



l'Observatoire
de Paris + GEPI

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...

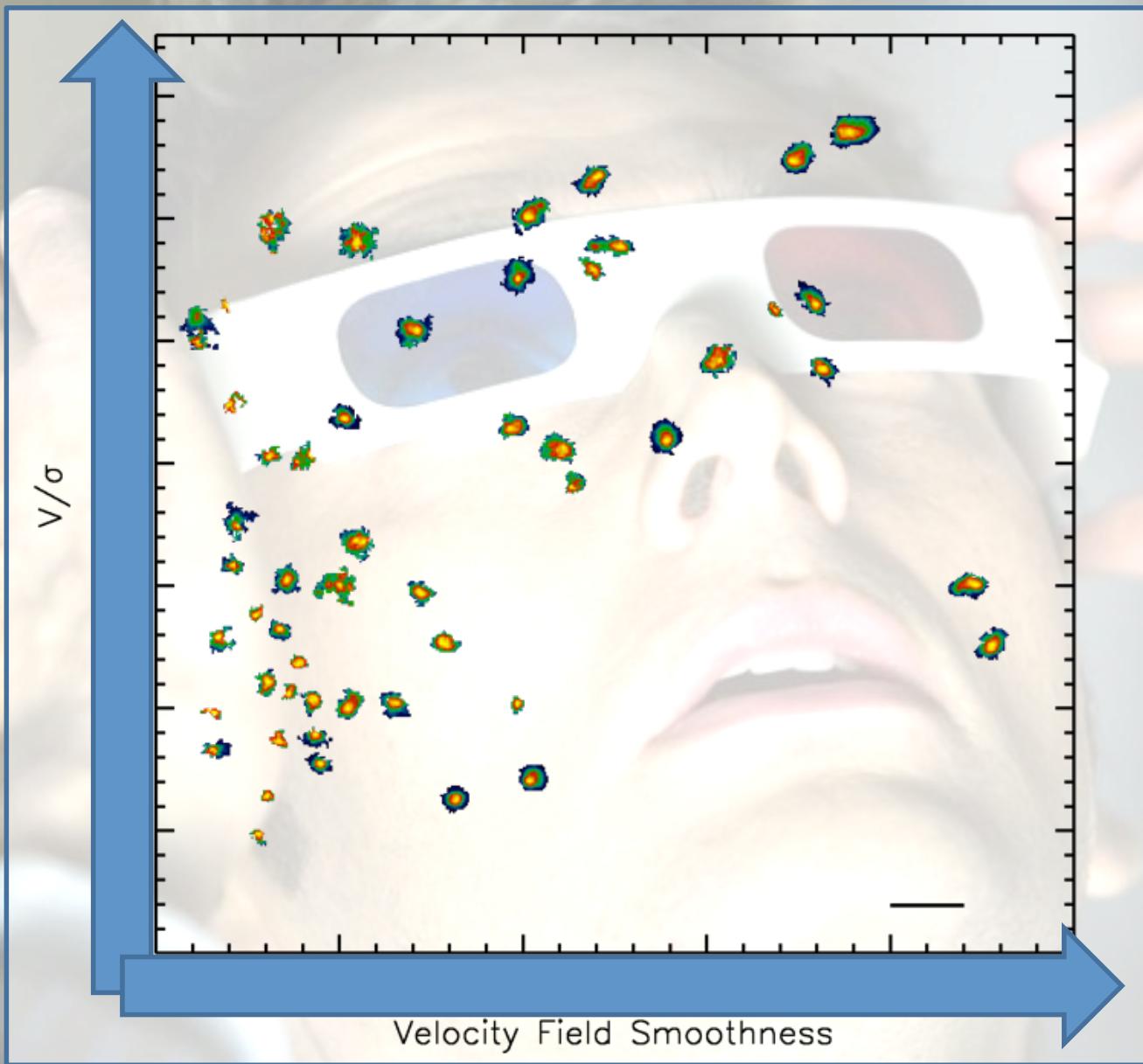
... the doctor and Rose



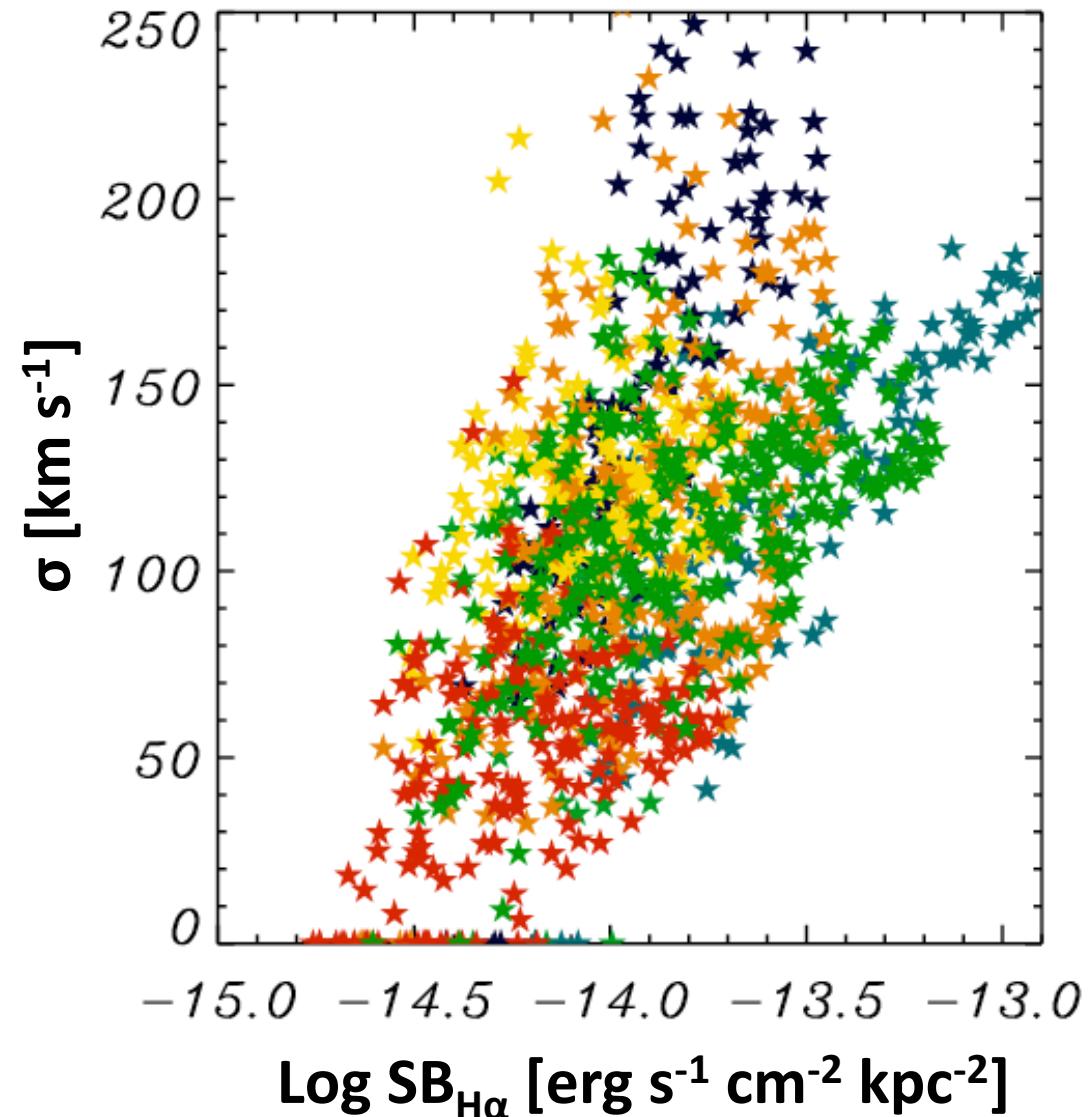
A man with brown hair, wearing a dark pinstripe suit, white shirt, and patterned tie, is gesturing with his hands while speaking. He is wearing white 3D glasses with blue and red lenses. A woman with blonde hair, wearing a light blue top, is partially visible on the left, facing him. An orange-outlined speech bubble is positioned in the lower-left foreground.

