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From simulations to observations (HI - Chaotic THINGs)

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Dwingeloo, March 2014

Spatially resolved star-formation in nearby mergers

Star-formation modes

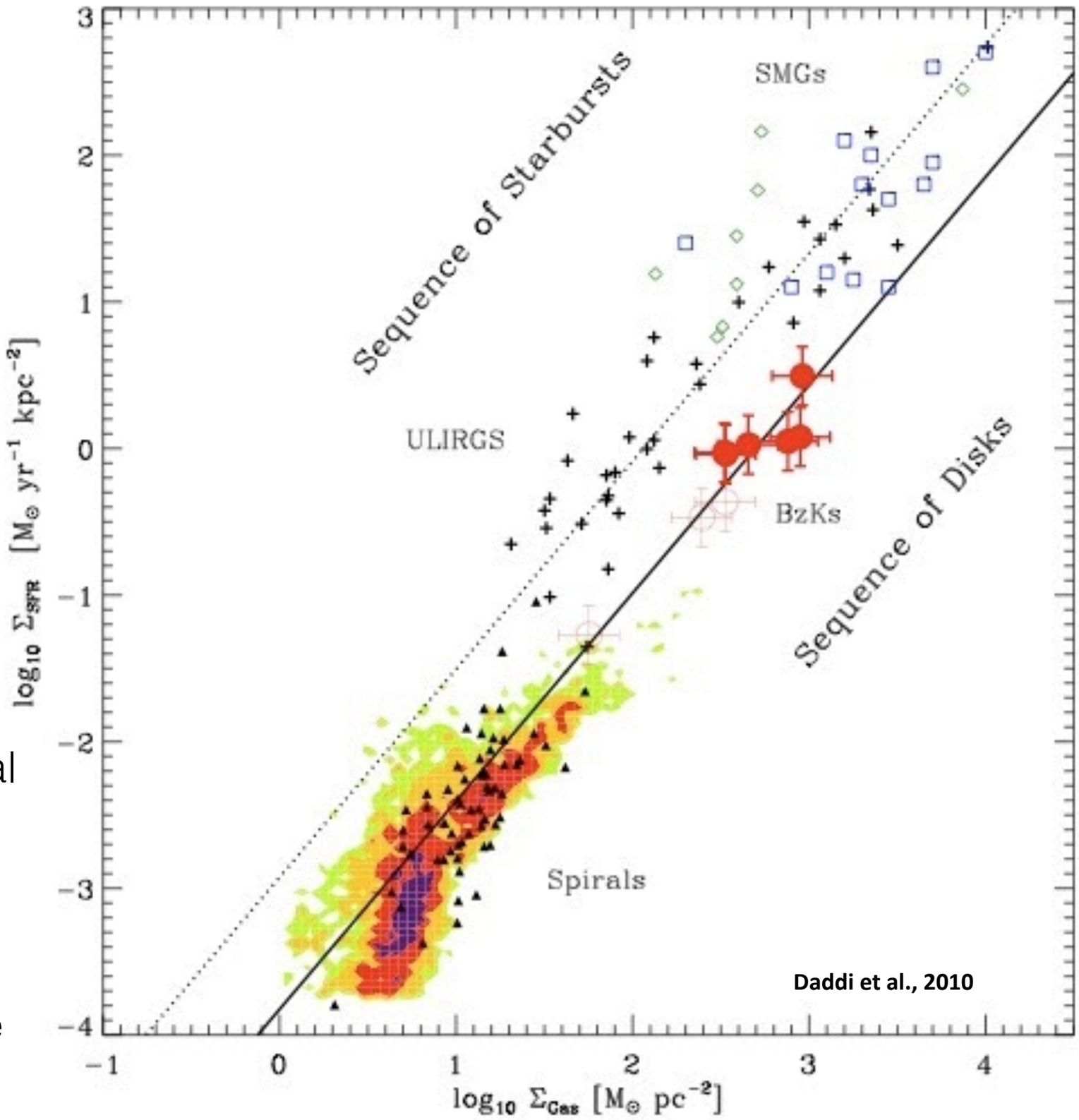
✓ A double mode ?

- Starbursts in mergers have globally a higher SFE, sSFR than «main sequence» disks

- How does the SFE vary as a function of merging stage?

- Is the SFE triggering due to local (nuclear inflow) or global processes?

- Does the SF mode within one merger vary from one region to the other?



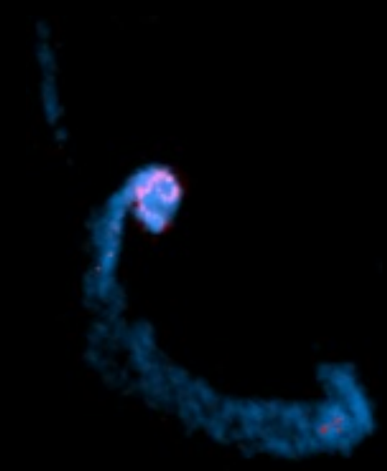
Daddi et al., 2010

Investigating SF in high resolution simulations of mergers

- Local (pc scale) and large scale effects (full galaxy) investigated with hydro AMR simulations (RAMSES)

