Stirring Up the Gas: Star Formation and Powering the High Pressures in Galaxies 10 Gyrs ago

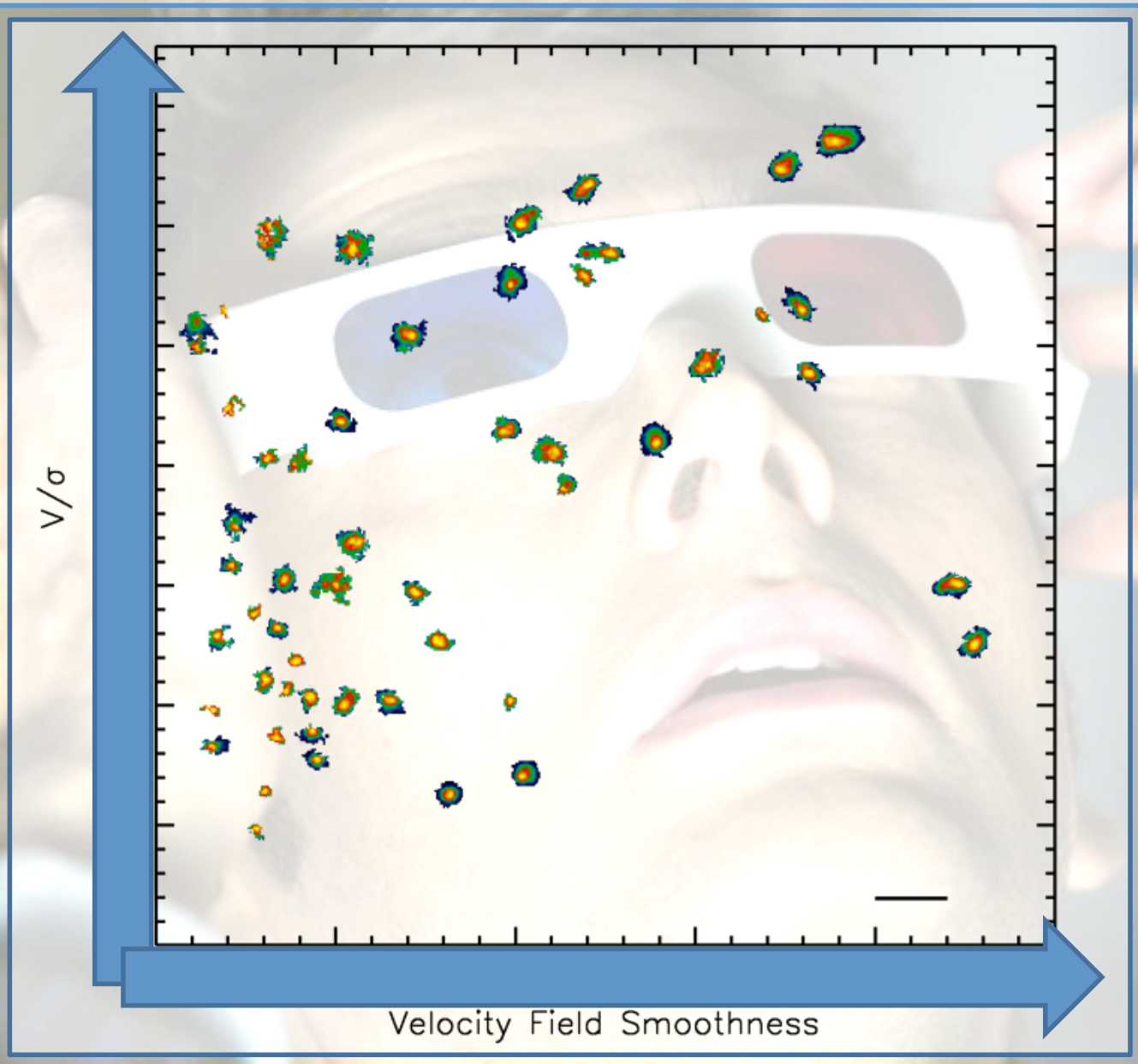
Loïc Le Tiran, Matt Lehnert, Paola Di Matteo, Nicole Nesvadba, Wim van Driel…

… the doctor and Rose

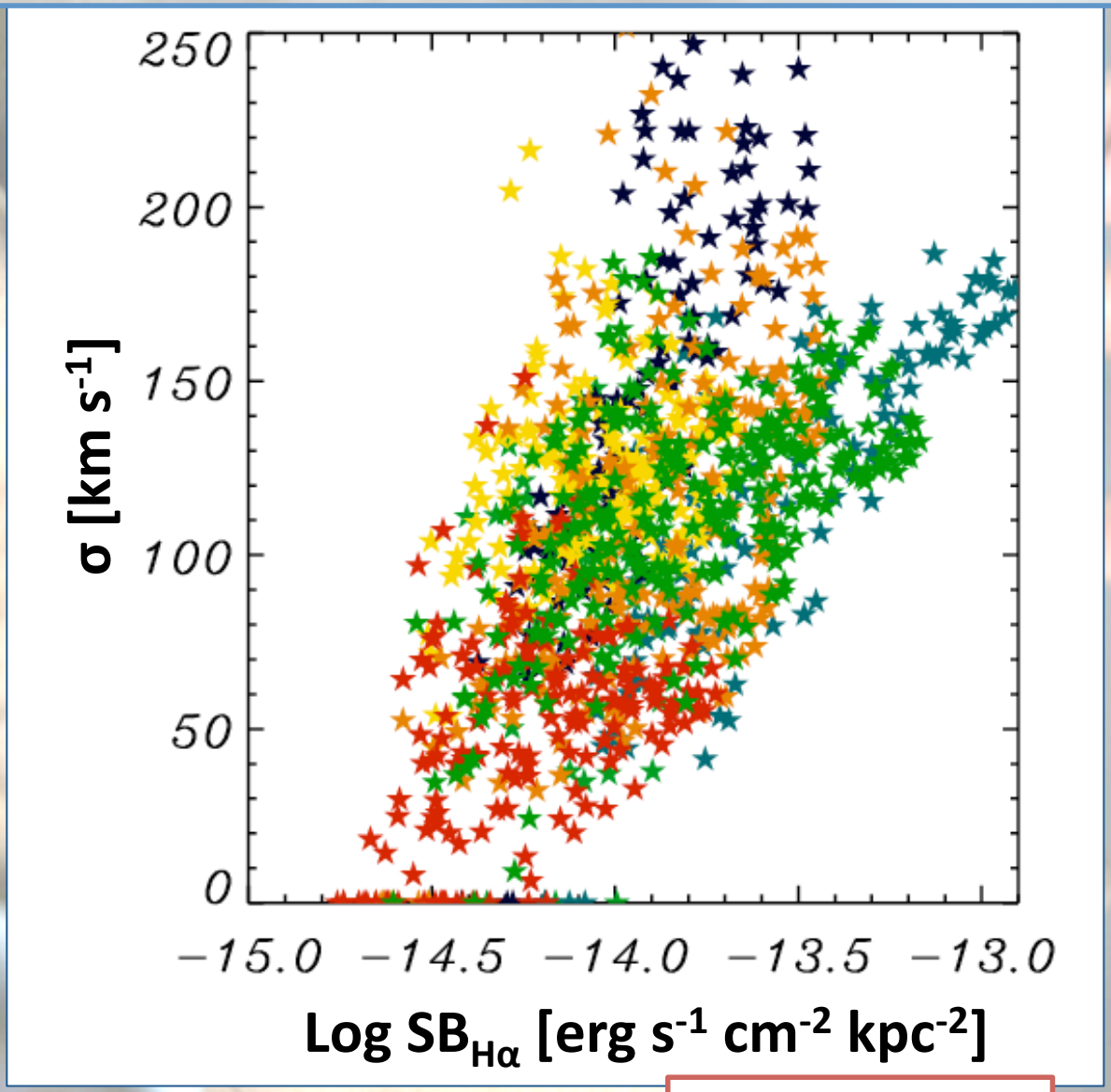

POLICE PUBLIC CALL BOX


Put your glasses on Rose,
we're doing
3D spectroscopy!

A sample of more than 50 objects

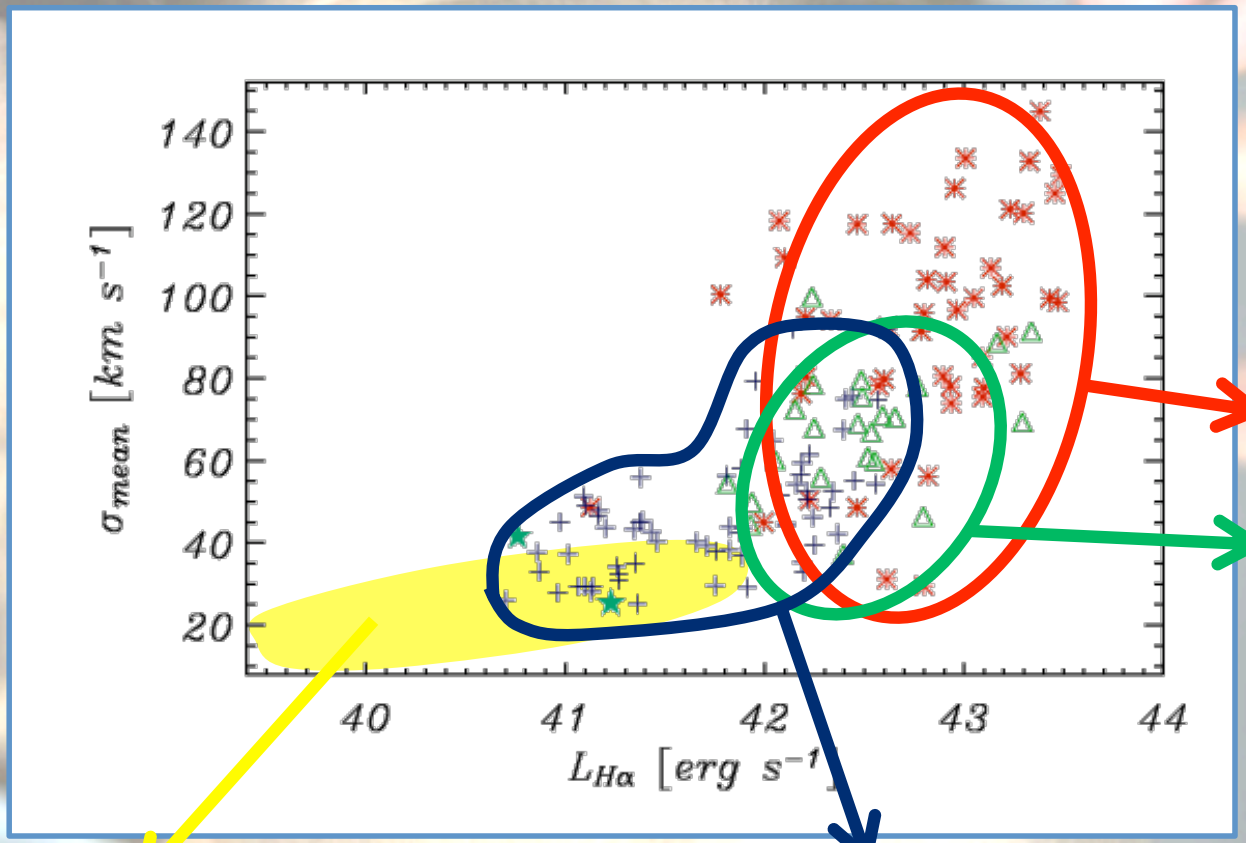


Is there a trend between SFR and Hα velocity dispersion?



