Opportunities with Gemini Observatory

Jennifer Lotz - K-GMT science meeting - 2/13/2019
Gemini Observatory Overview & Strategic Vision

• Gemini international partnership update

• Current observing capabilities and opportunities

• Gemini in the 2020’s
  • high-resolution spectroscopy, imaging for exoplanets, stellar chemistry, stellar populations, extragalactic astronomy & more
  • premier facility for time-domain & multi-messenger follow-up
  • future instrumentation: GHOST, SCORPIO, visiting instruments
  • revitalized adaptive optics, bi-hemisphere MCAO systems
Gemini International Partnership

Welcome Korea!
5% participant as of January 1st 2019

current international agreement ends 2021;

All current participants have stated intention to remain in partnership and participate in negotiations for new agreement in 2021

(+ Chile, Hawaii 5% time in South, North respectively)
National Center for Optical Infrared Astronomy (NCOA) will combine NOAO, Gemini and LSST operations into a single Center for astronomy. Launch in fall 2019- fall 2020.

Gemini Board & Financial Committee retain control of Gemini’s science vision and budget.
Gemini Observatory Overview

- Twin 8m OIR telescopes on Maunakea and Cerro Pachón

- Korea time allocation: ~14 nights on each telescope in 2019
  ~2.5-3.0x oversubscription for Band 1 & 2

- Queue, classical, and ToO observing; (Large & Long Programs)
  Subaru Telescope exchange program

- Flexible visiting instrument program with path for public access
  (e.g. IGRINS, 'Alopeke, MAROON-X)
Gemini-South Earthquake Recovery - Jan 19 2019

6.7-Mw 60km SSW of Cerro Pachón, 53km depth
Peak acceleration: x: 0.45g, y: 0.26g, z: 0.34g
Duration 60 sec

- observing with GeMS; crew on site during quake
- no major damage, no injuries
- 2 M1 actuators replaced
- back on sky in 5 days
<table>
<thead>
<tr>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>facility</strong></td>
<td><strong>facility</strong></td>
</tr>
<tr>
<td>GMOS (optical imaging/long-slit/IFU)</td>
<td>GMOS (optical imaging/long-slit/IFU)</td>
</tr>
<tr>
<td>NIRI (NIR imager)</td>
<td>GPI (ExAO coronagraph)</td>
</tr>
<tr>
<td>NIFS (NIR IFU)</td>
<td>FLAMINGOS-2 (NIR imager/long-slit)</td>
</tr>
<tr>
<td>GNIRS (NIR long-slit)</td>
<td>GeMS/ GSAOI (MCAO NIR imager)</td>
</tr>
<tr>
<td>Altair (NGS/LGS AO)</td>
<td>visiting</td>
</tr>
<tr>
<td><strong>visiting</strong></td>
<td>DSSI (optical speckle imager)</td>
</tr>
<tr>
<td>'Alopeke (optical speckle imager)</td>
<td>Phoenix (high-res NIR spectrograph)</td>
</tr>
<tr>
<td>GRACES (high-res optical spectrograph)</td>
<td></td>
</tr>
<tr>
<td>TEXES (mid-IR spectrograph)</td>
<td></td>
</tr>
<tr>
<td>POLISH2 (optical polarimeter)</td>
<td></td>
</tr>
</tbody>
</table>
2019A requested hours

- **Gemini-North**
  - GMOS: 58%
  - GNIRS: 12%
  - NIRS: 6%
  - DSSI: 8%
  - GSAOI: 10%
  - FLAMINGO2: 14%
  - GASP: 2%
  - GPI: 6%
  - Phoenix: 9%
  - MAROONX: 1%
  - 'Alopeke: 7%
  - POLISH2: 3%
  - GRACES: 5%

- **Gemini-South**
  - GMOS: 51%
Gemini Observing Opportunities

Spring & Fall Semester: BI-ANNUAL, queue, classical, ToO, priority visitor, eavesdropping; Subaru Telescope exchange (MARCH deadline!)

Fast-Turnaround: MONTHLY; queue, ToO

Director’s Discretionary: open call, queue, ToO

Poor Weather Programs: open call, queue (UNDERSUBSCRIBED)
Gemini in the 2020's

- high-resolution spectroscopy & imaging for exoplanets, stellar chemistry, stellar populations, extra-galactic, & more
- premier facility for time-domain & multi-messenger follow-up (LIGO now, LSST science operations ~2022)
- future instrumentation: GHOST, SCORPIO, visiting instruments
- revitalized adaptive optics, bi-hemisphere MCAO systems
Gemini Planet Imager (GPI, Gemini-South): extreme adaptive optics coronagraph/imaging polarimeter/integral-field spectrometer

Direct imaging, spectroscopy of massive exoplanets and proto-planetary disks around bright stars
MAROON-X:
High-resolution, high-stability spectrograph for exoplanet radial velocity studies

– visiting instrument, PI J. Bean/U. Chicago commissioning GN 2019B;

target radial velocity ~ 1 m/s at V=17, \( R = 80,000, \lambda =0.5-0.9 \) microns
(late M-dwarf out to 20 pc)
High Resolution Spectroscopy with Gemini

**IGRINS, PHOENIX** - visiting instruments from previous semesters

**GRACES** - Gemini Remote Access to CFHT ESPaDOnS Spectrograph

\[ R(\text{max}) = 67,000 ; \quad \lambda = 0.4-1.0 \text{ microns}, \quad \text{Gemini-N} \]

**MAROON-X** - \( R = 80,000, \text{ } \lambda = 0.5-0.9 \text{ microns}, \text{ } \text{Gemini-N in late 2019} \)

**GHOST**: \( R=50,000-75,000, \lambda = 0.36-0.95 \text{ microns}, \text{ } \text{Gemini-S in 2020} \)

**IGRINS2**: \( R \approx 45,000, \lambda = 1.4-2.5 \text{ microns}, \text{ } \text{Gemini-S in next few years will be built by KASI} \)
GHOST: Gemini High Resolution Optical Spectrograph - High throughput, fiber-fed optical high-resolution spectrograph. Simultaneous 363 nm to 950 nm at R=50K (2 targets) or R=75K (1 target).

