The Physics and Mass Assembly of Galaxies

Results of Simulations

(P.Rosati, M.Puech, A.Cimatti, S.Toft)

ELT SWG meeting - May 29, 2007

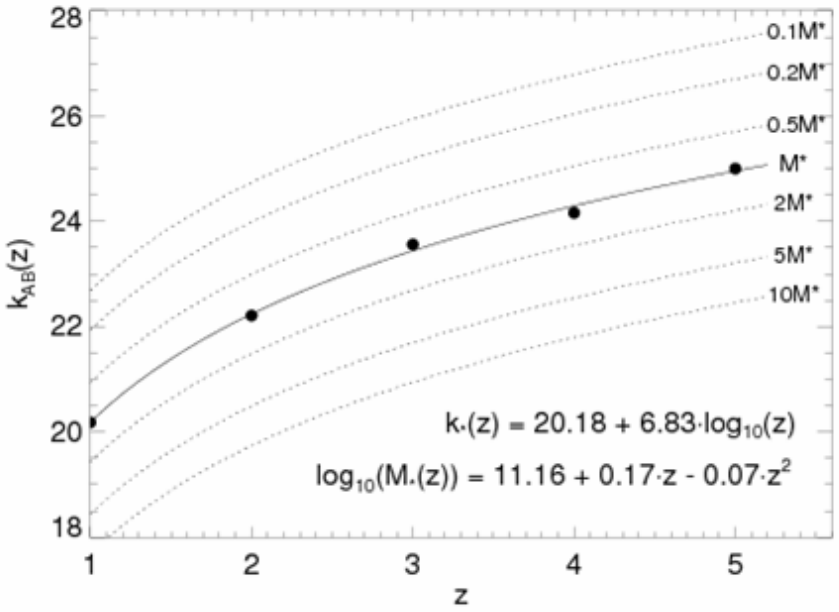
Science Case

- Provide the ultimate test of galaxy formation theories:
  epoch and mode of baryonic mass build-up

- Spatially resolved spectroscopy of a sample of ~1000 massive galaxies at $2<z<\sim5$
  - direct kinematics of stars and gas in the first generation of massive galaxies in the range $0.1<M_{star}<5\times10^{11}\ M_{\odot}$
  - dynamical masses, ages, metallicities
  - differential evolution of disk and spheroidal components as a funct. of z
  - physical channels of mass assembly from since z~5

Method

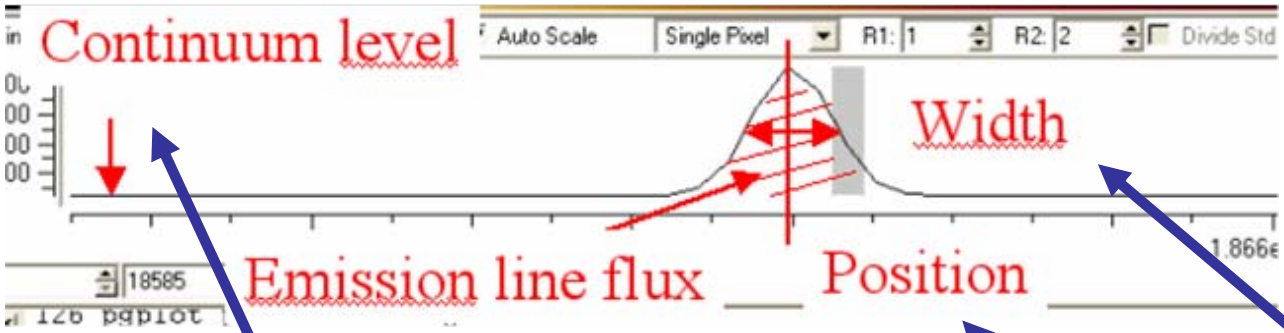
- Input for 3D Spectroscopy simulations (Mathieu P.)
  - (M_{star}, z) ⇒ K_{AB} and ∑(gals/arcmin^2) from observed $n(M_{star},z)$, $n(L_{UV},z)$
  - V(x,y) for a rotating disk (from kinematic observations of local galaxy) and a major merger (from models)
    V_{Max} from local TF relatio
  - PSFs for MOAO case & seei sampling
  - Sky spectrum (site, OH im



- Output of simulations: Vel em.line imaging

- Analysis of simulations
  - Kinematic classifications (mergers vs disks vs in/outflows)
  - Analysis of “Observations”-Models 2D kinematic maps
  - Diagnostic diagrams to establish minimum <S/N> needed for kinematic studies

Mathieu Puech's simulation pipeline



Continuum map

Emission line Flux map

Velocity field

Velocity Dispersion map

Fabry-Perot

Observations

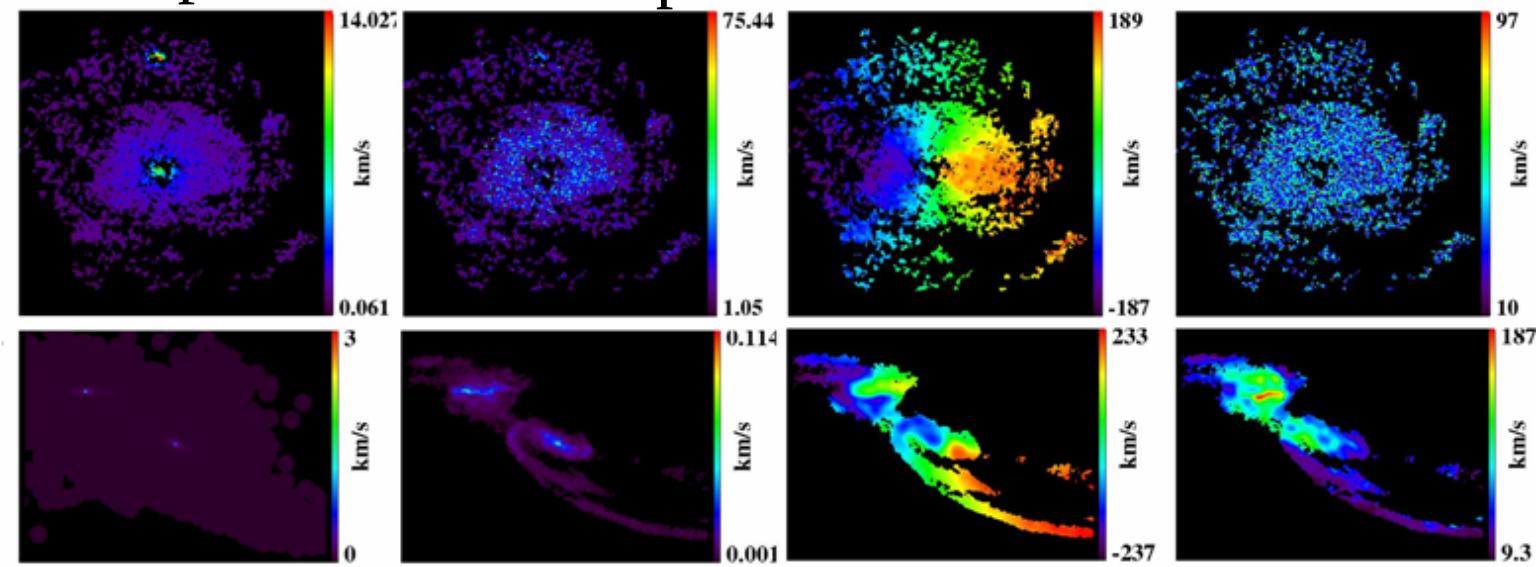
(GHASP-Amram et al.)