Lehnert et al. (2009)

Seen also on “integrated” galaxies

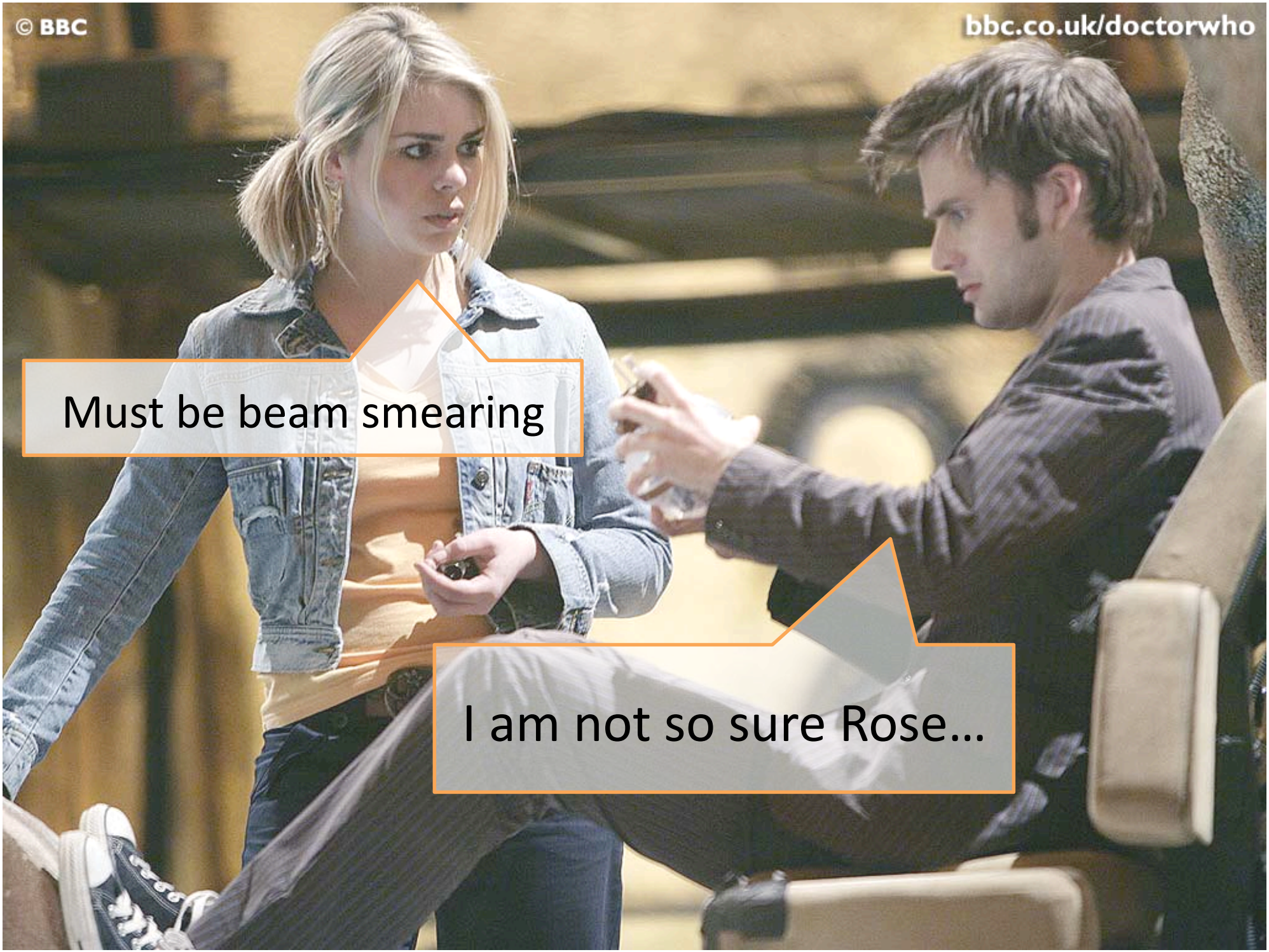


High redshift

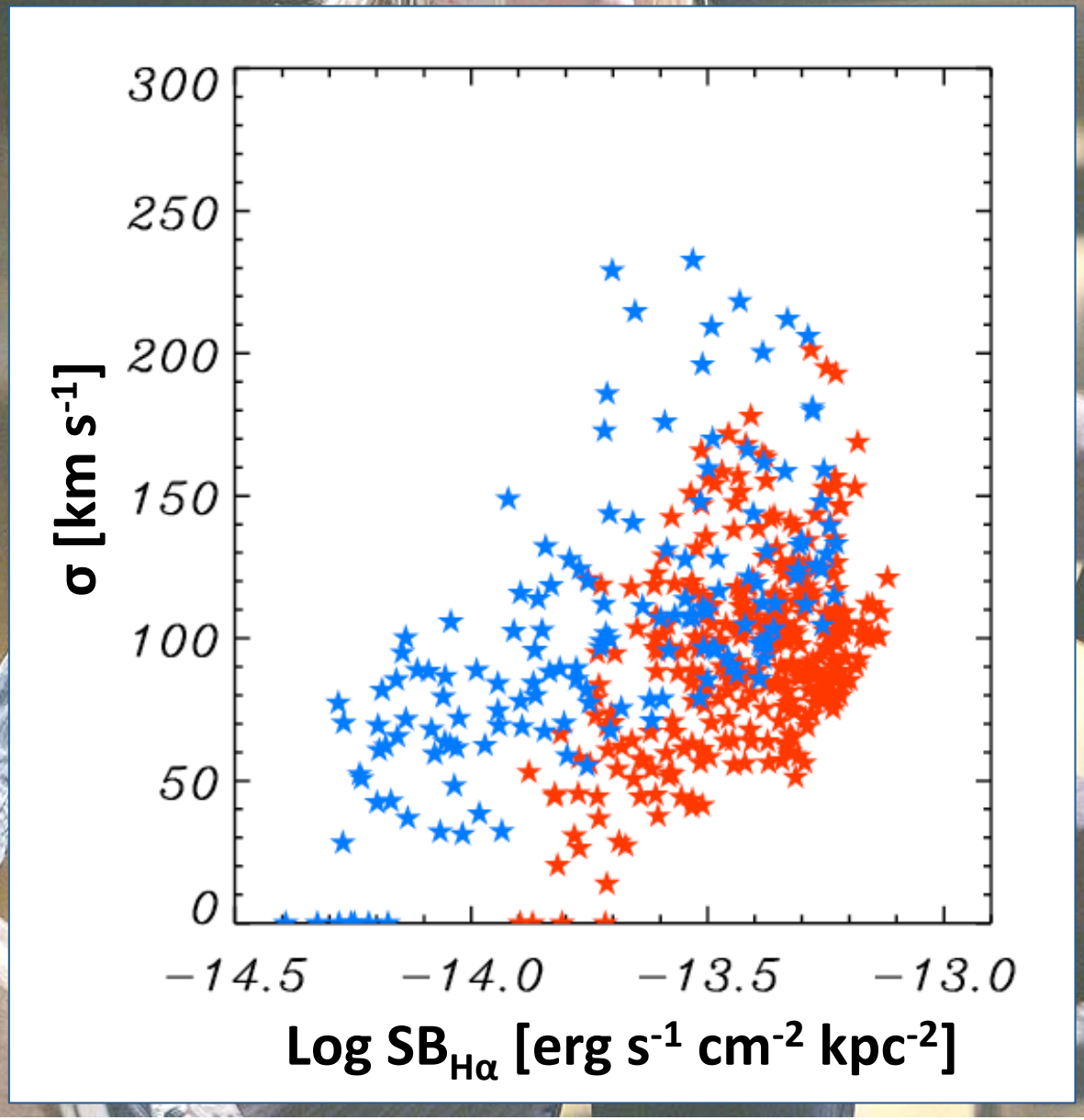
High redshift

Local galaxies

Local extreme galaxies (SDSS) – *Green 2010, Nature*


© BBC
bbc.co.uk/doctorwho
Must be beam smearing
I am not so sure Rose…

Not an effect of beam smearing…



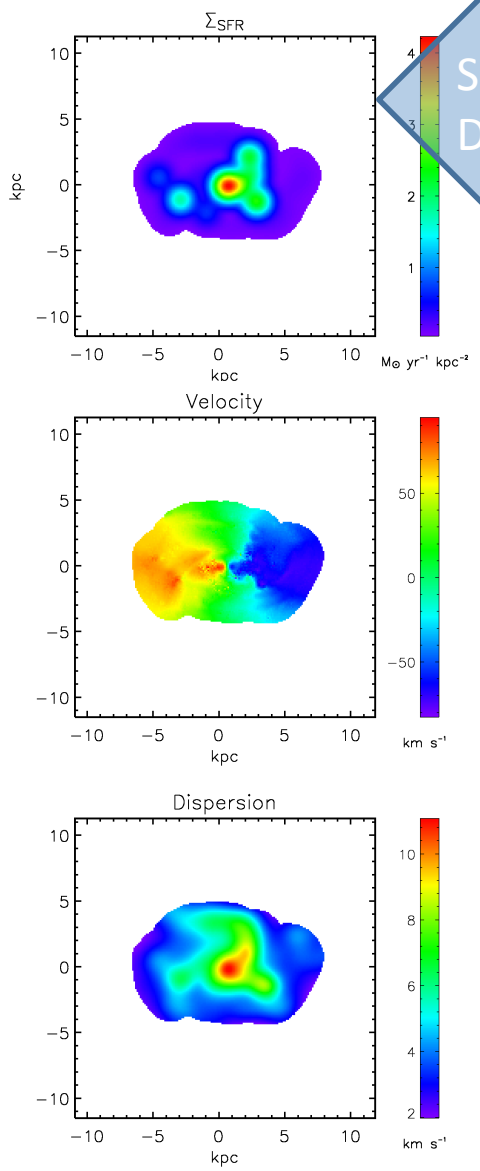
noAO (.6 arcsec)
AO (.2 arcsec)