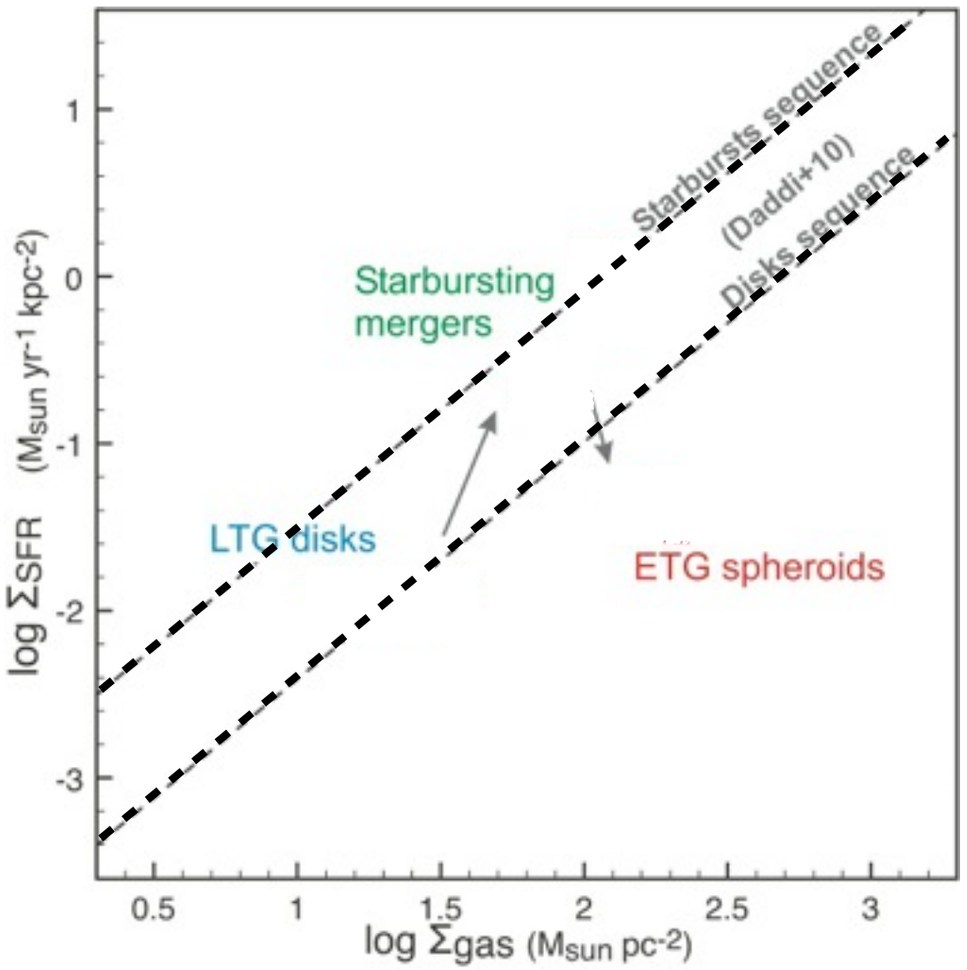
Renaud, Bournaud, Duc, 2014

- Density PDF of the ISM derived and compared to isolated disks



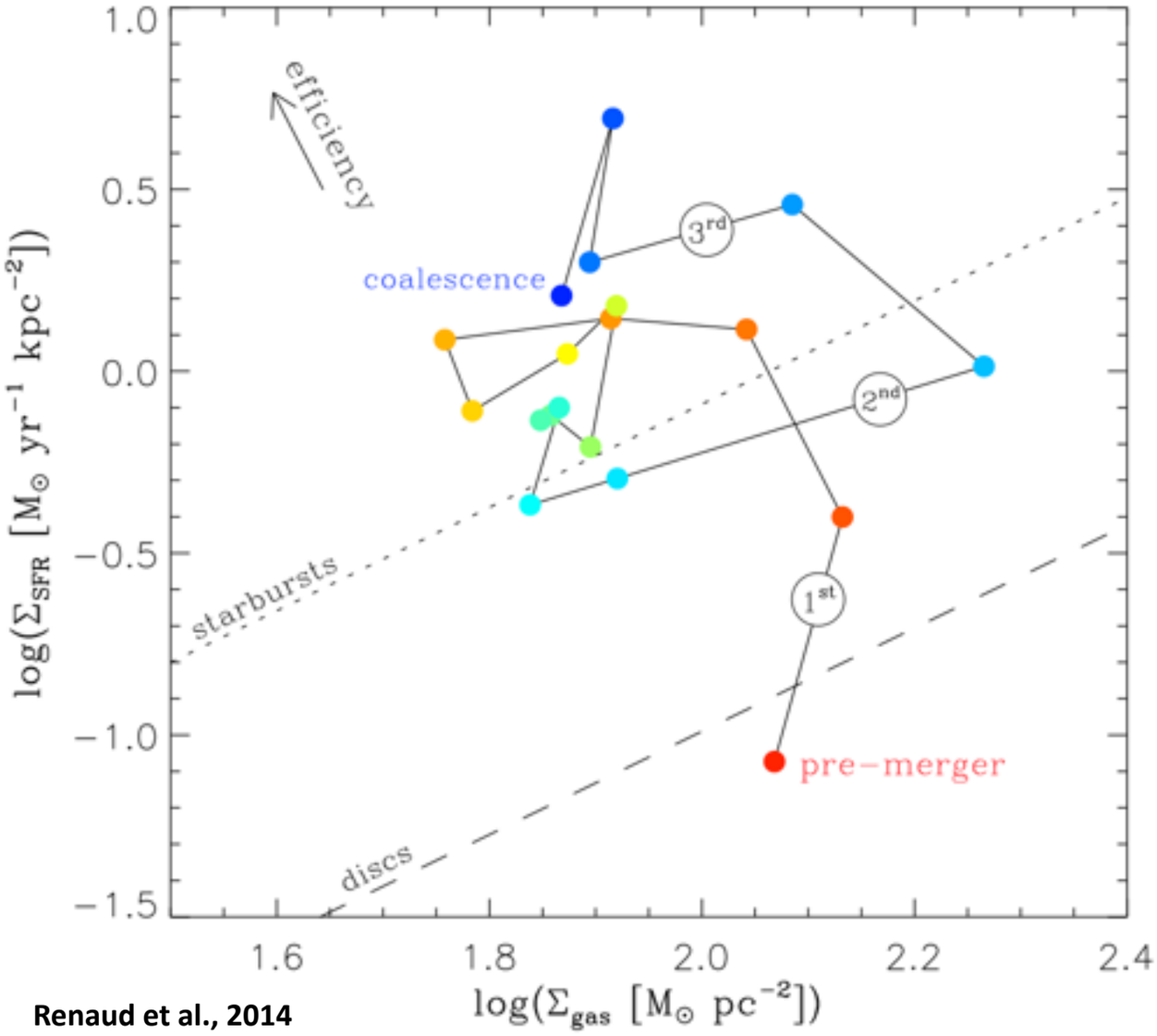
Hibbard, van der Hulst et al., 2001

Predictions from simulations



✓A varying Star Formation « Efficiency » in mergers

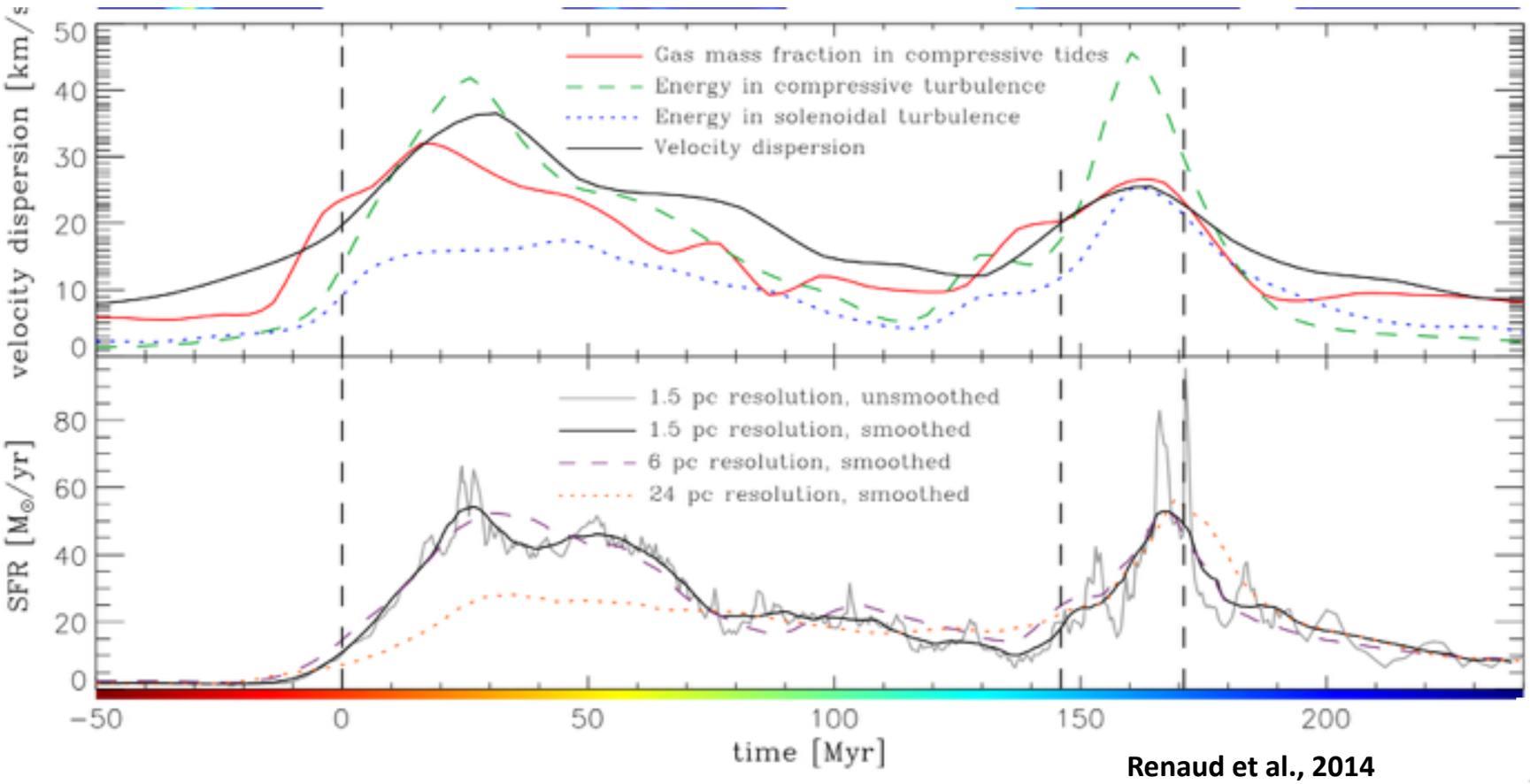
• The SFE quickly varies as a function of the interaction stage and peaks at the coalescence



Renaud et al., 2014

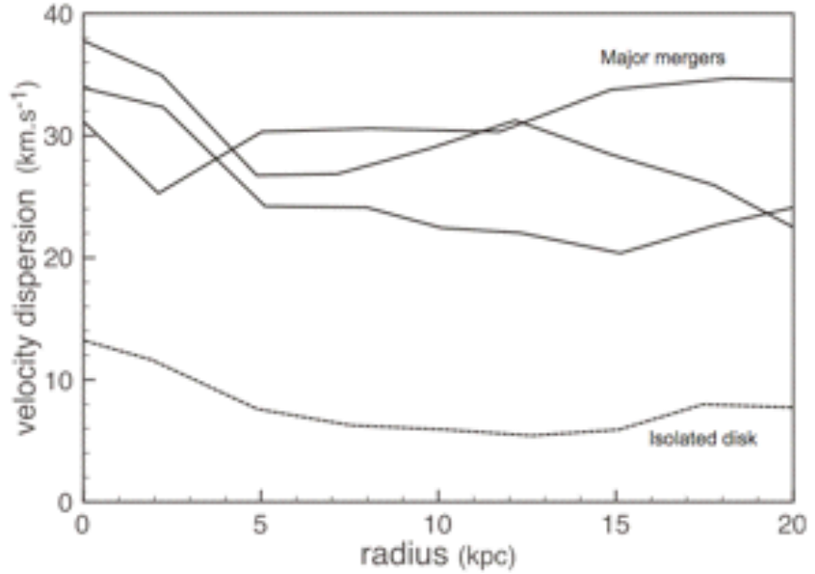
- Decrease in Post-merger ellipticals
  - more stable gas disk
  - less turbulent ISM
    (morphological quenching?)

Predictions from simulations



Renaud et al., 2014

✓Excess of gas turbulence



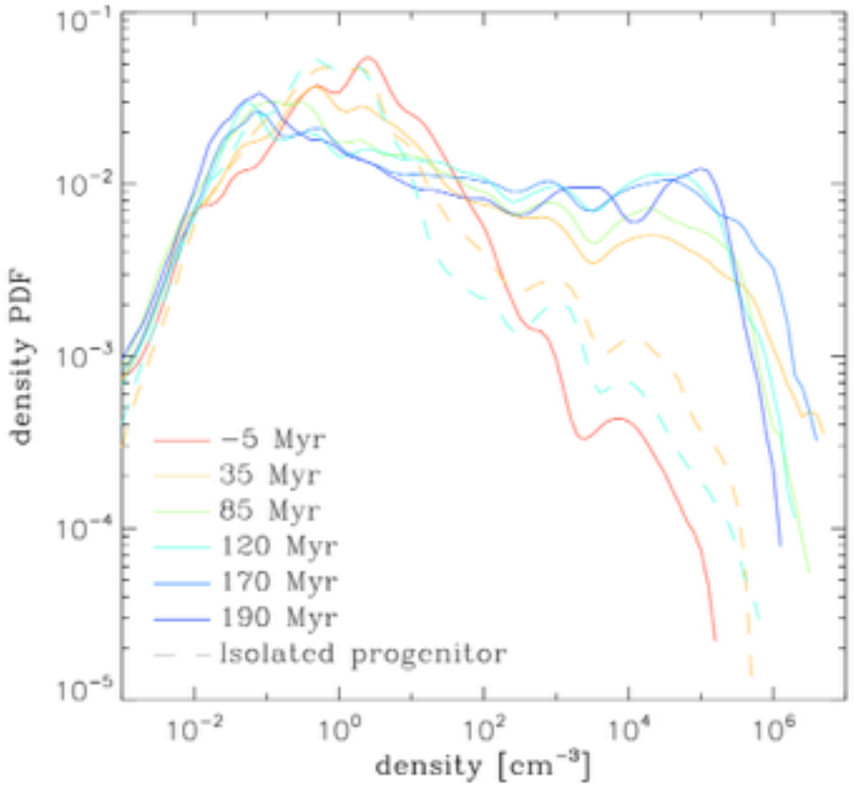
- ISM turbulence gets 3-4 times larger in major interactions and mergers

- Correlation between the star formation rate and the gas velocity dispersion

- ISM turbulence not due to feedback, but to the interaction (compressive tides)

➡Excess of SF may (not) only be driven by the central gas inflow, but may be spread over the whole system