OR

Hydro (SPH)

Simulations

(Cox, Dekel et al.)



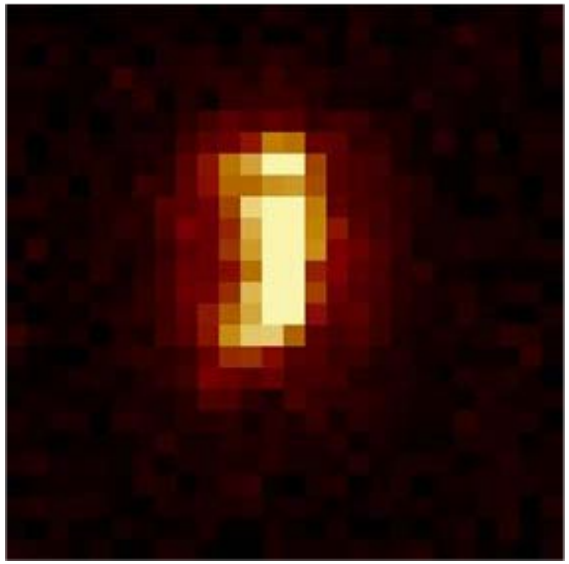
M.Puech

Parameter	Value
$M1$	42 m
$M2$	0 m
R	5000
Δ_{pix}	0.050"
t_{transm}	0.2
CTE	1
p	4000x4000/4
$dark$	0.01 e/sec/pix
ron	2.3 e/pix
dit	3600 s
m_{AB}	24.5 mag
EW	30 Å
λ_{em}	3727 Å
S	0.8"
z	4.0

✓ sky subtraction

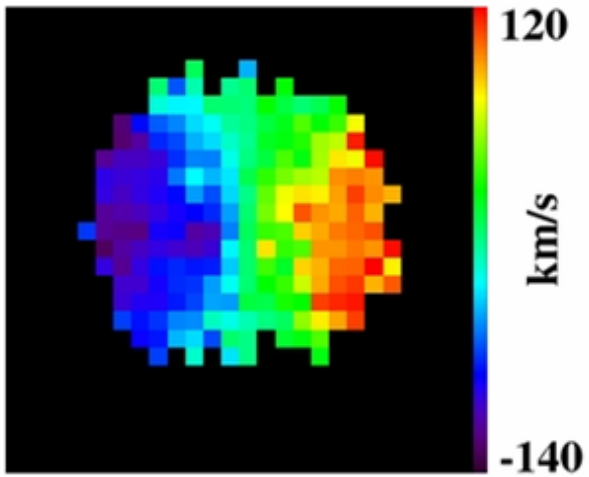
✓ atm. Abs.

✓ Readout noise,dark, etc.

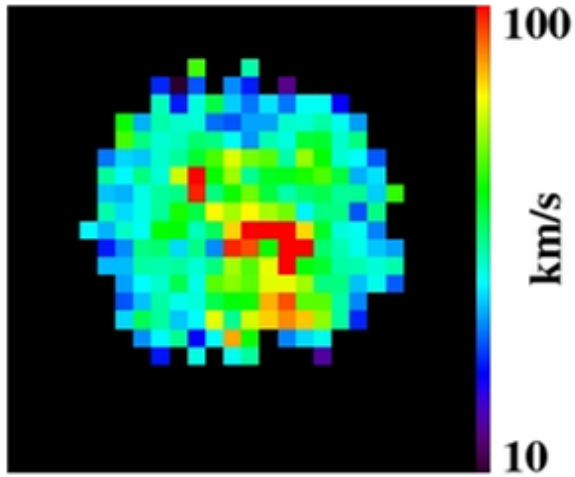


3D datacube « IFU data »

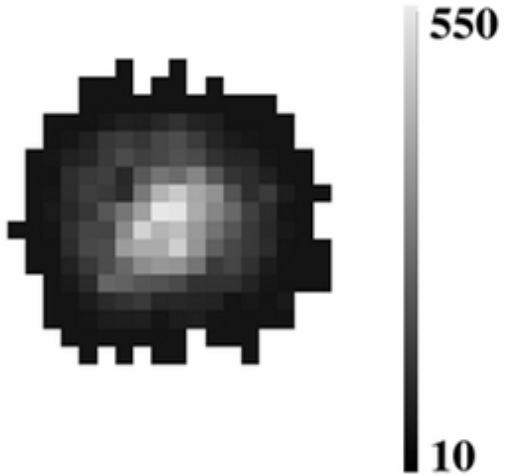
V.F.



σ map



Emission line flux map



Reference case (z=4, M* galaxy)

Physical params

z=4, H_{AB}=24.5 (M* @z=4)

V_{max}≈ 200 km/s → Log(M*)=10.7 $M_{\odot}$

EWrf=30A (OII in H band)

R_H=200 mas, R_{gal}= 4R_H=0.8”(5.6 kpc)

