KROSS: The KMOS Redshift One Spectroscopic Survey

Durham/Oxford KMOS GTO survey of ~1000 typical Star Forming Galaxies at z=1

John Stott
Hintze Fellow (Oxford)

KROSS P.I.s: Richard Bower (Dur), Martin Bureau (Ox)
Oxford: Andy Bunker, Matt Jarvis, Georgios Magdis, Alfie Tiley
Durham: Mark Swinbank, Ian Smail, Ray Sharples, Helen Johnson, Chris Harrison

Others: David Sobral, Philip Best
What drives SFRD rise to $z=1-3$?

- Mergers? Major? Minor? (e.g. Somerville+2001, Conselice+2008)
What drives SFRD rise to z=1-3?

- Need to look at Typical ‘Main sequence’ star forming galaxies at z=1
- Main Sequence: Term for correlation between mass and SFR for star forming galaxies (Noeske+2007) evolves with z (e.g. Elbaz+2011).
- KROSS targets the Main Sequence at z=1. Unbiased compared to earlier single IFU studies.
KMOS

- KMOS: multi object IFU on VLT
- 24 IFUs 3*3 arcsec size, pixel scale=0.2"/pix
- Wavelength range=0.8-2.5micron, zYJHK bands
- Placeable in 7.2 arcmin diameter circle
- Status: Observations began Autumn 2013
KMOS

- KMOS: multi object IFU on VLT
- 24 IFUs, 3*3 arcsec size, pixel scale=0.2”/pix
- Wavelength range=0.8-2.5 micron, zYJHK bands
- Placeable in 7.2 arcmin diameter circle
- Status: Observations began Autumn 2013

24x Spectral slice showing the spectra across the entire galactic nucleus
KROSS: The KMOS Redshift One Spectroscopic Survey

- KROSS - 30 Night Durham and Oxford KMOS GTO collaboration
- Up to 1000 resolved Halpha observations of mass selected typical ‘Main Sequence’ star forming galaxies
- 1000 hour stack of all P92 targets

SFR and metallicity/AGN content

Swinbank+ in prep.
KROSS Science Goals

- Disc fractions
- Merger fractions
- Tully Fisher relation
- Dynamical masses
- Gas fractions
- Metallicity Gradients
- Winds/Outflows
KROSS Selection

- Fields: UDS, ECDFS, COSMOS, SA22
- Main sample: known spectroscopic redshifts
- Mass selection ($K_{AB}=22.5$, $\log(M)\sim9-9.5$)
- Red and fainter galaxies lower priority
- HiZELS Halpha NB included too
KROSS P92-P94

- First 540 targets observed in ESO period 92-94
- Efficiency: 95% detections. 80% resolved Halpha.
- Much more efficient than single IFU studies (i.e. SINS, SHiZELS)
The KROSS Main Sequence at $z=1$

SFR corrected for Av-gas based on Herschel stacks

mass from full SED fitting

Stott+ in prep.
The KROSS Main Sequence at z=1

SFR corrected for Av-gas based on Herschel stacks

mass from full SED fitting

Stott+ in prep.
The KROSS Main Sequence at $z=1$

- Massive Progenitors of MW & Fast Rotators?

SFR corrected for Av-gas based on Herschel stacks

mass from full SED fitting

Stott+ in prep.
The KROSS Main Sequence at $z=1$

SFR corrected for $A_V$-gas based on Herschel stacks

$\log(\text{SFR} \ [M_\odot \ \text{yr}^{-1}])$

$\log(\text{Stellar Mass} \ [M_\odot])$

mass from full SED fitting

Stott+ in prep.
The KROSS Main Sequence at $z=1$

SFR corrected for Av-gas based on Herschel stacks

mass from full SED fitting

Stott+ in prep.
The KROSS Main Sequence at $z=1$

SFR corrected for $A_V$-gas based on Herschel stacks

mass from full SED fitting

Stott+ in prep.
The KROSS Main Sequence at $z=1$

Stott+ in prep.
Preliminary Result: Dynamical masses

- Dynamical mass \( \sim 5 \times \) Stellar mass. Therefore high gas fraction 80\% (-10-20\% DM).
- Gas Fraction evolves with \( z \)
- We have ALMA time to get gas masses for a subset of KROSS

Stott+ in prep.

Friday, 3 April 2015
Preliminary Result: Dynamical masses

- Dynamical mass $\sim 5x$ Stellar mass. Therefore high gas fraction 80% (- 10-20% DM).
- Gas Fraction evolves with $z$
- We have ALMA time to get gas masses for a subset of KROSS
Rotation or Dispersion support?

\[ V = V_{80} \]

\[ \sigma \text{ corrected for inst. and local } \frac{dv}{dr} \]

\[ \text{Rotation} \]

\[ \text{Dispersion} \]

\[ \text{Stott+ in prep.} \]

Friday, 3 April 2015
Rotation or Dispersion support?

