KMOS^{3D}

The evolution of resolved kinematics from z=2.5-0.7

Emily Wisnioski & THE KMOS^{3D} TEAM

N.M. Förster Schreiber, D. Wilman, K. Bandara, A. Beifiori, R. Bender, G. Brammer, J. Chan, R. Davies, M. Fabricius, M. Fossati, R. Genzel, S. Kulkarni, J. Kurk, P. Lang, D. Lutz, J.T. Mendel, I. Momcheva, E. Nelson , D. Rosario, R. Saglia, S. Seitz, L.J. Tacconi, P. van Dokkum, E. Wisnioski, E. Wuyts, S. Wuyts, et al.

MPE

MAX PLANK INSTITUTE FOR EXTRATERRESTRIAL PHYSICS

KMOS^{3D} : Survey Design

~600 mass selected galaxies at 0.7<z<2.7

1.

- Targeting: Halpha - [NII] - [SII]
- Statistics : 75nts over 5yrs
- deeper: 4hrs YJ, 6hrs H, 8-10hrs K
- Ancillary data: CANDELS fields

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What makes KMOS^{3D} unique?

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3D ST

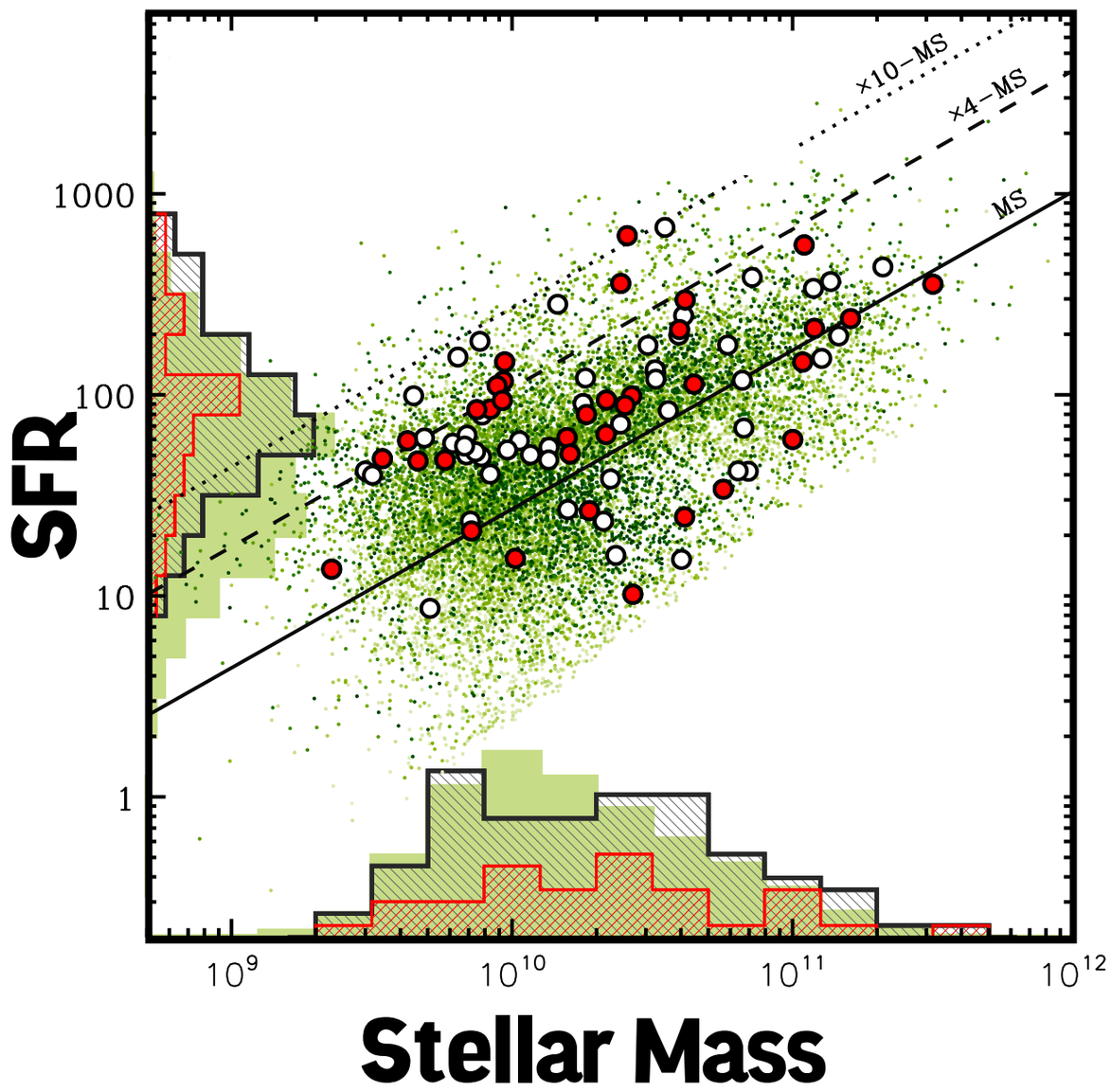
mass selection,
infrared redshifts

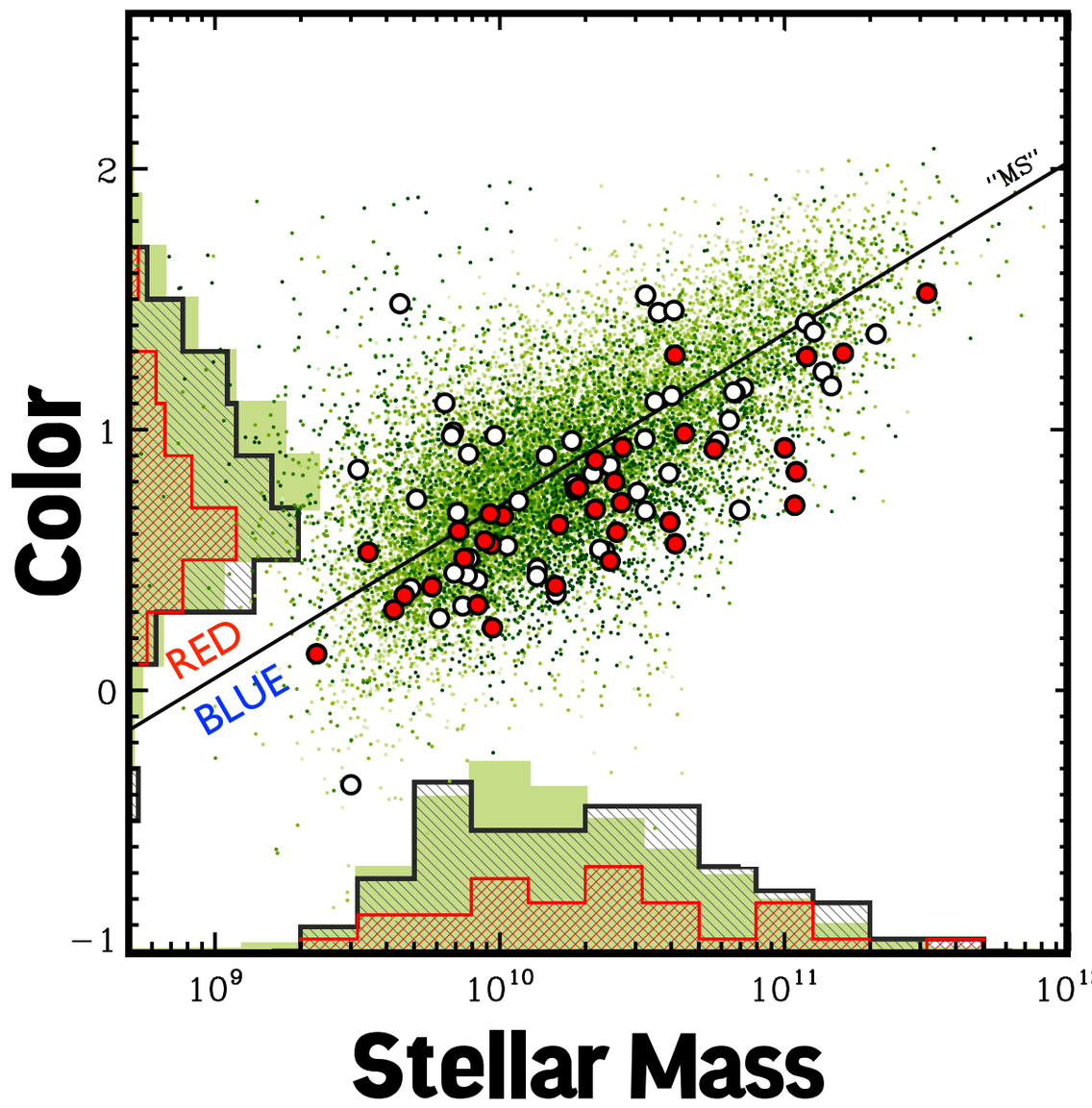
What makes KMOS^{3D} unique?

3D-HST

mass selection, infrared redshifts

SINS / zC-SINF : 1.4<z<2.5





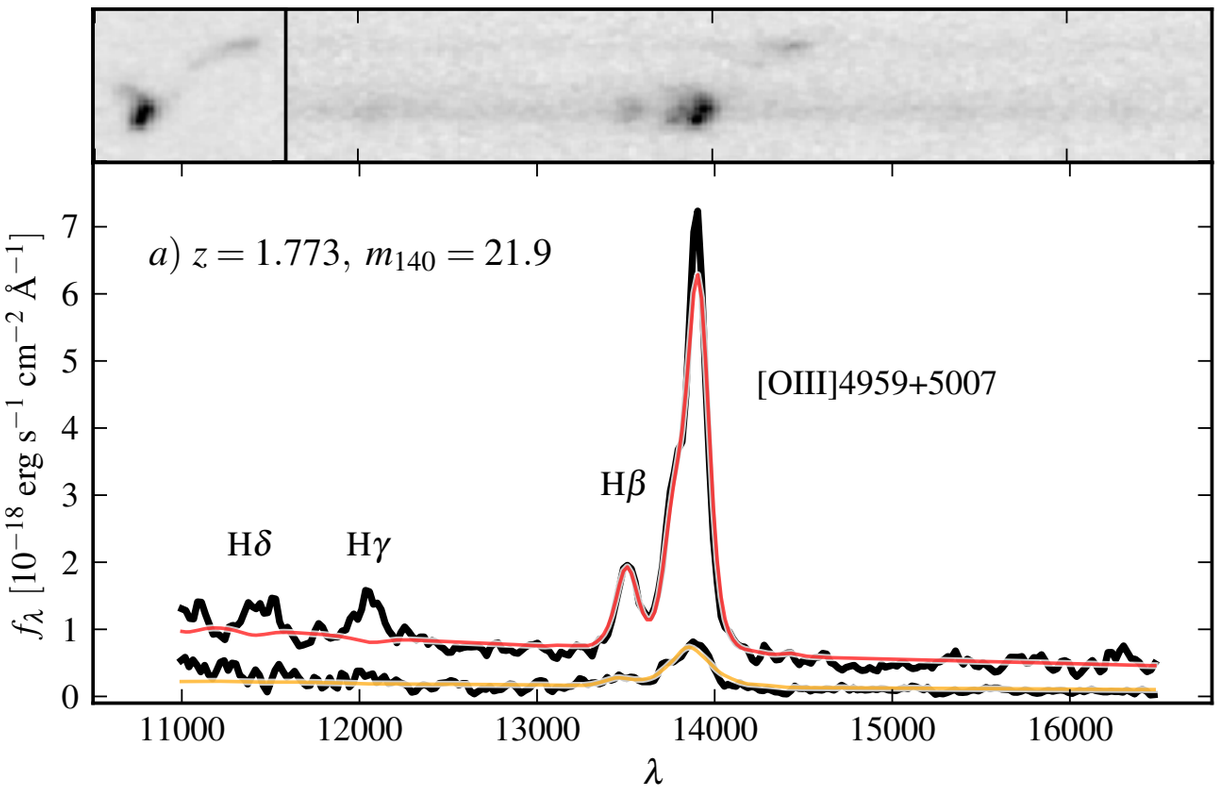
Förster-Schreiber et al. 2009, Förster-Schreiber et al. (in prep)

What makes KMOS^{3D} unique?