Instrumemt params

D=42m ExpTime=24h

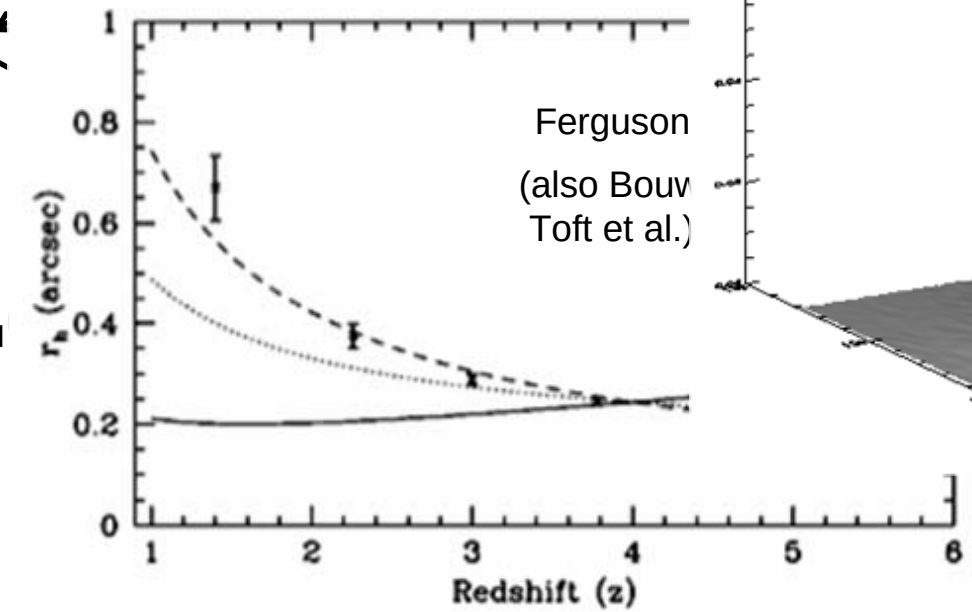
R=5000 Pixel=50 mas

Sky=16.4 in H (1.3 mag brighter than ETC)