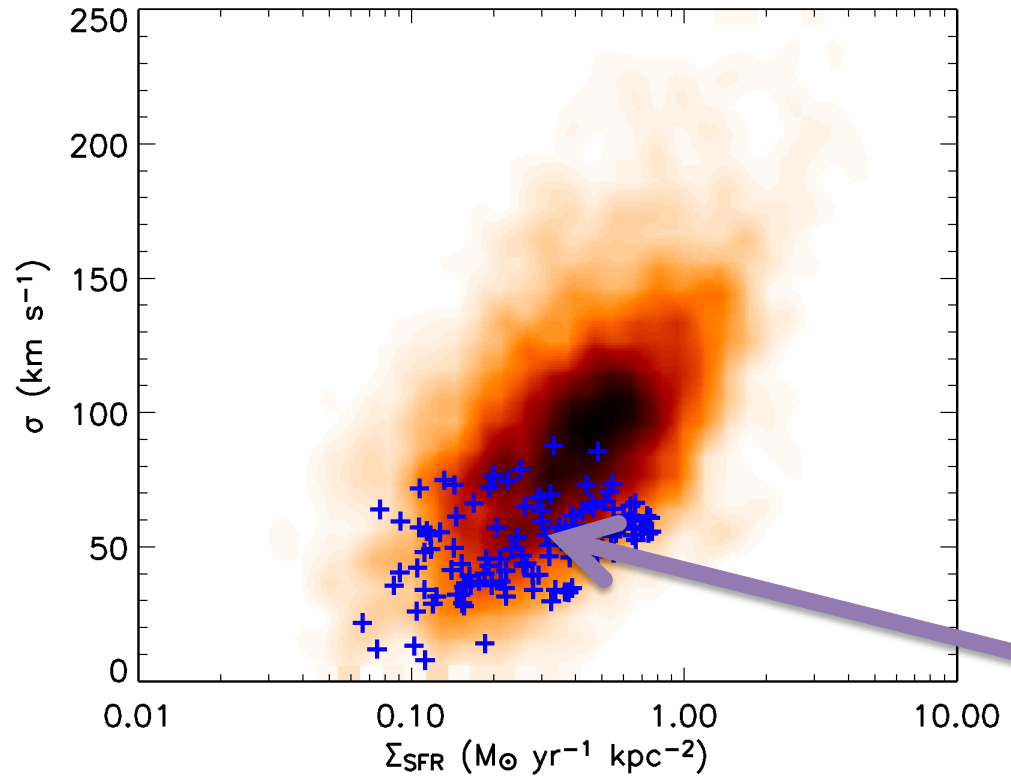
Lehnert et al. (2009)

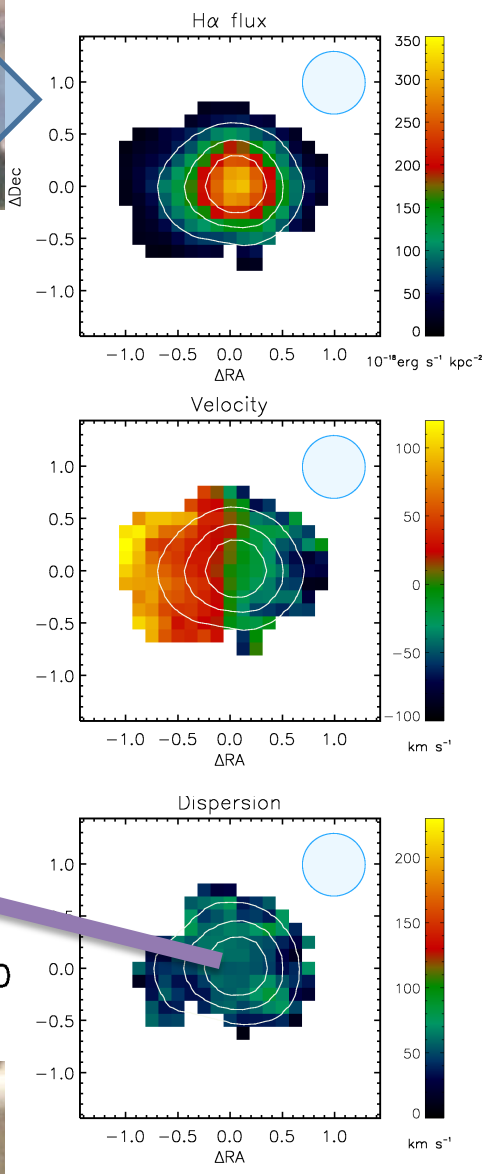
Beam Smearing Simulation

Simulations of clumpy galaxy:
Di Matteo, Bournaud et al. 2008

SINFONI
Analog at z~2



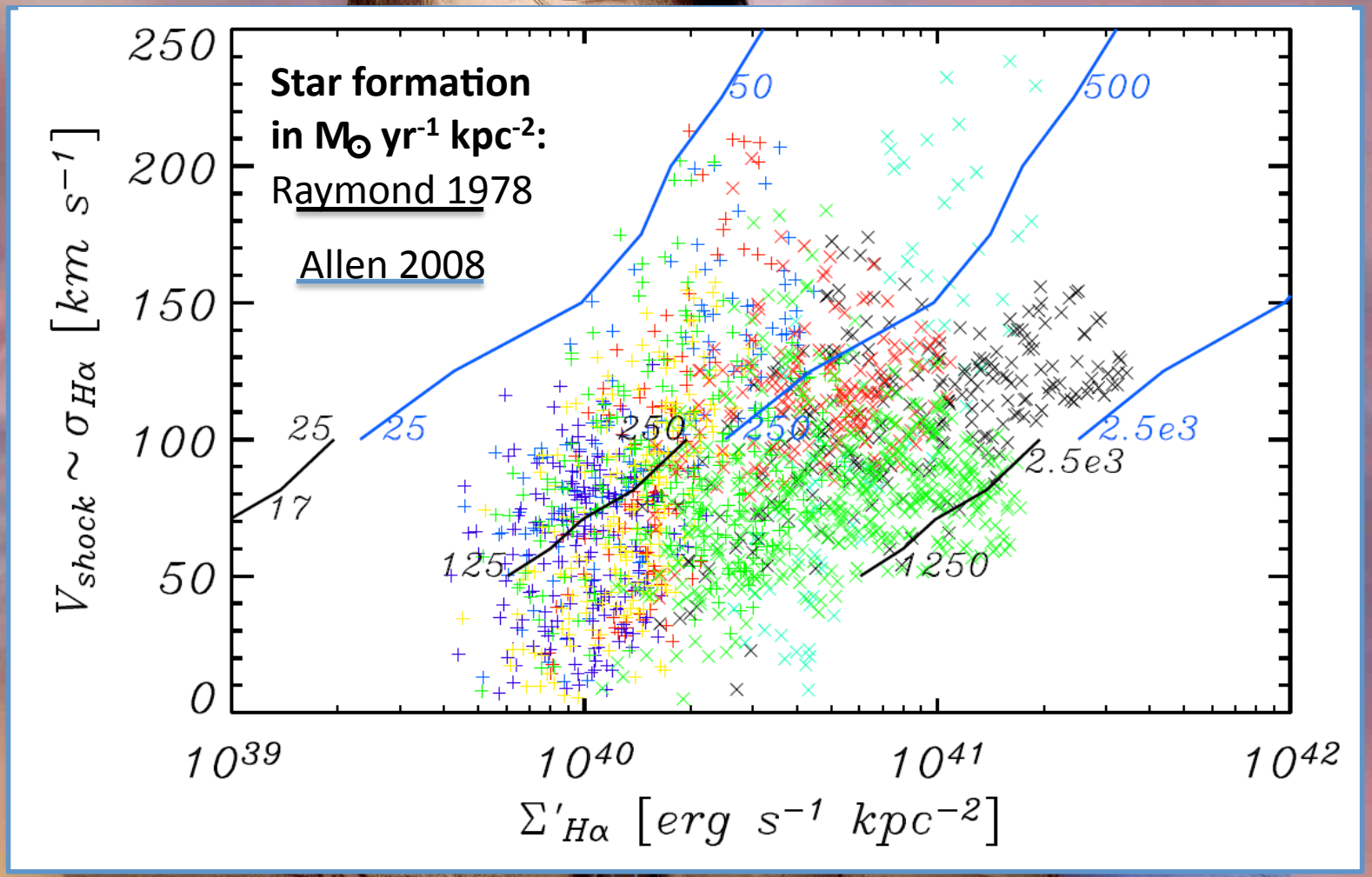




Le Tiran et al. 2011c, in prep

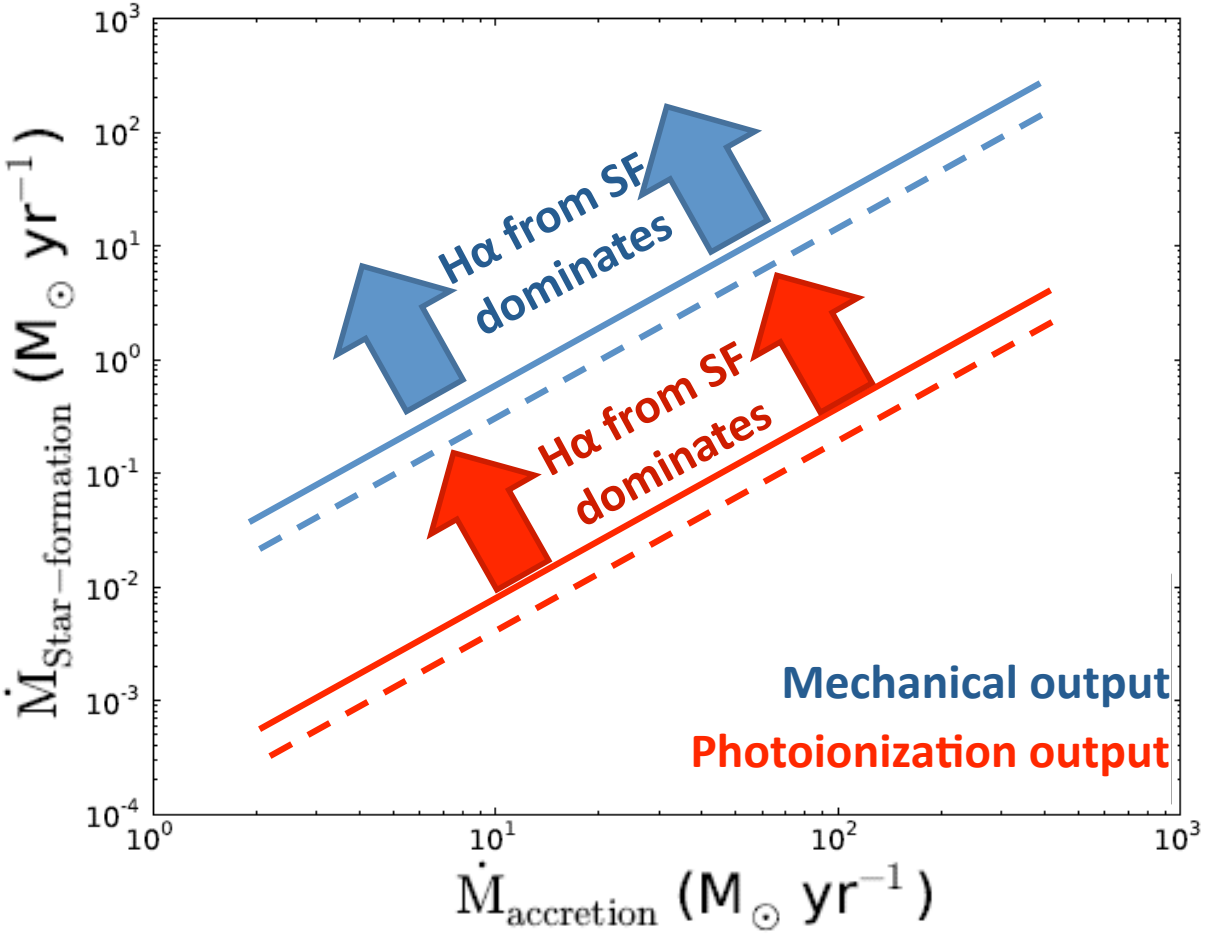

Gas accretion?
Let’s check!