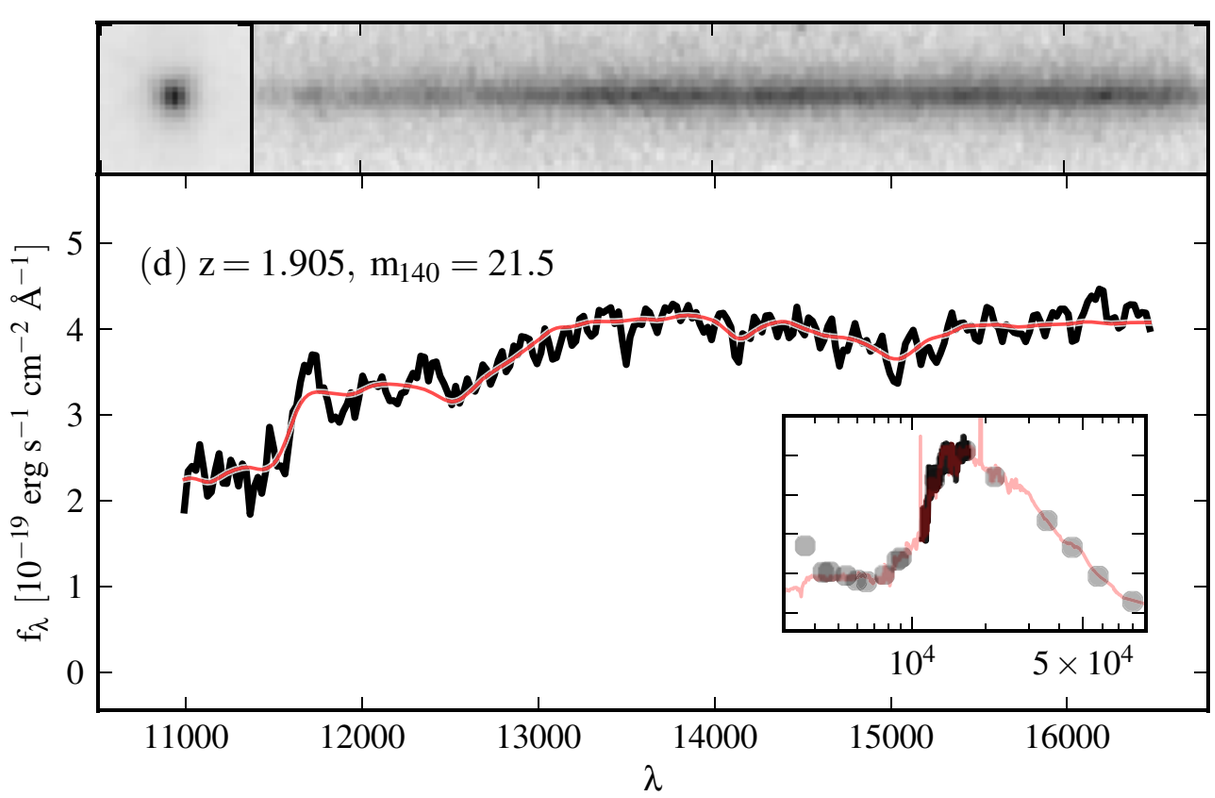
3D-HST

mass selection,
infrared redshifts

Zspec



Zgrism

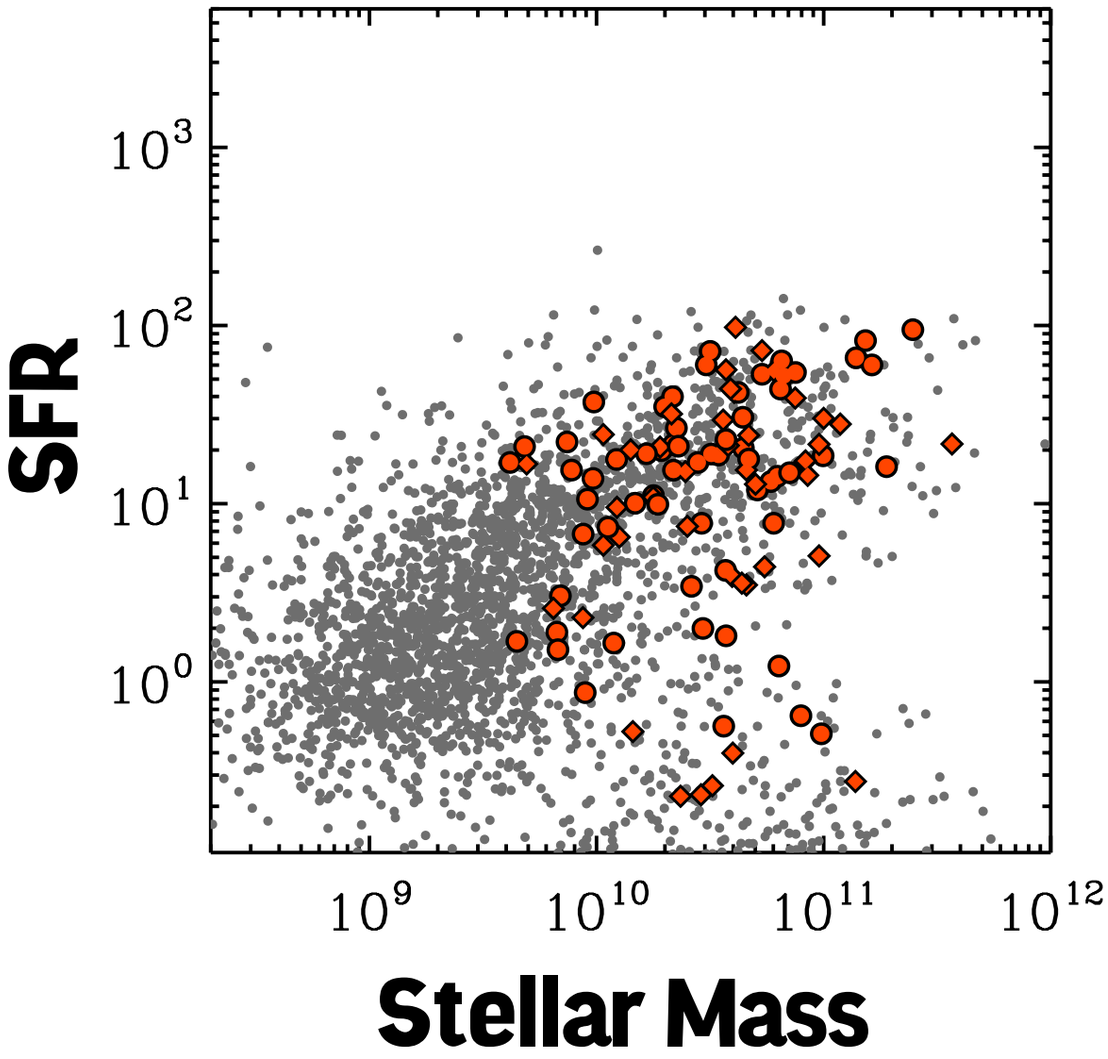


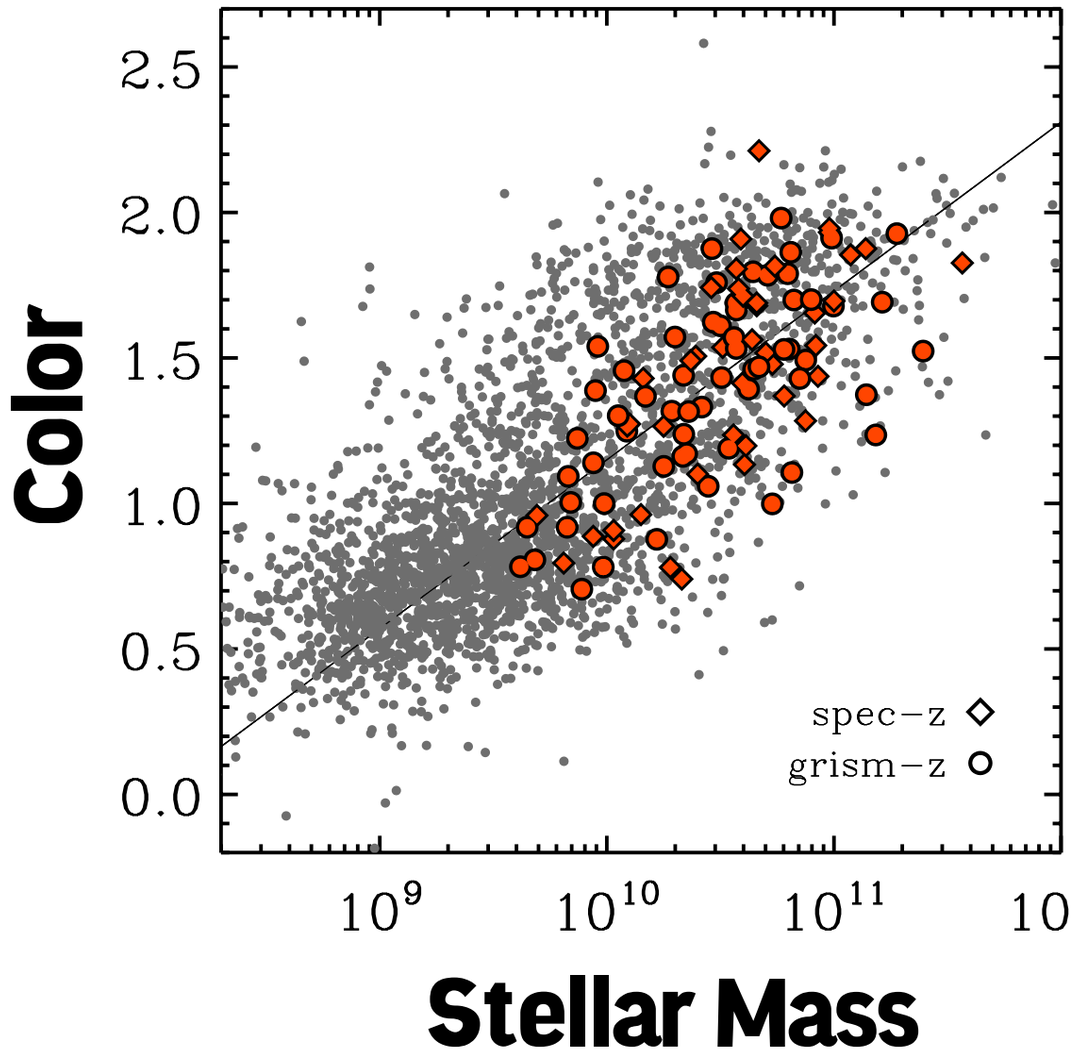
Brammer et al. 2012

What makes KMOS^{3D} unique?

selection properties z~1

KMOS^{3D} : 0.7<z<1.1



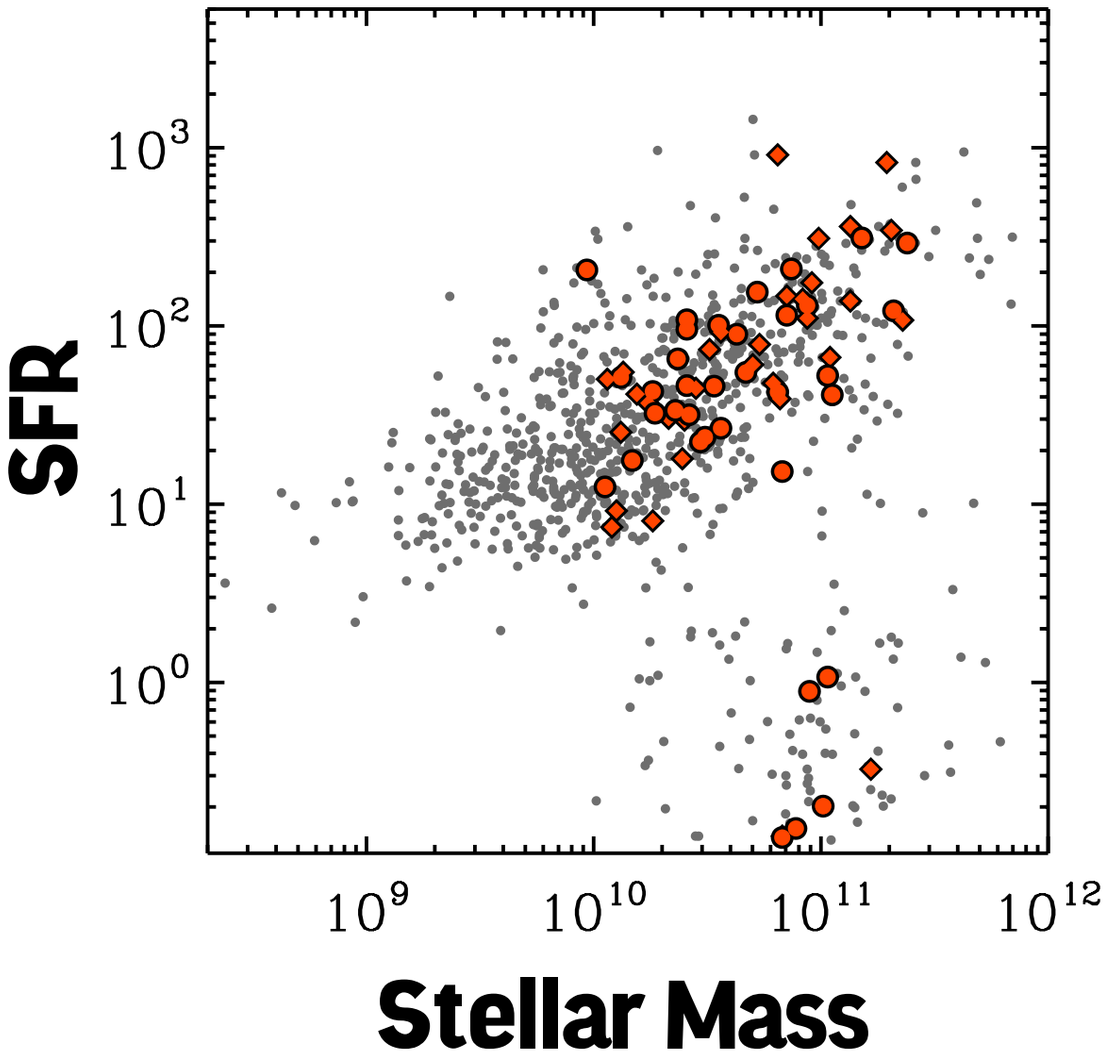


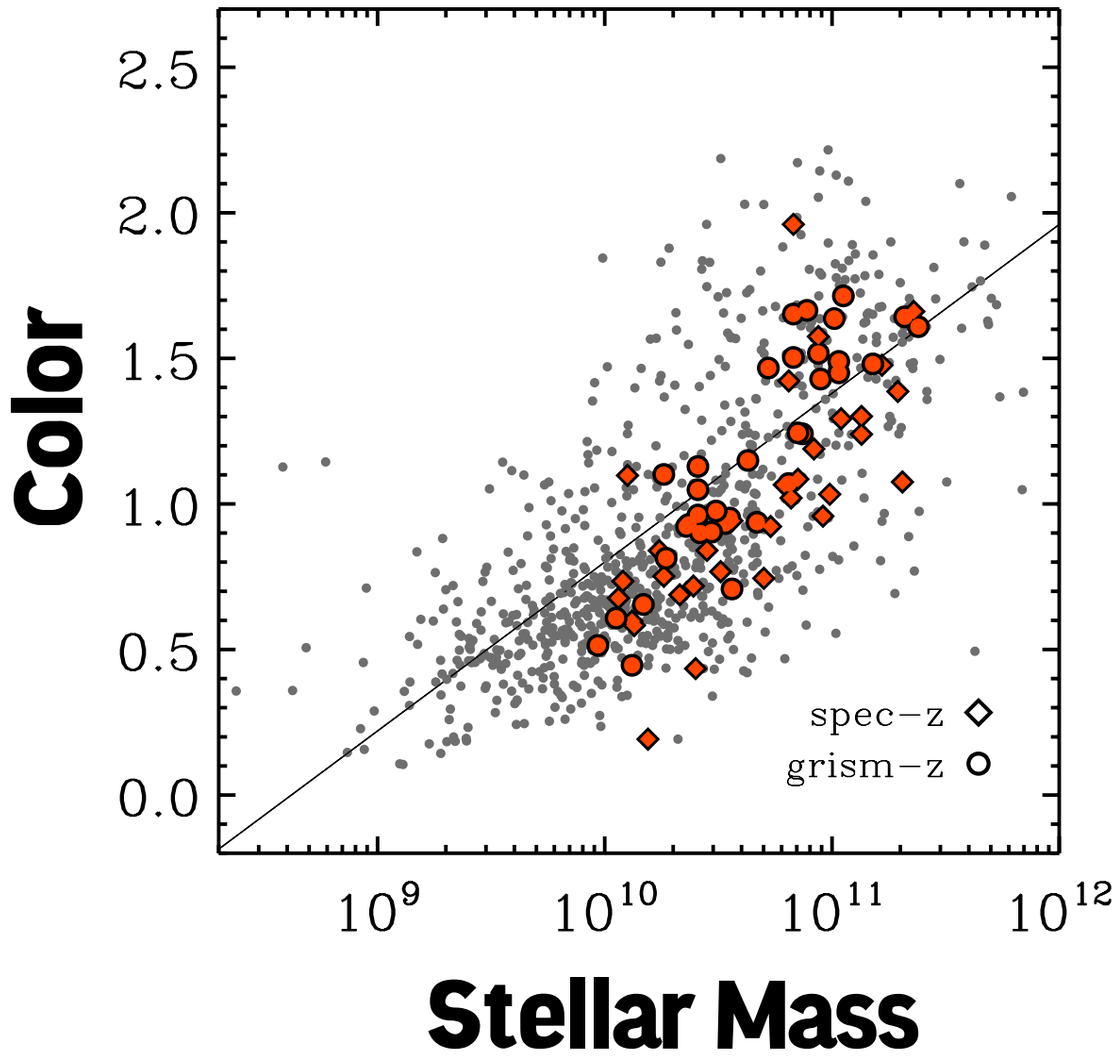
Wisnioski et al. (in prep)