MOAO PSF with EE=12-37% in100mas=2pxl

Mass

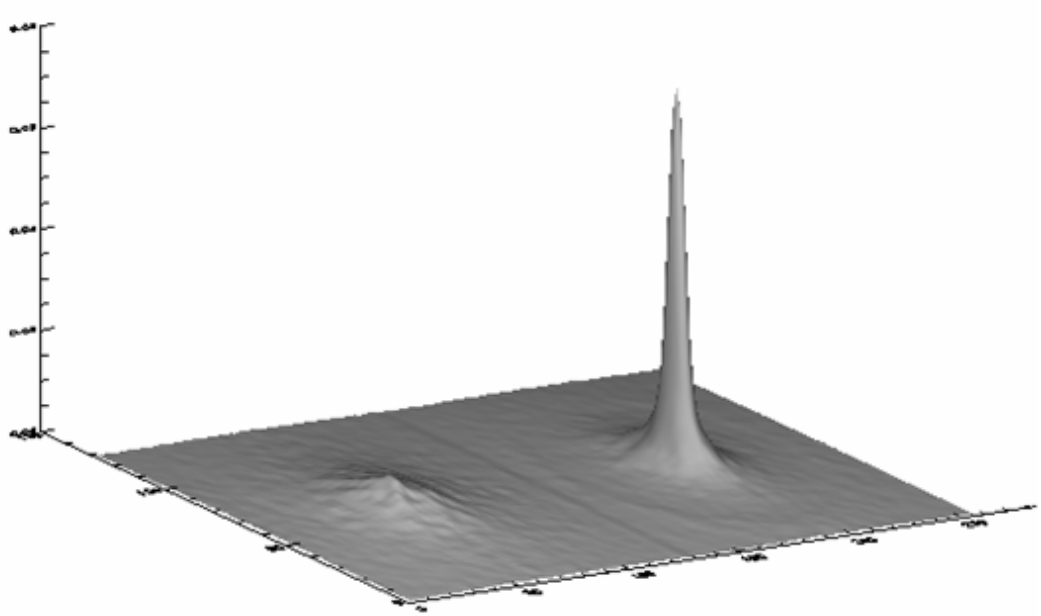
R_H

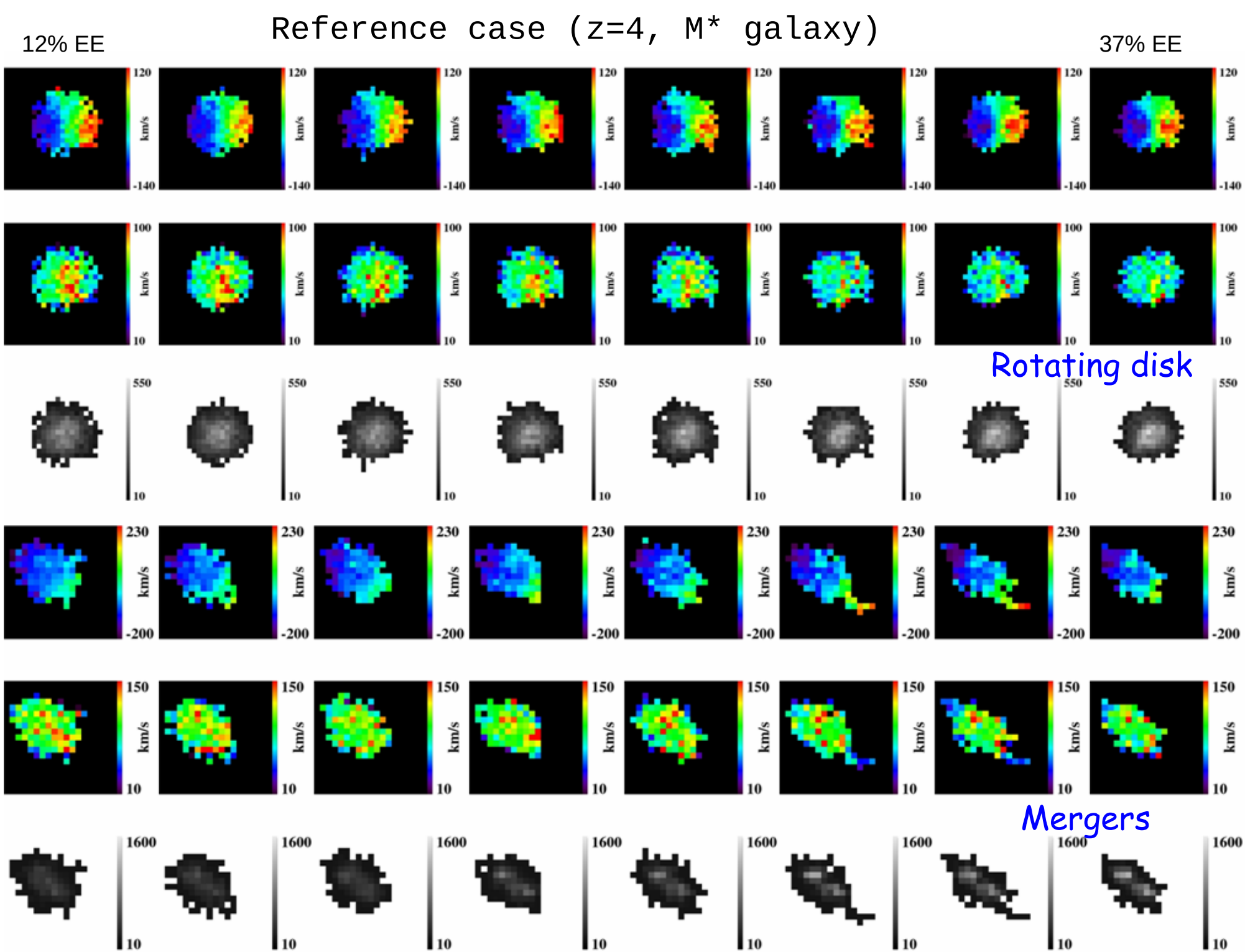


Ferguson

(also Bouv

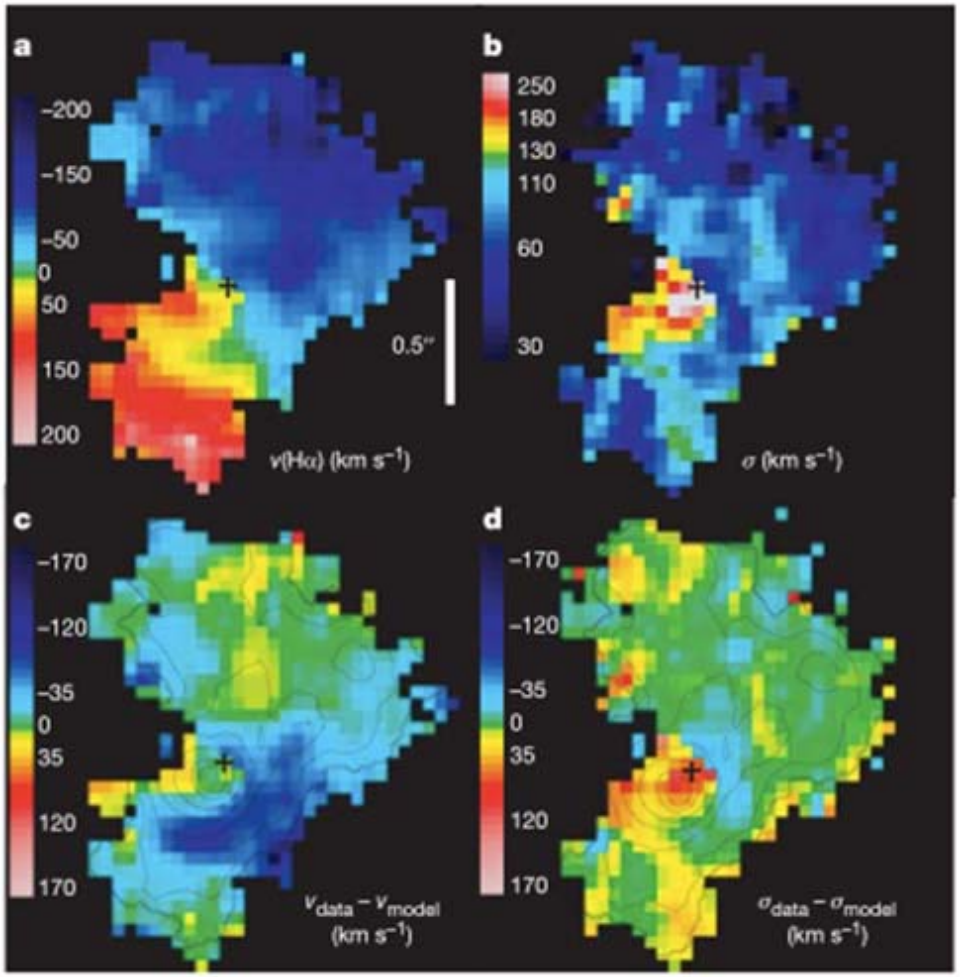
Toft et al.)



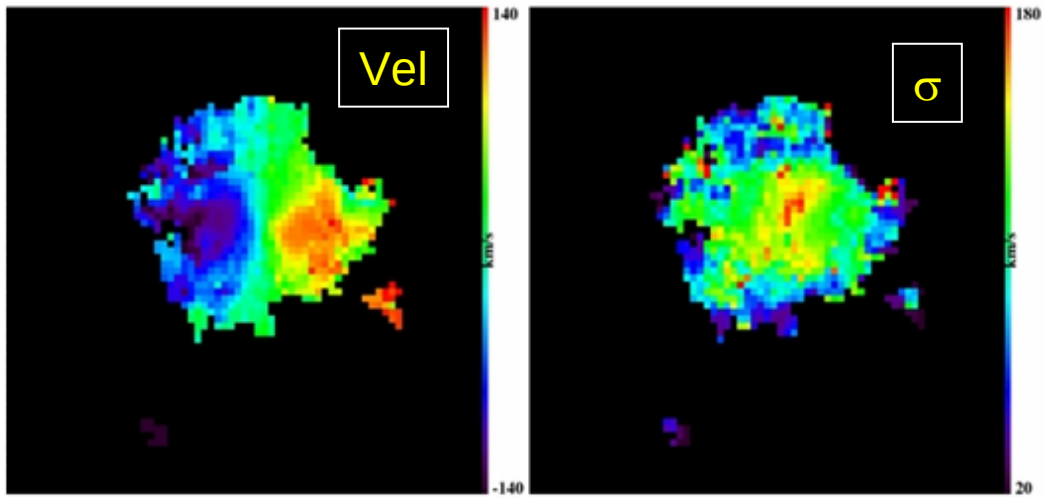

Reference case (z=4, M* galaxy)
12% EE
37% EE
Rotating disk
Mergers
120
-140
km/s
100
10
550
230
-200
150
1600

Simulating Sinfoni observations of a massive galaxy at z=2.34

(real life validation of simulations)



K_{AB}=21.1 (incl. Hα line em.), ($F_{H\alpha}$= 2.5×10^{-16} cgs)
R_{gal}~1″, M_{tot}=1.1×10$^{11}M_{\odot}$, M_{star}=8×10$^{10}M_{\odot}$
V_c=230 km/s, EW_{rest}=140 A, ExpT=6h