Predictions from simulations

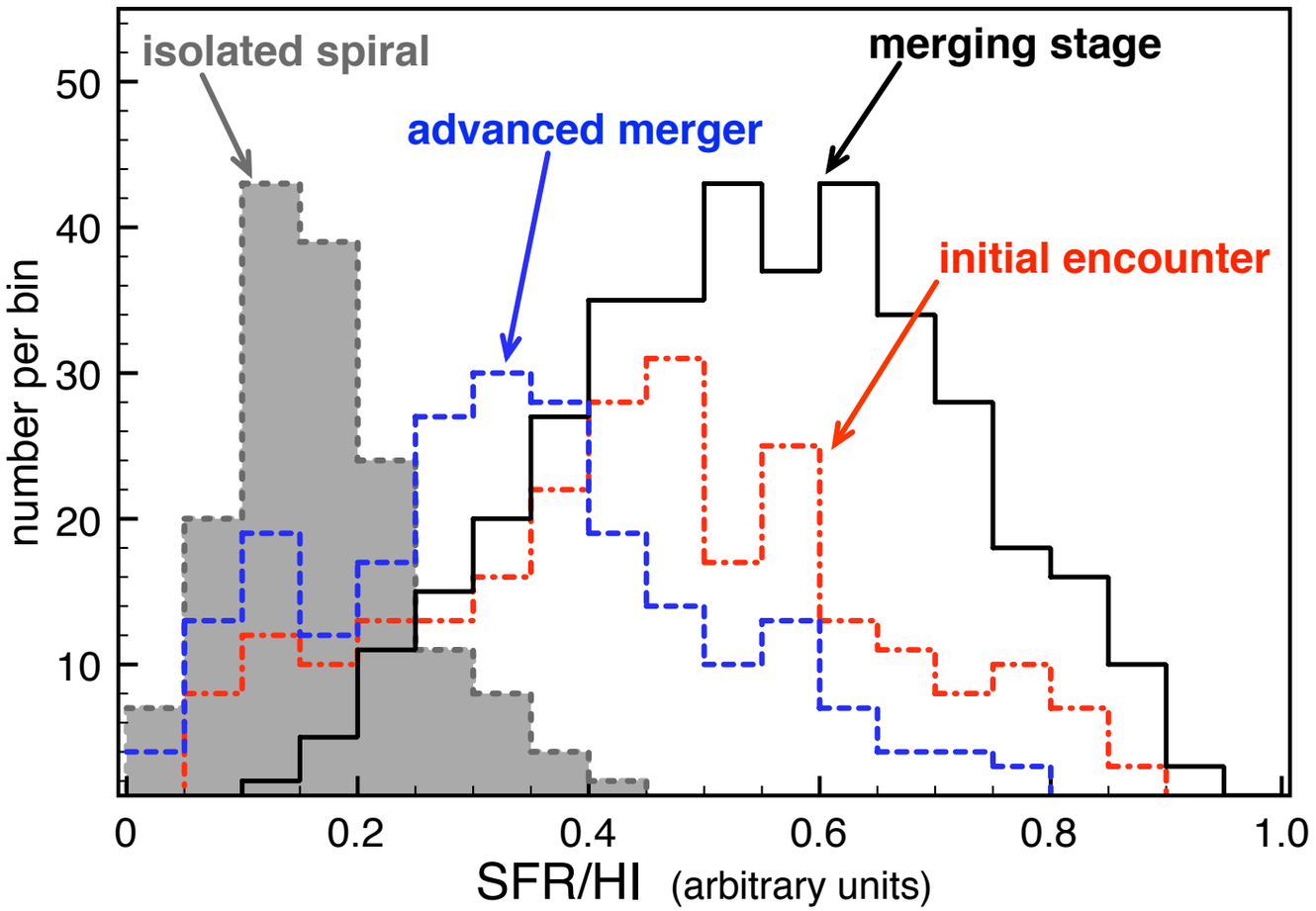


✓Excess of dense gas in mergers

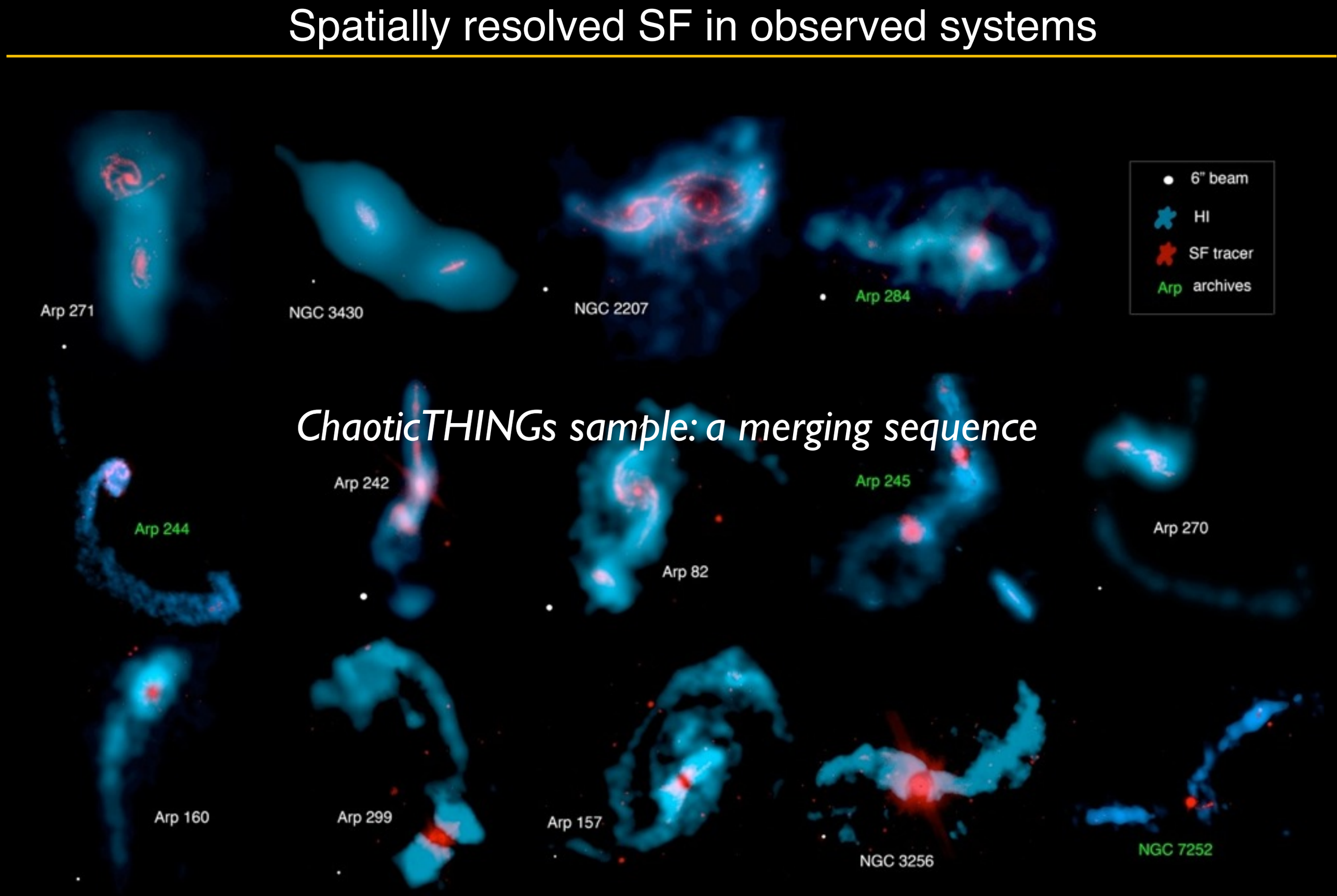
- Evolution of the density PDF of the ISM: a secondary peak emerging

- The excess may be observable comparing the HI (tracing low density gas) with a SFR tracer (tracing the high density gas): SFR/HI varies more in mergers than SFR/CO -> HI can tell about SF!

- The excess of dense gas is widespread, observable all over the system: because of its large FOV, SKA better than ALMA!



Spatially resolved SF in observed systems



ChaoticTHINGs sample: a merging sequence

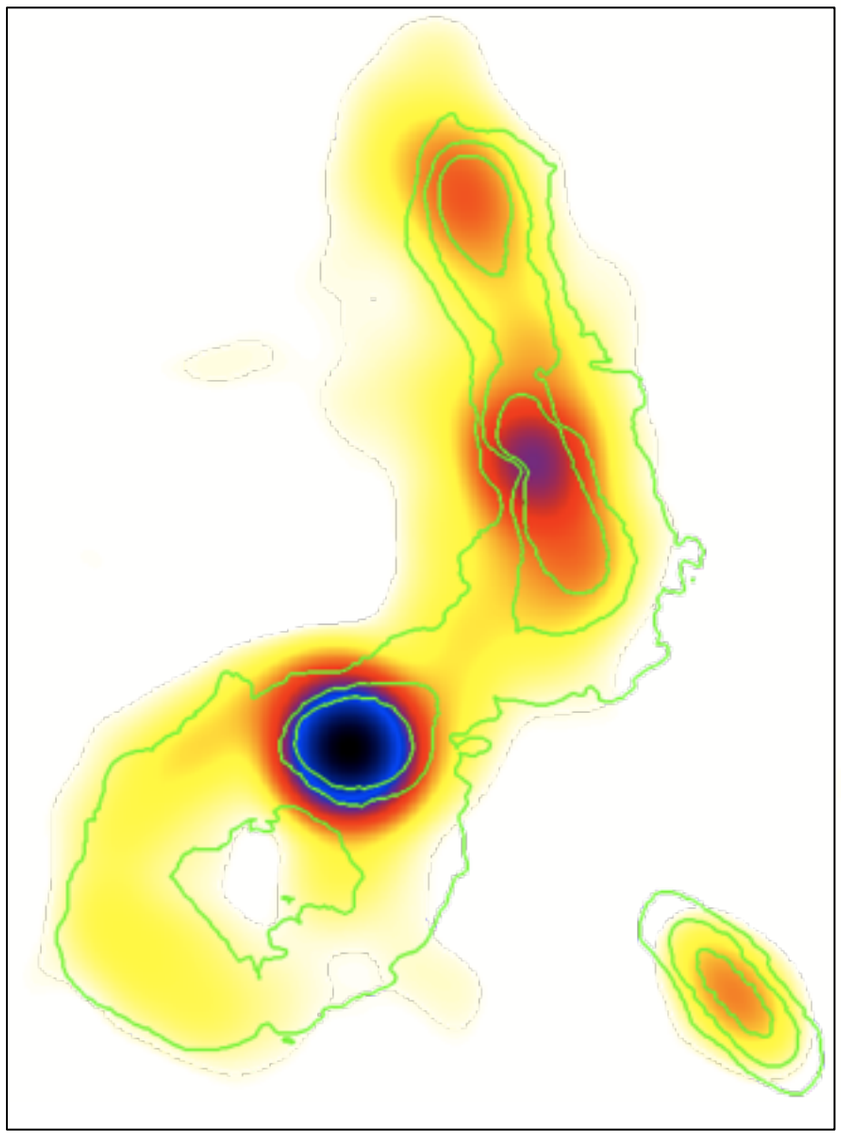
HI EVLA (B-array) observations, complementing database from THINGS, Little THINGS + SF tracers