What makes KMOS^{3D} unique?

selection properties z~2

KMOS^{3D} : 1.9<z<2.7





Wisnioski et al. (in prep)

KMOS^{3D} : Science goals

~600 mass selected galaxies at 0.7<z<2.7

2.

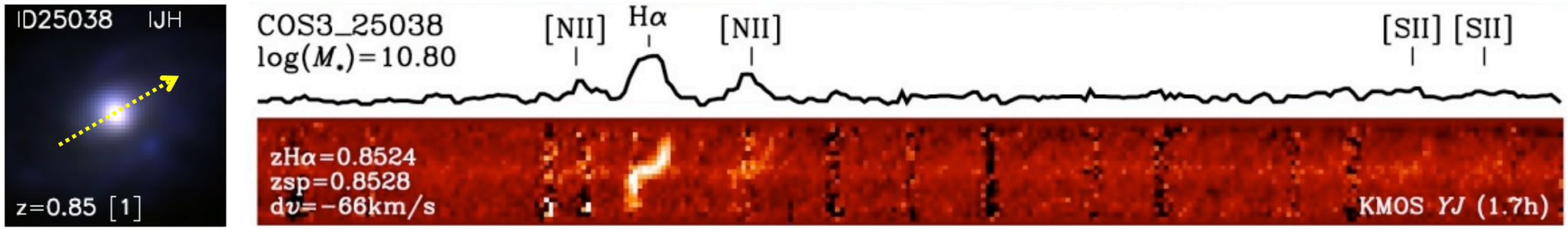
- Dynamical properties
- Outflows
- Quenching
- Chemical evolution

KMOS^{3D} : First Results

~600 mass selected galaxies at 0.7<z<2.7

3.

- 106 $z\sim1.0$ galaxies, 67 $z\sim2.2$ galaxies
- 13 galaxies at log(M*)>11



SFR [$M_\odot$/yr]

KMOS^{3D}

z~1

(72/106)

100

10

1

10^{10}

10^{11}

$M_*[M_\odot]$

×10−MS

×4−MS

MS

×1/4−MS

1″ (8kpc)

SFR [$M_\odot$/yr]

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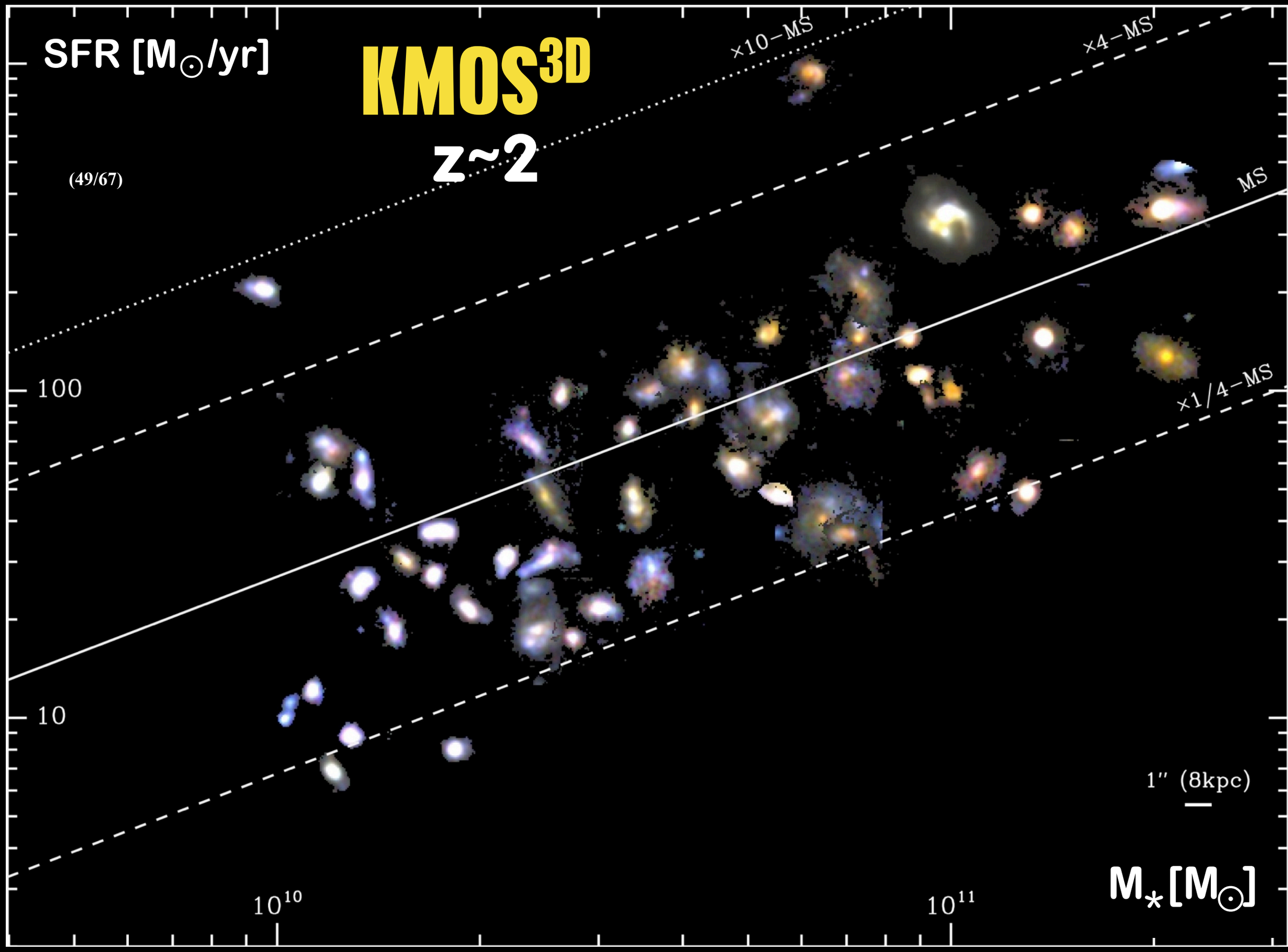
KMOS^{3D}

z~2

(49/67)



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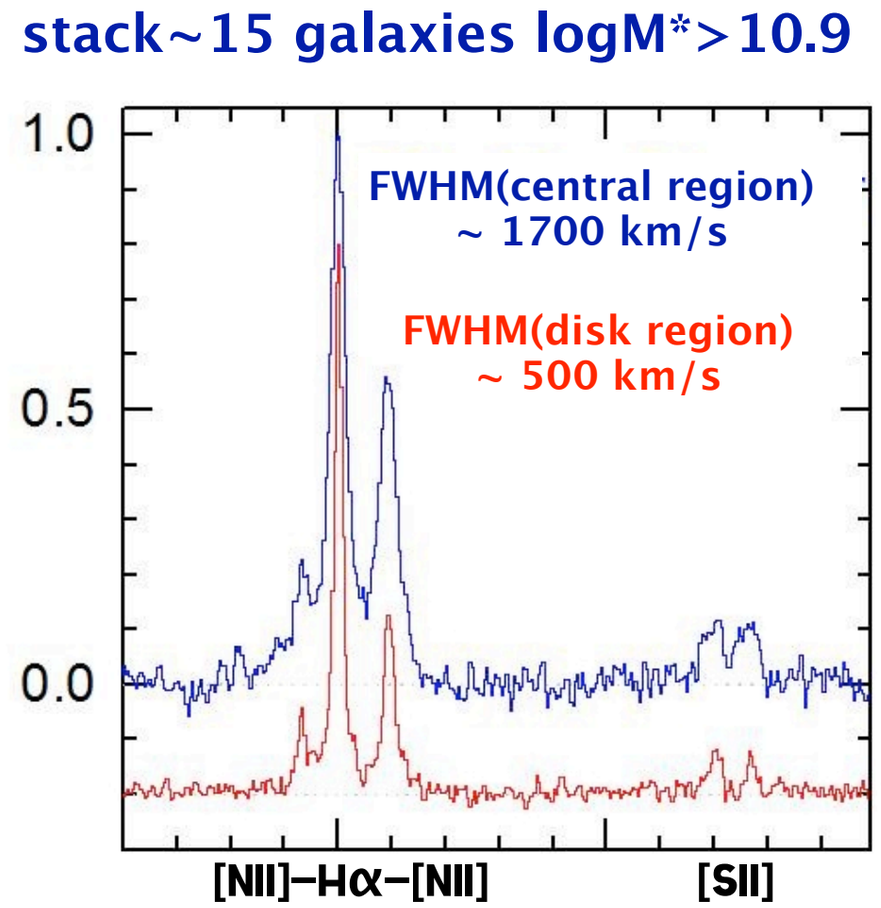
- **Outflows**
- **Quenching**
- **Dynamical properties**
- **Chemical evolution**

study the evolution of outflow properties as a function of mass to establish the role of star formation and AGN in governing stellar mass growth



Genzel et al., Förster-Schreiber et al. (in prep)

- **Outflows**
- **Quenching**
- **Dynamical properties**
- **Chemical evolution**

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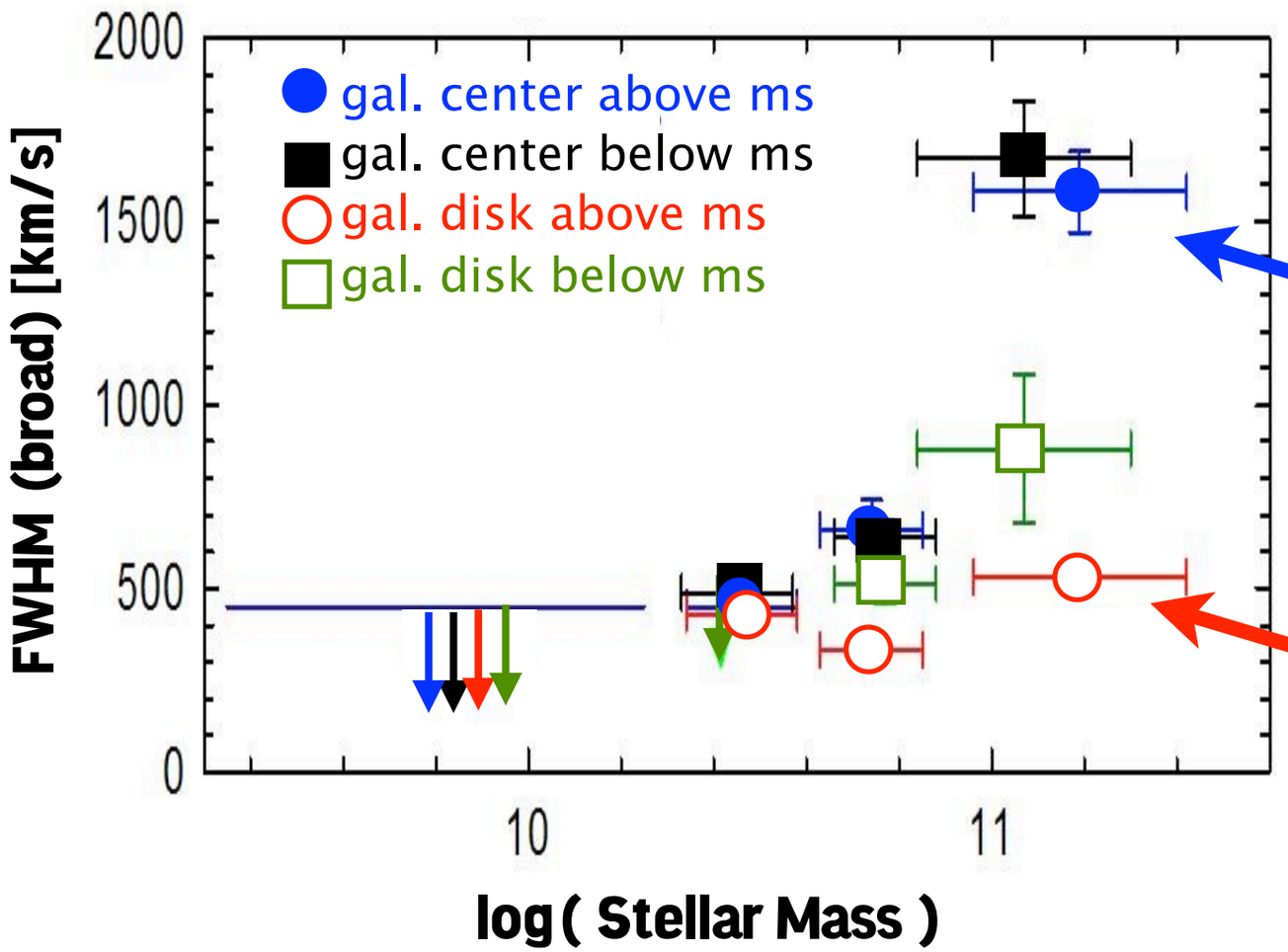
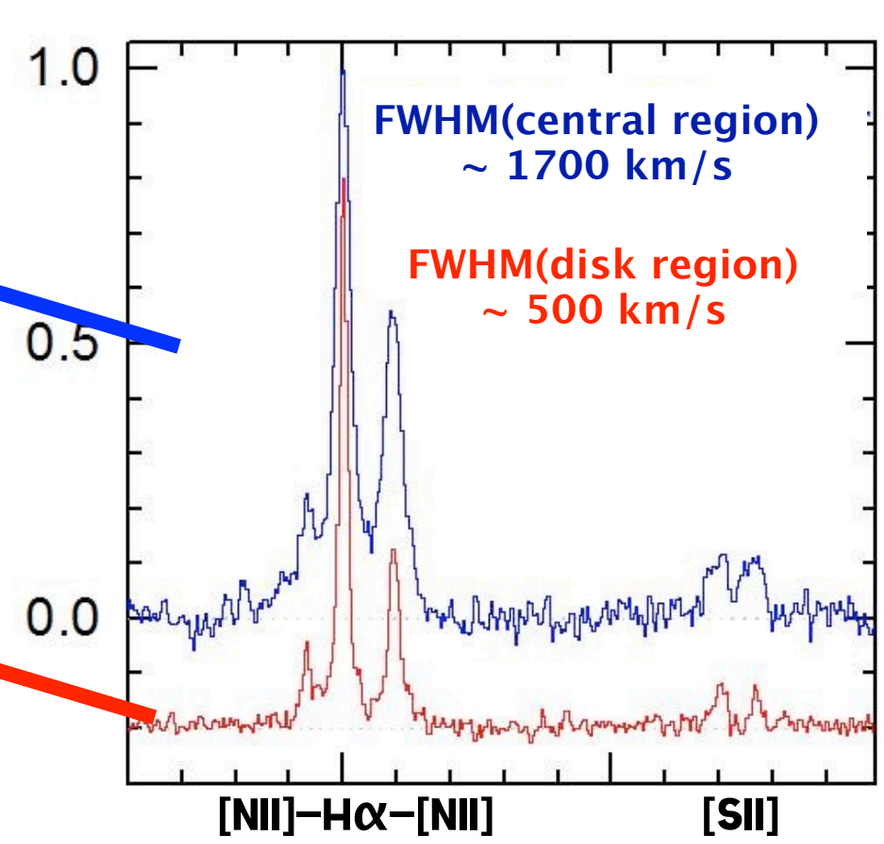
65 SINS/zC-SINF/KMOS^{3D}