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

A sample of more than 50 objects

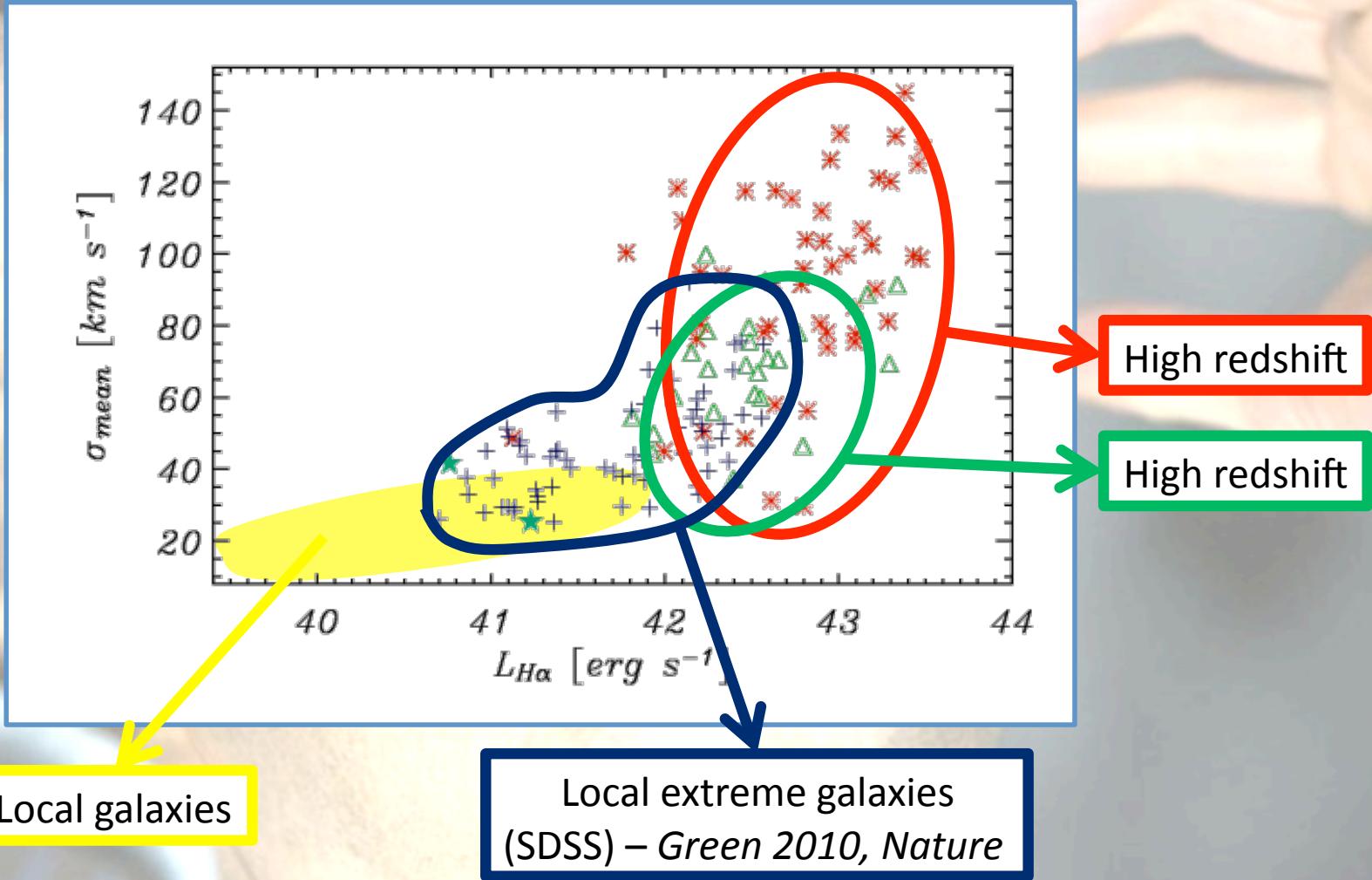


Is there a trend between SFR and H α velocity dispersion?



Lehnert et al. (2009)

Seen also on “integrated” galaxies

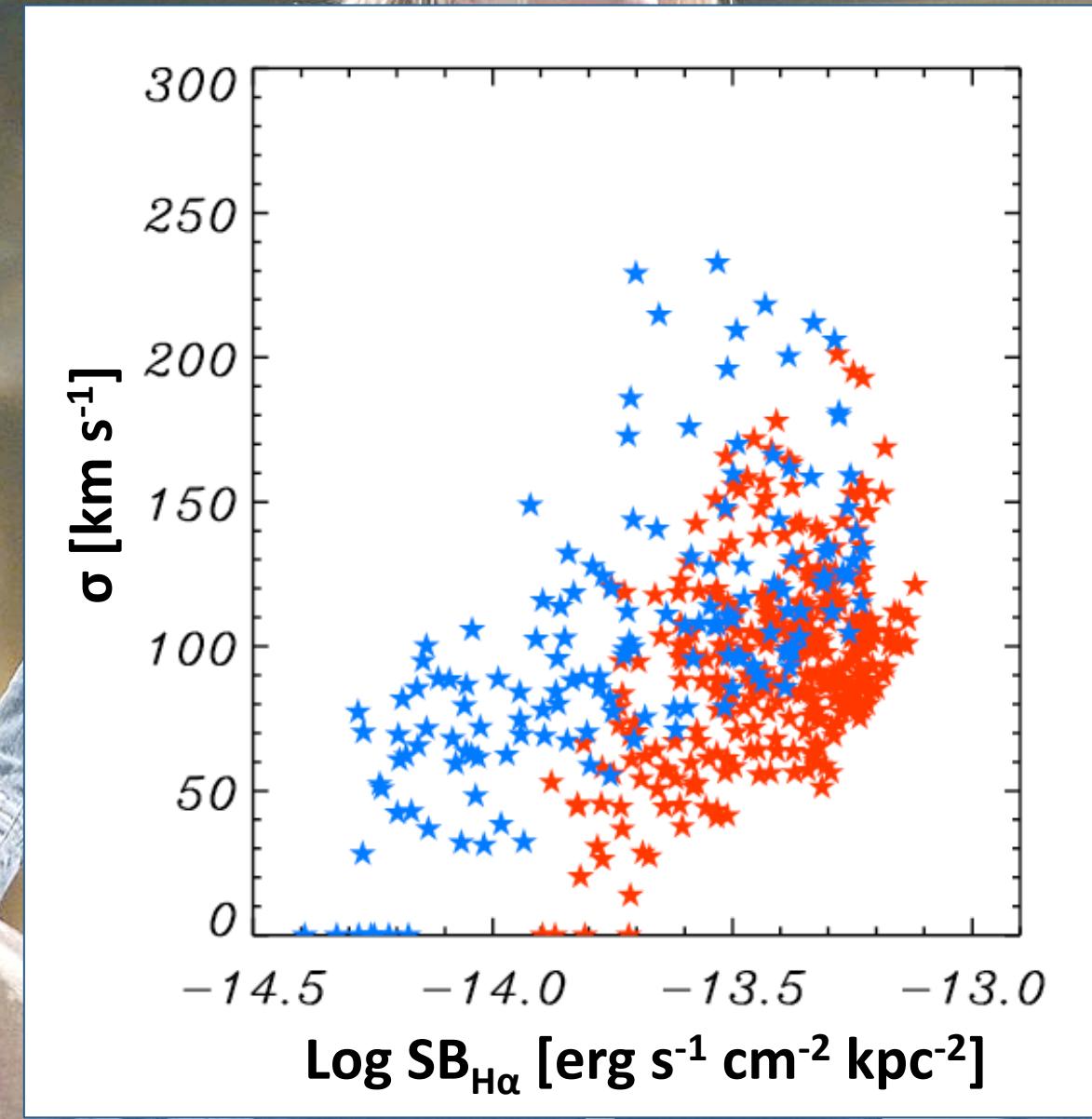




Must be beam smearing

I am not so sure Rose...

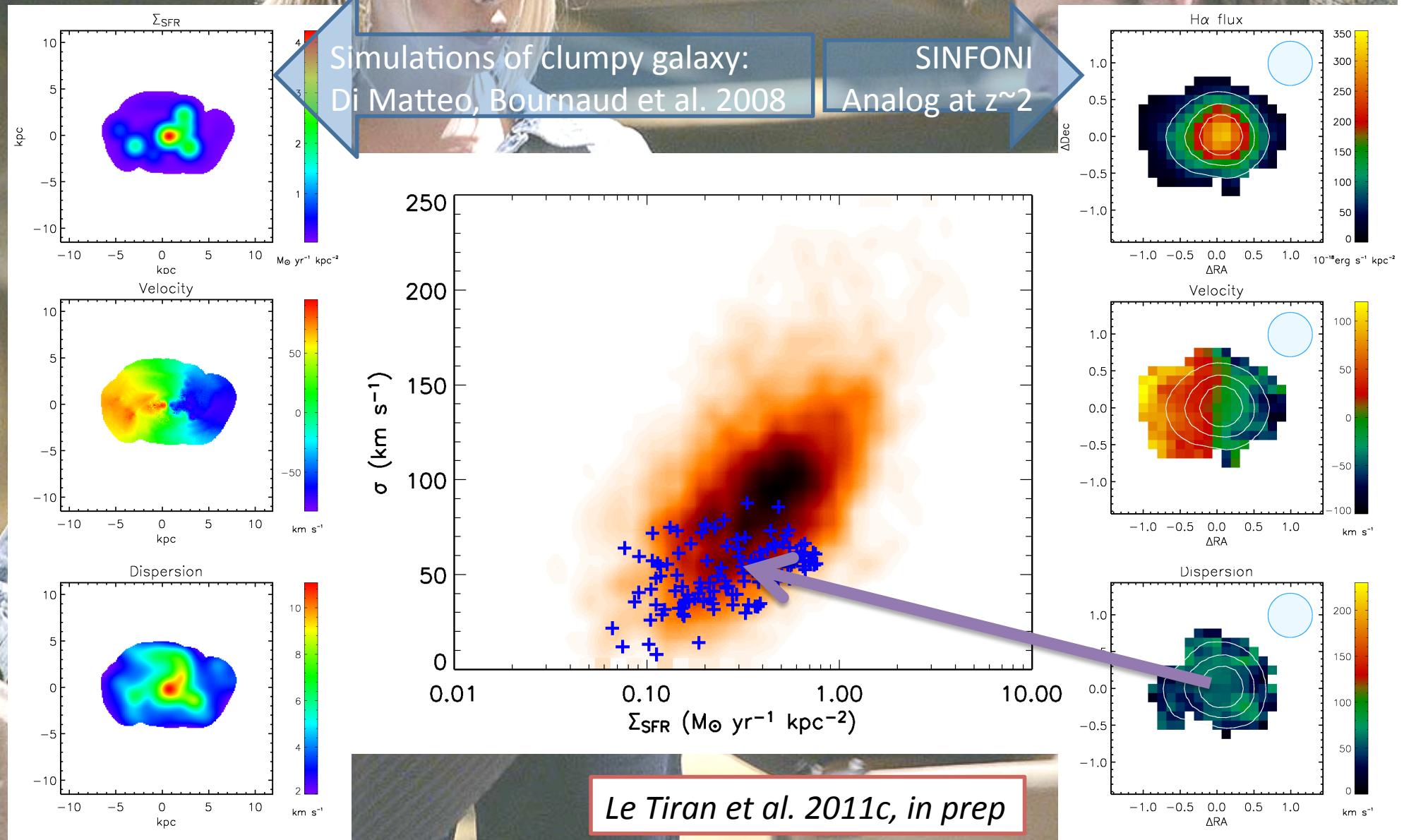
Not an effect of beam smearing...