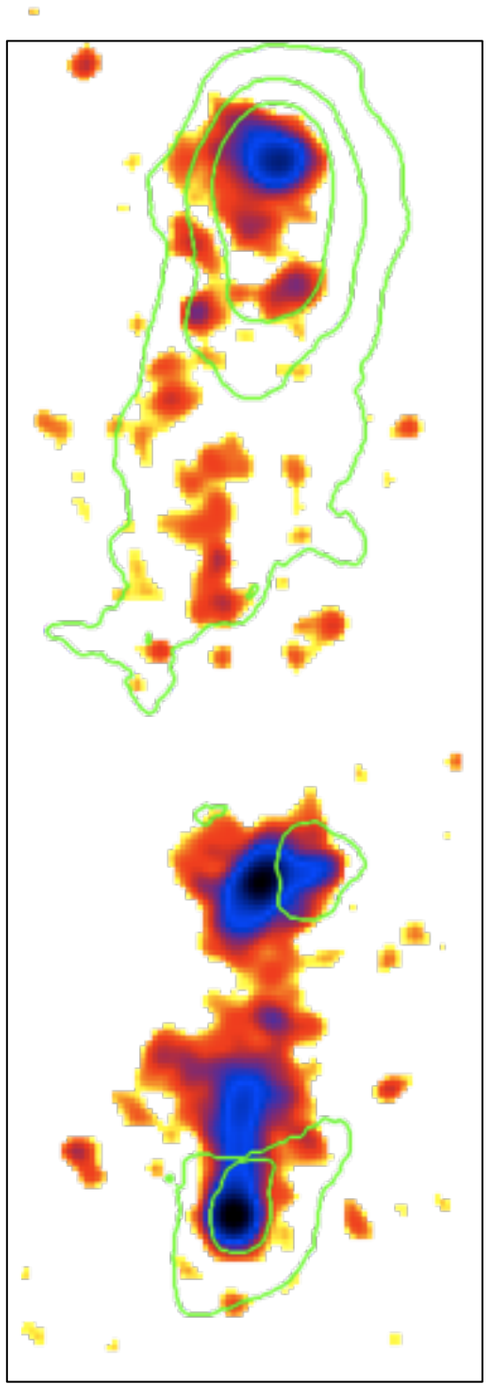
Spatially resolved Star-Forming regions

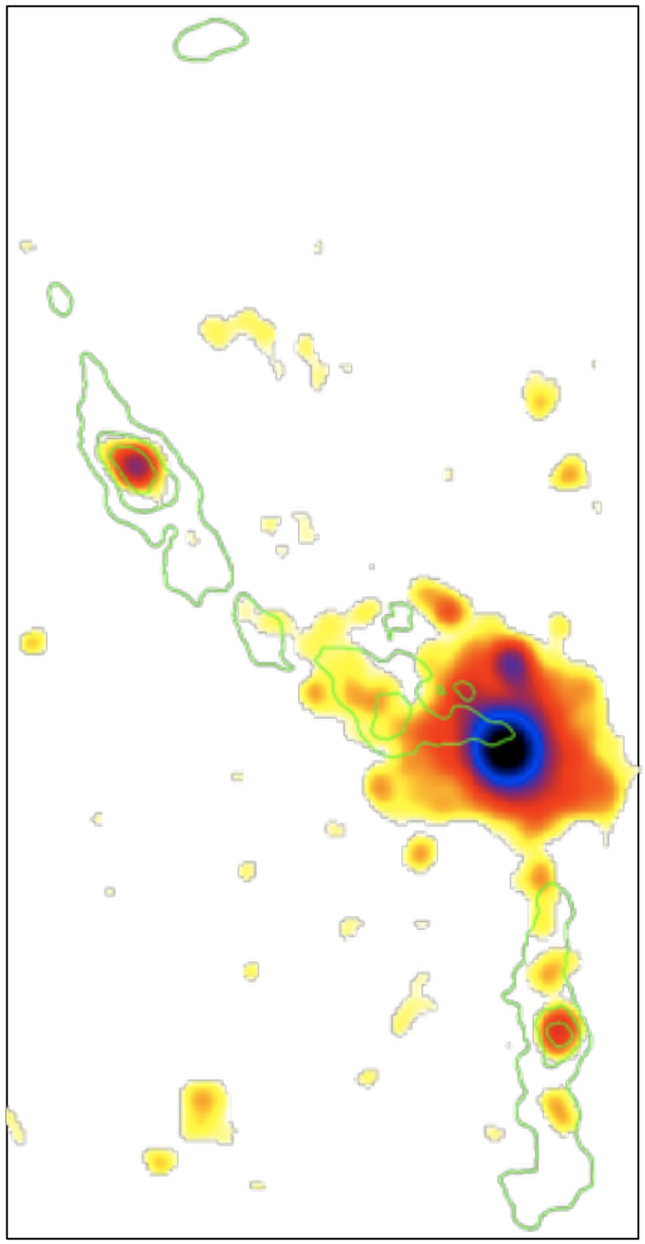
- HI over UV (GALEX)