As of early January 2019:
- Optical bonding issue resolved &
- Most optical components now mounted

Cassegrain unit testing at Gemini-S has gone well
most optical components now mounted (at NRC)
GHOST : Gemini High Resolution Optical Spectrograph

Blue throughput, wide spectral coverage, multi-object mode

• extremely metal poor stars
• extra-solar planet host stars
• stellar abundances in star clusters
• follow-up of GAIA sources
Time-Domain Astronomy with Gemini

Queue observations, North-South East-West access → ideal observatory for follow-up of gravitational wave EM counterparts, LSST, & other transient events.
Gemini Observatory operations

flexible queue scheduling, base-facility operations, & rapid instrument changes

enable agile, rapid-response operations
Transient Follow-up System:

- **LSST**
- **LIGO**
  (data)

**ANTARES**
(characterizes /ranks alerts)

**TOMs**
(trigger follow-up, interface with dynamical scheduler)

**Discovery engines**
**Broker services**
**Target & Observation Manager Systems**
**Observing facilities**
Scorpio

Spectrograph and Camera for Observations of Rapid Phenomena in Infrared and Optical

8-channel optical/near-infrared imager and spectrograph

Imaging: g, r, i, z, Y, J, H, and Ks bands, simultaneous with 3'x3' f.o.v.

Spectroscopy: Simultaneous coverage of 0.37-2.35 μm with 3' long slit

delivery by 2021 - LSST science ops.
Versatile 'work-horse' instrument

simultaneous optical-IR wavelength coverage, high-time resolution → Time Domain Astronomy

• gravitational wave optical counterparts
• supernovae explosion physics & dust evolution
• solar system transients - asteroids, comets
• exoplanet stellar hosts & atmospheres
• galaxy evolution
Wide-Field Adaptive Optics at Gemini Observatory

GeMS/GSAOI - multi-conjugate adaptive optic imaging at GS
1.4' FOV, 0.085'' resolution in K-band (with 3 NGS)
Future of Adaptive Optics at Gemini Observatory

**GeMS/GSAOI** - multi-conjugate adaptive optic imaging at GS 1.4' FOV, 0.085" resolution in K-band (with 3 NGS)

*update natural guide star sensor → ~triple GeMS sky coverage*

**Gemini in the Era of Multi-Messenger Astronomy**
- build improved MCAO for Gemini-N. (GNAO), with 1st light imager (GNAOI) ~2024; multi-object IFU (**GIRMOS**) ~2025
- new Real-Time Computing systems for GeMS and GNAO

**Adaptive Secondary Mirror** for Gemini-N in mid-2020s enable wider field corrections/GLAO for full G-N instrument suite
Projects

Adaptive Optics

The Gemini North Adaptive Optics (GNAO) upgrade project will deliver the first queue-operated multi-conjugate adaptive optics (MCAO) system in the northern hemisphere. The GNAO effort will build on experience with the Gemini Multi-conjugate System (GeMS) at Gemini South, but it will employ the latest technologies for improved performance in support of the next generation of AO-assisted instruments at Gemini North. With a corrected field-of-view of about 2 arcmin and spatial resolution similar to that of JWST, GNAO will take advantage of Maunakea’s outstanding conditions for AO performance and establish GN as the premier ground-based facility for wide-field AO studies.

Time Domain

The Time Domain Astronomy (TDA) project will develop the infrastructure for incorporating Gemini’s telescopes into the Astronomical Event Observatory Network (AEON), an efficient new system for following up transients identified by LSST, LIGO, and other time-domain and multi-messenger surveys. The goal of this effort is to maximize Gemini’s contributions to discoveries in the TDA era, and Gemini will provide the largest aperture within AEON to enable studies of the faintest, highest priority targets. The TDA project also includes development of automated data pipelines for rapid delivery of science-quality reduced data so that users can assess the outcome of their observations in real time.

Outreach

GEMMA enables Gemini Observatory to expand on its legacy of ambitious Public Information and Outreach (PIO) initiatives. The basis for this expanded outreach is multimessenger astronomy (MMA) and the role of Gemini and other ground-based facilities in this new discovery arena. Specifically, the GEMMA PIO initiatives include a multimedia planetarium program to illustrate MMA concepts, classroom materials to promote careers in related science and technology fields, training workshops for science writers, and an ambitious “MMA summit” to establish a charter for the public communication of MMA concepts and discoveries.
Tell us about your ideas for scientific studies that may be enabled by the GNAO and TDA efforts described above, and any specific requirements that must be met (particularly in the case of GNAO) to make those studies possible.

Remember to send us your ideas for science with GEMMA so we can optimize the design of GNAO and TDA!

**Big Ideas**

**GEMMA Big Ideas**

Gemini In The Era of Multi-Messenger Astronomy

* Required

Email address *

Your email

What science goals do you want to pursue?

Your answer

If your science goals involve GNAO, what instrument requirements must be met to achieve these goals?

Your answer

What observations would you propose to pursue these goals?
The next 5 years will be exciting times for Gemini users!

Strong international partnership, strong development of new instruments

Many ways to propose & observe; open call for visiting instruments

Strong science opportunities for time-domain astronomy, exoplanet science, high-res spectroscopy, high-res imaging with new & improved adaptive optics

We want your big ideas!  www.gemini.edu/gemma/#big-ideas

Gemini Science Meeting - Seoul, Summer 2020