The kinematics of intermediate redshift galaxies with LEGA-C

“Emission Line Galaxies with MOS”
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LEGA-C collaboration
MPIA
3D modeling

I-band

Hα  Hβ

original - continuum

radius (arcsec)

wavelength (Å)
Recipe 🍰

Ingredients
- gasdisk: exponential
- sigma: constant
- velocity (R): arctangent
- (...) inclination
- slit angle
- PSF
- (...) PSF

Directions
Model the gas disk in 3D and simulate light path through VIMOS instrument.
3D modeling

I-band

Hβ
3D modeling

**line-of-sight velocity**

**Hβ**
3D modeling

Hβ

original - continuum

model

residual

radius (arcsec)

wavelength (Å)
3D modeling

Hγ

original - continuum

model

residual
What’s inside a galaxy?

**Stellar mass Tully Fisher relation**

\[ \Delta \log M ? \]

**Stars + gas + DM**

Use stellar + gas dynamics to find out how well stellar light traces total dynamical mass.
Evolution with redshift

\[ \text{Slope @ Reyes+11} \quad \log M \sim 3.4 \log V \]

See also Straatman+17
Evolution with redshift

Slope @ Bell+01 \[ \log M \sim 4.5 \log V \]

Slope @ Reyes+11 \[ \log M \sim 3.4 \log V \]

See also Straatman+17
\[ \Delta \log M (M_\odot) = 0.39 \text{ dex} \]

Selection bias

disky: v/\sigma

See also Straatman+17
Stellar mass

*everything with Chabrier03 IMF

e.g. Miller+11 with 3D-HST masses

See also Straatman+17
LEGA-C: $0.6 \lesssim z \lesssim 1$

See also Straatman+17
sample
N = 57 in DR2

1. Hβ signal with no strong skylines. *by eye
2. no mergers. *by eye
3. valid GALFIT fits. *by eye
   (need radius and inclination)
4. axis-ratio < 0.7.
5. slit misalignment < 40 degrees
6. no AGN. (log OIII5007 / Hβ < 0.5)
7. not quiescent.
   (log sSFR > log 1 / 3th + 0.3; Damen+09)
8. line is resolved.
   (v (km/s) has the same sign for 95% of parameter space)
Does the (intercept of the) stellar-mass TFR evolve?

\[ V_{2.2} = v \ (R = 2.2 \times \text{disk scale radius}) \]

\[ \Delta \log M = -0.32 \]

\[ \log M \sim 3.4 \log V \]

\[ N = 57 \text{ in DR2} \]
Does the (intercept of the) stellar-mass TFR evolve?

\[ V_{2.2} = v \left( R = 2.2 \times \text{disk scale radius} \right) \]

\[ \Delta \log M = -0.37 \]

\[ v/\sigma > 3 \]

\[ N = 35 \text{ in DR2} \]
How well does stellar light trace total dynamical mass?

LEGA-C: gas AND stellar dynamics
How well does stellar light trace total dynamical mass?

\[ v_{\text{RMS}} = \sqrt{v^2 + \sigma^2} \] ... at any radius
How well does stellar light trace total dynamical mass?

I-band

formula with stellar stuff:

$$\log M_{\text{dyn,stars}} = 5 \log q_{\text{axis}} + 2 \log \sigma_{\text{stars}} + \log R_e + K(n_{\text{sersic}}) + 6.07$$

$M_{\text{dyn,stars}} \rightarrow V_{\text{dyn,stars}} \ldots \text{at any radius}$

Gas and stars move in the same potential, so

$v_{\text{RMS}} = V_{\text{dyn,stars}} \ldots \text{at any radius}$?
How well does stellar light trace total dynamical mass?

$v_{RMS} = V_{dyn, stars} \ldots \text{at any radius?}$
How well does stellar light trace total dynamical mass?

$v_{\text{RMS}} = V_{\text{dyn,stars}}$ ... at any radius?
Conclusions

the stellar mass Tully-Fisher relation has evolved since $z \sim 0.7$

dynamical evidence for presence of gas and/or dark matter at low stellar mass
S05 = $\sqrt{(v^2 + \sigma^2)}$
see also: Kassin+07
Does the (intercept of the) stellar-mass TFR evolve?

$\Delta \log M = -0.59$

Slope @ Bell+01  $\log M \sim 4.5 \log V$
Does the (intercept of the) stellar-mass TFR evolve?

$\Delta \log M = -0.66$

Slope @ Bell+01 \hspace{1cm} \log M \sim 4.5 \log V