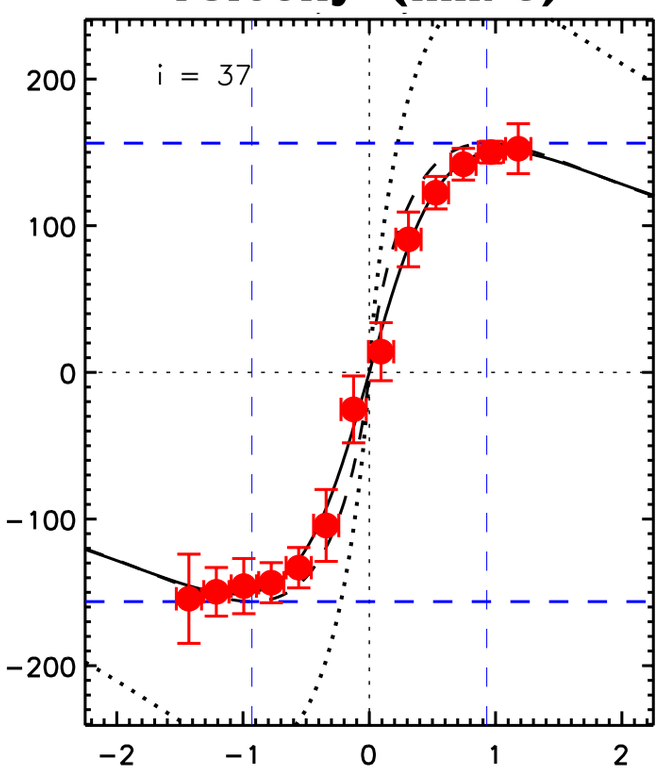


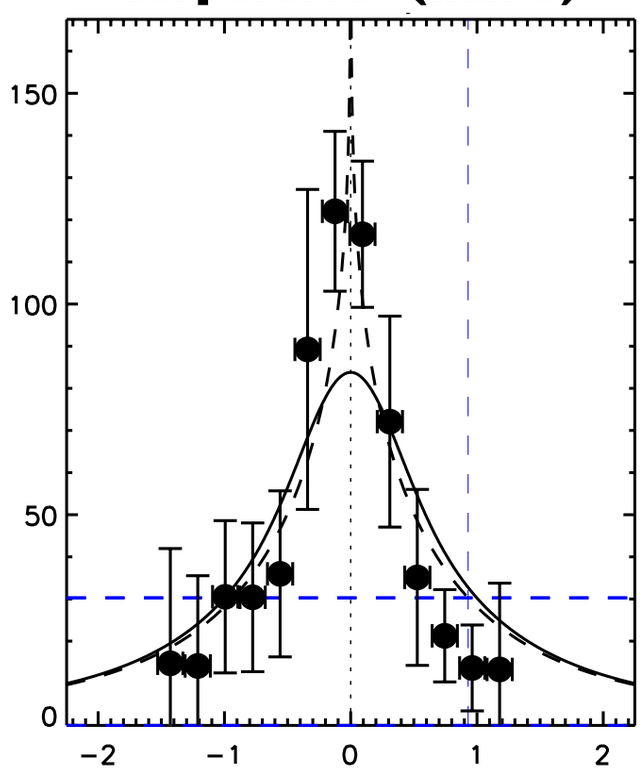
stack~15 galaxies logM*>10.9



Genzel et al., Förster-Schreiber et al. (in prep)

- Outflows
- Quenching
- **Dynamical properties:** establish the connection between stellar structure and kinematics in order to understand the role/timescale of secularly- vs. merger-driven evolution
- Chemical evolution





- exponential disk model
- simulations to understand beam smearing
- careful handling of dispersion measure

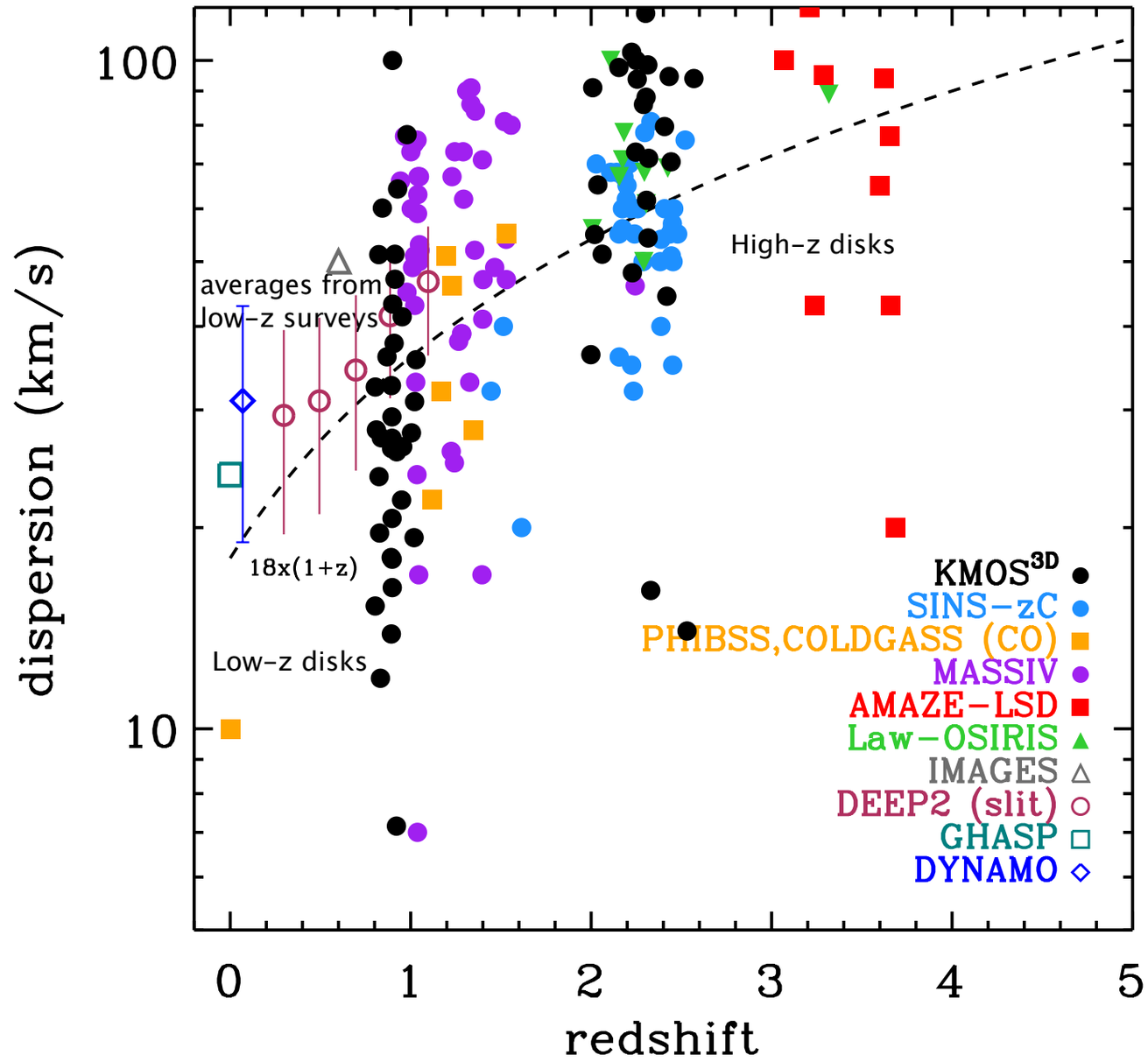
Wisnioski et al. (in prep)

Dispersion Evolution with KMOS^{3D}

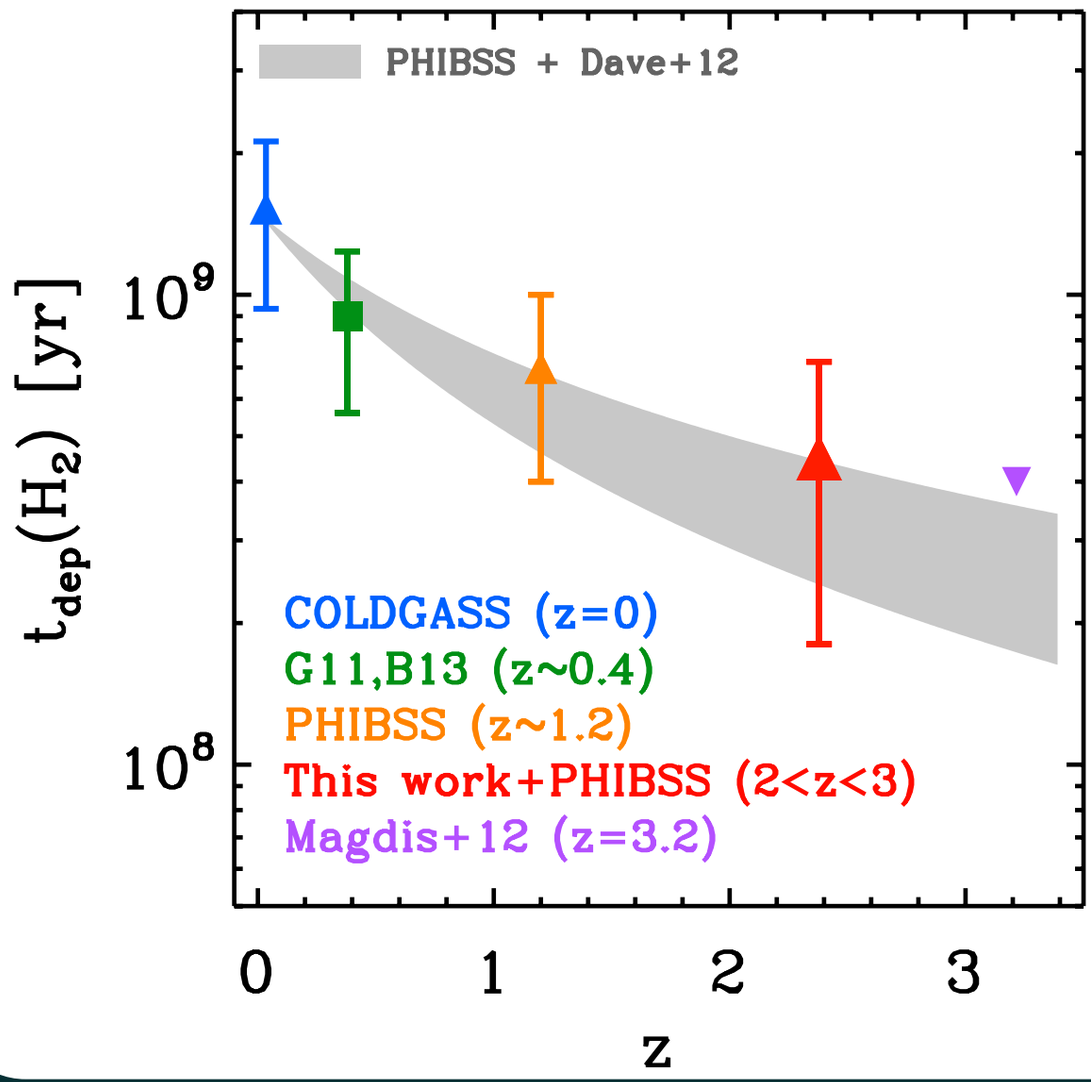
- disks are unsettled and thick at high-z