Lehnert et al. (2009)



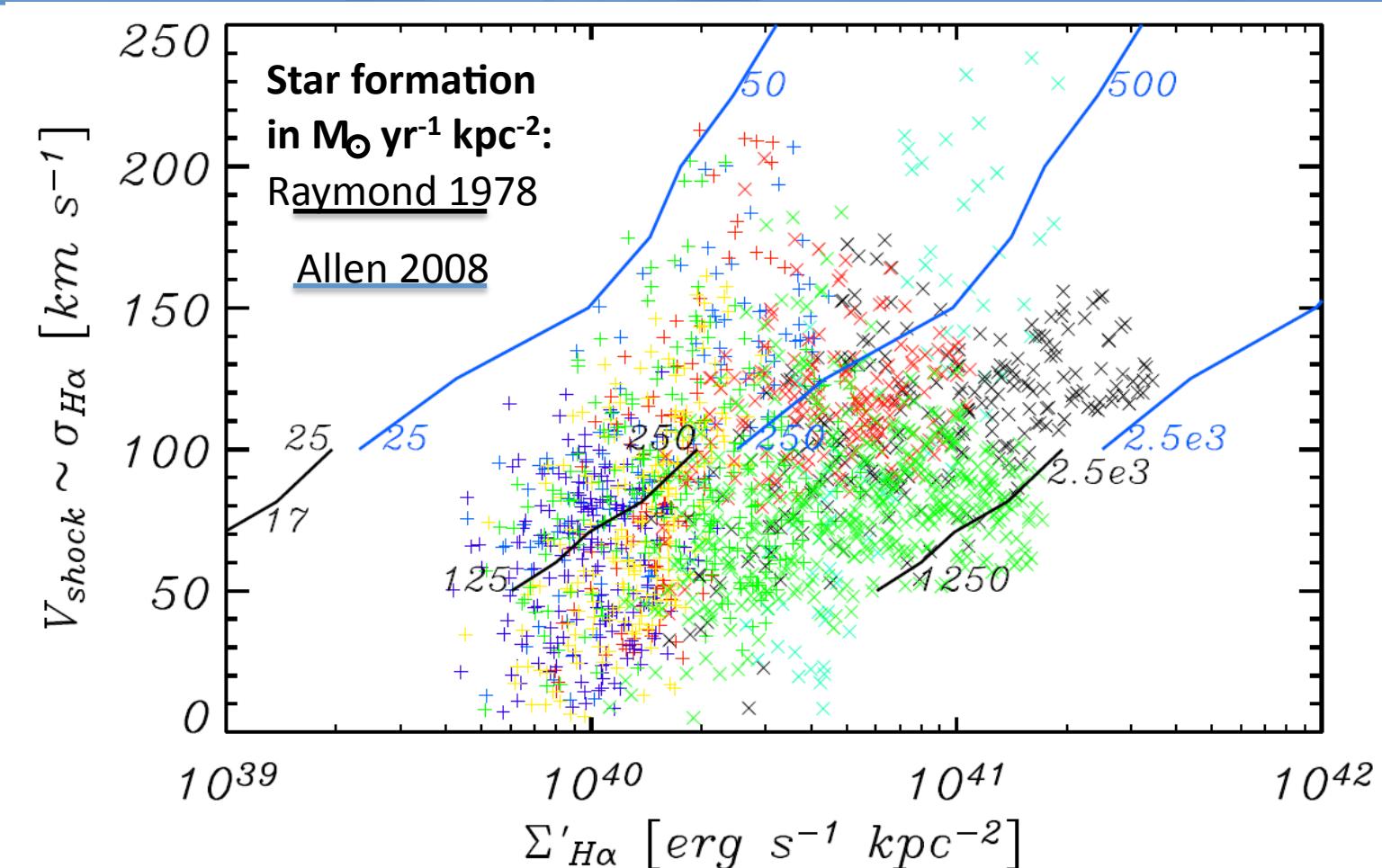
Beam Smearing Simulation



Gas accretion?

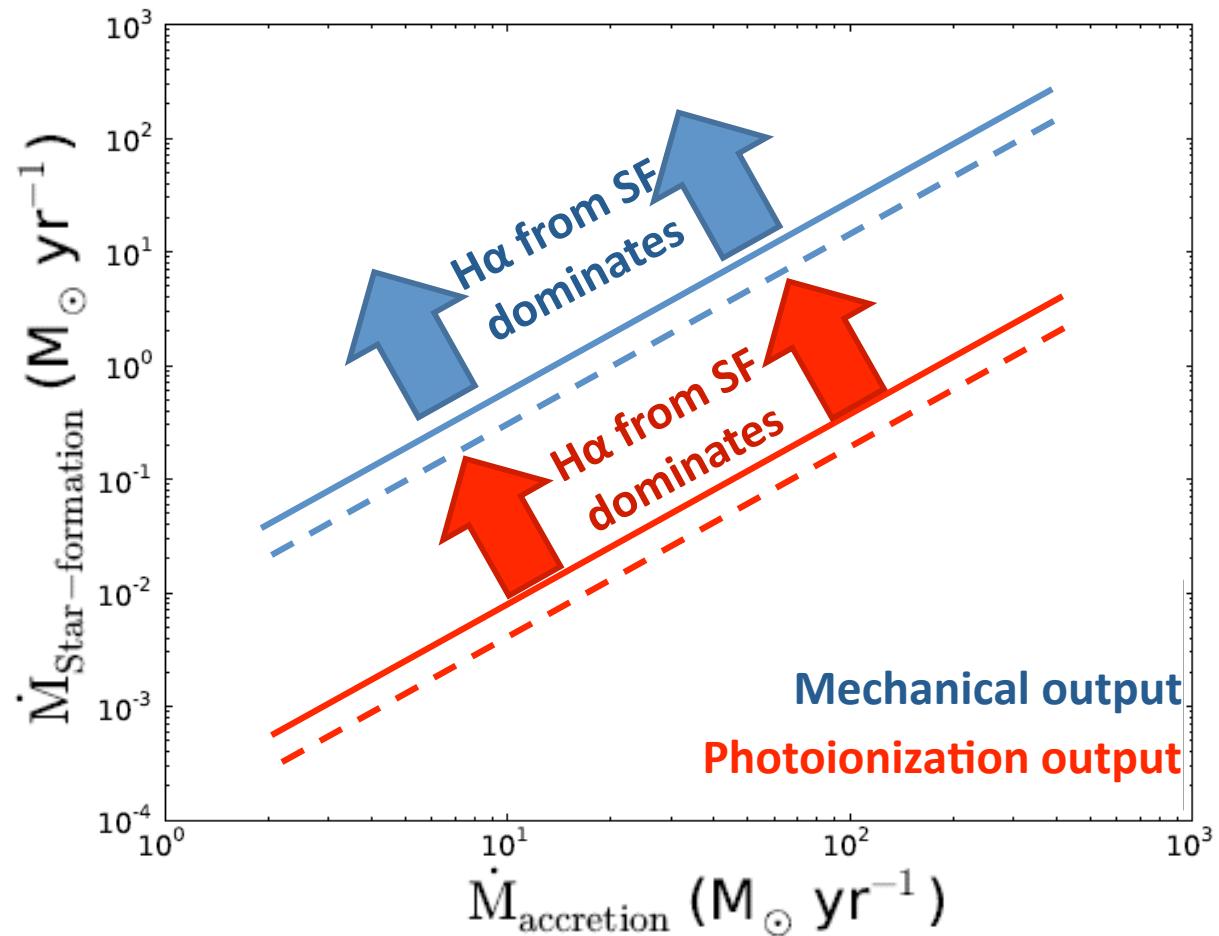
Let's check!

Not an effect of gas accretion...



Le Tiran et al. 2011a

Talking about gas accretion...



Le Tiran et al. 2011a



A man and a woman are standing in a modern building with a large glass wall. The woman, on the left, has blonde hair and is wearing a light blue sweater over a white shirt and black pants. The man, on the right, has dark hair and is wearing a dark suit. They are facing each other. A pink speech bubble with a blue outline is positioned above them, containing the text "So do you think these random motions are produced by the intense star formation?". The background is a soft-focus view of a city skyline at sunset or sunrise, with warm colors like orange, yellow, and pink.

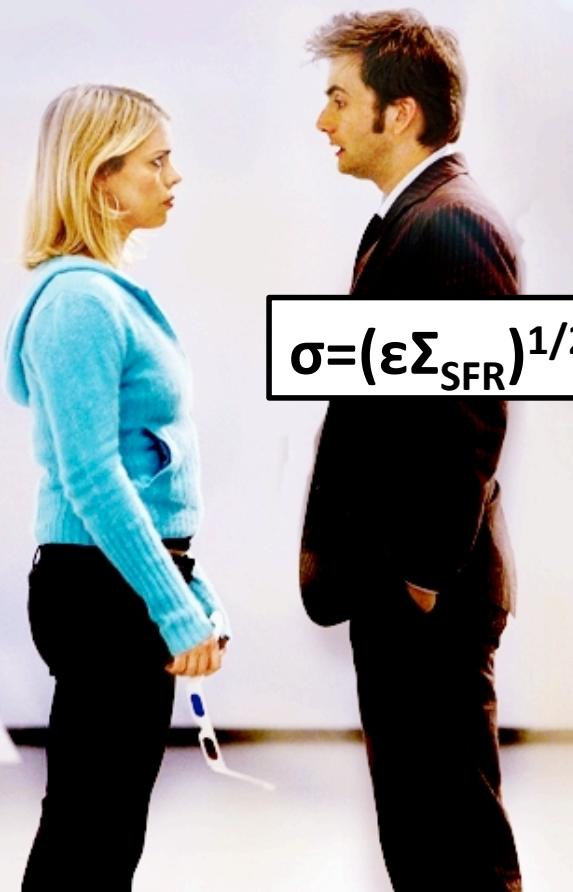
So do you think these
random motions are
produced by the intense
star formation?

