints with graphite, india ink, and pastels; it was a magical marriage of art and science.

This was Colleen's second observatory Artist in Residency experience, as she previously held that distinction at the Canada-France-Hawaii Telescope; the Canadian government funded her time at Gemini South. Colleen's interactions left a positive impression with staff who participated in activities like cyanotype printing, where one lays various objects on paper saturated in photosensitive chemicals before exposing it to direct sunlight.

Colleen also shared with the staff the techniques of sumi-e — a Zen-like ink-wash painting method — and Sho-do calligraphy. Mistakes do not exist, but rather become part of the art. Of the experience, Gemini's Constanza Araujo said, "In a blink of an eye I was refreshed in some special way, I felt inspired and re-energized for the rest of the workday."

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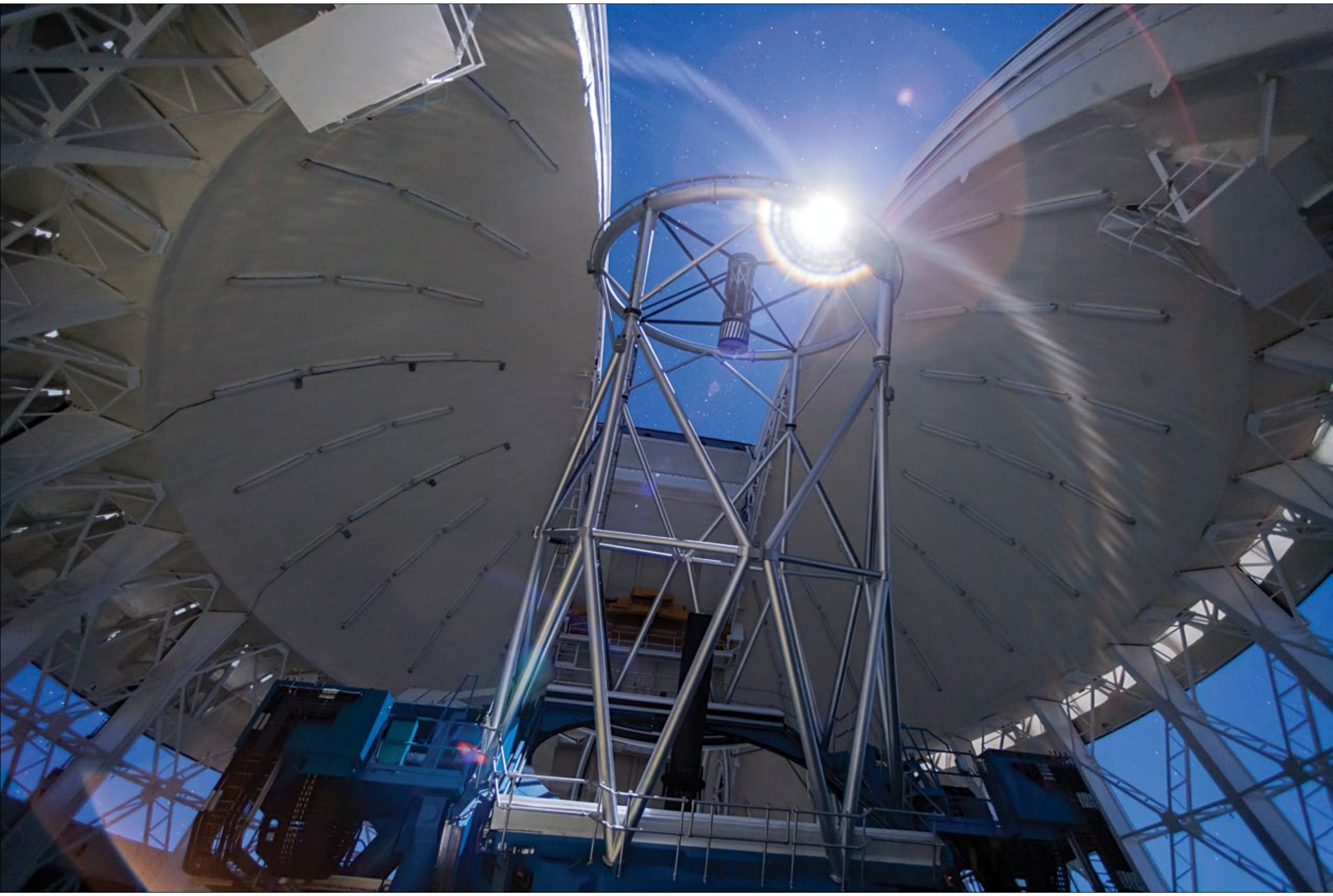
Gemini South laser spotter Jorge Muñoz tries his hand at copying the Japanese technique called Sho-do.

Optical engineer Constanza Araujo receives instructions from Artist in Residence Colleen McLaughlin Barlow as she prepares to work on a cyanotype piece of art.



Gemini North telescope (with Moon flare) imaged by Joy Pollard on December 8, 2014.

The Gemini Observatory is operated by the Association of Universities for Research in Astronomy, Inc., under a cooperative agreement with the National Science Foundation on behalf of the Gemini Partnership.

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