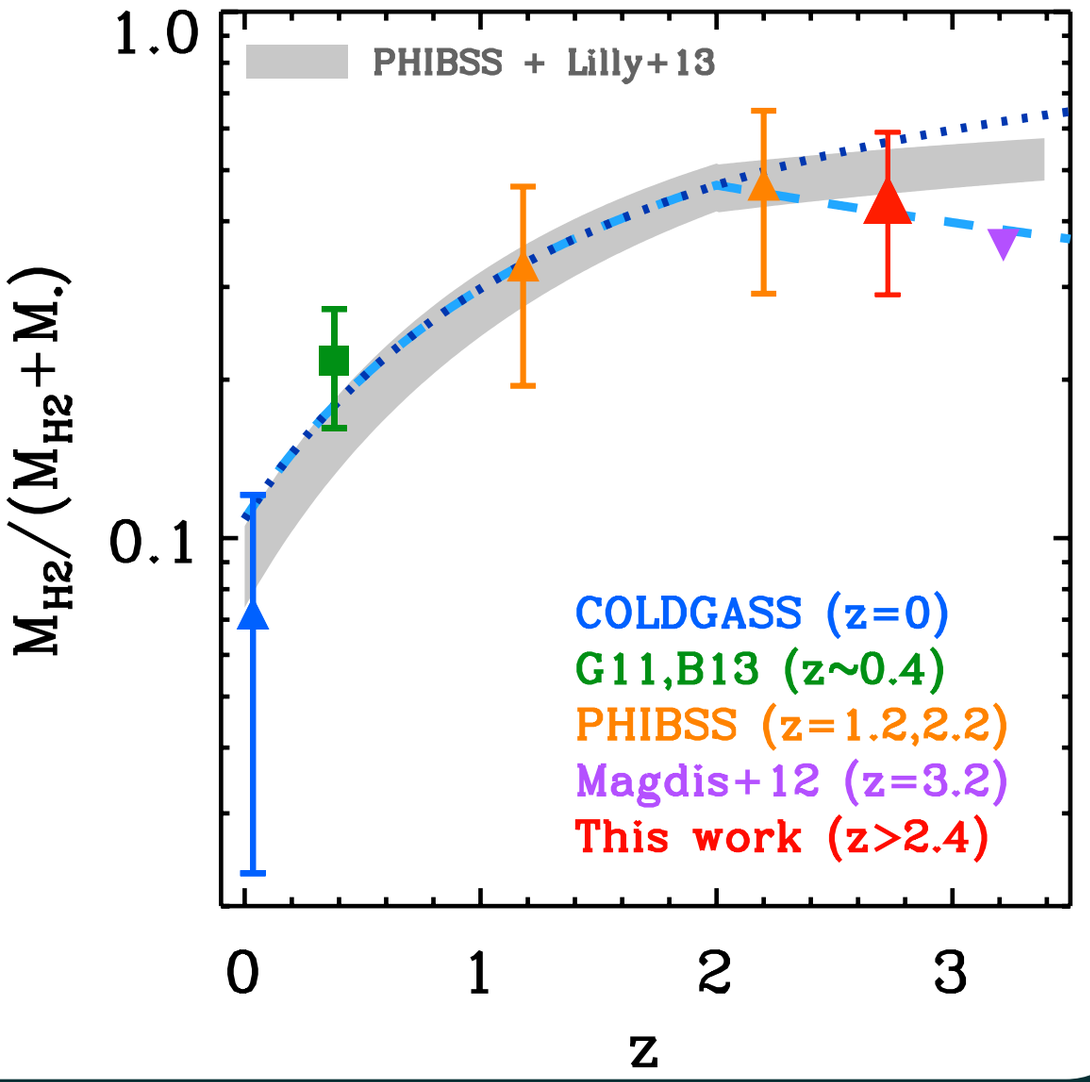
All galaxy types

Ionised & Molecular



Wisnioski et al. (in prep), also see Kassin et al. 2012





Saintonge et al. 2013

$$t_{\rm dep}(z) = 1.5(1+z)^{\alpha}\,[{\rm Gyr}],$$

Tacconi et al. 2013

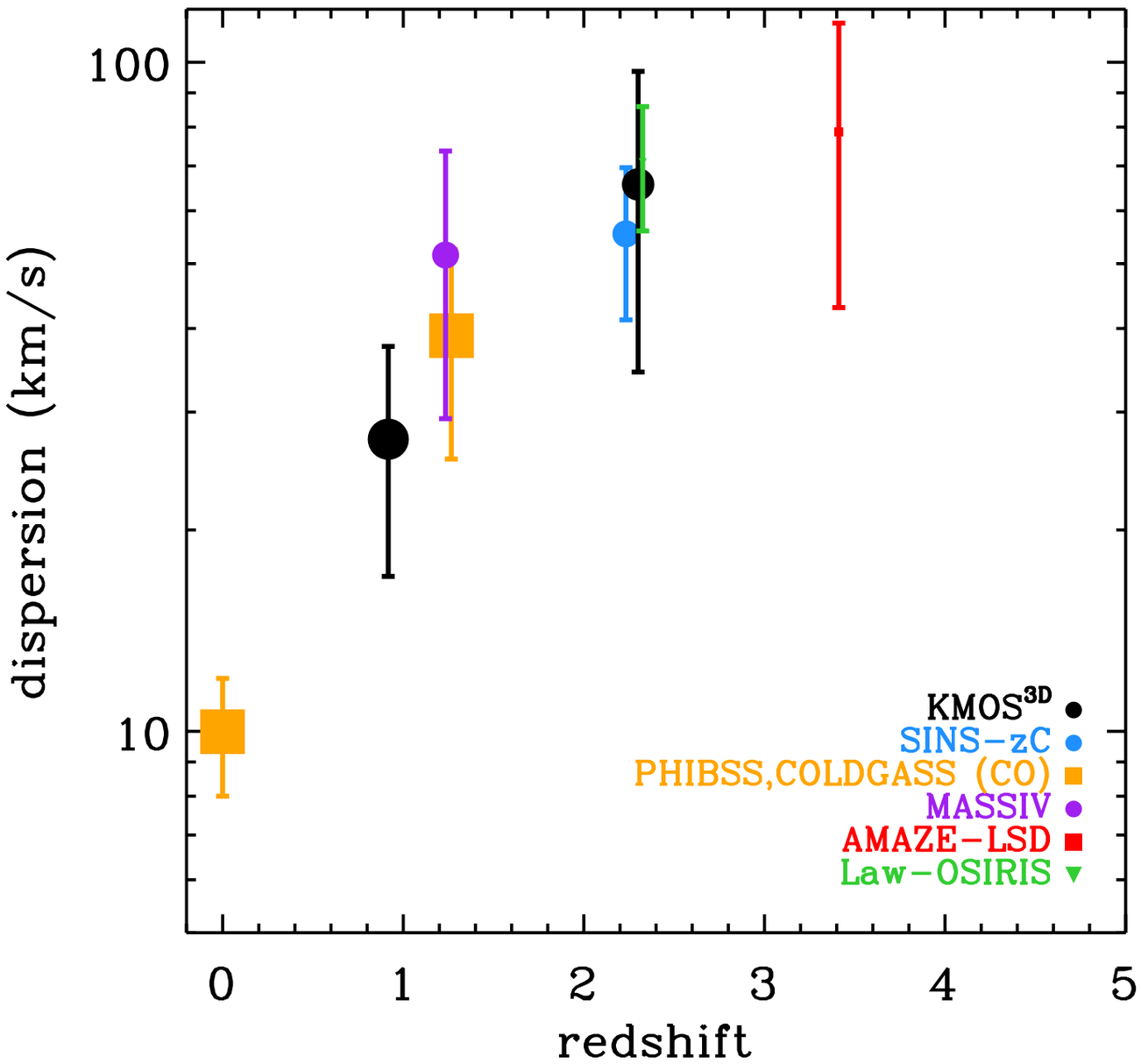
$$f_{\rm gas} = \frac{1}{1+(t_{\rm dep}\,{\rm sSFR})^{-1}},$$

$$\mathrm{sSFR}(M_*, z) = \begin{cases} 0.07\left(\frac{M_*}{10^{10.5}\,M_\odot}\right)^{-0.1}(1+z)^{3} & \text{if } z < 2 \\ 0.30\left(\frac{M_*}{10^{10.5}\,M_\odot}\right)^{-0.1}(1+z)^{5/3} & \text{if } z > 2. \end{cases}$$

Lilly et al. 2013

Dispersion Evolution with KMOS^{3D}

Disk galaxies only



Wisnioski et al. (in prep)

Dispersion Evolution with KMOS^{3D}

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Tacconi et al. 2013

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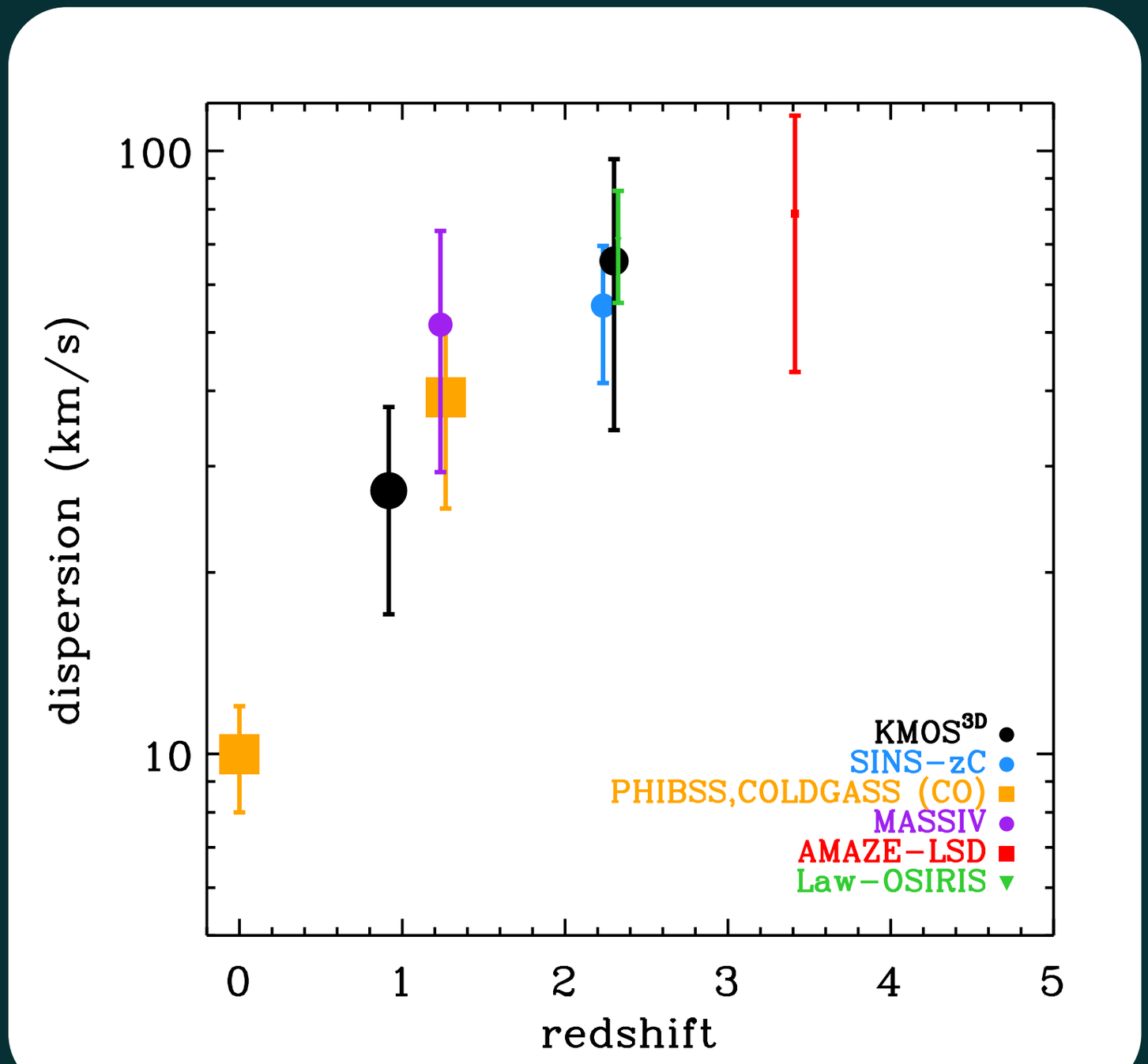
Genzel et al. 2008