$V = V_{80}$
sigma corrected for inst. and local $dv/dr$

Rotation

Dispersion

Stott+ in prep.

Friday, 3 April 2015
Rotation or Dispersion support?

$V = V_{80}$

sigma corrected for inst. and local $dv/dr$

Stott+ in prep.
Rotation or Dispersion support?

rotation or dispersion support?

V = V_{80}
sigma corrected for inst. and local dv/dr

V/W.

Rotation

Dispersion

Stott+ in prep.

Friday, 3 April 2015
Preliminary Result: Disc fractions

- Still a high fraction of rotation supported systems at $z \sim 1$ (see also SINS, KMOS3D etc)
- $V/\sigma < 5$ (typical low $z$ disc=10)
- dynamically hotter
Preliminary Result: Disc fractions

- Rotator fraction correlates with SFR and Mass (weaker). Hint of anti-correlation with sSFR.

- $v$/sig and rotator frac decrease with redshift (careful with selection!)
Preliminary Result: Disc fractions

- Rotator fraction correlates with SFR and Mass (weaker). Hint of anti-correlation with sSFR.

- $v/\sigma$ and rotator frac decrease with redshift (careful with selection!)

Kassin+ 2012

Stott+ in prep.
Preliminary Result: Disc fractions

- Rotator fraction correlates with SFR and Mass (weaker). Hint of anti-correlation with sSFR.

- $v/\sigma$ and rotator frac decrease with redshift (careful with selection!)

Stott+ in prep.
Preliminary Result: Disc stability

- Toomre Q: Gaseous disc will disintegrate ($Q<1$).
- All consistent with $Q=1$. Average $Q=0.9\pm0.2$
- i.e. Gaseous Discs are marginally (un)stable
Preliminary Result: Disc stability

- Toomre $Q$: Gaseous disc will disintegrate ($Q<1$).
- All consistent with $Q=1$. Average $Q=0.9\pm0.2$
- i.e. Gaseous Discs are marginally (un)stable

Gas rich, turbulent discs in main sequence galaxies driving the high SFRD at $z=1$? as SINS, SHiZELS saw for high-sSFR galaxies

Stott+ in prep.

$Q = \frac{\sigma}{v} \frac{a}{f_{\text{gas}}}$
Mass-Metallicity Relation

Pettini & Pagel 2004

Stott+ in prep.
Mass-Metallicity Relation

Pettini & Pagel 2004

KROSS

[NI]/Hα map

z=0 Mass-Metallicity Relation (Kewley & Ellison 2008)

Stott+ in prep.
Results: KMOS SV observations of HiZELS

• Metallicity gradient correlates with SSFR.
• High SSFR driven by metal-poor gas funneled towards centre?
• Explains ‘evolution’ and discrepancies seen by others

Stott et al. 2014 arxiv:1407.1047

Figure 3. The metallicity gradients for five representative galaxies from the KMOS-HiZELS SV sample. Left: The metallicity map with the annuli used to measure the metallicity gradient overplotted. Central: These are the individual spectra from each annuli going out in galactocentric radius. The red line is the fit to the Hα and [NII] emission lines. Right: The metallicity plotted against galactocentric radius. The red line is a fit to the data points.

Friday, 3 April 2015
Results: KMOS SV observations of HiZELS

- Metallicity gradient correlates with SSFR.
- High SSFR driven by metal-poor gas funnelled towards centre?
- Explains ‘evolution’ and discrepancies seen by others

Stott et al. 2014 arxiv:1407.1047
Results: KMOS SV observations of HiZELS

- Metallicity gradient correlates with SSFR.
- High SSFR driven by metal-poor gas funneled towards centre?
- Explains ‘evolution’ and discrepancies seen by others

Stott et al. 2014 arxiv:1407.1047
KROSS: Durham/Oxford KMOS GTO survey of ~1000 typical Star Forming Galaxies at z=1

KROSS Results: Typical z=1 Star Forming galaxies have:

- High Gas Fractions
- Marginally (un)stable discs
- Metallicity gradients correlated with sSFR

This must drive/be driven by z=1 enhanced SFRD through efficient gas accretion/SFR feedback

KROSS: Durham/Oxford KMOS GTO survey of ~1000 typical Star Forming Galaxies at z=1

correct out the ssfr of MS

Stott+ in prep.