All your praying moments amount to just one breath

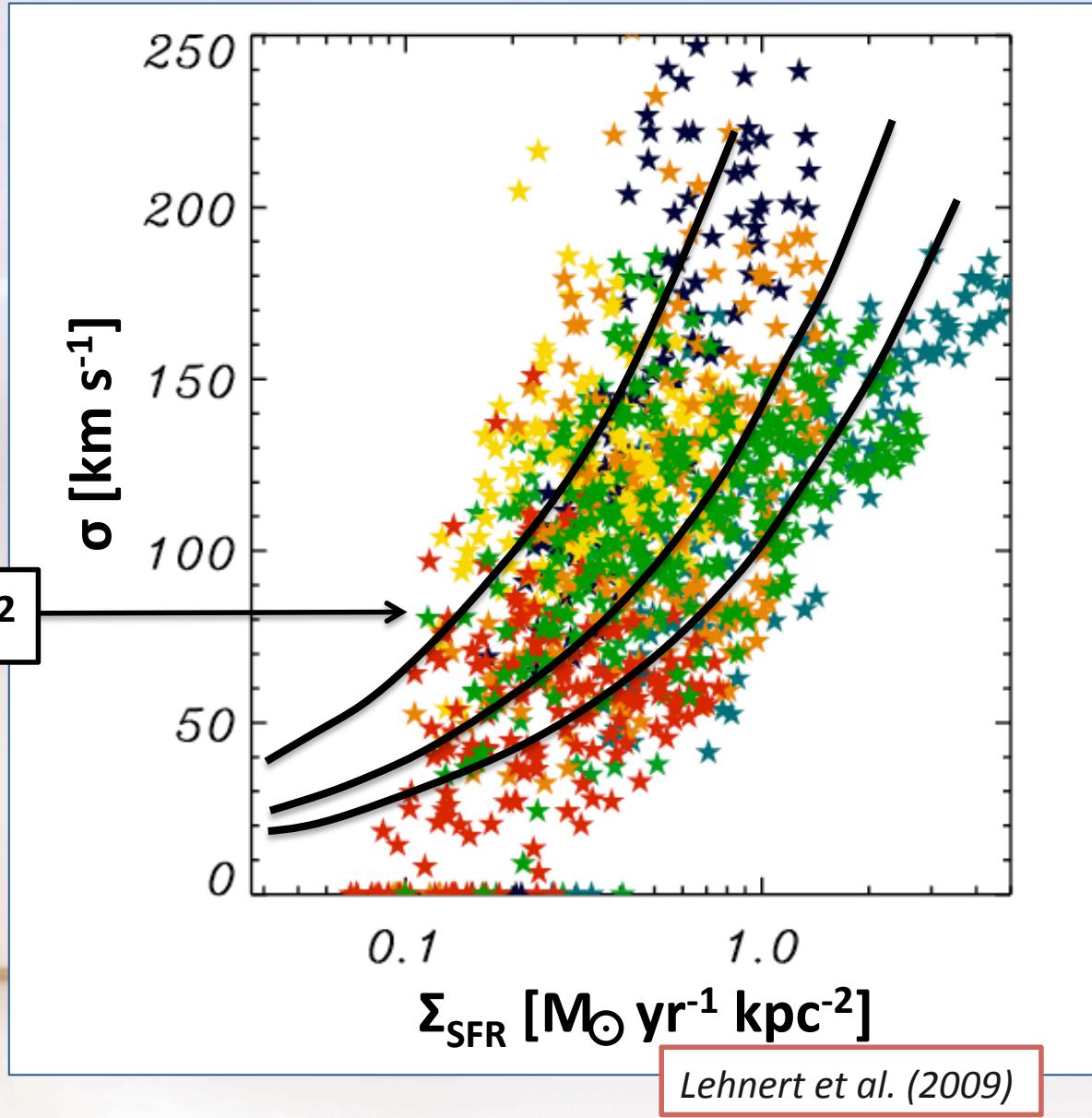
What else?