Not an effect of gas accretion…



Le Tiran et al. 2011a

Talking about gas accretion…

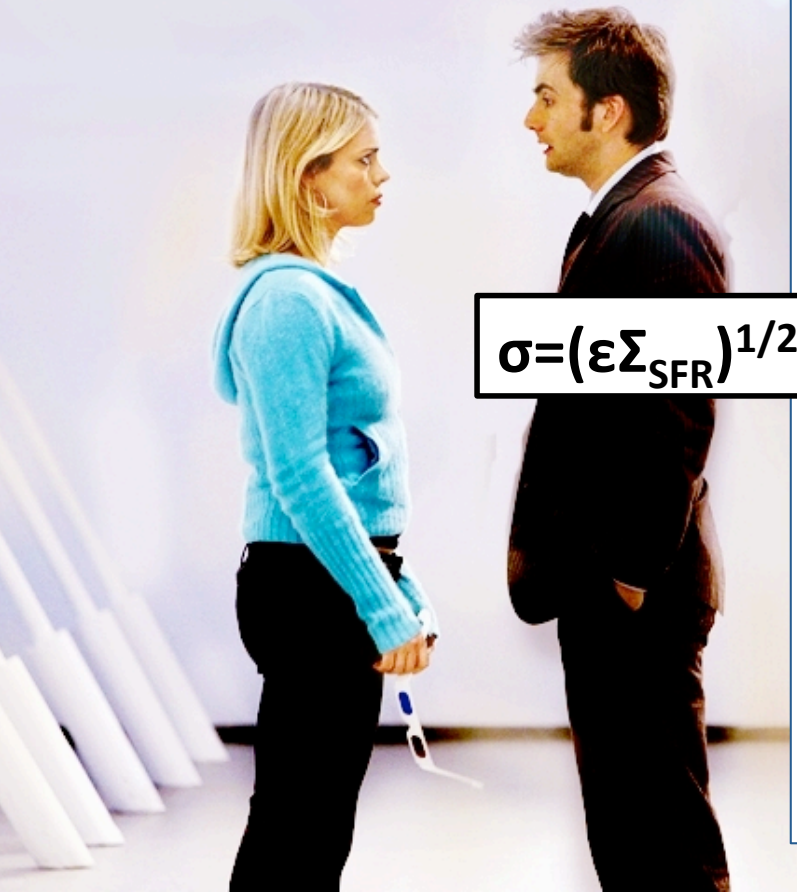


Le Tiran et al. 2011a

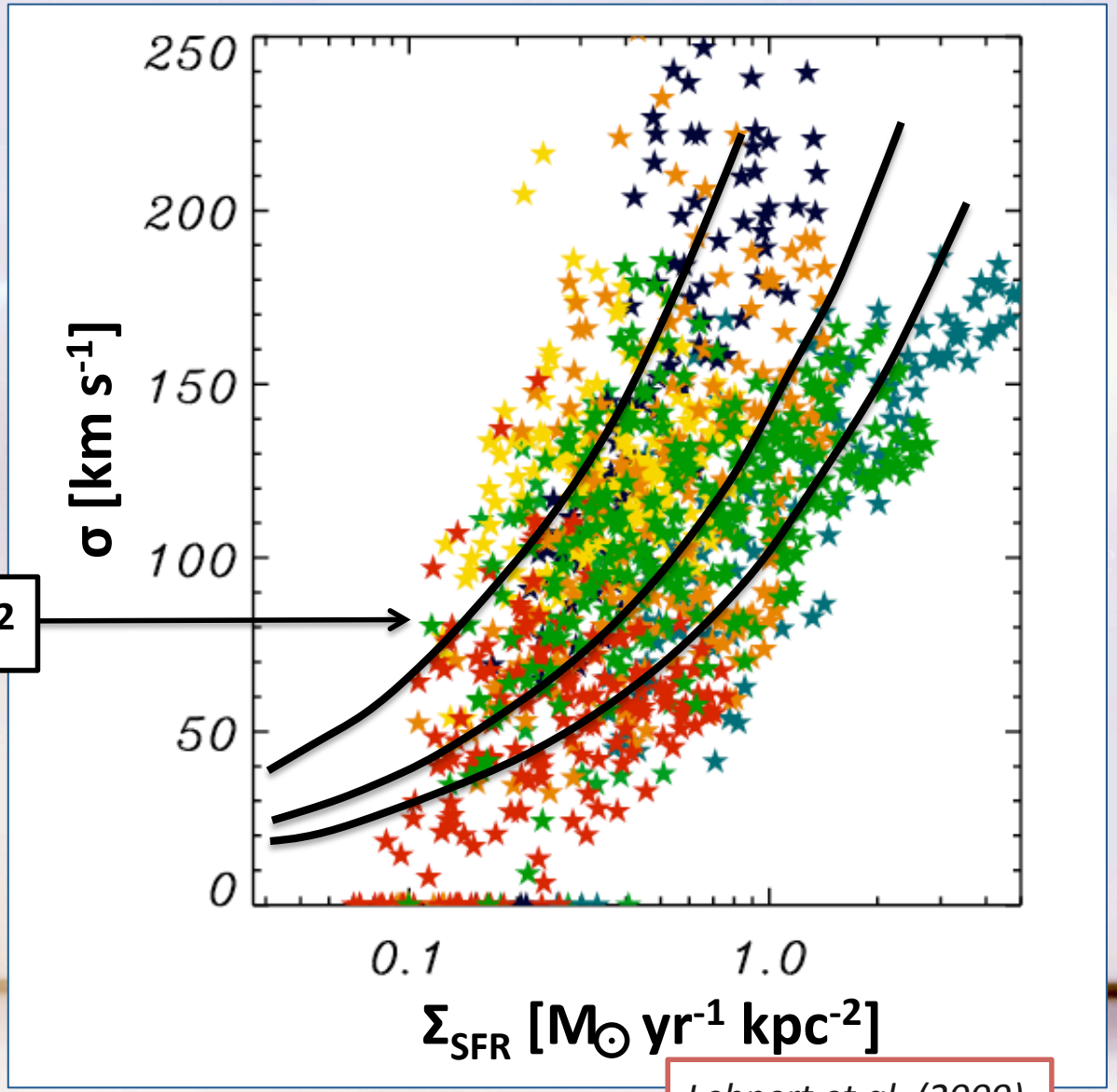

So do you think these random motions are produced by the intense star formation?
All your praying moments amount to just one breath


What else?
Lehnert et al. 2009, Le Tiran et al. 2011abc

ISM regulation by star formation



$\sigma=(\varepsilon\Sigma_{SFR})^{1/2}$

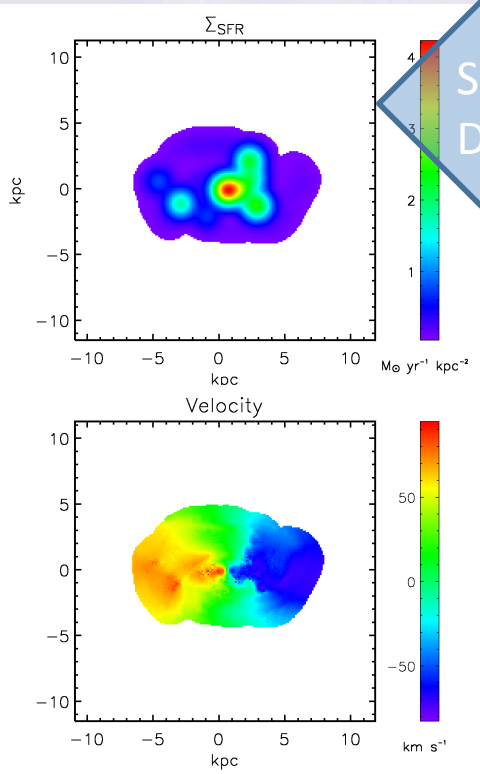


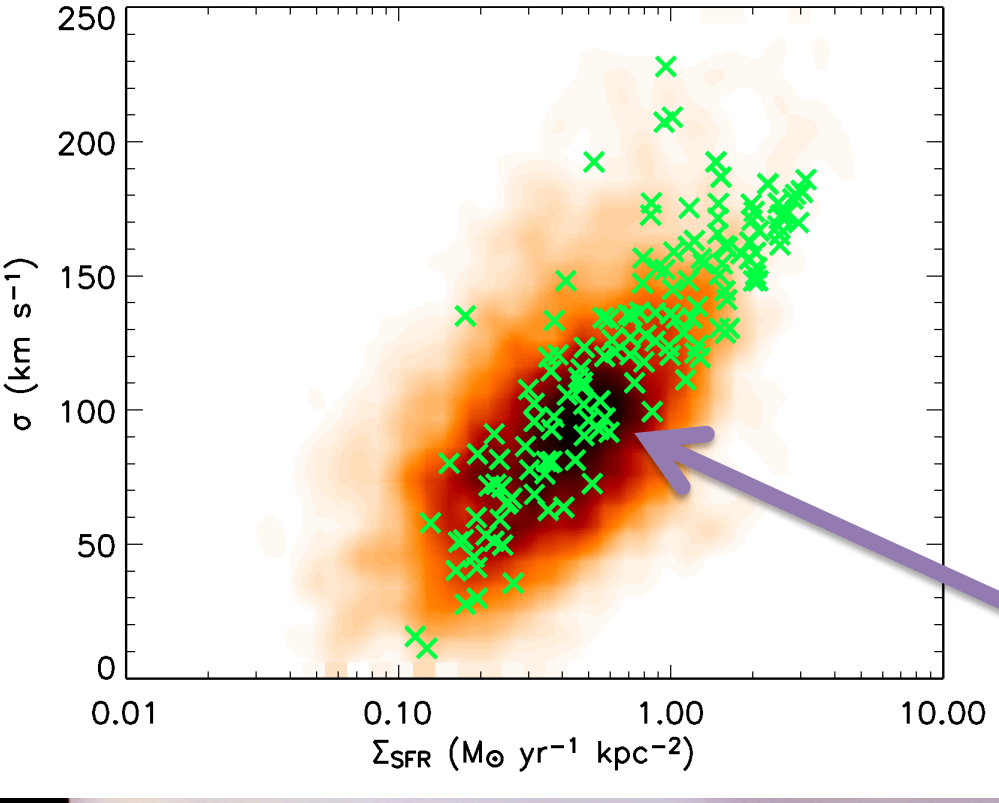
Lehnert et al. (2009)