low density gas

SFR (not corrected for extinction), tracing high density gas

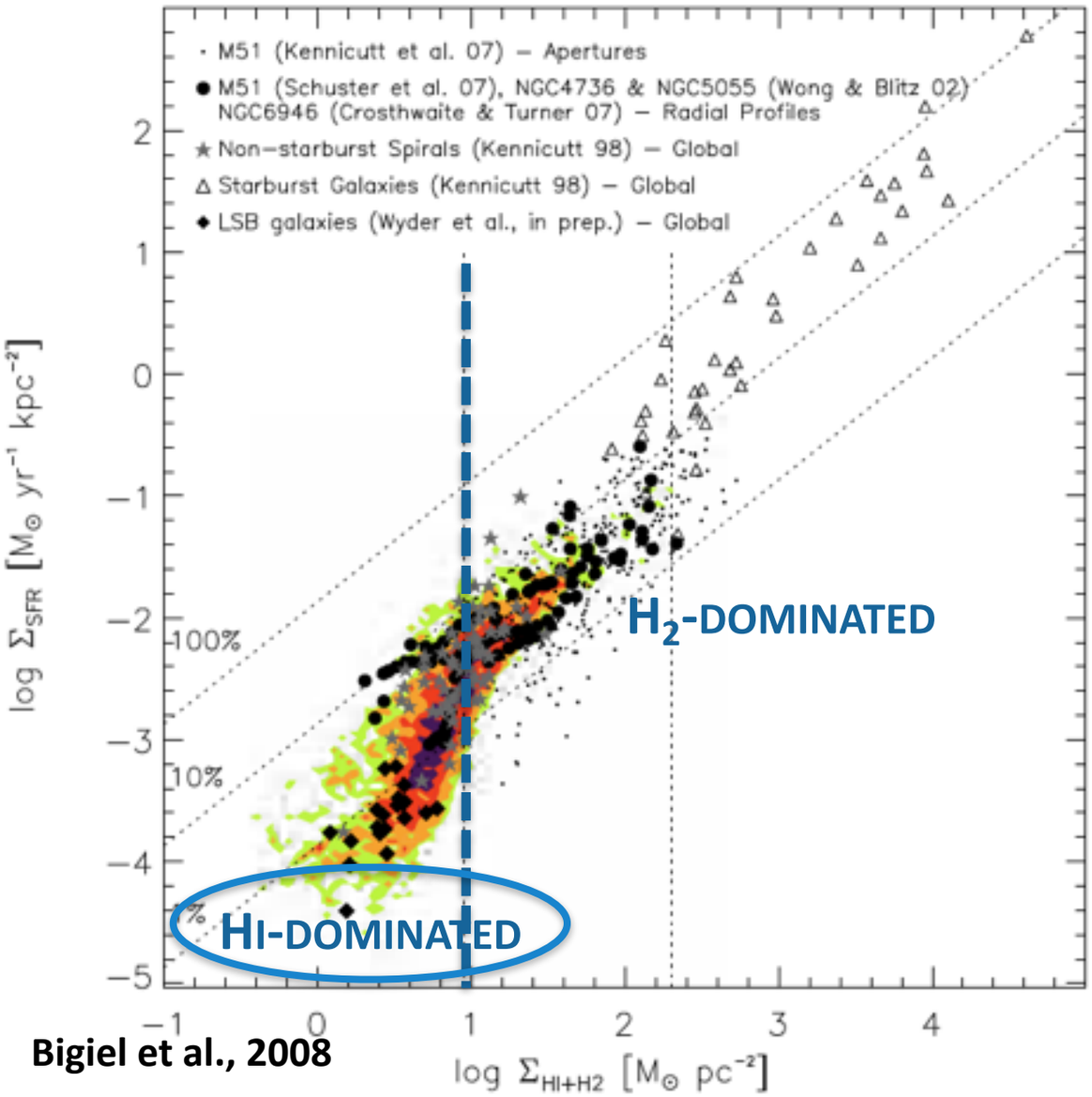




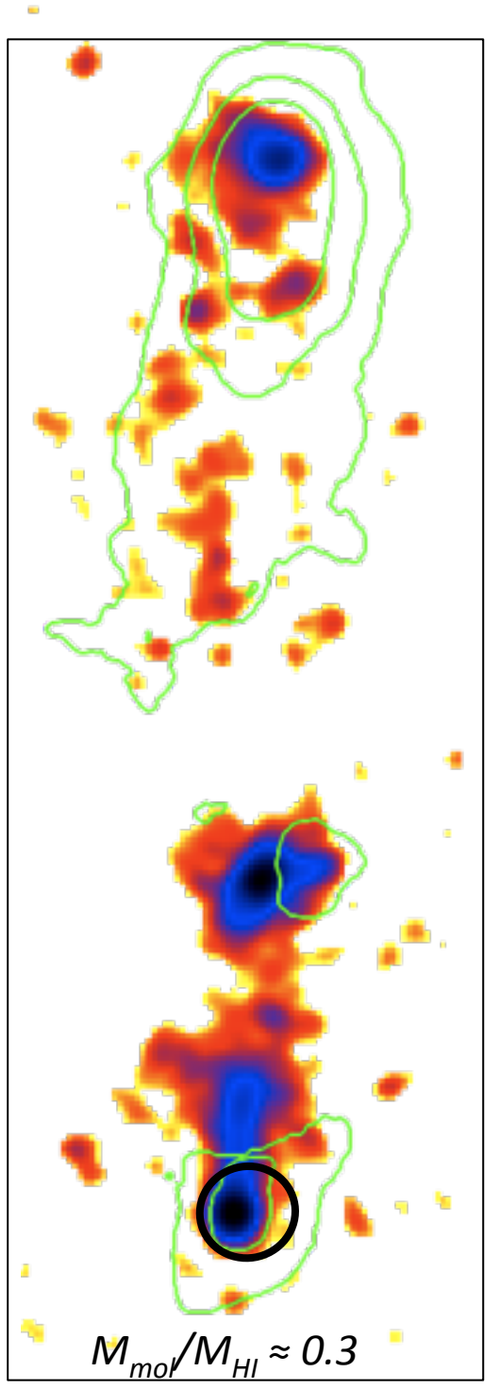


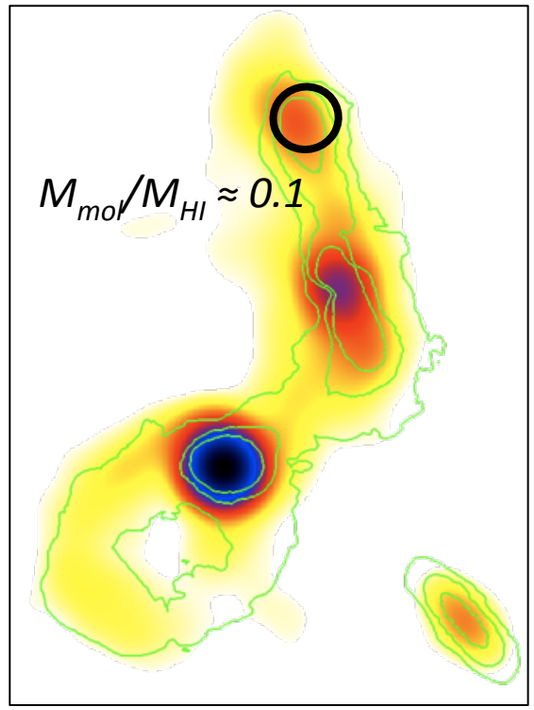
at resolution of 5-10 arc sec (2-5 kpc): UV and HI distribution match