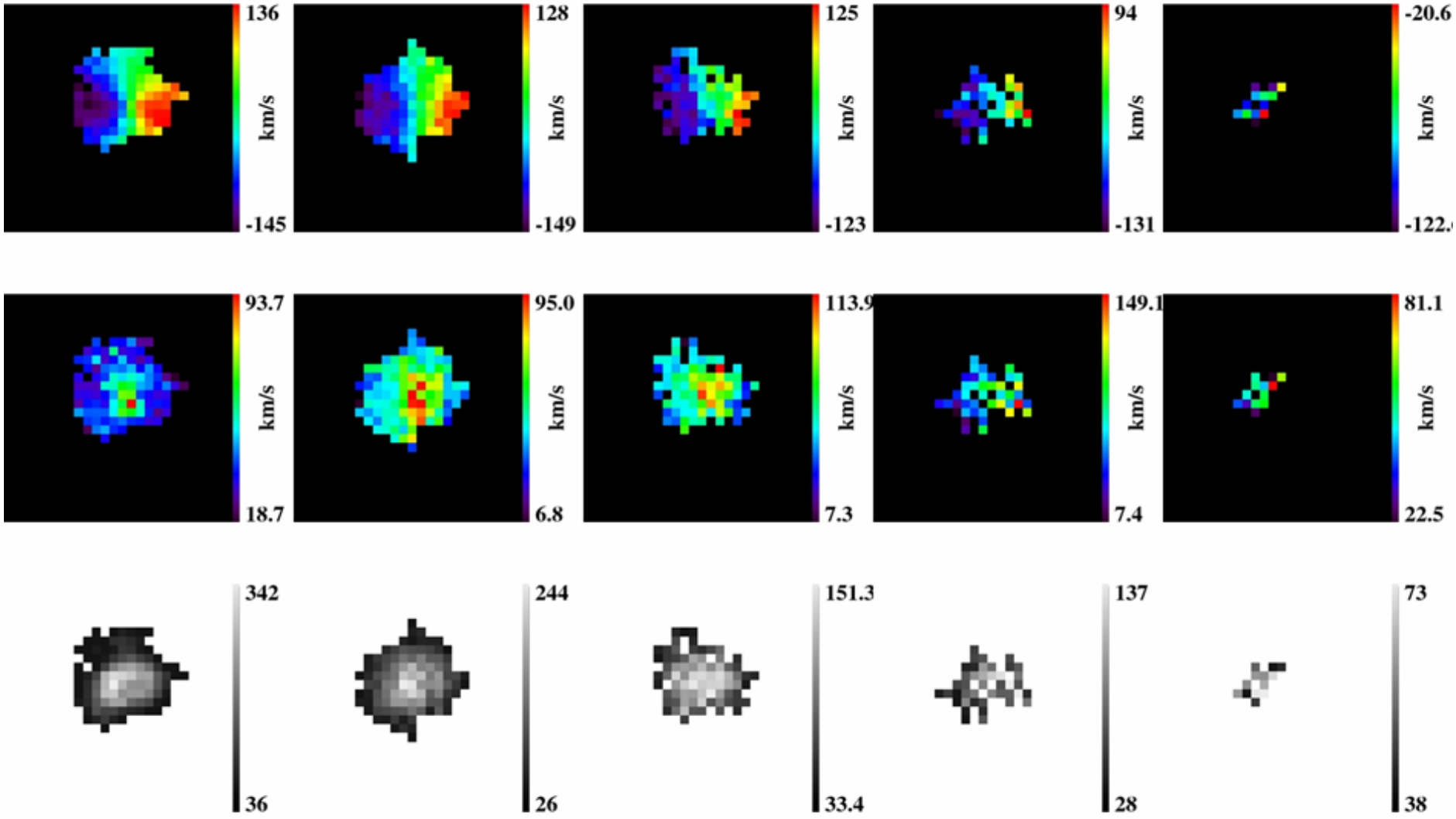


(Genzel et al., Nature, 44, 2006)

Gaussian PSF (improved seeing)

Rotating disk

FWHM: 100 mas 200 mas 300 mas 400 mas 500 mas

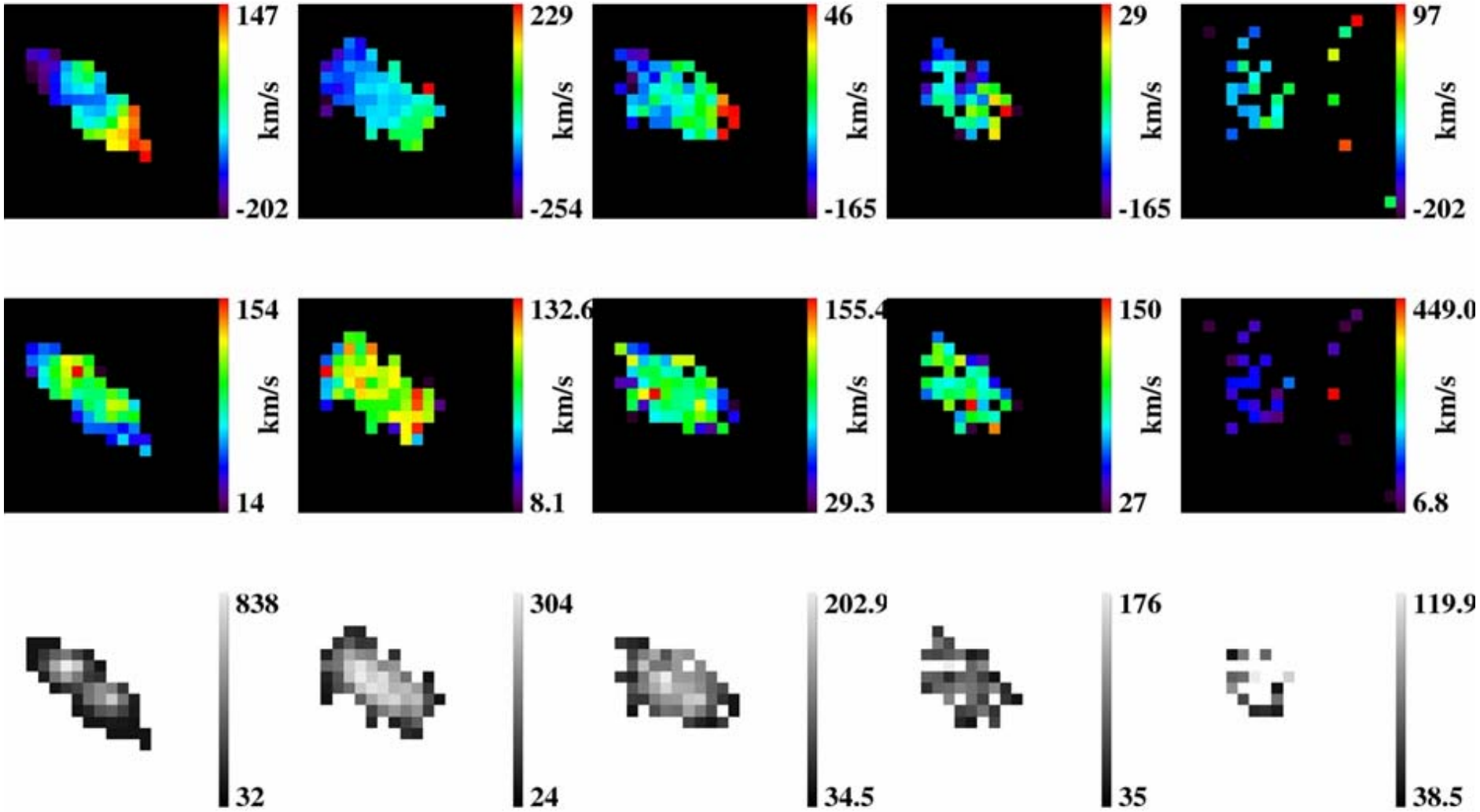


30 m

Gaussian PSF (improved seeing)