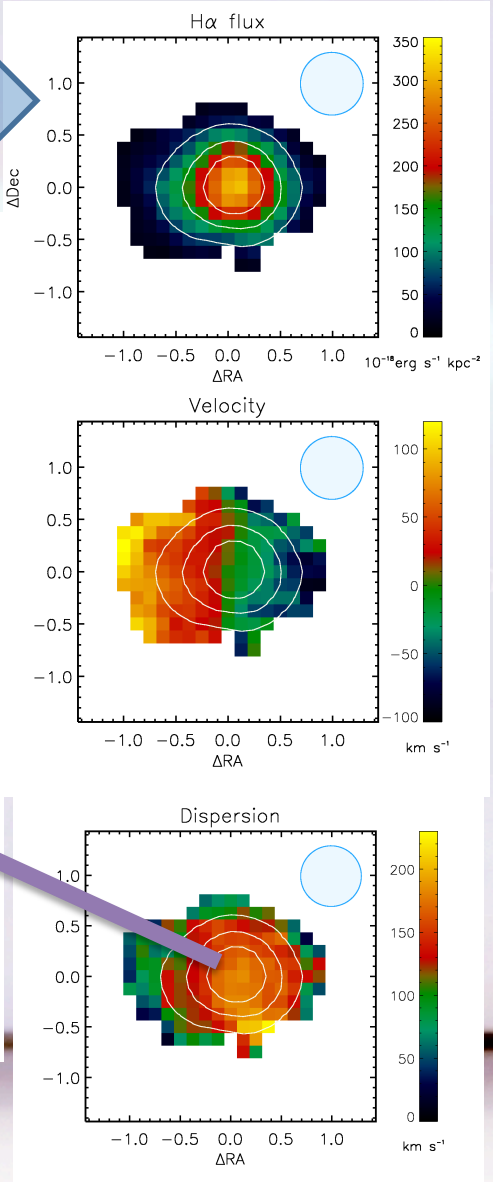
A better match: dispersion constrained with the SFR

Simulations of clumpy galaxy: Di Matteo, Bournaud et al. 2008

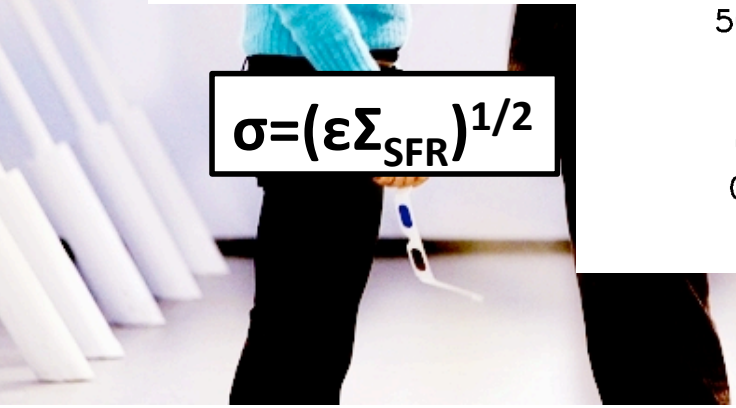
SINFONI Analog at z~2







$\sigma=(\varepsilon\Sigma_{SFR})^{1/2}$

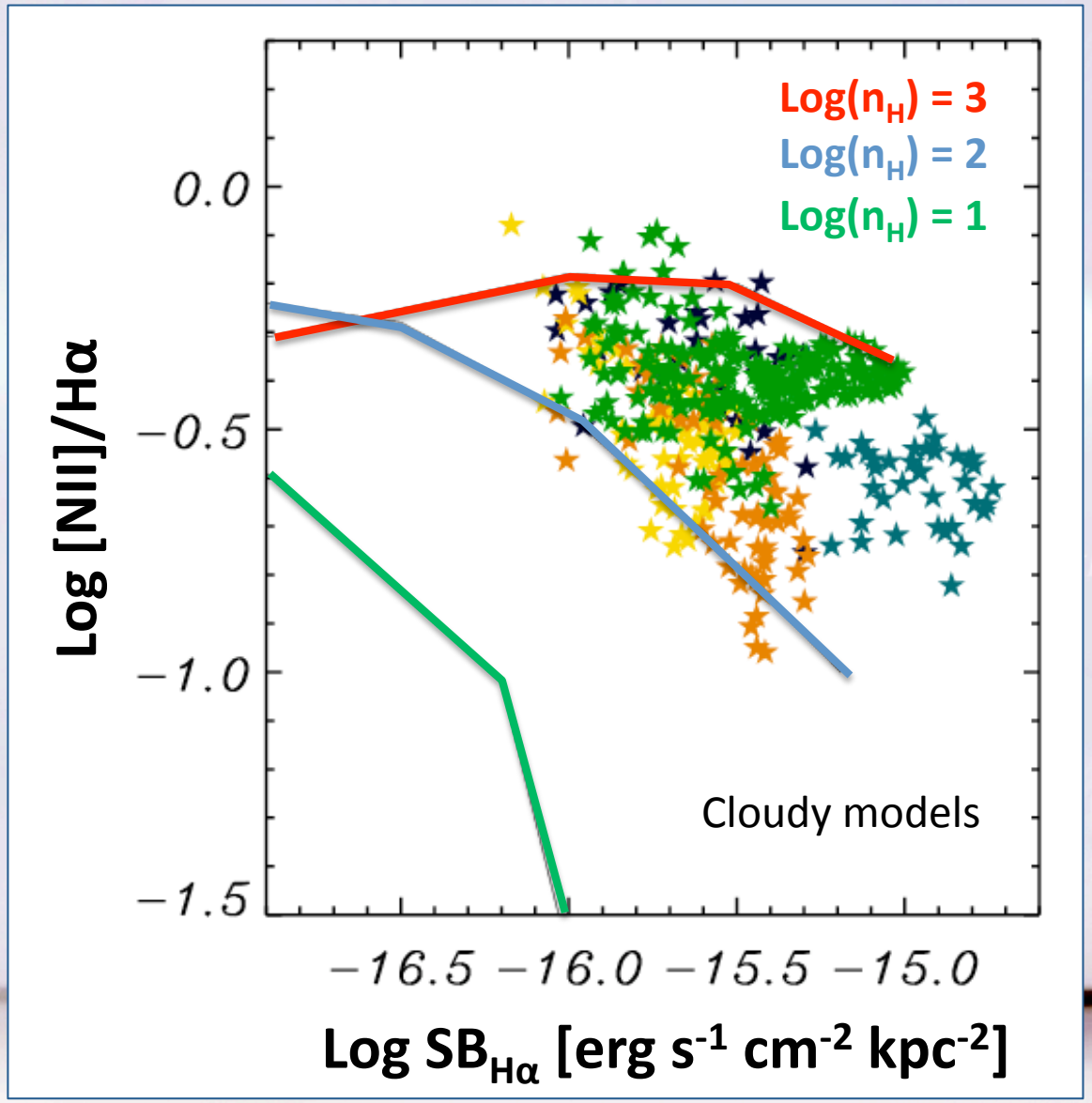


Le Tiran et al. 2011c, in prep

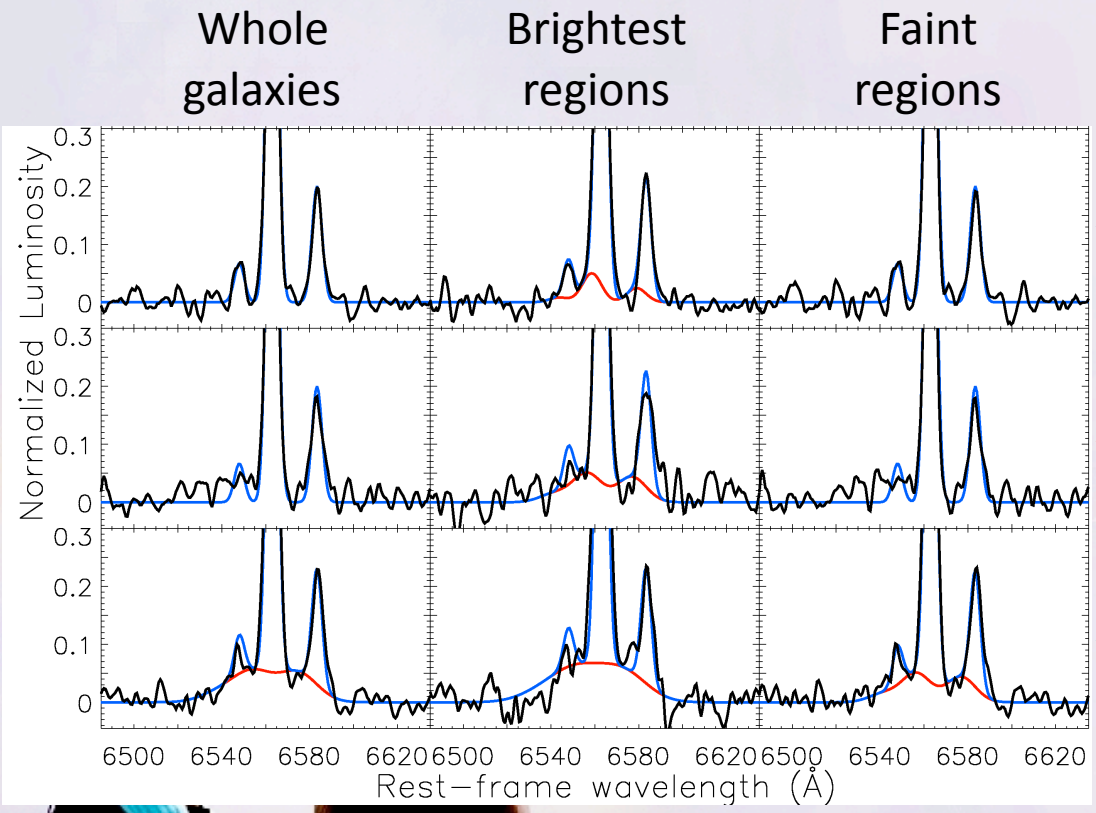
ISM internal conditions: High densities

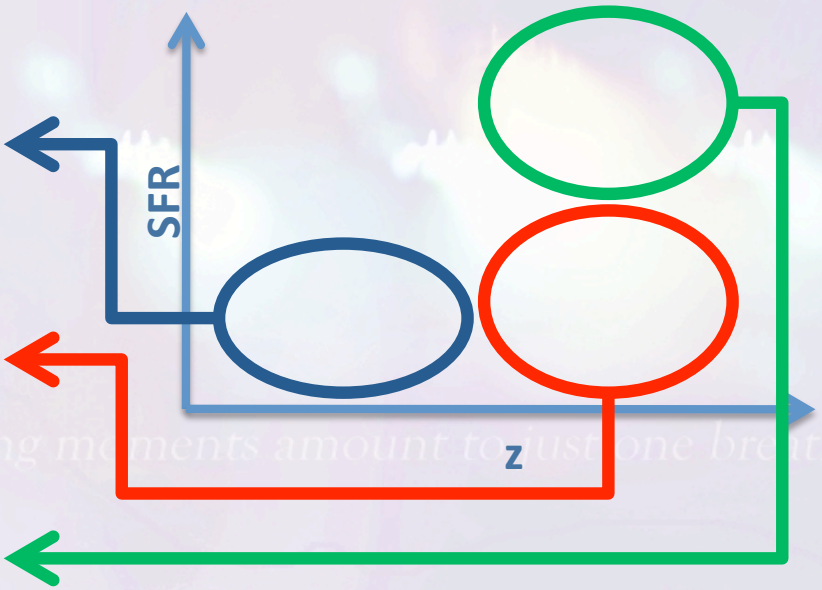
Only the high pressures models reproduce our observations