Lehnert et al. 2009, Le Tiran et al. 2011abc

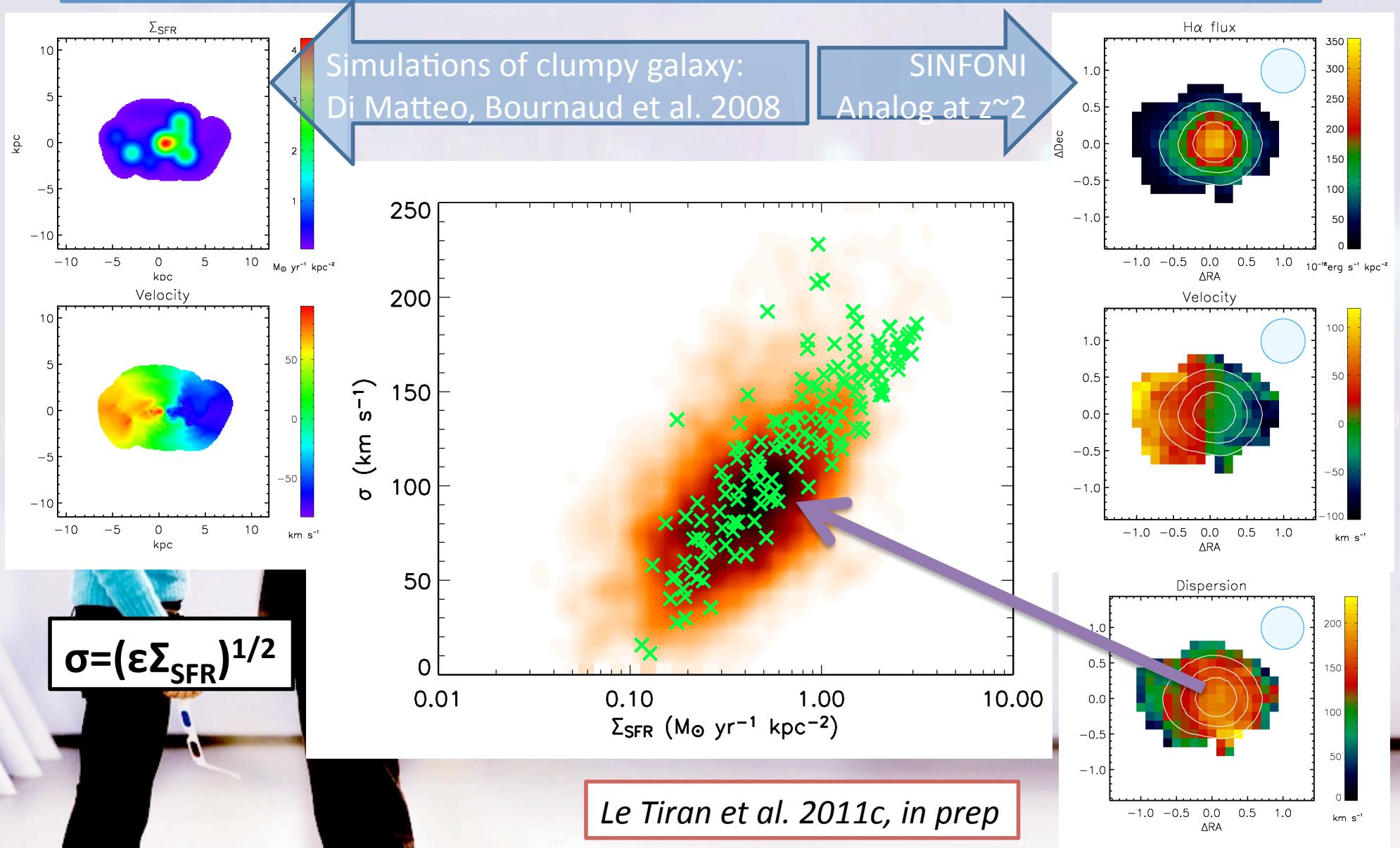
ISM regulation by star formation



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

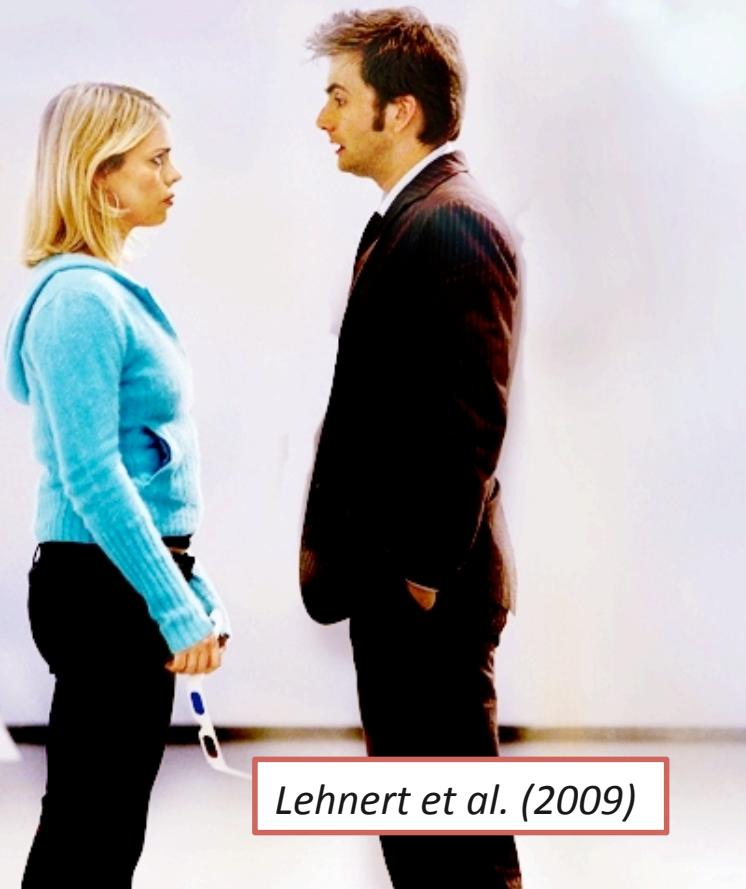


A better match: dispersion constrained with the SFR

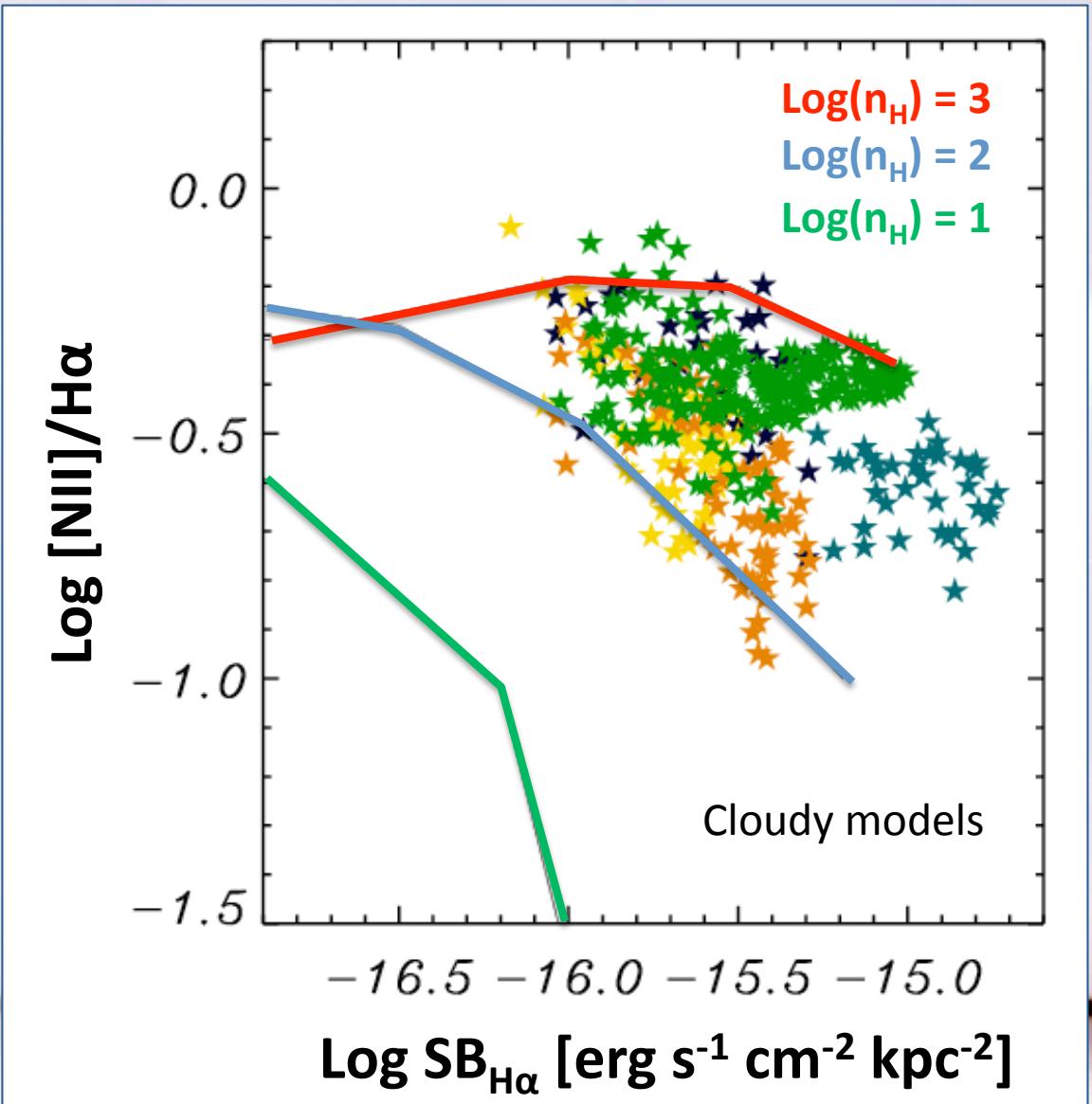


ISM internal conditions: High densities

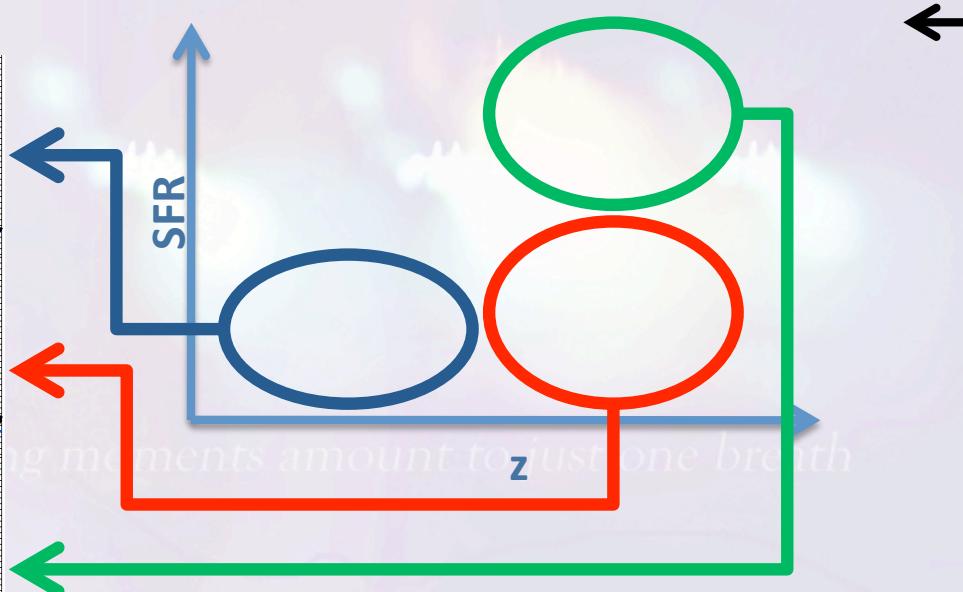
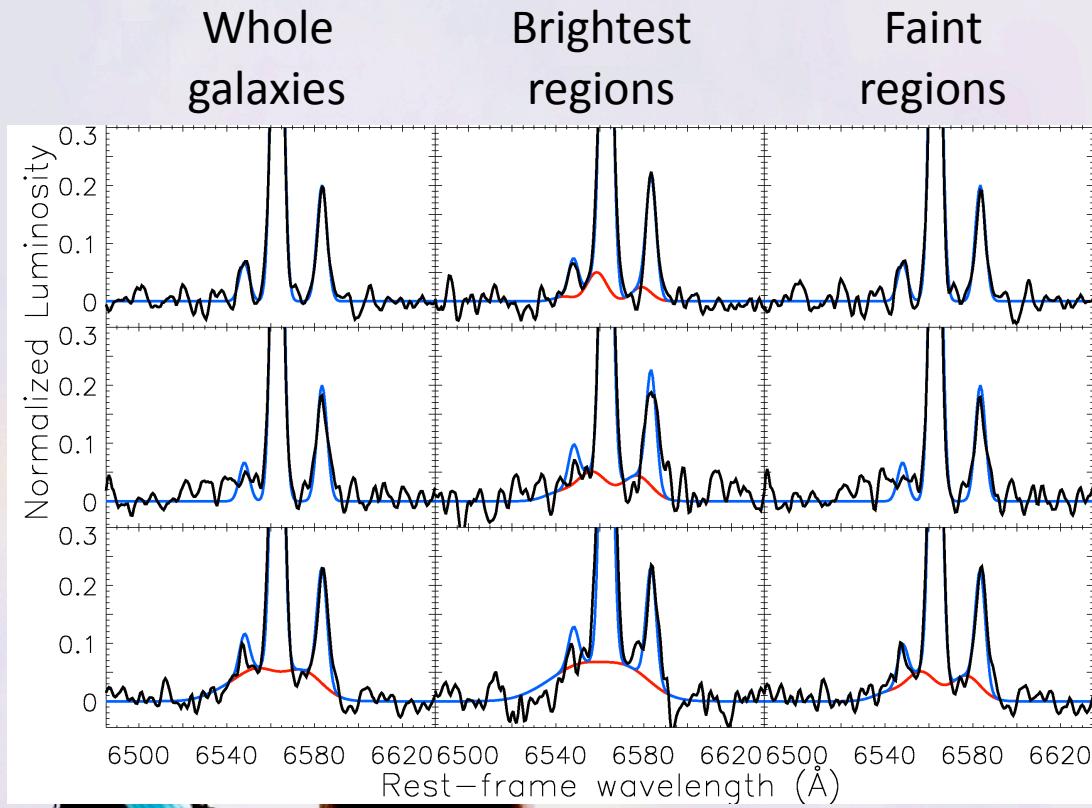
Only the high
pressures models
reproduce our
observations



Lehnert et al. (2009)