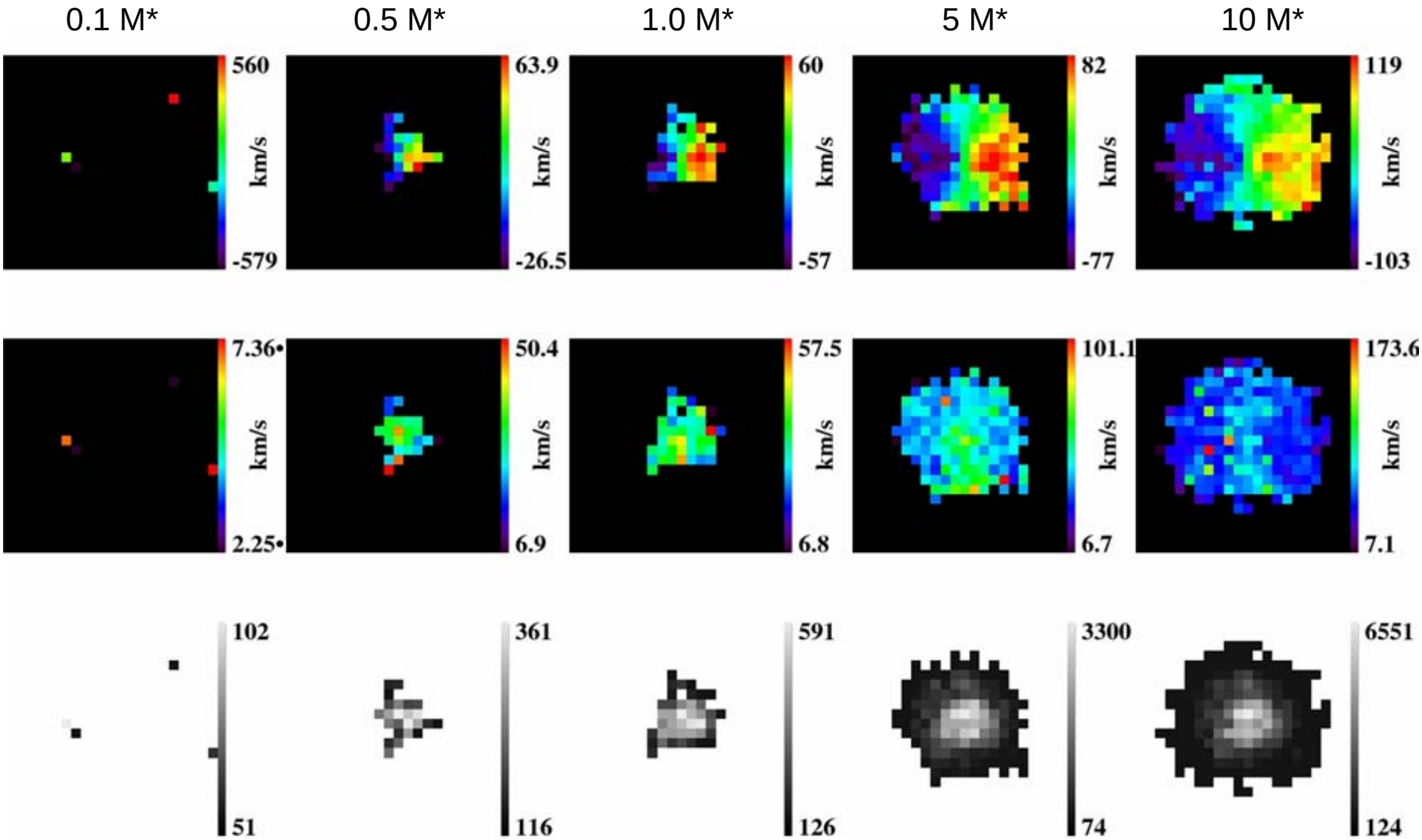
Merger

FWHM: 100 mas 200 mas 300 mas 400 mas 500 mas



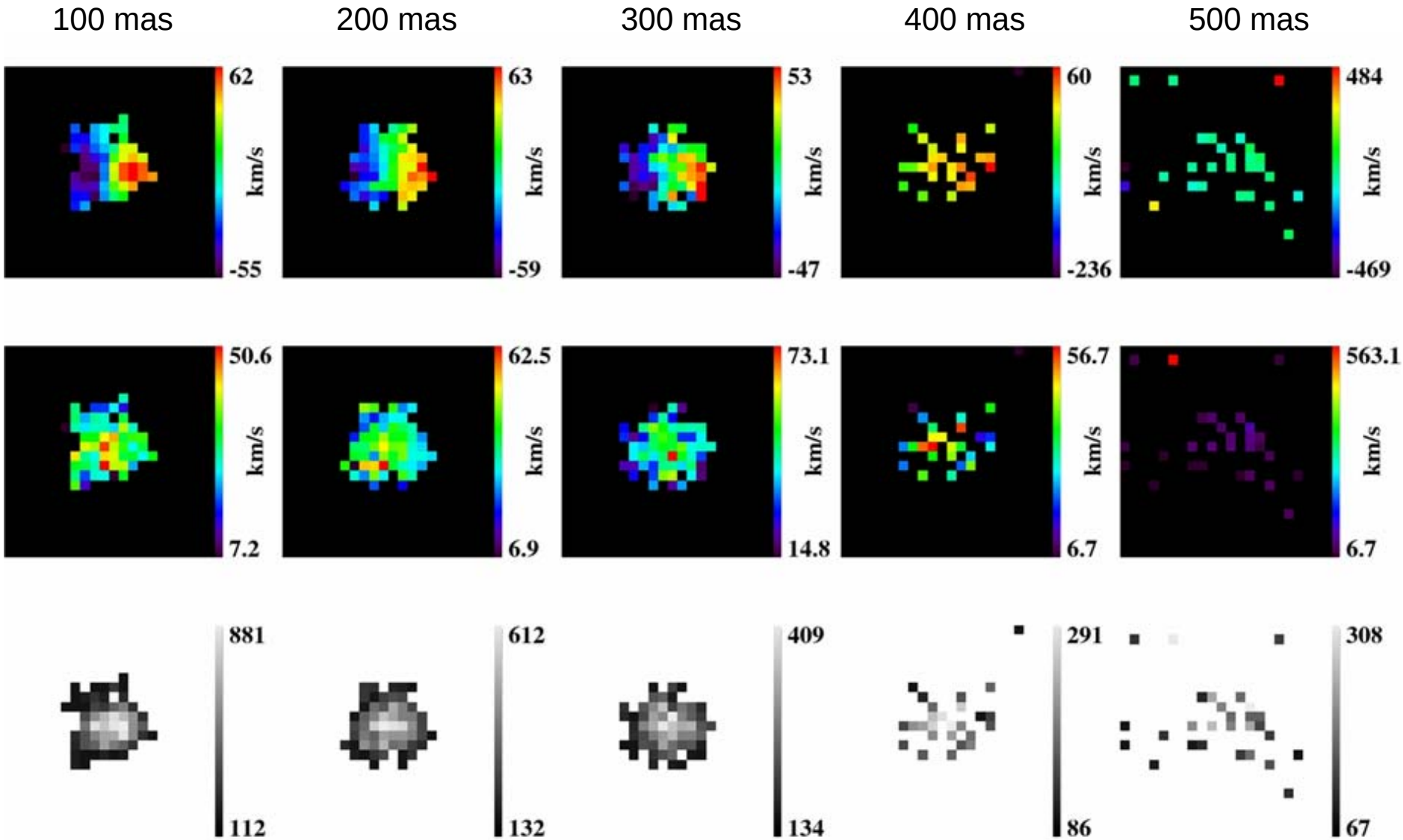
30 m