Lehnert et al. (2009)



Evidence for winds



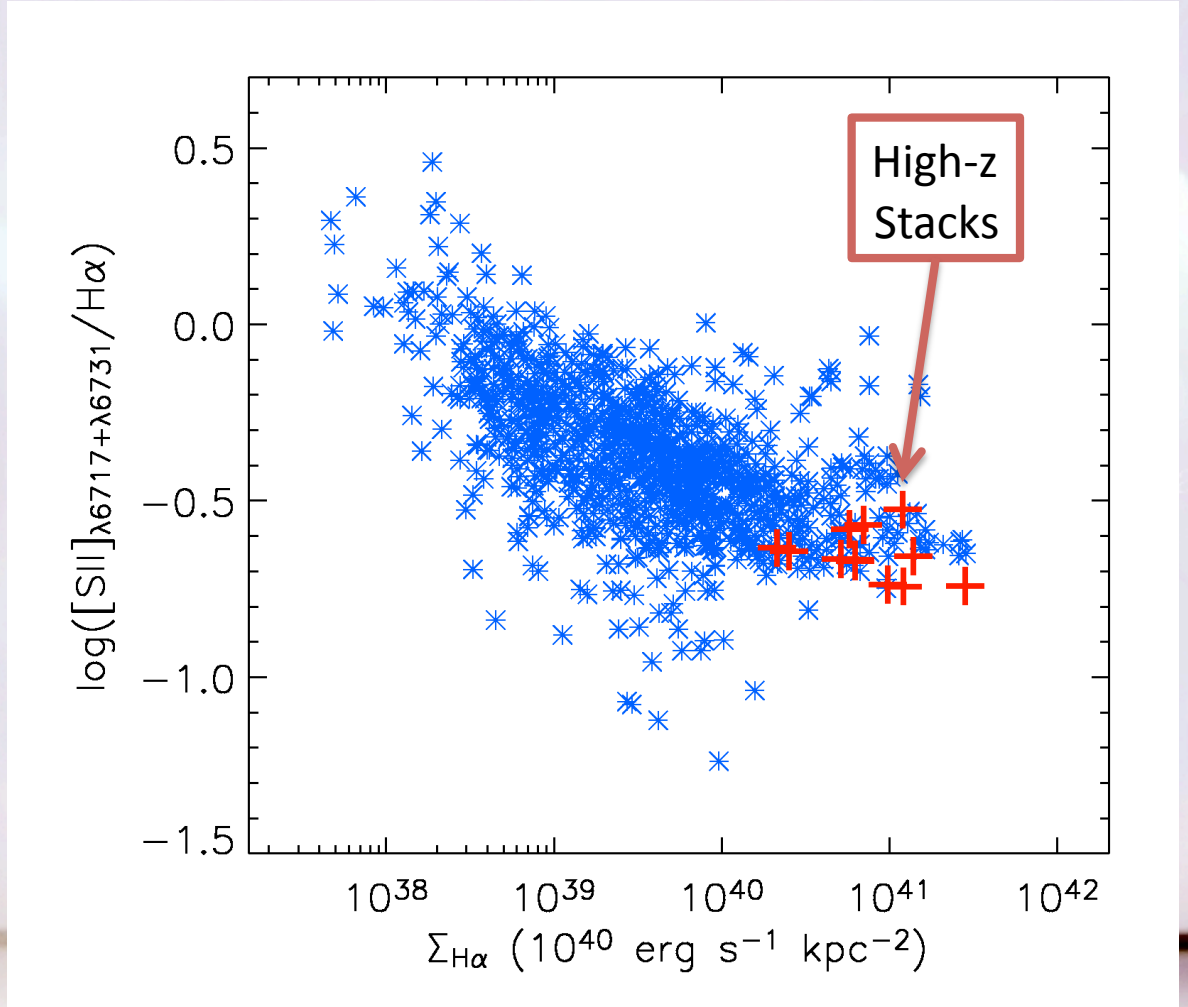


In red: Simple Broad Lines Model for Ha & [NII]:
$V_{offset} = \sigma_{H\alpha} = \sigma_{[NII]}$ = [NII]/Hα constraint
Like in extended emission in nearby starbursts

Le Tiran et al. 2011b, in prep.

Forming a single parameter family with local galaxies

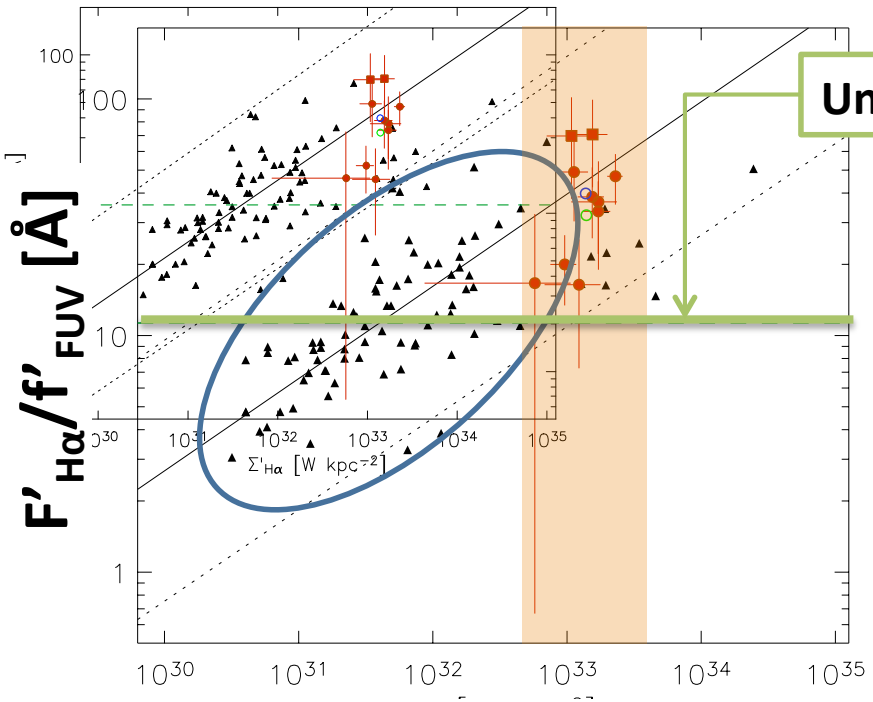
Can be modelled (CLOUDY) with:
High average densities
+
High ionization parameter

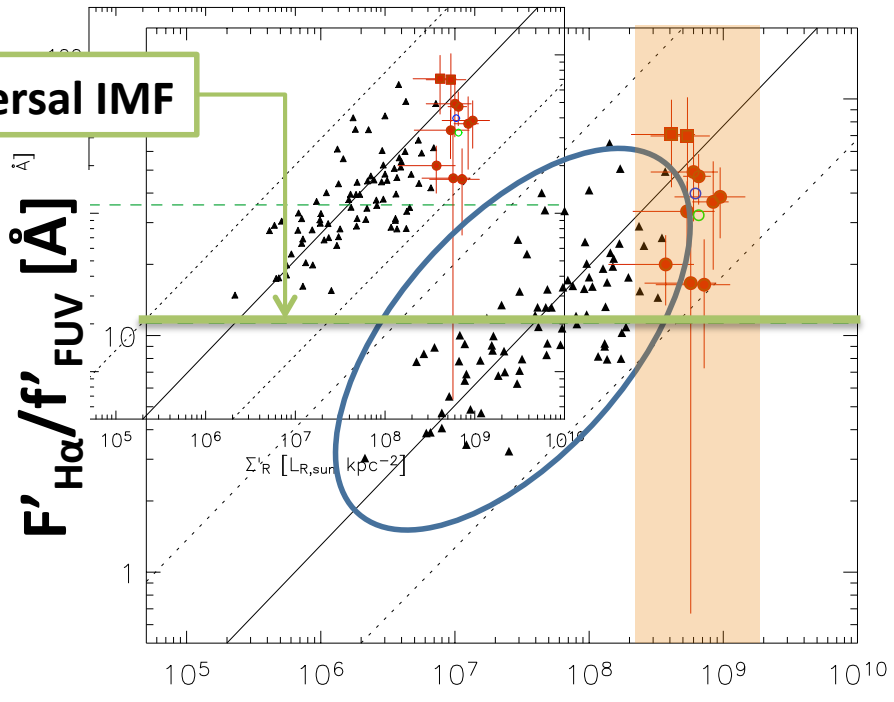


Le Tiran et al. 2011b, in prep.


A WORD ABOUT THE IMF

Universal IMF or bursty star formation?



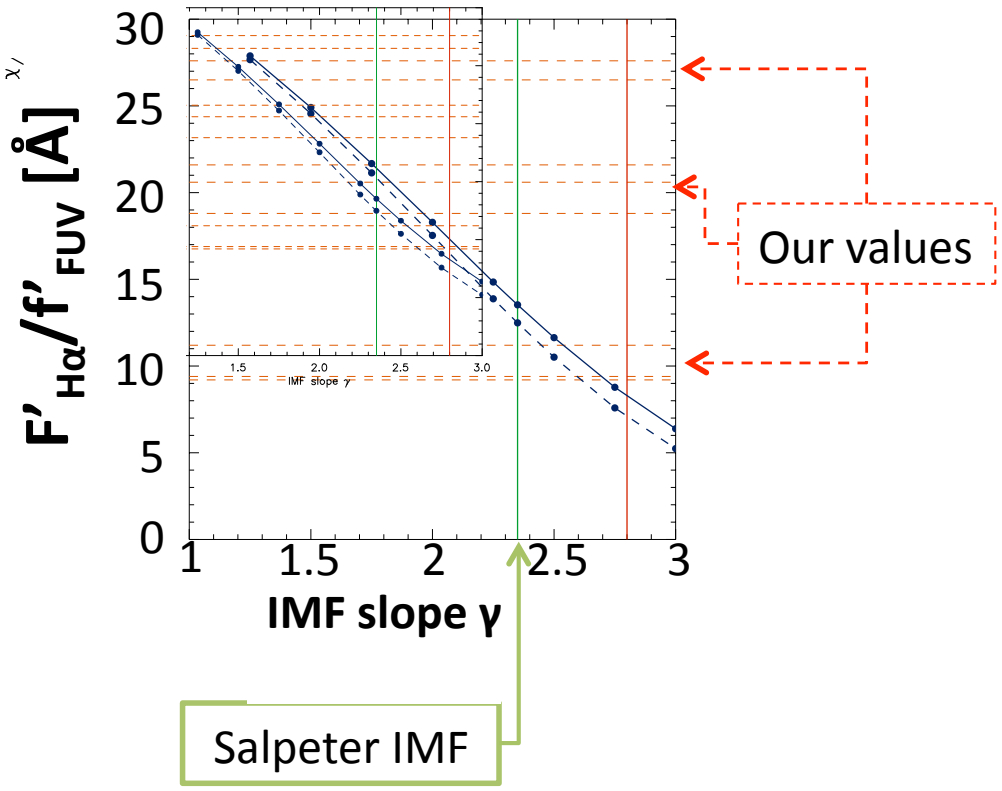


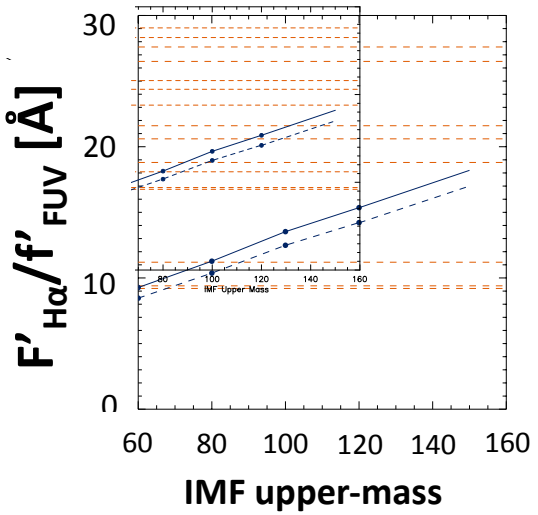
▲ Meurer et al. 2009

● We extend the relationship to z=1.4!