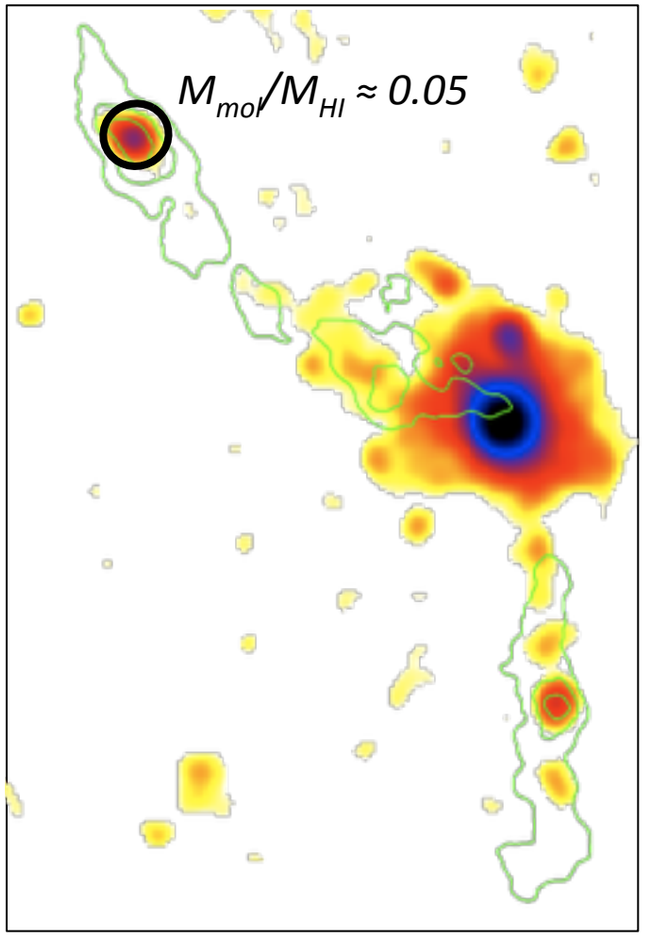
The different modes of star formation



Bigiel et al., 2008

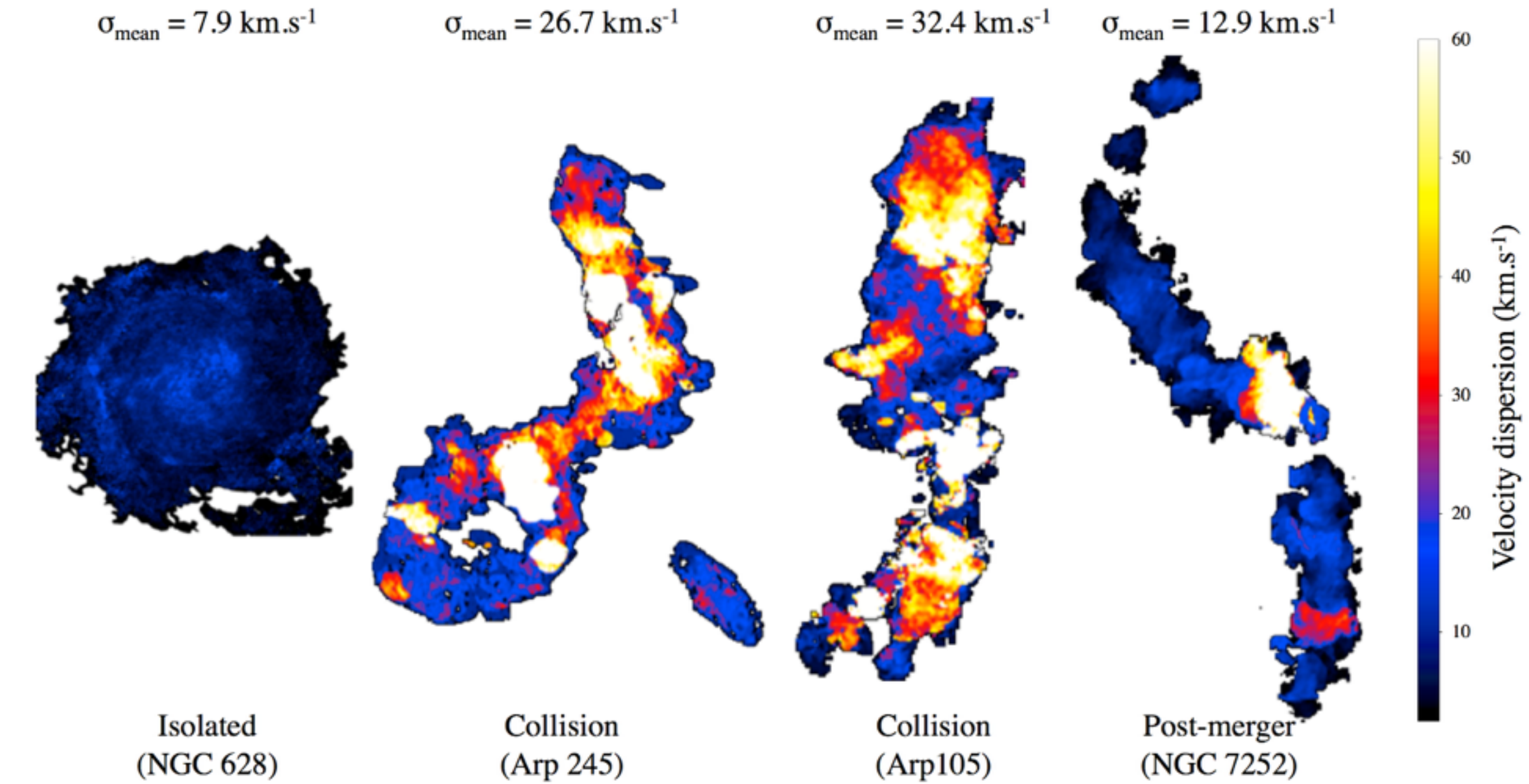






- Compared to isolated disks, HI dominated regime over large regions

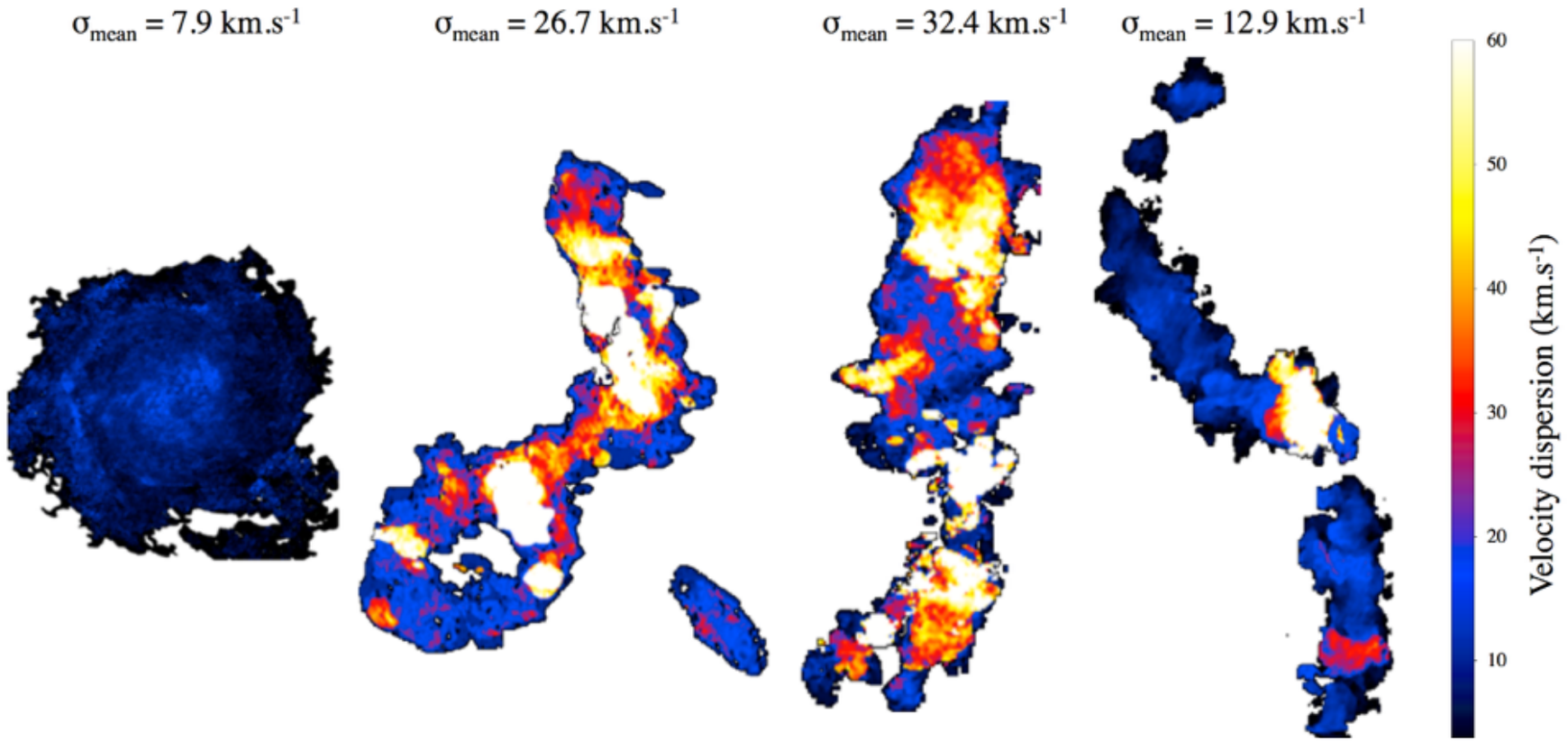
Checking prediction on enhanced gas turbulence



Belles et al., in prep

- Increased HI velocity dispersion at the merger stage, even in regions with little star forming activity: not an effect of feedback!

Checking prediction on enhanced gas turbulence



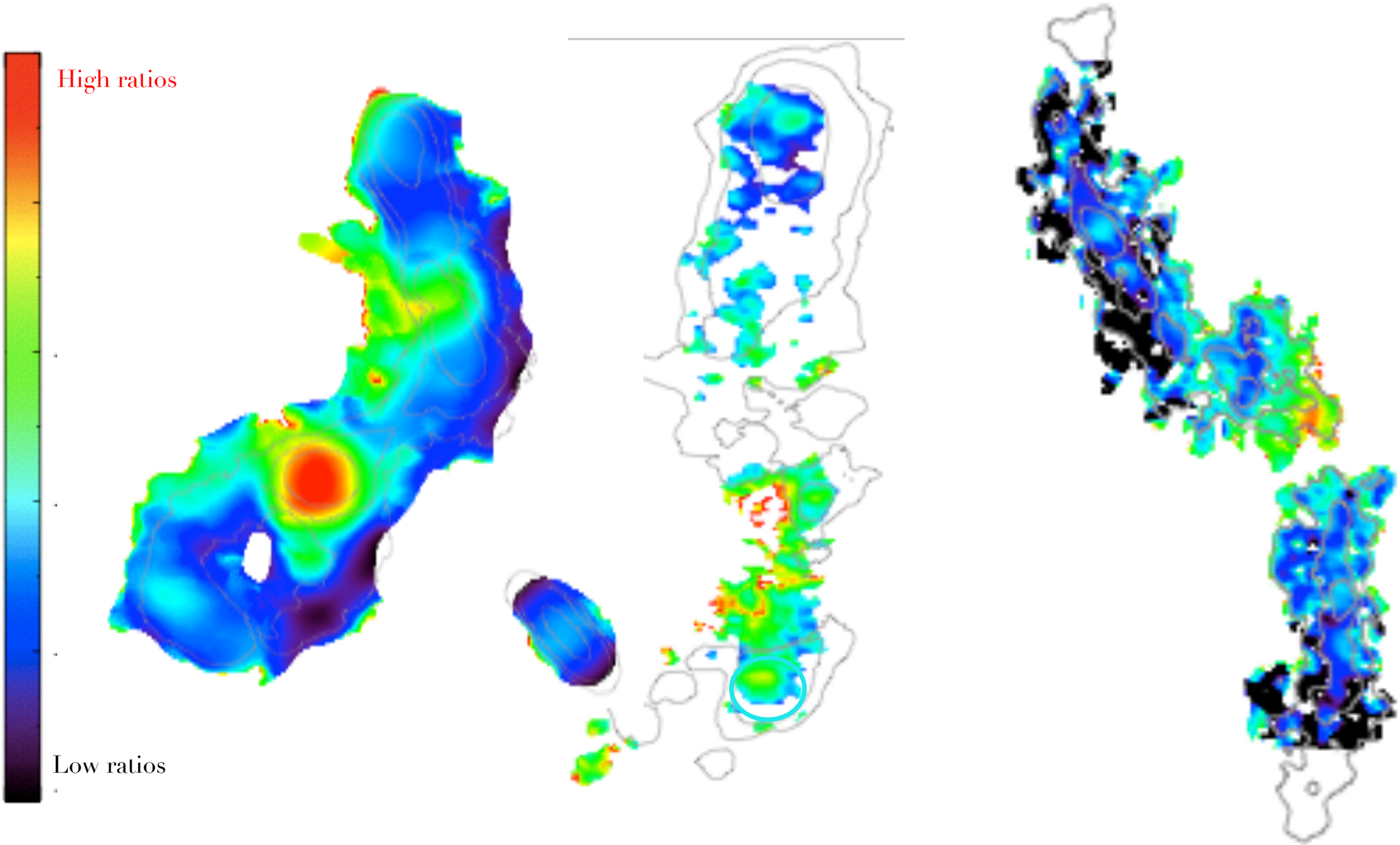
Isolated (NGC 628)

Collision (Arp 245)

- Increased velocity dispersion at the merger stage …. as expected

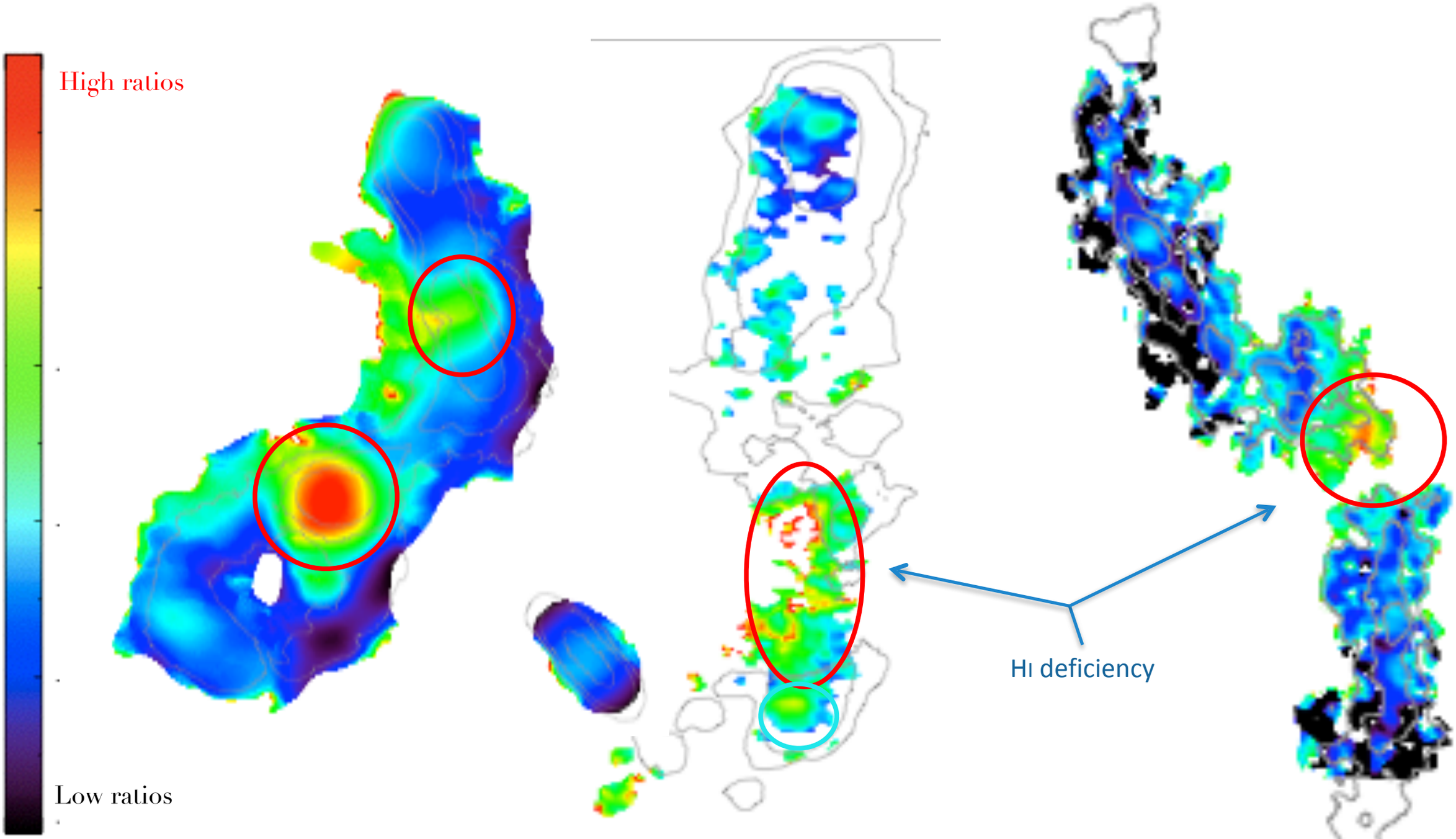
Checking prediction on enhanced dense gas fraction