Evidence for winds



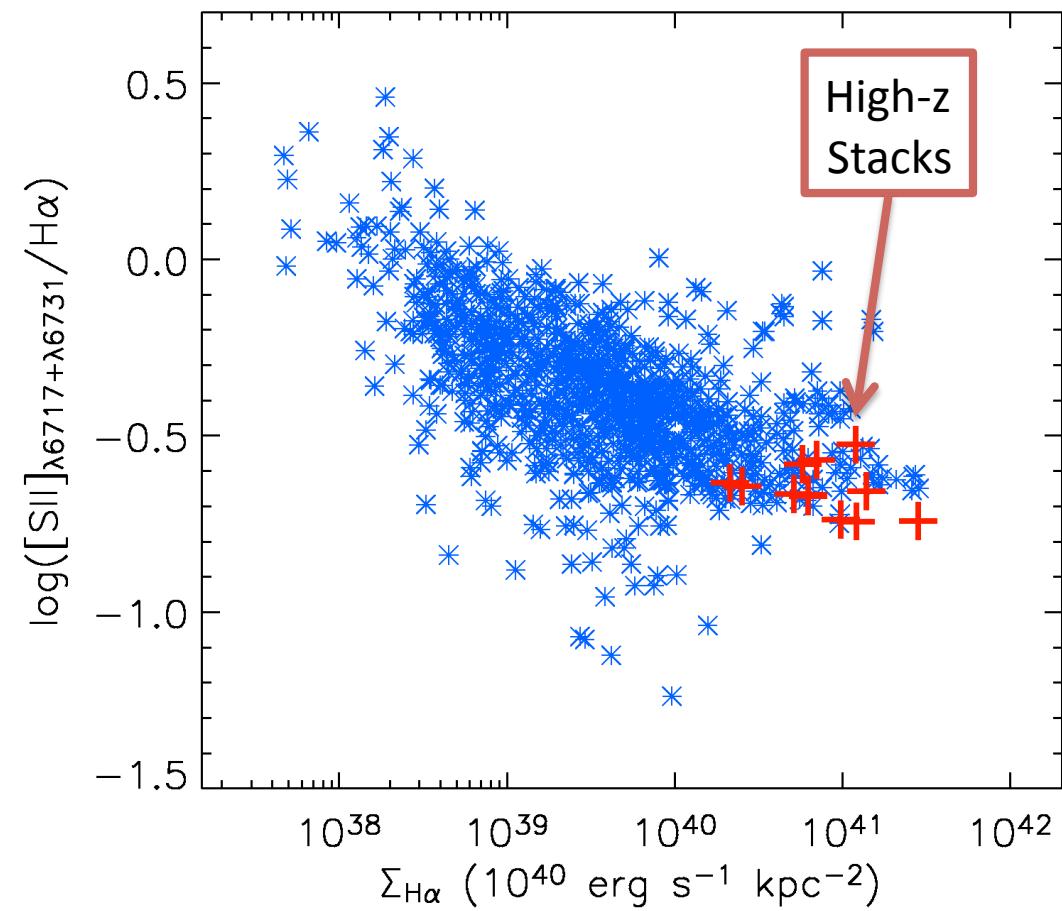
In red: Simple Broad Lines Model for H α & [NII]:
 $V_{\text{offset}} = \sigma_{\text{H}\alpha} = \sigma_{[\text{NII}]} = [\text{NII}]/\text{H}\alpha$ constraint
Like in extended emission in nearby starbursts

Forming a single parameter family with local galaxies

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



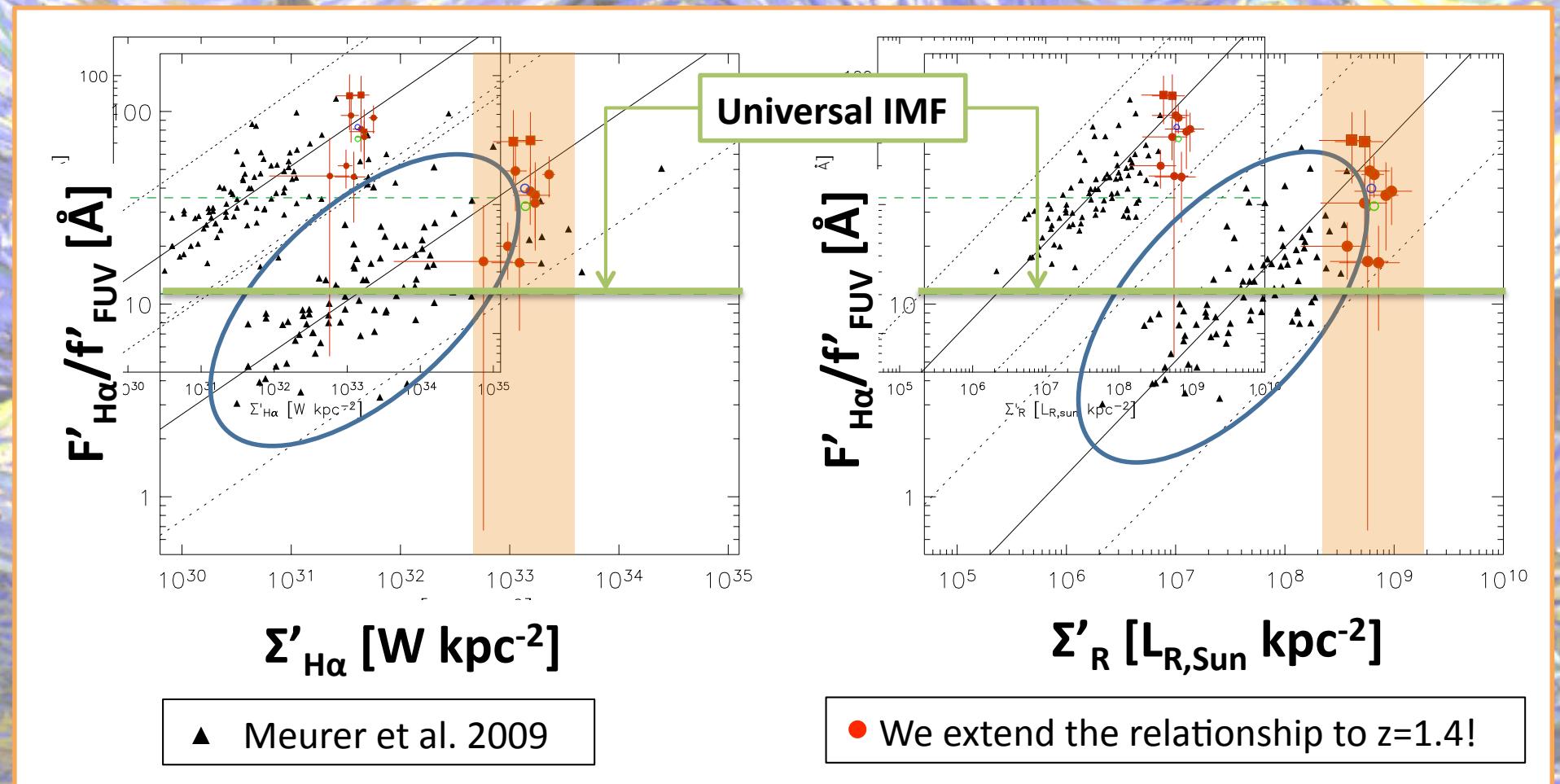
Le Tiran et al. 2011b, in prep.



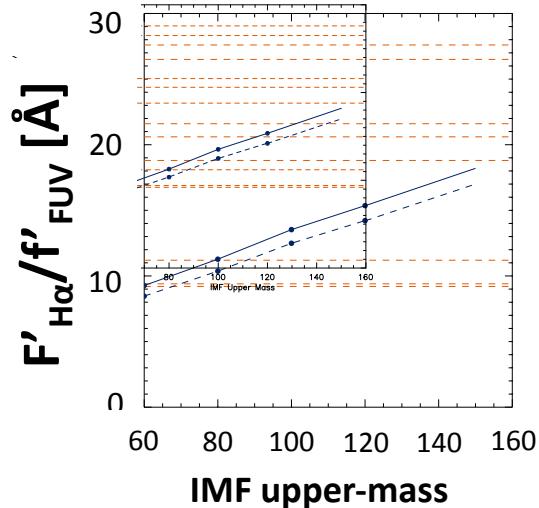
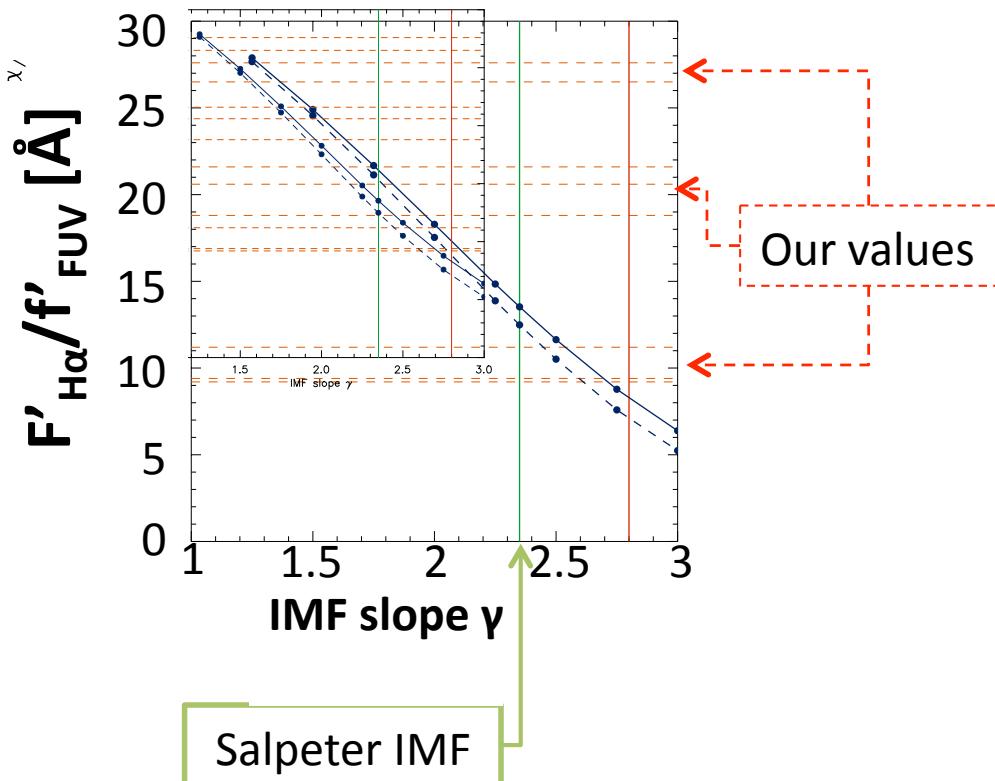
A reproduction of Vincent van Gogh's painting "The Starry Night". The scene depicts a dark, swirling night sky filled with numerous small, yellow, star-like dots. A large, bright crescent moon is visible on the right side. In the foreground, a dark, craggy pine tree stands on the left, its branches reaching down towards a town below. The town features several buildings with illuminated windows, and a prominent church steeple rises in the center. A blue police box, known as the TARDIS from Doctor Who, is positioned in the upper right quadrant of the painting, appearing to float in the star-filled sky.