Le Tiran et al. (in prep.)

IMF variation?



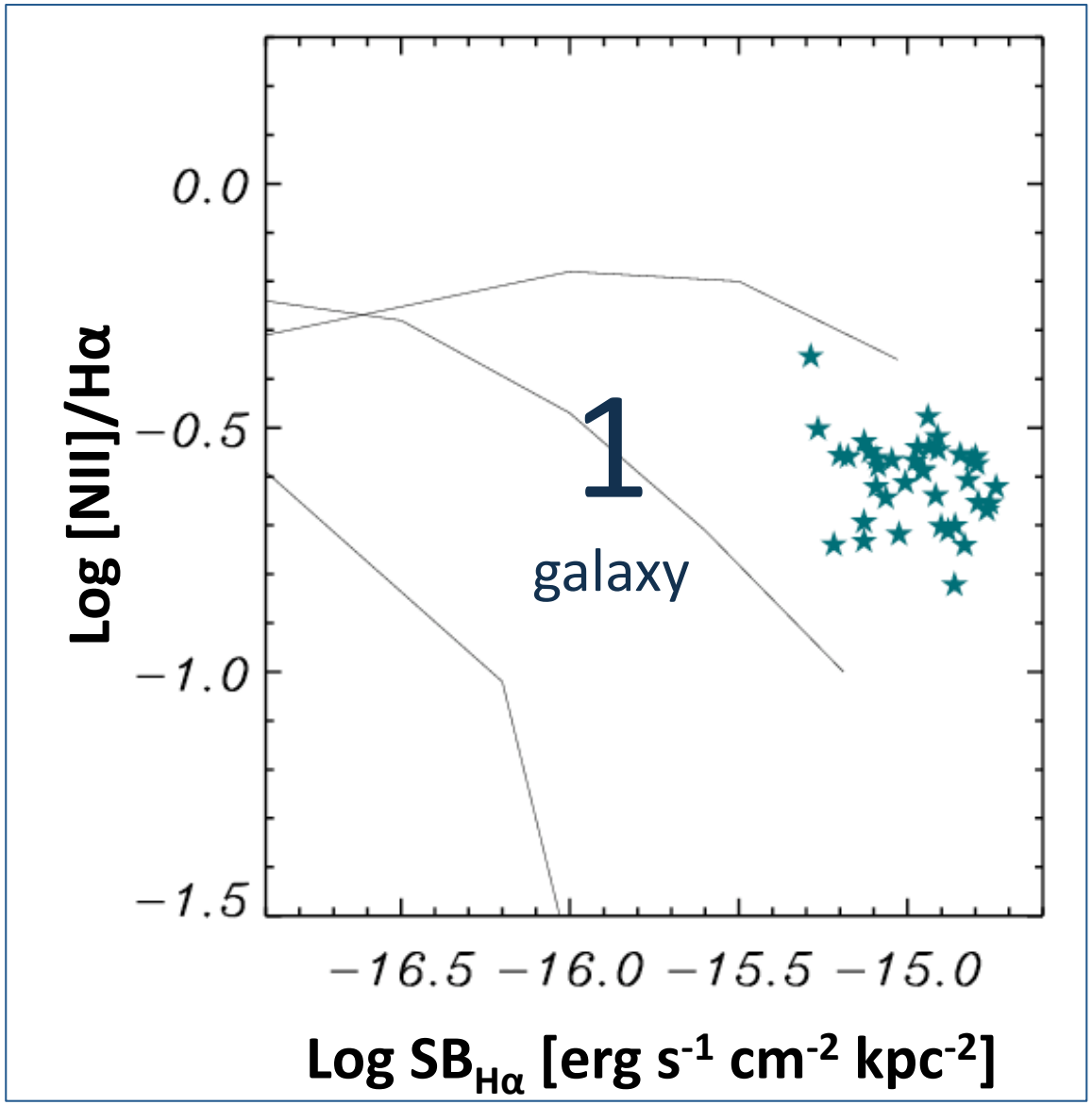


Variations of the slope (or upper-mass) of the IMF could explain our observations

Le Tiran et al. (in prep.)

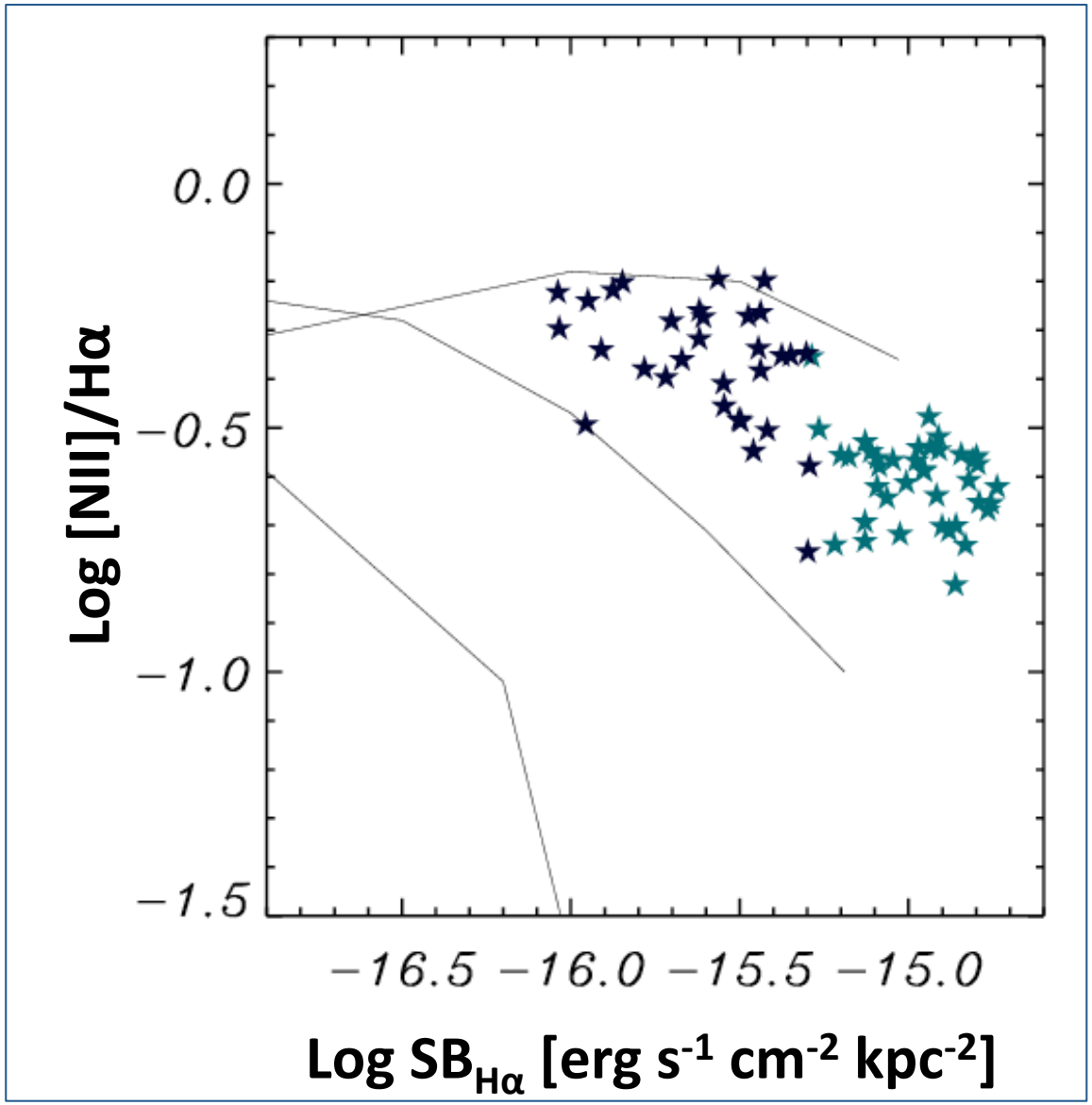

The end?

Internal densities



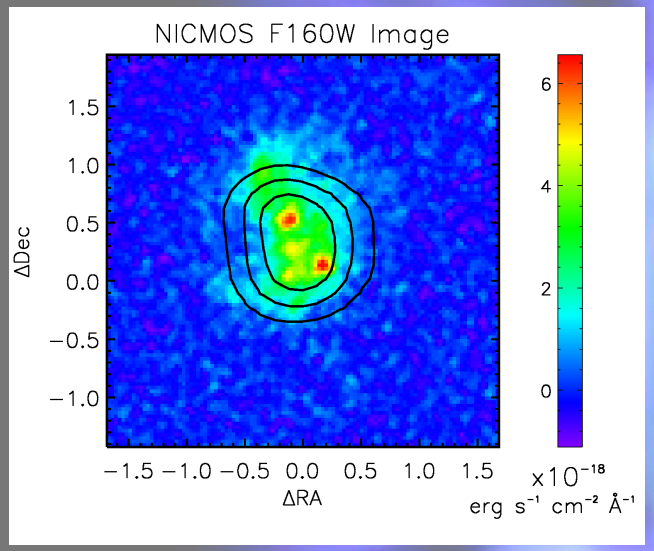
Lehnert et al. (2009)