- PSF matched NUV / HI map distribution



Checking prediction on enhanced dense gas fraction

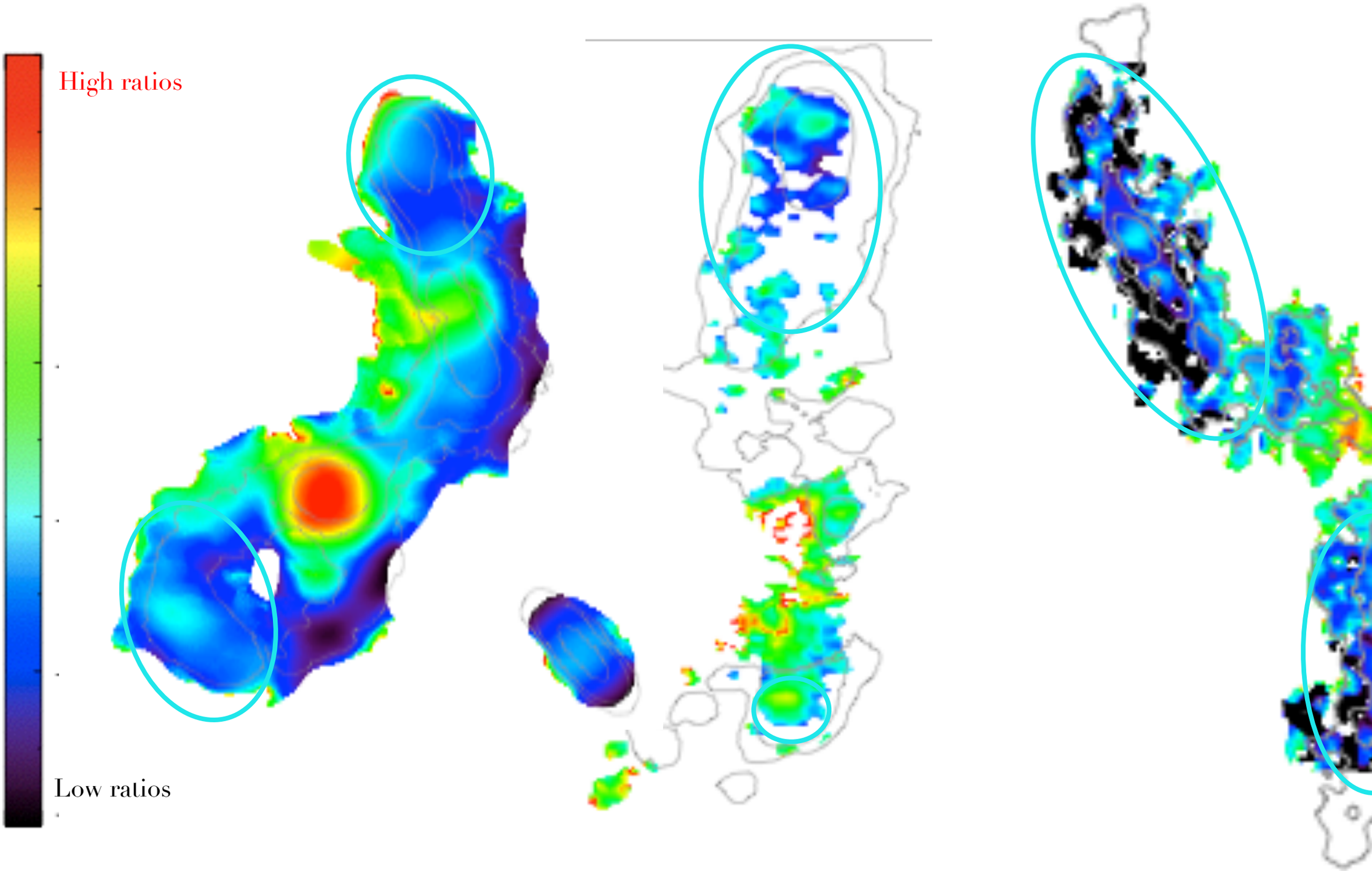
PSF matched NUV / HI map distribution: central regions



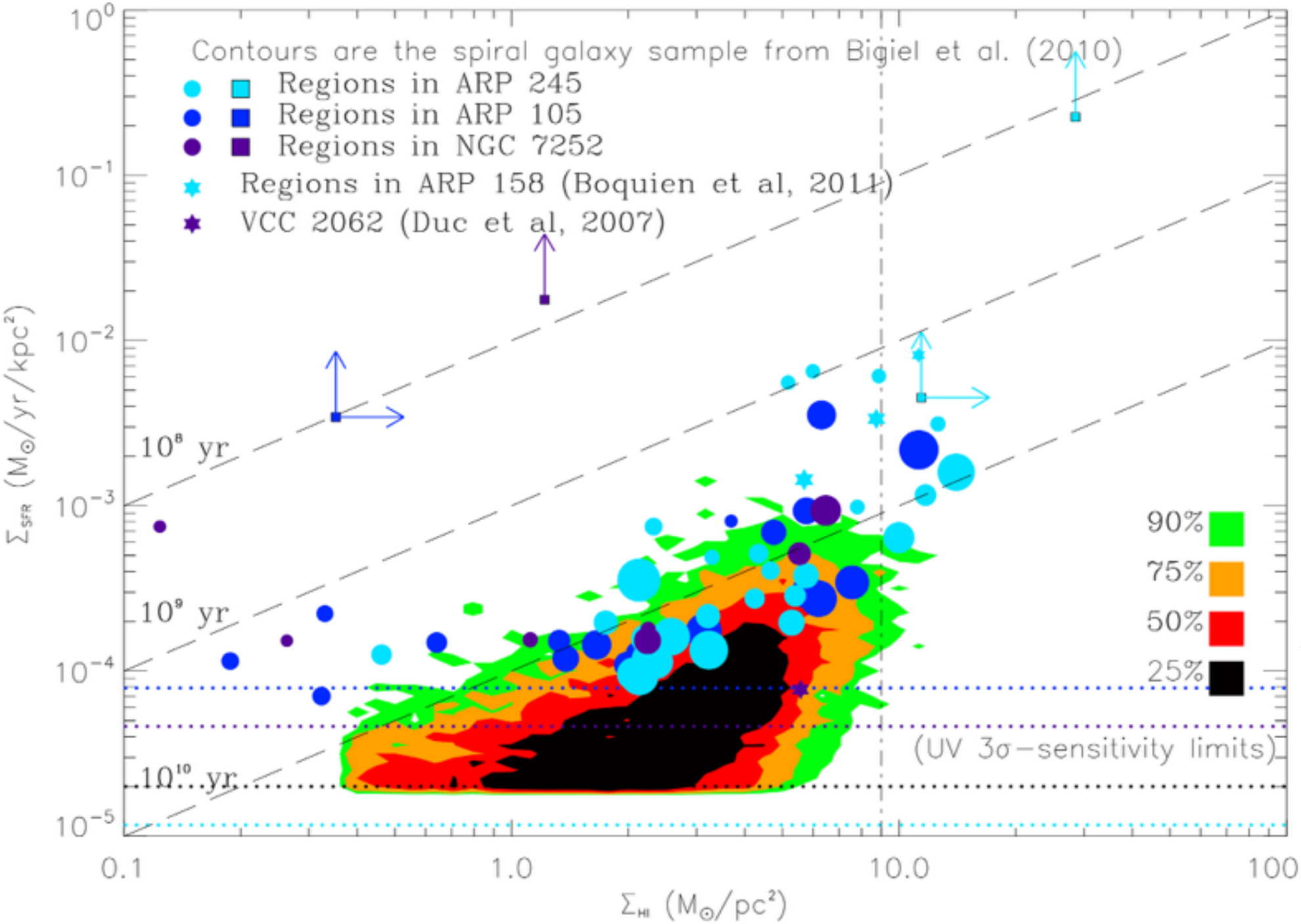
- NUV/HI ratio peaking in central regions, due to lack of HI there (transformed into H2/CO)