A WORD ABOUT THE IMF

Universal IMF or bursty star formation?



IMF variation?

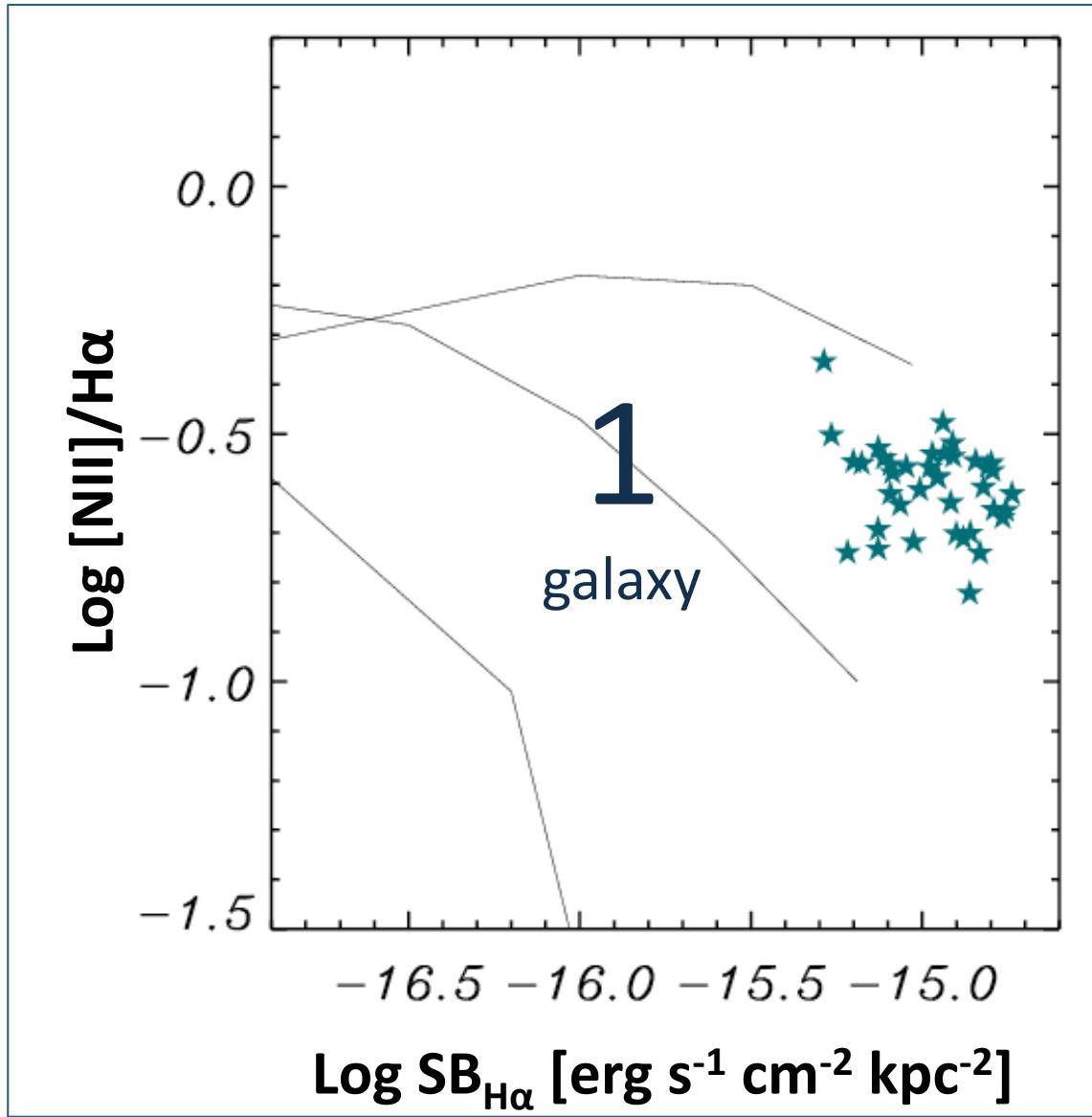


Variations of the slope (or upper-mass) of the IMF could explain our observations



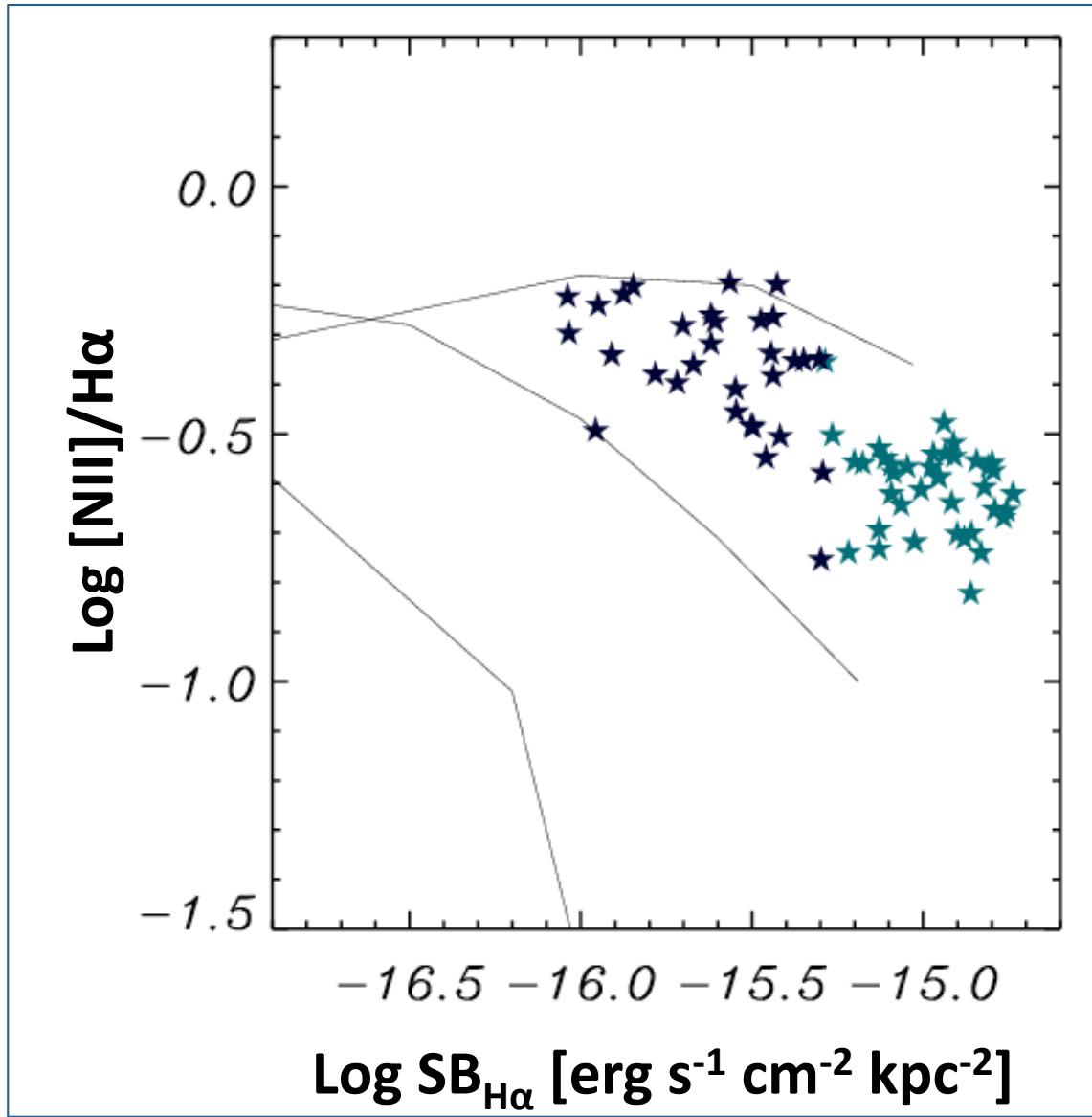
The end?