z=5.6 (OII in K) disk galaxy at different masses



MOAO PSF (EE=44% in 0.1″)

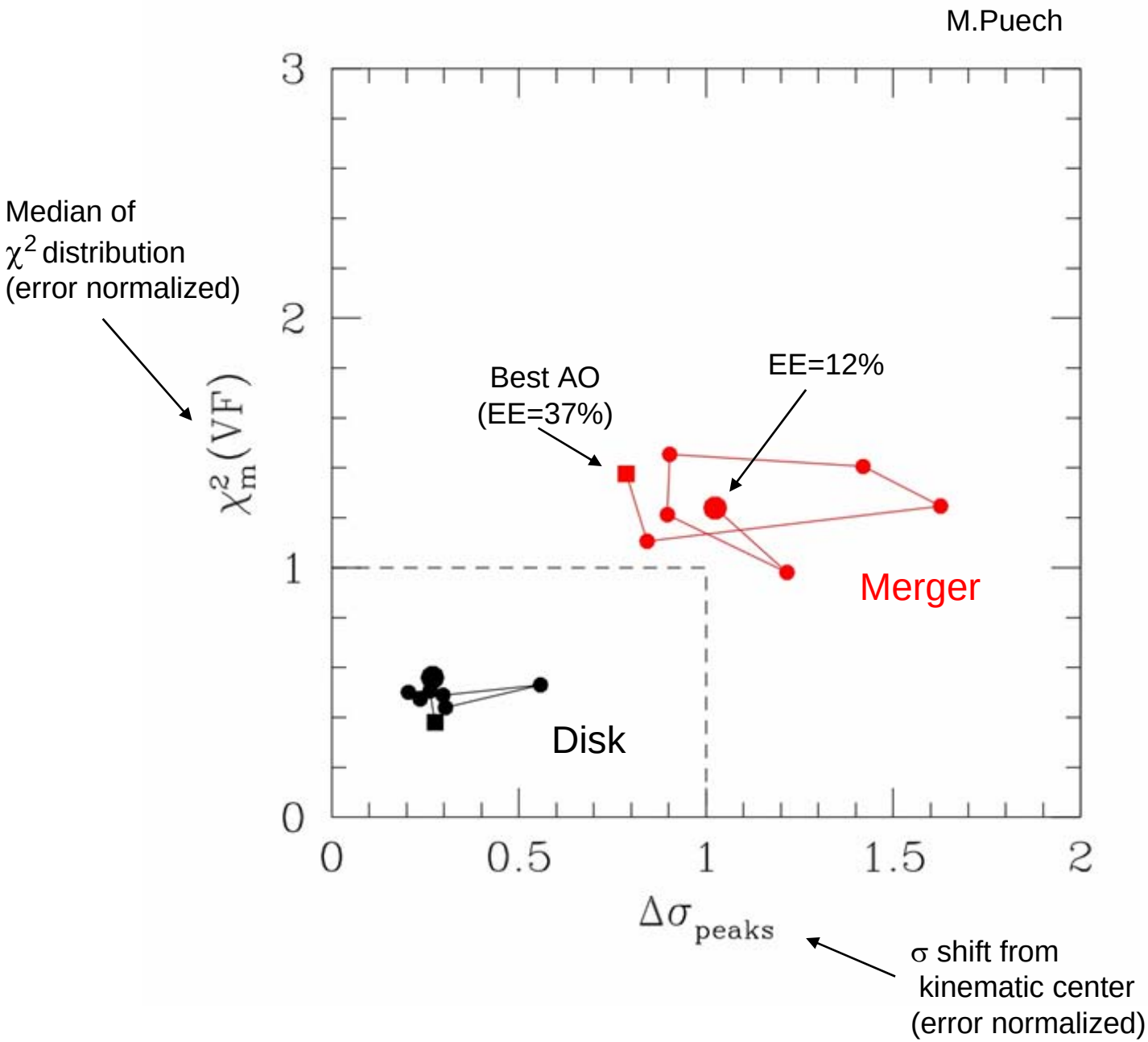
z=5.6 disk M* galaxy at different “seeing”