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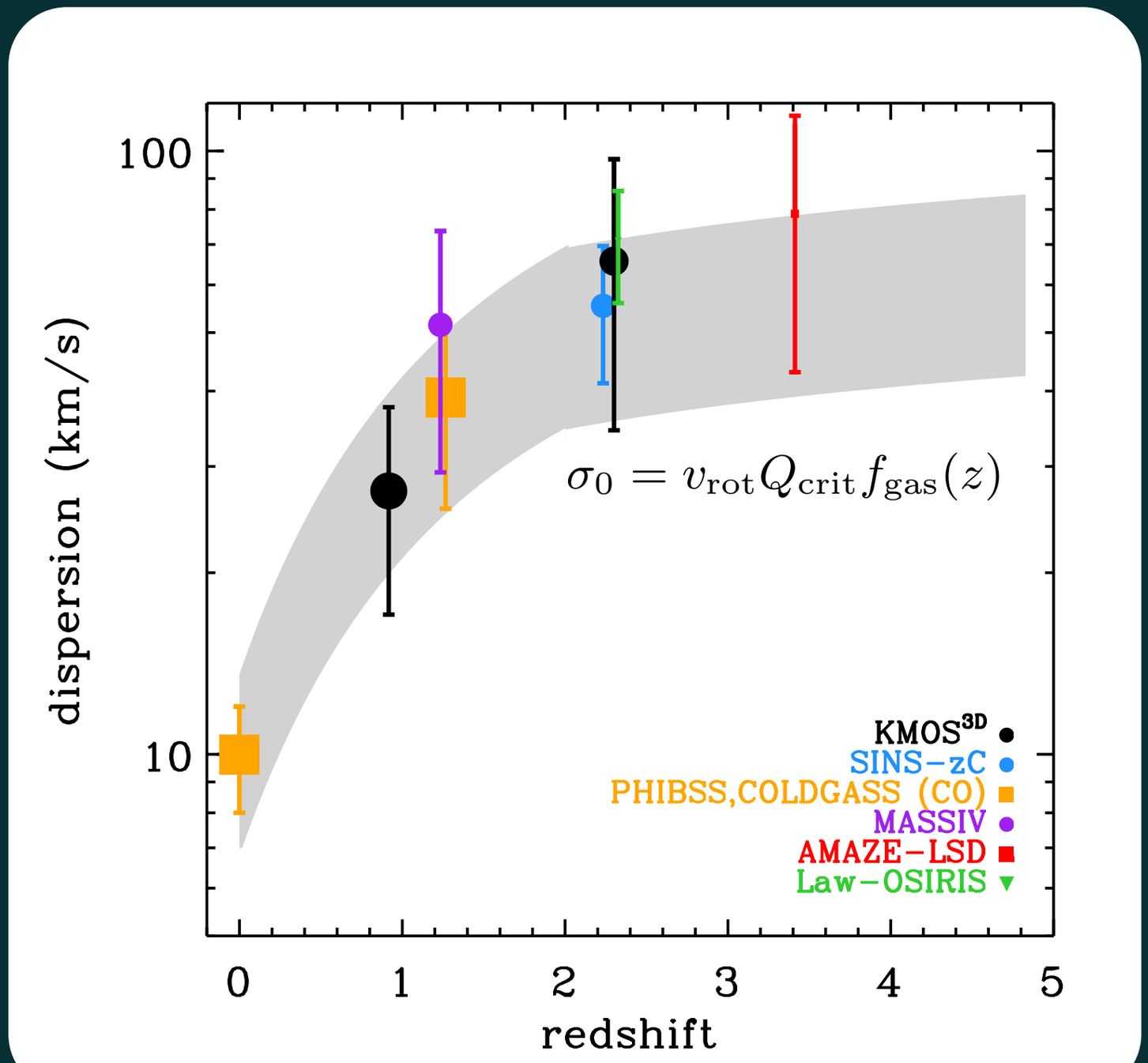
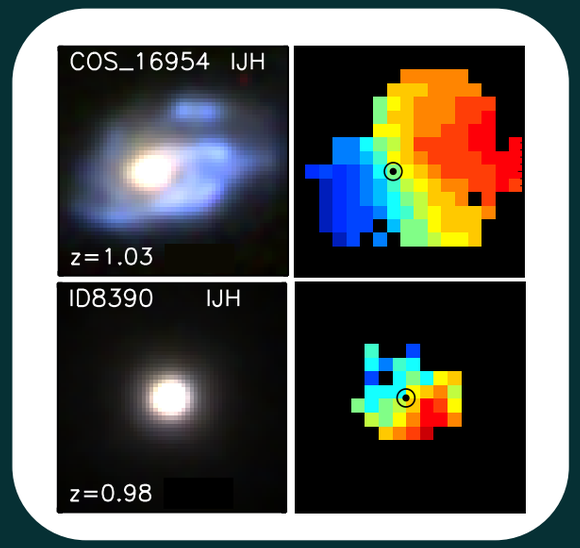


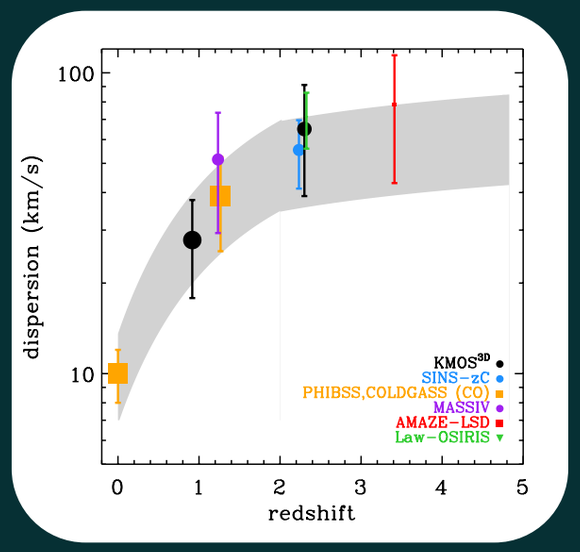
Wisnioski et al. (in prep)

KMOS^{3D} : Summary

Thanks!

- KMOS^{3D} observations underway
- Survey designed to maximise unbiased science
- Dispersion values closely tied to galaxy gas fractions
- Dispersion evolution consistent with the “equilibrium model”





Additional slides

Near-IR IFU surveys at z~1-3

Wisnioski et al. 2011, 2012, 2013

NMFS et al. 2006,2009,2013
Genzel et al. 2006, 2008, 2011;
Bouché et al. 2007; Shapiro et al. 2008;
Genel et al. 2008; Cresci et al. 2009;
Mancini et al. 2011; Newman et al. 2012,2013

Wright et al. 2007, 2009, 2010;
Law et al. 2007,2009

Nesvadba et al. 2006a,b; 2007; 2008;
Kriek et al. 2007; vStarkenburg et al. 2008;
Bournaud et al. 2008; Lehnert et al. 2009;
Lemoine-Busserolle et al. 2010a,b

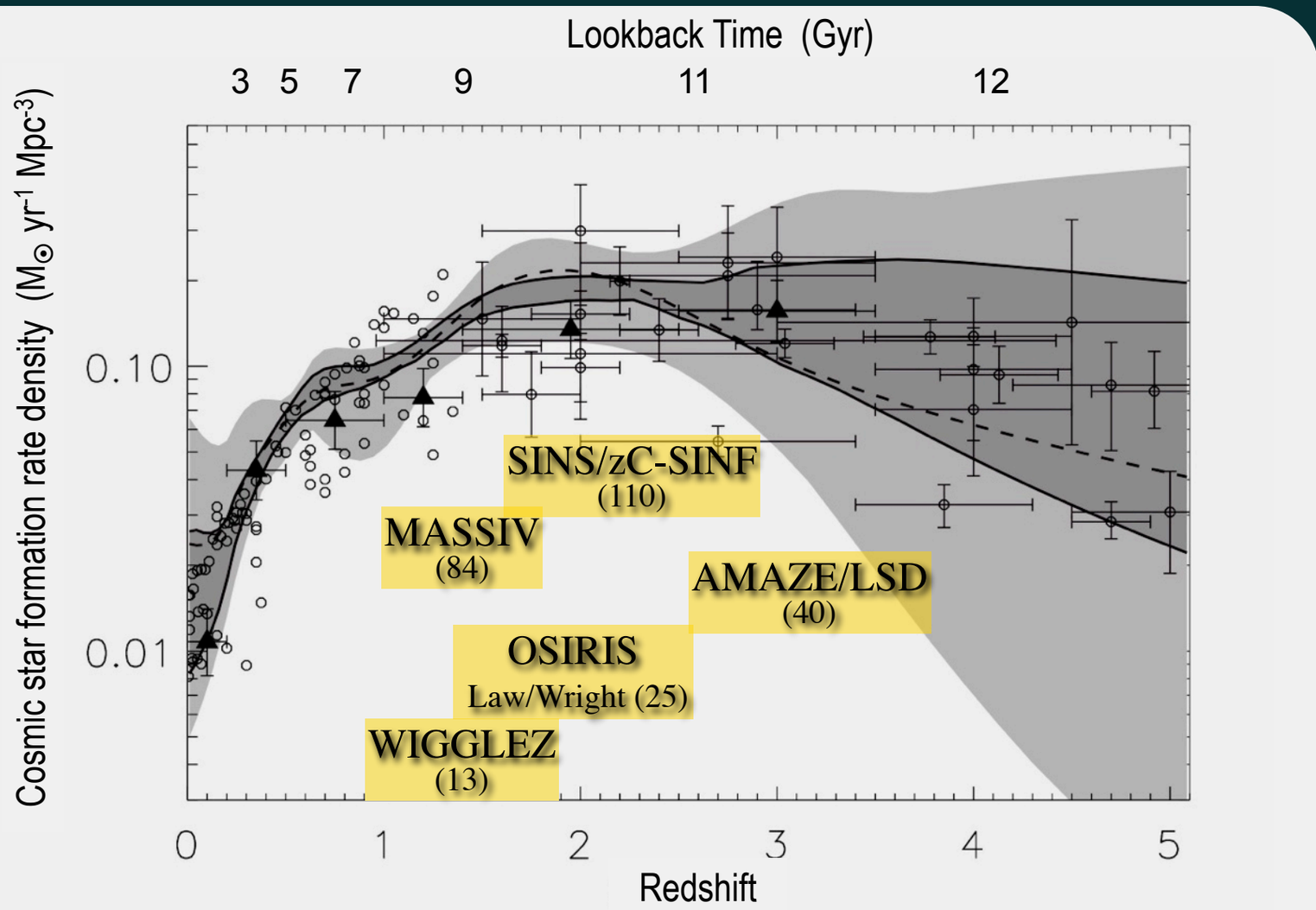
Hammer, Puech, Flores, Yang, Neichel
et al. 2005-2012

Swinbank et al. 2006,2007,2009,2012a,b;
Jones et al. 2009,2010,2012;
Stark et al. 2008

Maiolino et al. 2008; Mannucci et al. 2009;
Gnerucci et al. 2010, 2011; Cresci et al. 2010

Épinat et al. 2009, 2012; Queyrel et al. 2009, 2012;
Sanchez-Lopez et al. 2012; Contini et al. 2012

... Among others ...



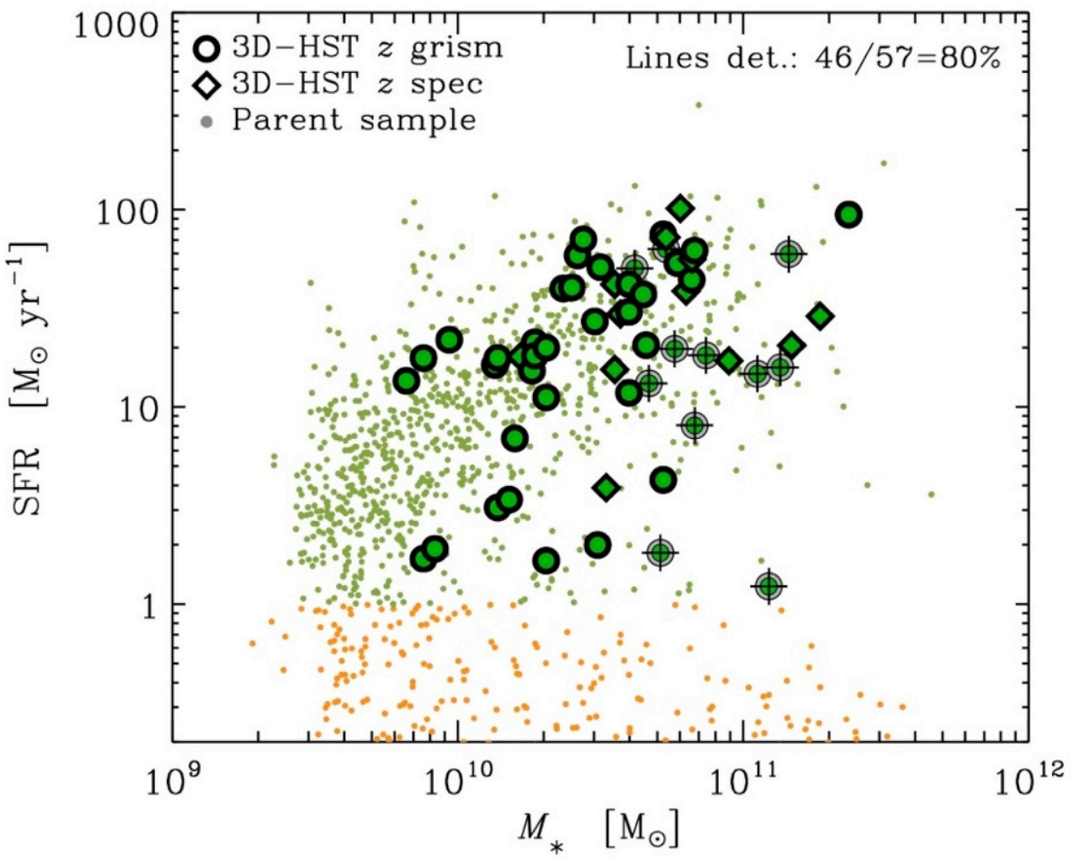
Le Borgne et al. (2009)

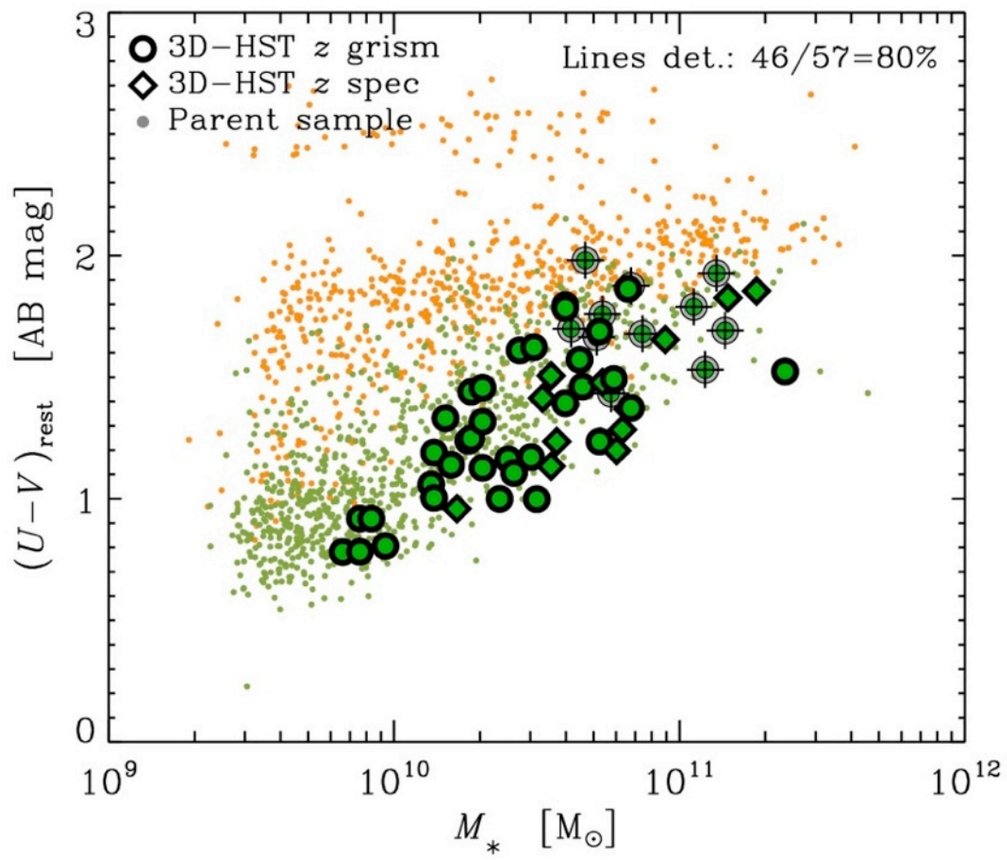
Currently: ~300 galaxies in ~300 nights of observing