Internal densities



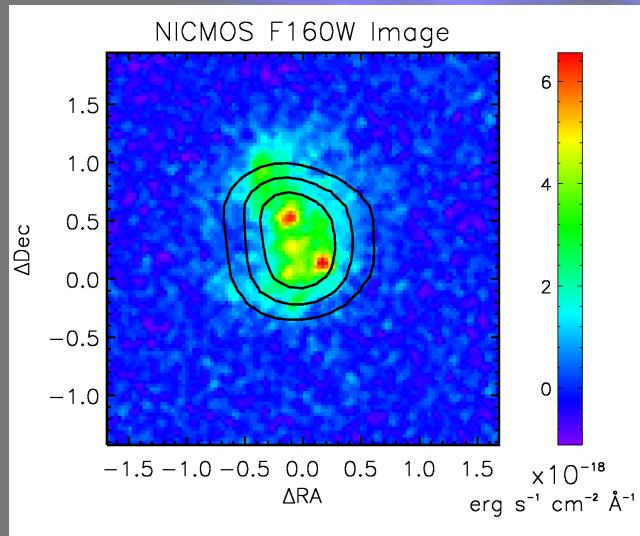
Lehnert et al. (2009)

Internal densities



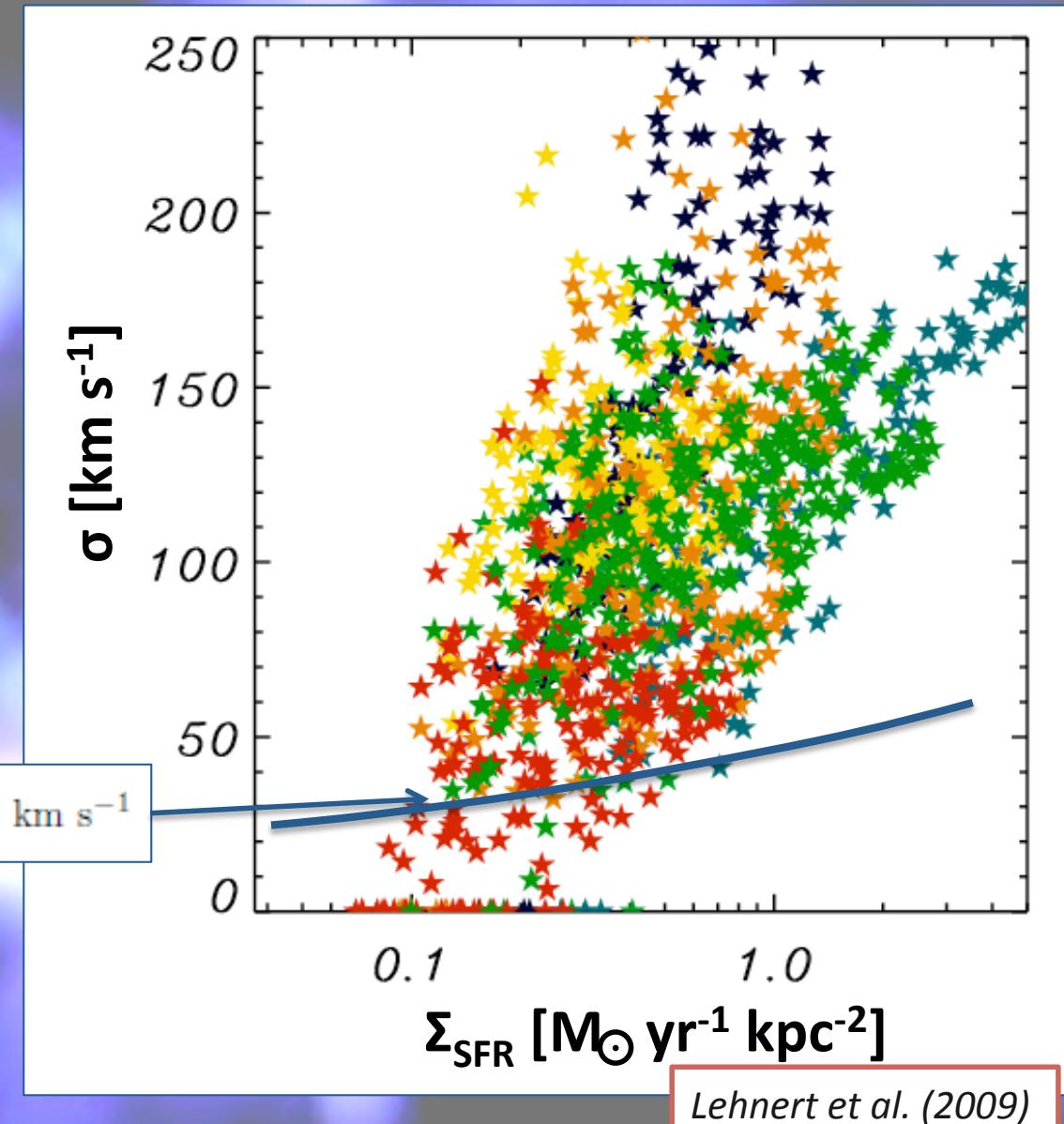
Lehnert et al. (2009)

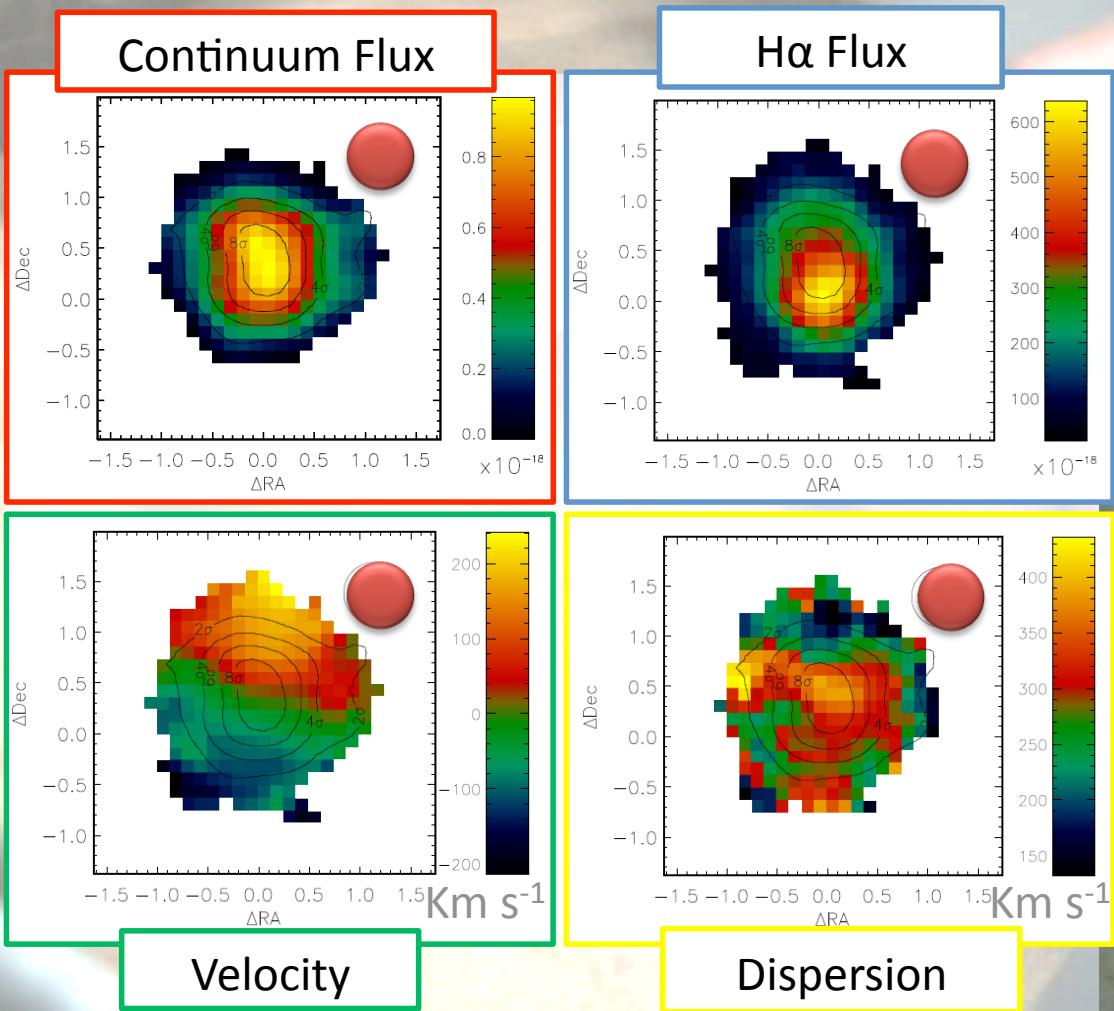
Not an effect of clumps...



Jeans instability:

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

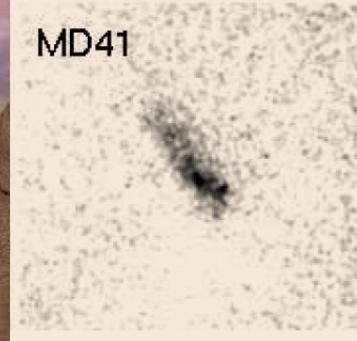
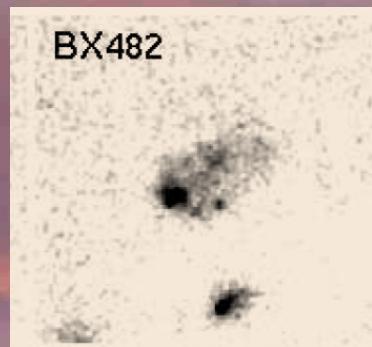
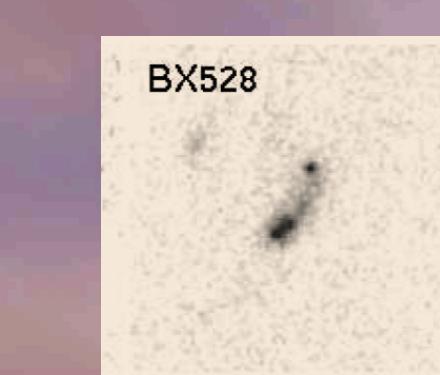






Where are we travelling
today Doctor?

3 billion years after the
Big Bang Rose...



Galaxies at this time
were so... brilliant!

They are very luminous,
way more than the ones
we travel to usually!