Gaussian PSF

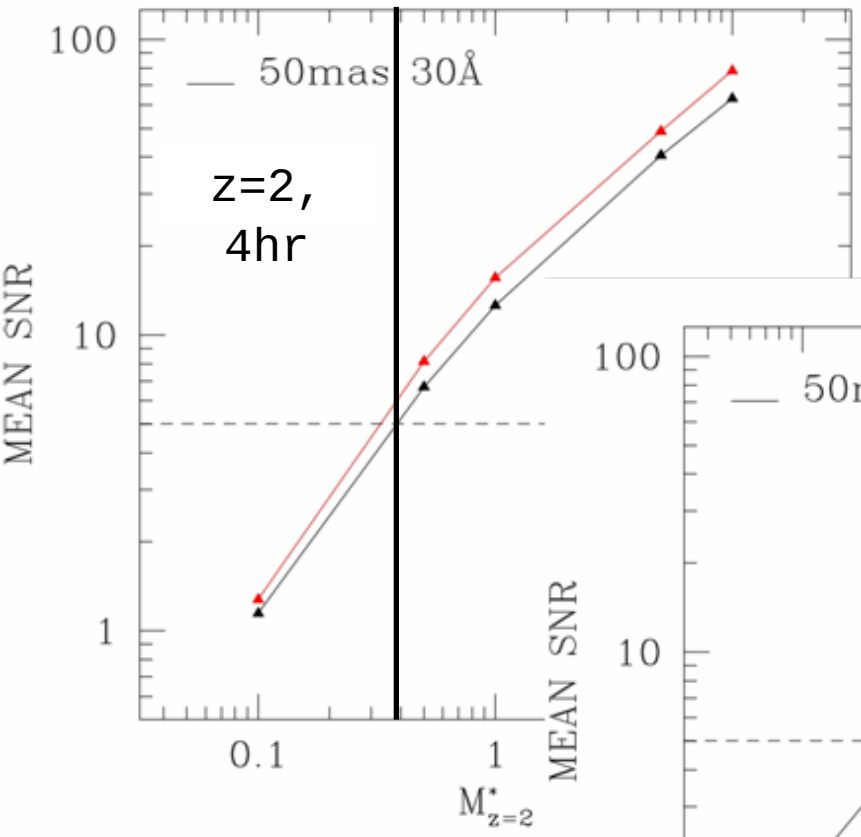
Analysis of 2D kinematic simulations

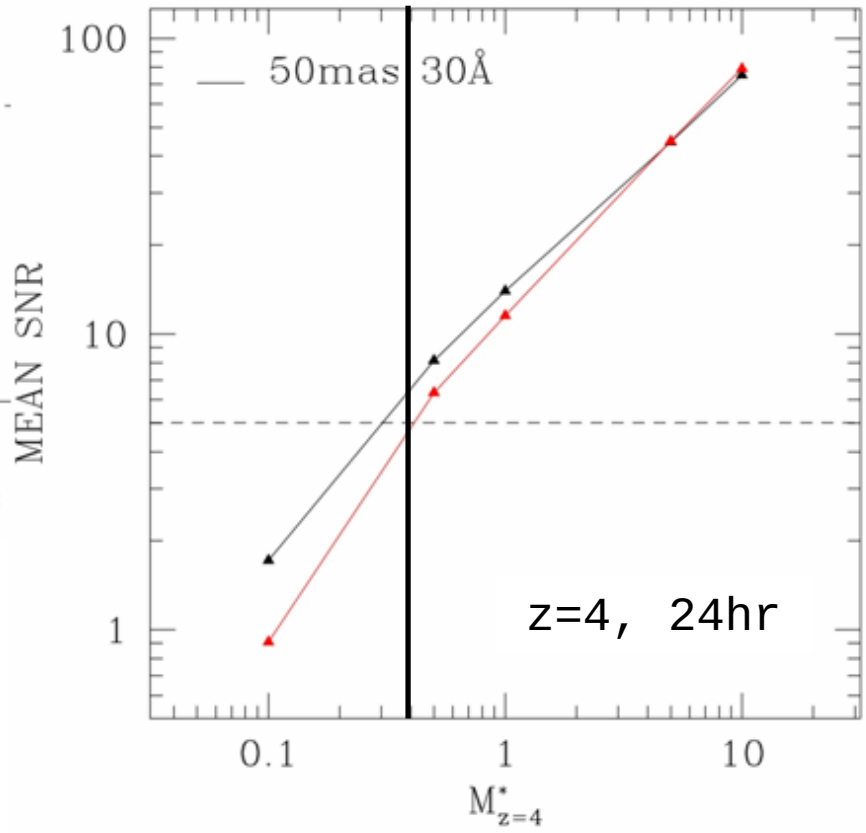
M.Puech

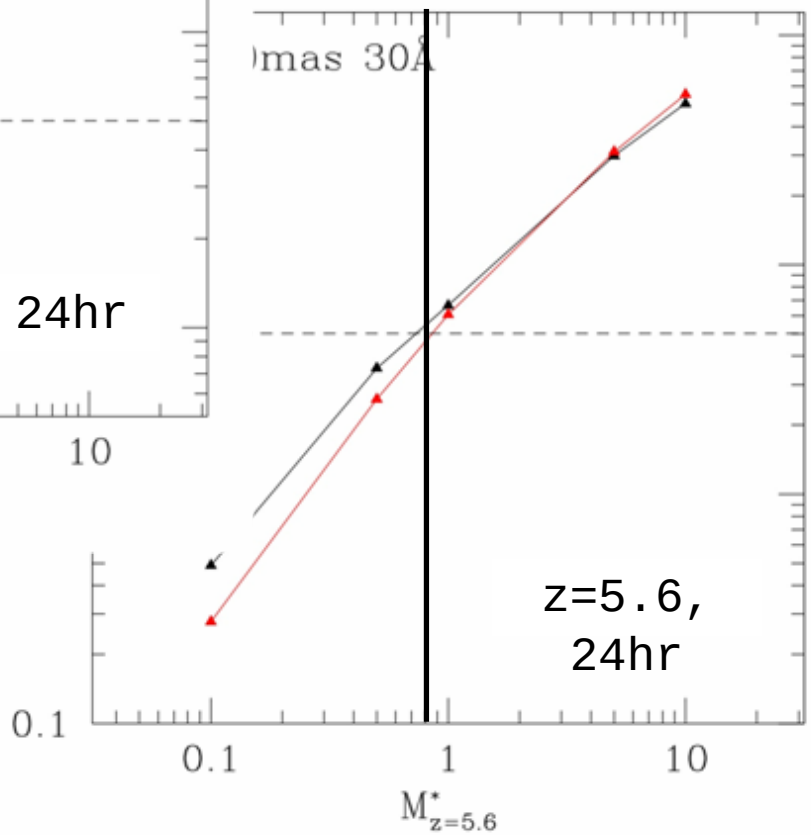


Avg. emission weighted <S/N>

$$< S/N >= \frac{\int I(x,y) SN(x,y)}{\int I(x,y)} \quad \text{as a funct of} \quad M^*_{star}$$







Scaling relations and Summary

Minimum <S/N> for kinematic studies:

$$< S/N >_{min} = 5 \left(\frac{M/M^*}{0.4}\right) \left(\frac{z}{4}\right)^{-2.4} \left(\frac{T}{24h}\right)^{0.5} \left(\frac{D}{42\,m}\right) \left(\frac{EW}{30\text{Å}}\right) \left(\frac{R}{5000}\right)^{-0.5}$$

- Reli … es, and
- No
  - … the very tip
  - …
- "Im … from MOAO witl … Bet
- ELT
- Stu