Extending the SAMI survey to z~1

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With help from Julia Bryant and Scott Croom
SAMI key science topics

› What are the physical processes responsible for galaxy transformations?
  - Morphological and kinematic transformations; internal vs. external; secular vs. fast; ram pressure stripping; harassment, strangulation; galaxy–group/cluster tides; galaxy-galaxy mergers; galaxy-galaxy interactions…

› How does mass and angular momentum build up?
  - The galaxy velocity function; stellar mass in dynamically hot and cold systems; galaxy merger rates…

› Feeding and feedback: how does gas get into galaxies, and how does it leave?
  - Winds and outflows; feedback vs. mass; triggering and suppression of SF; gas inflow; metallicity gradients; the role of AGN…
The SAMI Instrument

› Located at the prime focus of the AAT
› 1 degree diameter f-o-v.
› 13 x 61 fibre IFUs using hexabundles (Bryant, Bland-Hawthorn et al.).
› 15” diameter IFUs, 1.6” diameter fibre cores.
› Feeds AAOmega, a bench mounted optical spectrograph (42m fibre cable)
› Spectral resolution R~1700 (blue), R~4500 (red).
› A forerunner to HECTOR @ AAT - a 100,000 galaxy survey from 2020-2025
The SAMI survey

- 3,400 galaxies
- Median redshift $z \sim 0.05$ (low redshift)
- Primary fields are the Galaxy And Mass Assembly (GAMA) regions.
- Specific galaxy cluster fields are targeted to probe the highest density environments.
- Started in March 2013 (completion in 2018)
- First data release: [http://sami-survey.org/edr](http://sami-survey.org/edr)
The SAMI survey (as of Nov. 2015)
Early SAMI results - Galactic winds

Fogarty et al.

Can be done with a single line Hα
Early SAMI results - Galactic winds

AGN
shocked
star formation

Requires a broad wavelength interval
Early SAMI results - Shocks and outflows

Ho et al. 2014, Leslie et al.

Examples of SAMI spectral decomposition

Examples of our spectral decomposition using the SAMI data. First, second and third rows are examples of selected spaxels requiring 3-component, 2-component and 1-component models, respectively. The black data cubes are the composite of three SAMI data cubes in red, green and blue. The red, green and blue data cubes are the SAMI 3 components, SAMI 2 components and SAMI 1 components, respectively. The upper panels and lower panels show the SAMI 3 components and SAMI 2 components, respectively. The SAMI 1 components are shown in the lower panels. The red data cube covers 30 kpc from the SDSS, and the blue data cube covers 10 kpc from the WiFeS. The R.A. Offset and Dec. Offset are shown in arcsec, and the wavelength is shown in Angstrom.

Requires moderate resolution over a broad wavelength interval
The Universe at $z=1$

- It is 7.8 billion years younger (middle age)
- It is 8 times denser
- The SFR density is 10 times higher, i.e. more SNe
- The AGN number density is $\sim$100 times higher
- Galaxy clusters are a factor of 3 less massive

How do the processes that shape galaxies at $z=1$ differ in importance from the ones we see today?

For example, one might expect galaxy scale winds to be far more common
ULTIMATE Multi-object IFU Galaxy Survey

A SAMI-like at three (four) redshift intervals: $z \sim 0.6, 0.9, \text{ and } 1.4 (2.2)$

- 3000 galaxies over 50 nights
- Targets from the COSMOS and SXDF-UDS fields (HSC ultra-deep survey and forerunner ULTIMATE imaging surveys)
- Limited to star-forming galaxies (10 solar masses / year)

Four main questions

- How does feedback work and how does it change with cosmic time (S)
- What causes quenching and what is the influence of the environment (S)
- How does gas accretion change with time (M)
- What drives galaxy transformations (S)
## SAMI and ULTIMATE M-IFU

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>SAMI @ z~0.05</th>
<th>ULTIMATE @ z~1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of IFUs</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>FoV of positioner</td>
<td>3.6 Mpc (60’) diameter</td>
<td>7.2 Mpc (15’) diameter</td>
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<tr>
<td>FoV of IFU</td>
<td>15 kpc (15””)</td>
<td>11.0 kpc (1.35””)</td>
</tr>
<tr>
<td>Number of fibres per IFU</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Fibre pitch</td>
<td>1.6 kpc (1.6””)</td>
<td>1.2 kpc (0.15””)</td>
</tr>
<tr>
<td>Minimum sep.</td>
<td>30kpc (30””)</td>
<td>160 kpc (20””)</td>
</tr>
<tr>
<td>Spectral resolution</td>
<td>1,700-4500</td>
<td>3,000-5,000</td>
</tr>
</tbody>
</table>
Questions from the organisers

Q1. Key science questions
Quenching, what causes it, when does it happen, and where does it happen, and how (if at all) does it change with redshift?

Q2. First priority instrument
WFC to create an optimal target catalogue for follow-up with up with the IFU, but please allow the possibility to add a multi-object IFU later

Q3. Could GLAO + nuMOIRCS be used
Yes, but a dedicated near-IR spectrograph (more IFUs and optimised for IFU spectroscopy) would be better

Q4. Which survey is best?
E, of course, and A.

Q7. Spectrograph design?
Yes, but see comment above.

Q8. Non-GLAO (natural seeing) mode?
Yes, but for Galactic science
Instrumental issues that affect the survey

I. New grisms in MOIRCS
II. Closer fibre spacing (how close can we pack them?)
III. New IR spectrograph with more detector real estate
IV. The availability of the K band
VI. An ADC
Additional slides
Outflow driven by a starburst
Excitation from UV photons from star formation and shocks
Hexagonal tiling

1.35"

d=0.15"
pitch or flat-to-flat

Area = 61 \times 1.5 d^2 / \sqrt{3}

= 1.18 \text{ sq. arc seconds}