Checking prediction on enhanced dense gas fraction

PSF matched NUV / HI map distribution: external regions



Checking prediction on enhanced dense gas fraction



Nucleus

Inner regions

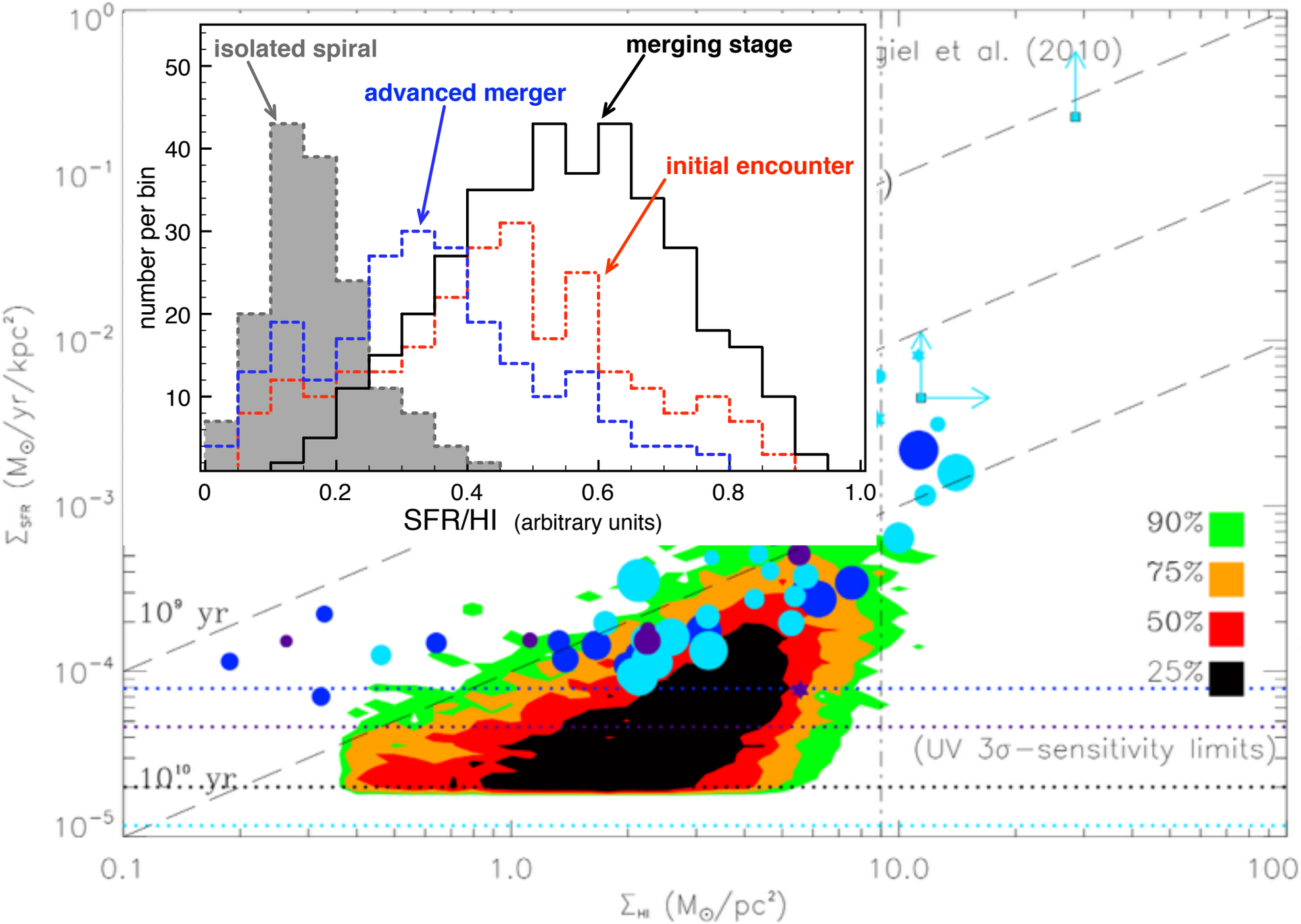
Outer regions

Mergers

Outer disk of spirals (THINGs)

- A correlation of the HI column density with SFR up to large gas column densities
- A SFR/HI tracing the high/low density gas in mergers larger than in external HI disks, but comparable to the inner HI disk

Checking prediction on enhanced dense gas fraction



Nucleus

Inner regions

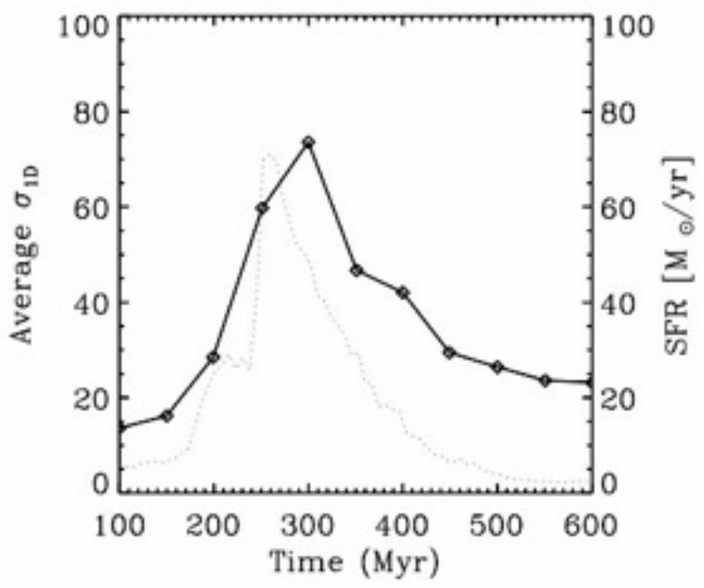
Outer regions

Mergers

Outer disk of spirals (THINGs)

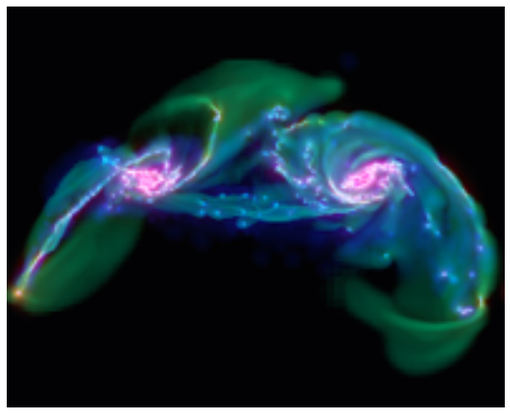
- A correlation of the HI column density with SFR up to large gas column densities
- A SFR/HI tracing the high/low density gas in mergers larger than in external HI disks, as predicted

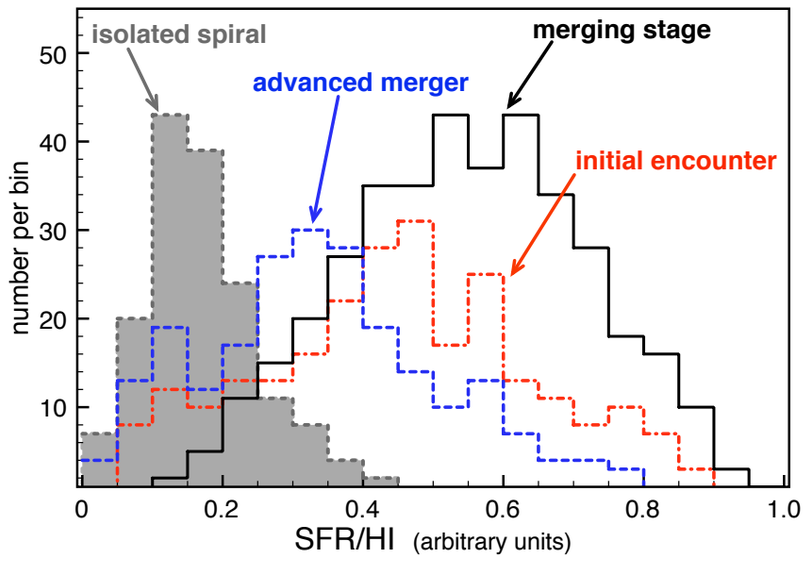
Conclusions: spatially resolved SF in mergers



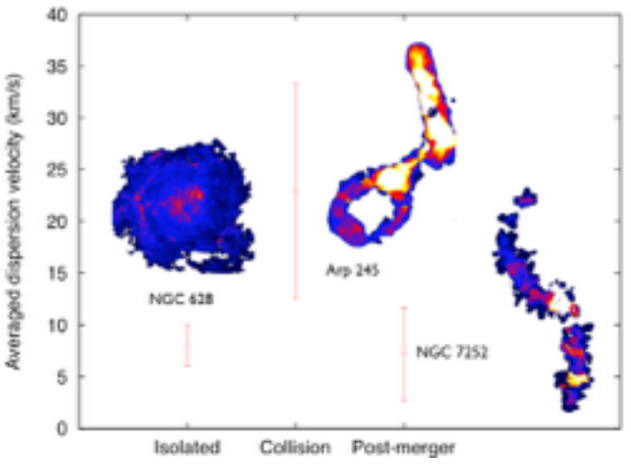
Simulations

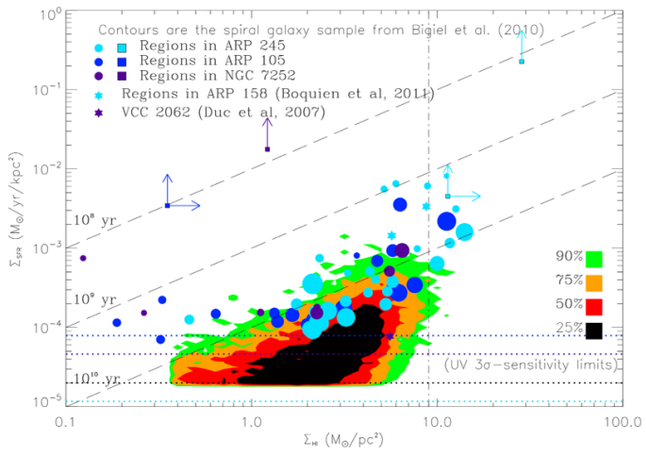
- High spatial resolution, AMR grid





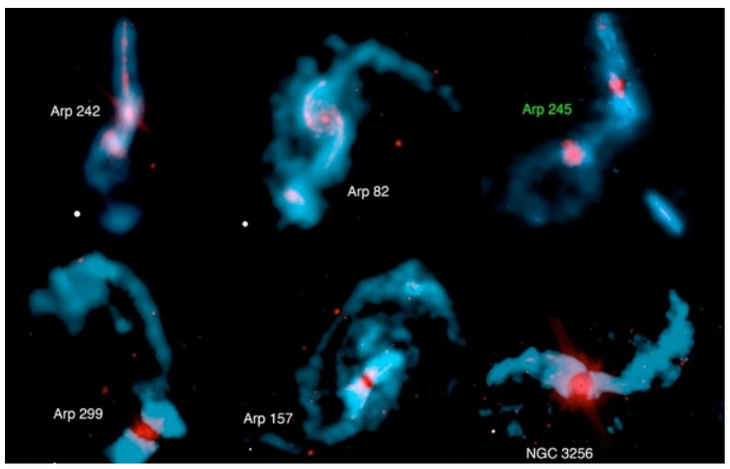
- A varying SFE, SFR/HI during the merger sequence due to the increased compressive turbulence





Observations

- High spatial resolution VLA HI maps (ChaoticTHINGs) of nearby mergers + IRAM CO observations for a few of them



- HI dominated regime in large regions of the systems, except in central regions which are HI deficient

- Increase wide-spread turbulence during the merger, as predicted

- SFR/HI, tracing high/low density gas, higher in mergers than in isolated spirals in HI dominated regime, as predicted

- HI can tell something about star-formation