Slide courtesy of N.M Forster-Schreiber

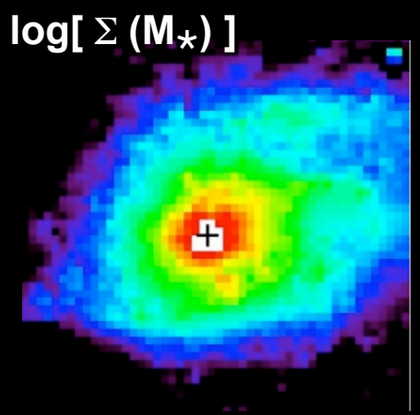
KMOS^{3D}
Pilot z ~ 1 Sample

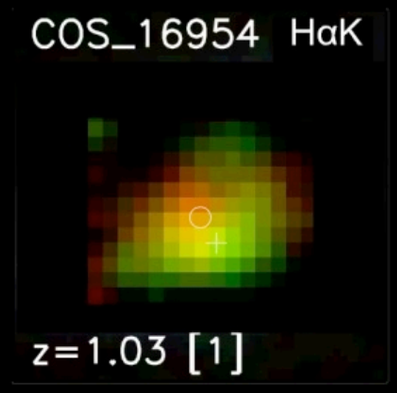
Commissioning II + III (t_{obs}^{med}=2hrs): *57 Galaxies 100% continuum detections*
80 % Halpha detections