Internal densities



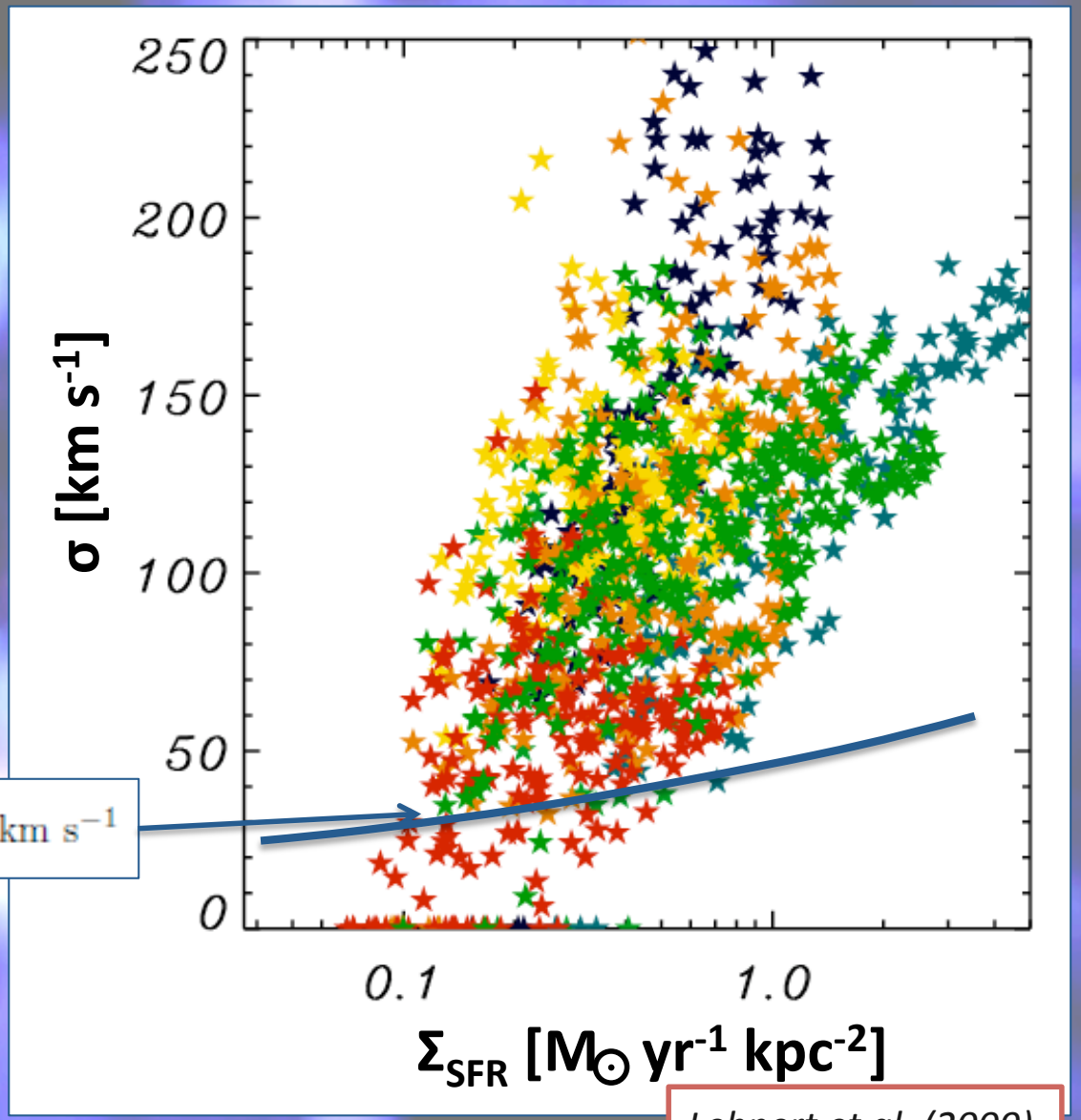
Lehnert et al. (2009)

Not an effect of clumps...



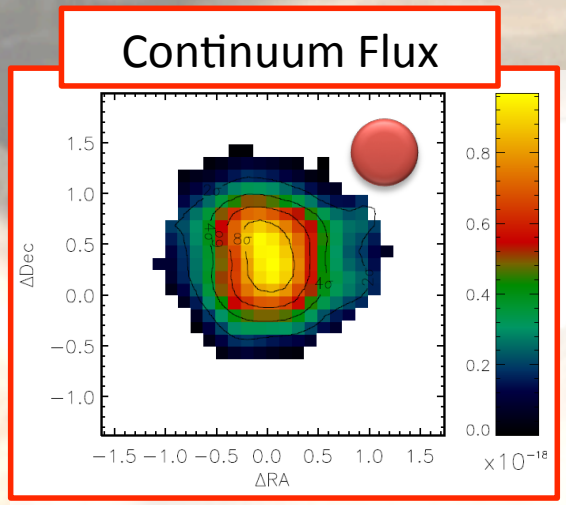
Jeans instability:

$$\sigma_{gas} \sim M_J^{1/4} G^{1/2} \Sigma_{gas}^{1/4} = 54 M_{J,9}^{1/4} \Sigma_{SFR}^{0.18} \text{ km s}^{-1}$$

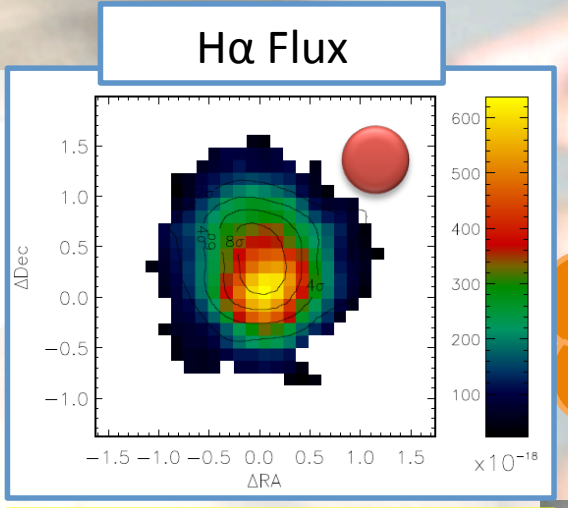


Lehnert et al. (2009)

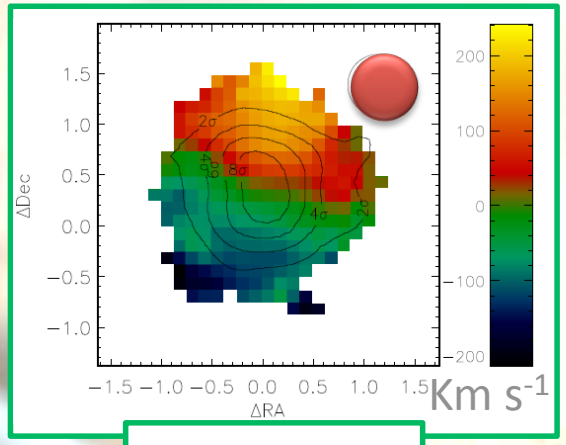
Continuum Flux



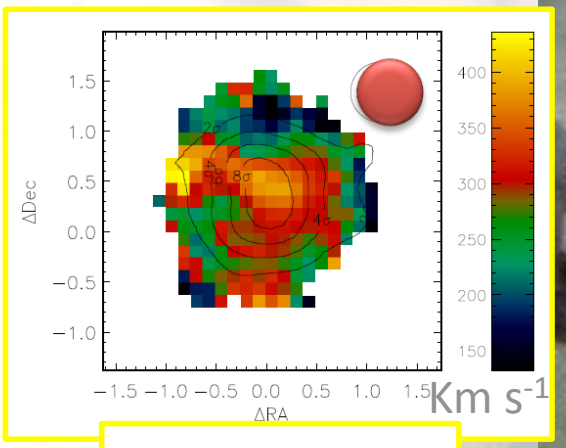
Hα Flux



These are quite high values!



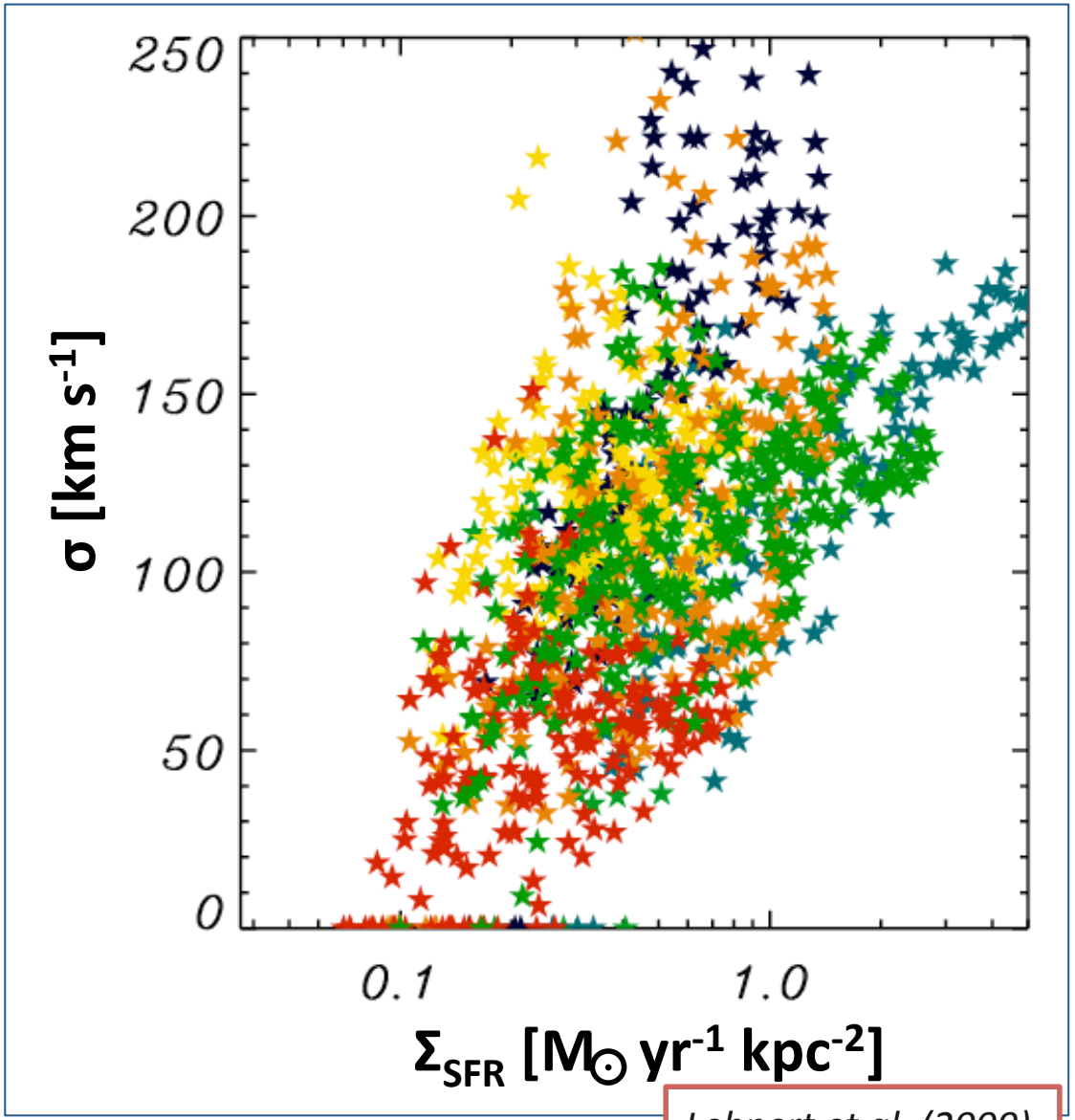
Velocity



Dispersion


Where are we travelling today Doctor?
3 billion years after the Big Bang Rose…


BX528
BX482
MD41
They are very luminous, way more than the ones we travel to usually!
Galaxies at this time were so… brilliant!
BX389
BX610



Lehnert et al. (2009)