Gemini Multi-Object Spectrograph
Gemini Multi-Object Spectrograph

GMOS at Gemini North
**GMOS overview**

- First facility instrument (Gemini North and South)
- Wavelength interval: 360 - 1000 nm.
- Observing Modes:
  - Direct imaging (5.5’ x 5.5’ field of view)
  - Spectroscopy: Long-slit, MOS and IFU (with N&S capabilities)
  - Different ROIs and binning modes
- GMOS detectors: three 2048x4608 E2V (formerly EEV) chips (6144 x 4608 pixels)
  - Pixel scale: 0.073”/pix (15 µm)
- Observations limited by the sky background: > 95% of the programs require ‘dark/darkness’ conditions (SB better than 50%-il)
GMOS Field of View: image

Areas of the detectors that are outside the imaging field of view

Vignetting by the OIWFS guiding on a star inside the imaging field of view

Gaps between the detectors
GMOS Field of View: spectroscopy

Grating R150, 740 nm central wavelength
GMOS - mechanical structure
GMOS components: filters

- Sloan: $u'$, $g'$, $r'$, $i'$, $z'$
- Long-band pass filters: GG455, OG515, RG610, RG780
- Other filters: CaT, Ha, HaC, OIII, OIIIC, SII
- 2 filter wheels - space for 11 filters in each wheel
- Transmission curves measured last week
GMOS components: masks

- Longslit - standard set
  - Slit width of 0.25”, 0.5”, 0.75”, 1”, 1.5”, 2” and 5”
  - N&S longslits: 0.5”, 0.75”, 1”, 1.5” and 2”
    - Slit length of 108” (1/3 of the CCD in y-direction).
- Multi-object spectroscopy (MOS)
  - Masks designed from GMOS direct imaging and from non-GMOS images (2008A)
  - Slit widths 0.5” or larger
  - Mask design - done with the GMOS Mask Making Software (gmmps v0.304)
- Nod & shuffle: Longslit and MOS mode for accurate sky subtraction. IFU N&S : GMOS-S only)
- 3 cassettes - support 18 mask (including IFU).
### GMOS components: gratings

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<tbody>
<tr>
<td>B1200</td>
<td>1200</td>
<td>4630</td>
<td>3744</td>
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<tr>
<td>R150</td>
<td>150</td>
<td>7170</td>
<td>631</td>
<td>10710</td>
<td>1.74</td>
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</tbody>
</table>

Grating turret support only 3 gratings + mirror
GMOS components: IFU

- IFU: Spatially resolved spectroscopy: 2-slit mode: 5"x7" in size, 1-slit mode: 5"x3.5" in size. 1 arcminute away.
- 1500 fibers. Hexagonal lenslet. Wavelength range 400-1100 nm.
- 2 fields separated by 1 arcmin.
  - Target field of view 5"x7" (1000 lenslet).
  - Sky field of view 5"x3.5" (500 lenslet).
- GMOS-S IFU: N&S capabilities: FOV: 5"x5"
GMOS components: IFU

GMOS-IFU: Field Orientation With Respect To Slits (Not To Scale)
GMOS components: IFU

- Pick off mirrors
- Enlarger body
- Slit blocks
- Output micro-lens array
- Fore-optics barrel
- Input micro-lens array holders
- Fibres (only partially shown)
Observing considerations

- Extended to all instruments
  - Write a proposal with a GOOD science case
  - Calculate accurately the total on-source time required according to the science case.
- Important: include the setup time (time needed to slew to the target + ALL overheads
  - Readout time for all images
  - Time to change the filters, gratings, etc.
  - Time to do an offset on the sky
- The setup times and overheads are tabulated for all instrument in the Gemini Public Webpage.
Observing with GMOS

• **Image mode:**
  - define filters, dither patterns, offset sizes as needed
  - Offsets should be large enough to avoid the gaps (37 pixels, un-bin).
  - Bias and twilight flats are baseline calibrations and should not be included in the program
    - Bias are observed weekly.
    - Twilight flats: 25 or more flats per filter per month.

• **Spectroscopic mode (Long-slit, MOS and IFU modes):**
  - Acquisition sequence (class: acquisition)
  - Science sequence (class: science)
    - Includes GCAL flat (Nighttime Partner calibration)
    - CuAr Arc is optional - charged to the program if the arc is included in the sequence, otherwise is daytime calibration (not charged)
Observing with GMOS

- **IFU**: Arcs observations - recommended to include in the science sequence (time consuming, in particular in the blue)
  - Offset in wavelength (recommended) to avoid lost of information in the gaps
- **Daytime calibrations** (not charged to the program)
  - Bias, CuAr arcs, imaging twilight flats (class: Daytime)
- **Nighttime partner calibrations** (charged to partner)
  - GCAL flat: included in the science sequence
  - Flux standards (relative flux calibration) - requires a separate acquisition sequence and should be included in the program.
    - MOS only: Three wavelengths are used to cover the wavelength range covered by the slit-est.
    - The middle setting is the same as one of the MOS spectral dithers.
- **Nighttime program calibrations**
Fringing frames: $i'$ and $z'$

At 900nm - fringing amplitude is 76%!!!
Fringing frames: ì’ and z’