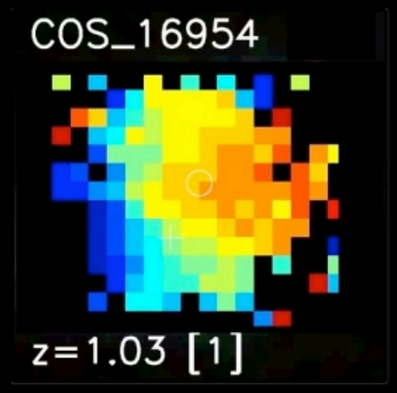


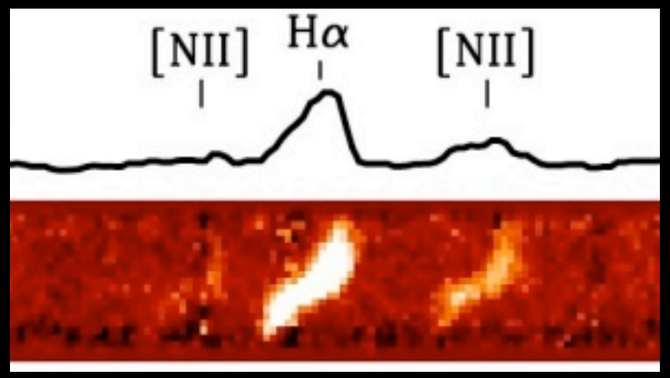


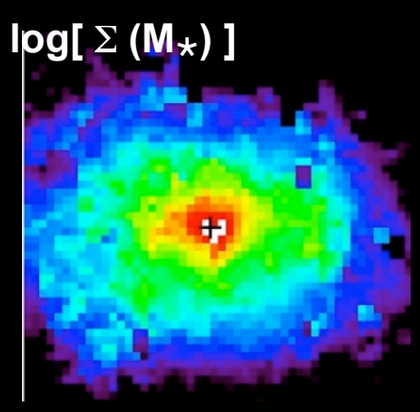
KMOS^{3D}

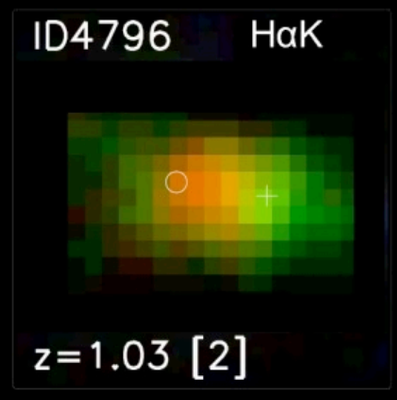


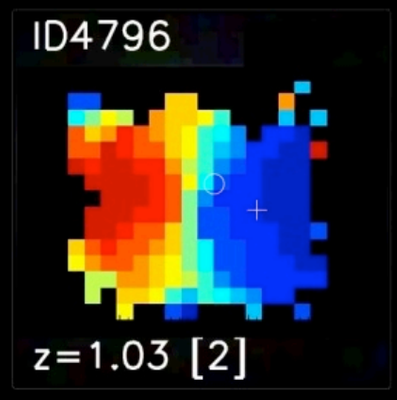


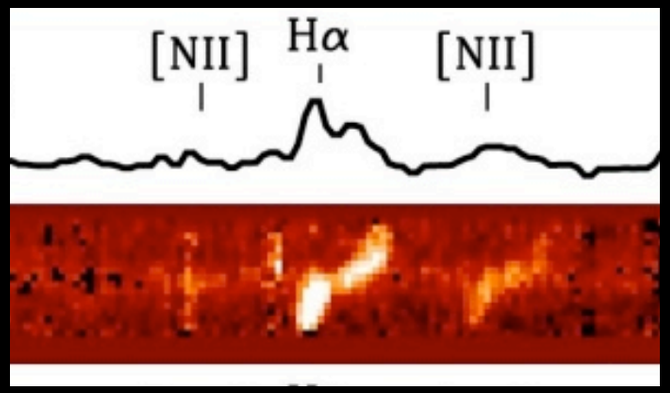


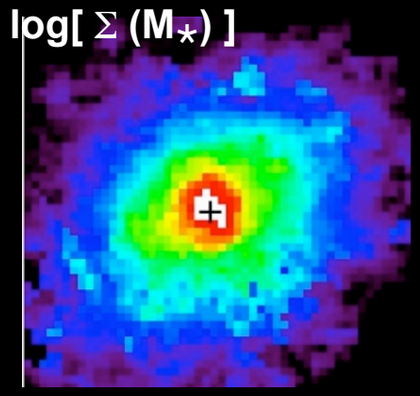


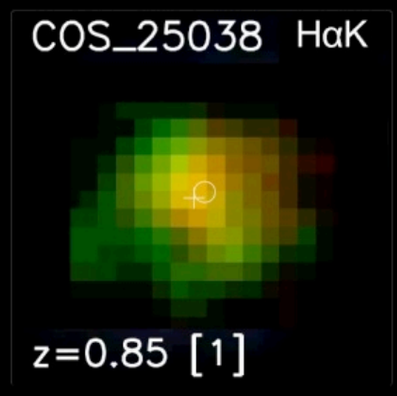


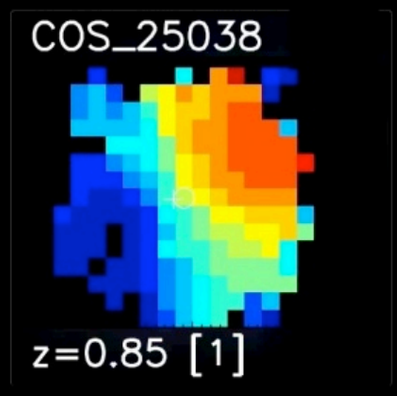


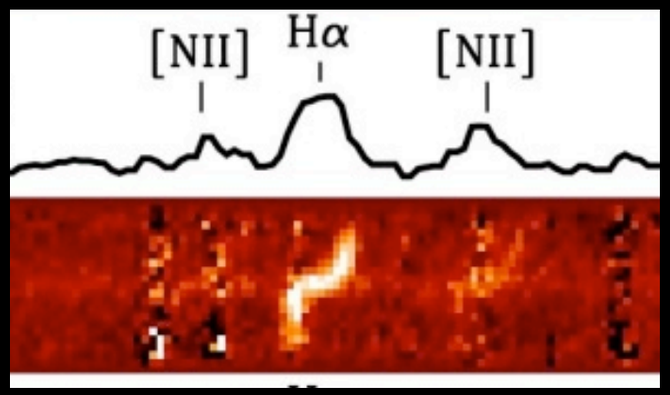






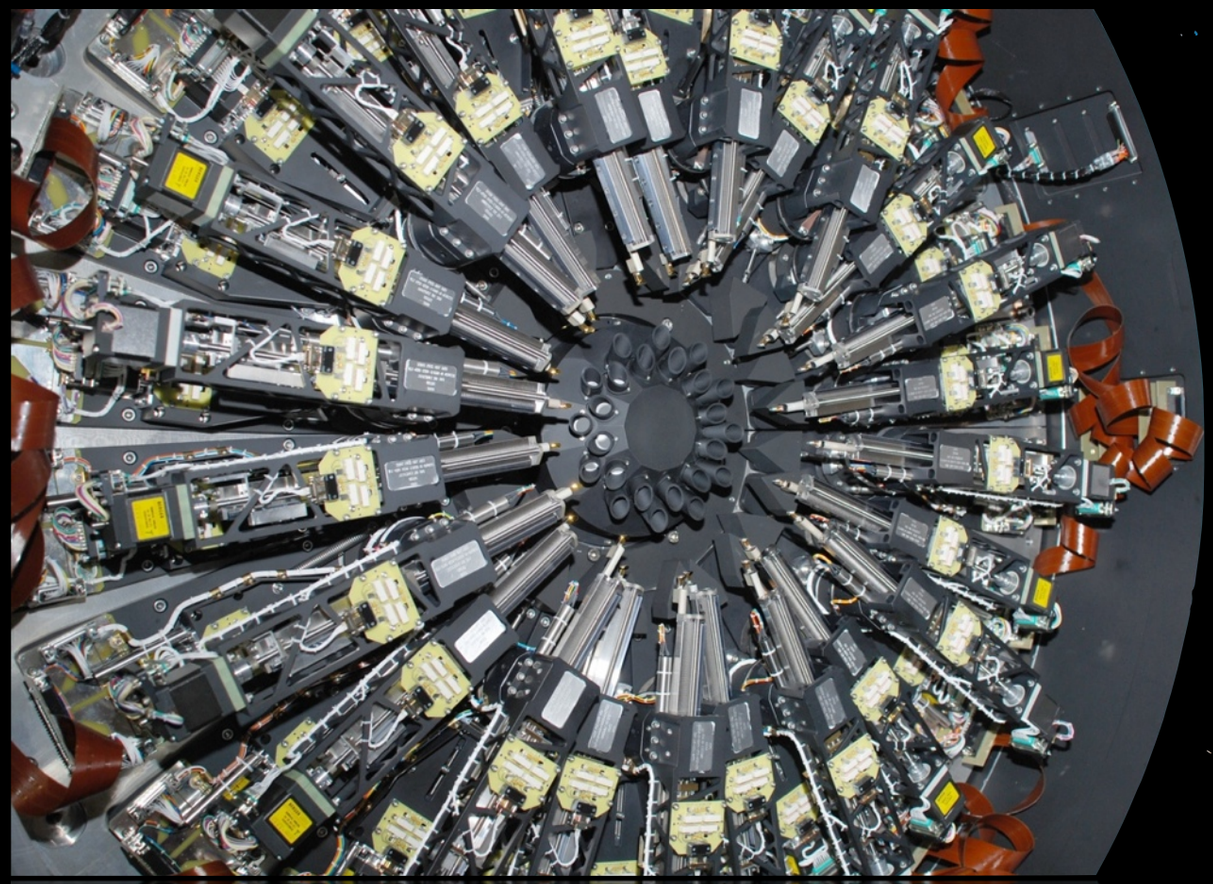




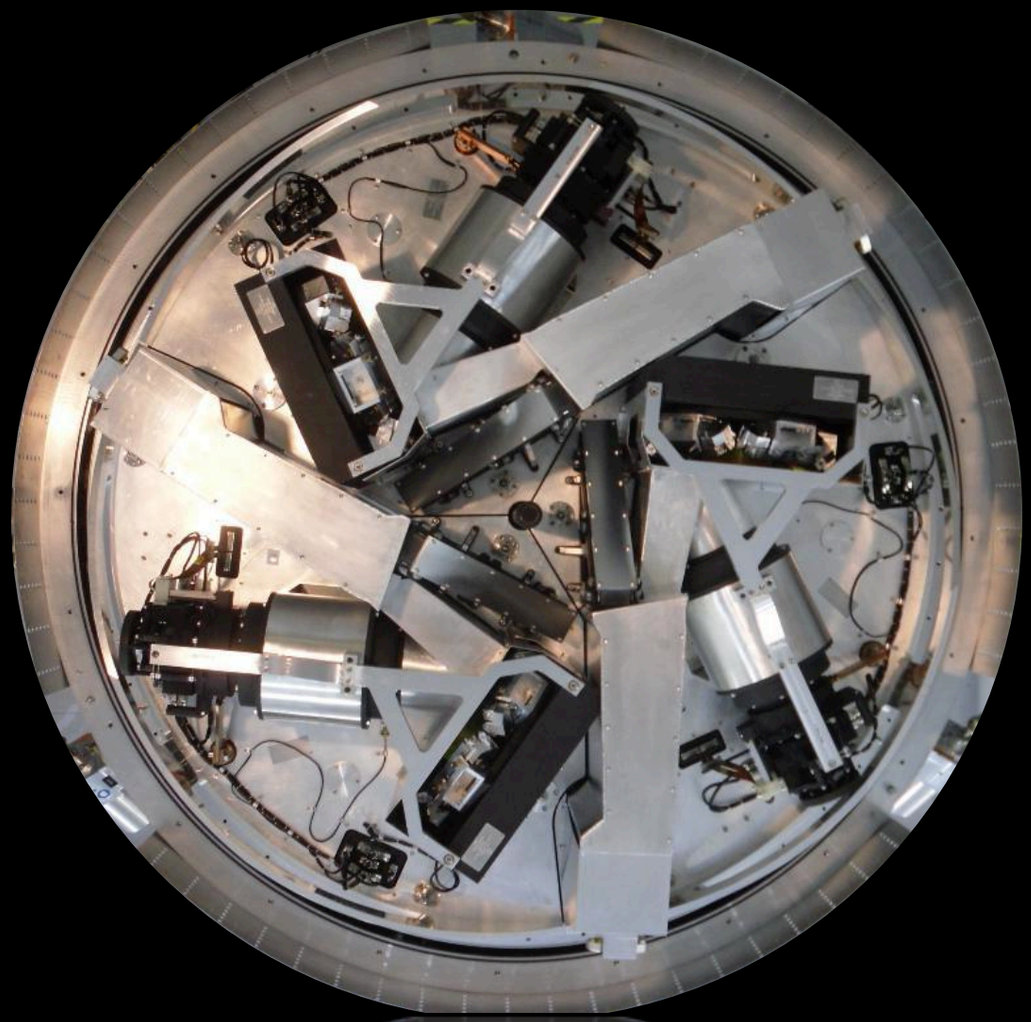


KMOS^{3D} Team / Mass maps c.o. S.Wuyts & P.Lang also see Tacchella talk

KMOS: K-band Multi-Object Spctrgrph



- Highly-multiplexed IFU: 24 pick-off arms over a 7.2’ field, each sampling 2.8”x2.8”
- Wavelength coverage from 0.8-2.5 microns → R~3500 spectra at 0.8 < z < 2.5
- Packed IFU configurations: >2 within 6”, >3 within 1 sq. arcmin



- Factor of ~24 increase in survey speed relative to seeing-limited SINFONI@VLT
- Compared to slit spectroscopy, IFU allows for unbiased studies of galaxies with complex morphology/ kinematics

An Era of Kinematic Surveys

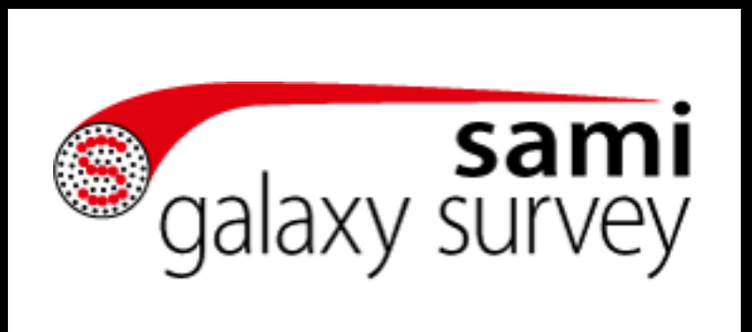
AUS Synergies w/ KMOS

z=0.7-2.5

KMOS^{3D} *(also: MOS-DEF, VIRIAL)*

- ~600-1000 galaxies
- 75nts, (2013 - 2017)
- deep fields (COSMOS, GOODS-S, UDS)
- mass(sed) selection
- parallel cluster program

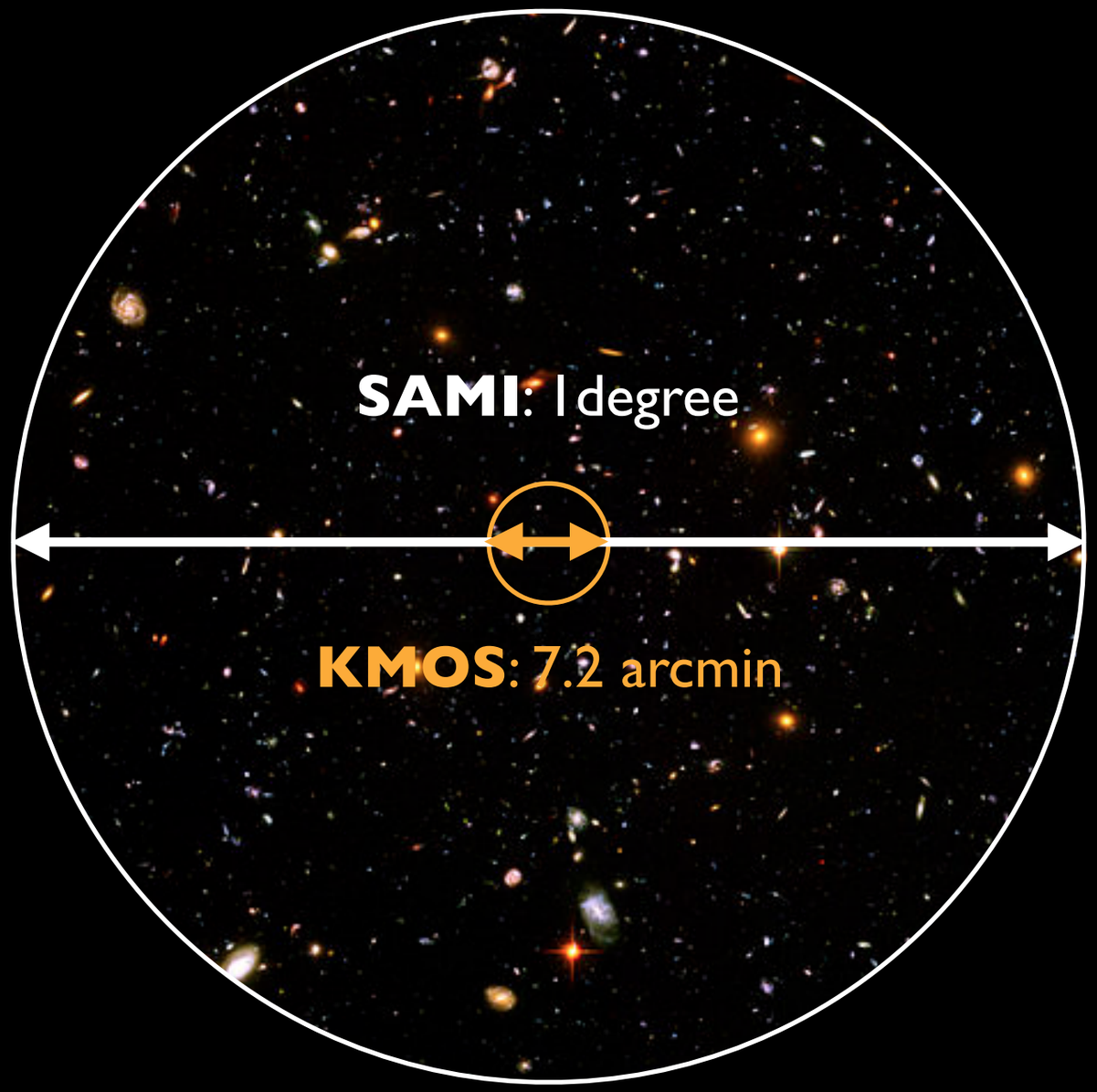
z<0.1



SAMI (also: MaNGA, CALIFA, DYNAMO)

- ~3400 galaxies
- 151-181nts, (2013 - 2016)
- GAMA/SDSS/2dF
- mass(color) selection
- parallel cluster program

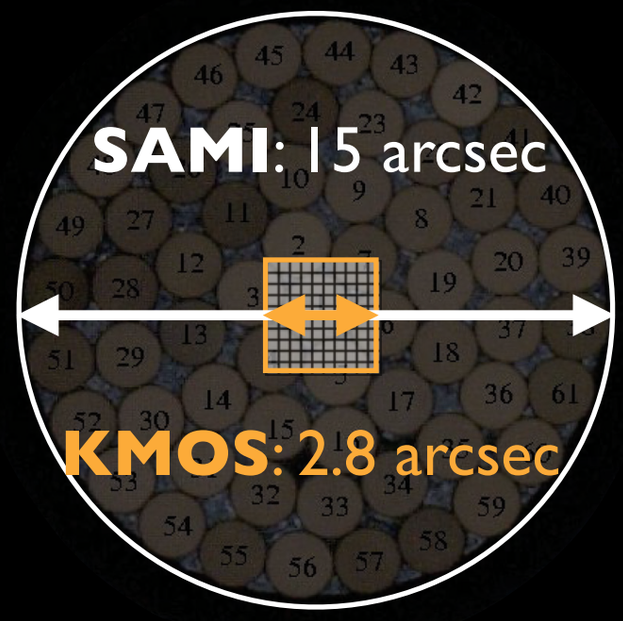
Field Size



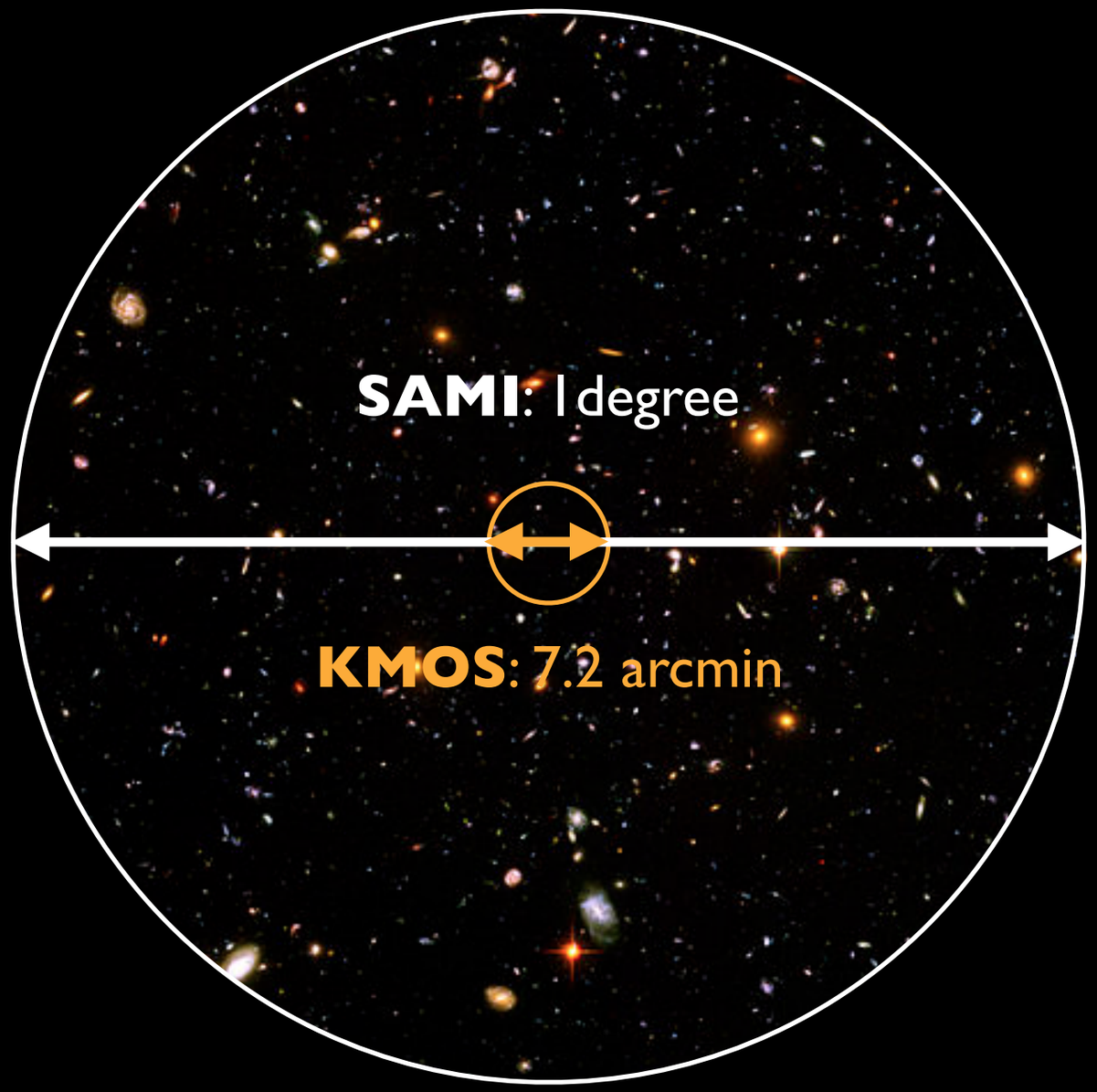
IFU Size

SAMI: 13 IFUs

KMOS: 24 IFUs



Field Size



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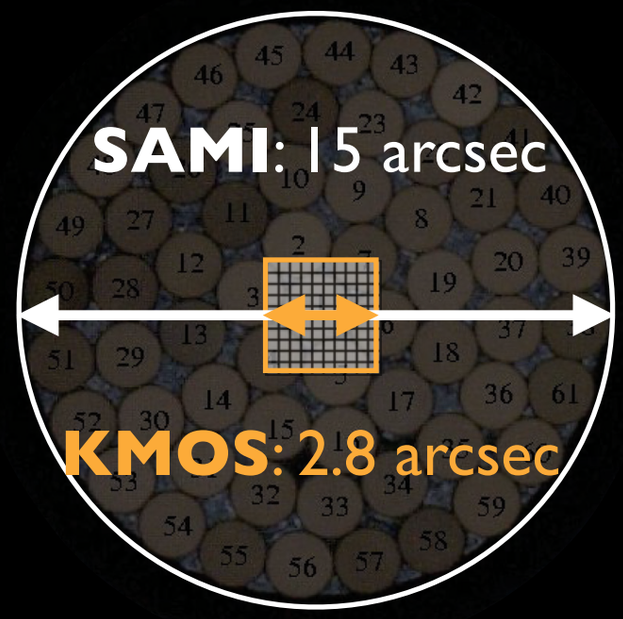

SAMI: ~23 kpc @ z=0.08

KMOS: ~23 kpc @ z=1