At 900nm - fringing amplitude is 76% !!!
Fringing frames: $i'$ and $z'$

At 900nm - fringing amplitude is 76%!!!
Observing tools: QPT

Queue Planning Tool: used by the night time observer

### PLAN BY CONDITIONS: (follow the link)

<table>
<thead>
<tr>
<th>Water Vapor</th>
<th>Image Quality</th>
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<tbody>
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<tr>
<td>50</td>
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<tr>
<td>90</td>
<td>WV=Any</td>
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<tr>
<td>Any</td>
<td>WV=Any</td>
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</table>

### INSTRUMENT INFORMATION

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Pixel Scale</th>
<th>FoV</th>
<th>Orientation</th>
<th>IFU</th>
<th>Saturation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMOS-S</td>
<td>0.073&quot;/pix (unbin)</td>
<td>5.5&quot; x 5.5&quot; (Full frame)</td>
<td>N(down), E(left) (IPA=deg)</td>
<td>7&quot; x 5&quot; (IFU-2)</td>
<td>~65000 ADU</td>
<td>Non-linearity start at 50000 ADU; Internal / External web pages.</td>
</tr>
<tr>
<td></td>
<td>0.146&quot;/pix (2x2 binned)</td>
<td>2.43&quot; x 5.5&quot; (CCD2)</td>
<td></td>
<td>7&quot; x 3.5&quot; (IFU-R)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phoenix</td>
<td>0.055&quot;pix (imaging)</td>
<td>0.085&quot;pix (spectra)</td>
<td>Default IAA = 180 IPA = 90 (d11 F-W) Imaging; N up, E left Sjing: N up, F right</td>
<td>5&quot; x 5&quot; (NS-IFU-2)</td>
<td>~7000 ADU (e.g., flats)</td>
<td>Internal webpages</td>
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<tr>
<td>T-ReCS</td>
<td>0.089&quot;/pix</td>
<td>28.5&quot; x 21.4&quot;</td>
<td>N(up), F(def) (IPA=deg)</td>
<td></td>
<td>~35000 ADU/frame (SroA)</td>
<td>Internal / External web pages.</td>
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### Observing tools: QPT

#### Resource Summary

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<th>Photometric, Super Seeing, Dry</th>
<th>Photometric, Super Seeing, Moist</th>
<th>Photometric, Super Seeing, Wet</th>
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<tbody>
<tr>
<td>G0088 / B000, naso, 0.5 and 0.6</td>
<td>G0098 / B000, g, 0.5 and 0.6</td>
<td>G0088 / B000, g, 0.5</td>
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<th>Photometric, Terrible Seeing, Dry</th>
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Itajubá, 09 de abril de 2008

Rodrigo Carrasco
Observing tools: QPT

Queue Planning Tool: used by the night time observer

Itajubá, 09 de abril de 2008
Rodrigo Carrasco
Observing tools: Seqexec

Sequencer executor: used to observe the sequences
-The sequences are queued from the OT and loaded to Seqexec
Strong Gravitational-Lensing Features in Abell 3827 (z~0.1)

- Abell 3827 - one of the most massive galaxy clusters known
- At the center:
  - Most extreme example of on-going galaxy cannibalism known at the present: a super-giant elliptical (cD) galaxy is in the process of formation.
- GMOS multi-slit observations:
  - Physically interacting
  - Stellar populations
  - Provide detailed initial conditions for modeling the evolution of the system (comparison with BCG)

M. West, ESO 1m telescope (1998)

Carrasco, Lee, Bermgmann, Diaz, Gomez, Miller, Turner (Gemini); West (ESO)
Observations

- GMOS direct imaging \( (g', r', i') \) and MO spectroscopy
- Imaging: seeing: 0.48” - 0.65”
- Spectroscopy:
  - Longslit observations (DD program) of the central galaxies
  - MOS observations of > 60 galaxies
- 55 galaxies member of the cluster:
  - \( M_V = 3.8 \times 10^{14} M_{\odot} \)
  - \( \sigma_v = 1134 \) km/s
- Strong gravitational arcs
South East and North West arcs

- Southeast arc: tangential with a radius curvature 20", length ~ 10", thickness ~ 0.7"
  - Derived redshift: 0.402
  - Assuming a circularly symmetric lens: $M = 5 \times 10^{13} M_{\text{sun}}$ (inside 20" or 40 kpc).
- Northwest feature(s): two symmetric "eggs-like" features
  - Features similar to lensed-images of the bread ring-like galaxy seen in CL1024+1654 at $z=1$.
  - Estimated redshift: 0.2
Southeast and X-ray emission

SE arc - continuum subtracted

XMM-Newton (P. Gomez):
- A3827: regular cluster
- No evidences of interaction
Preliminary conclusions and future observations

- To produce these features, the cluster core must be very massive.
- Normal X-ray emission.
- Northwest feature: the four “eggs” suggest that the background source is very close to the optical axis joining the observer, lens, and source.
- Carefully subtraction of the light from the cluster core galaxies and the diffuse intracluster medium is required to confirm the existence of the Einstein ring.

Future observations:
- VLT-VIMOS IFU observation, band A - ongoing (52”x52”)
- HST ACS3 proposal submitted to image the cluster core and resolve the lens
- Next step: CTIO 4m (MOSAIC) observations to analyze the environment at larger scale.