

Galaxy evolution through cosmic time : Synergy with the GTC and LMT

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Main Collaborators

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NGC 4921 HI on HST VI

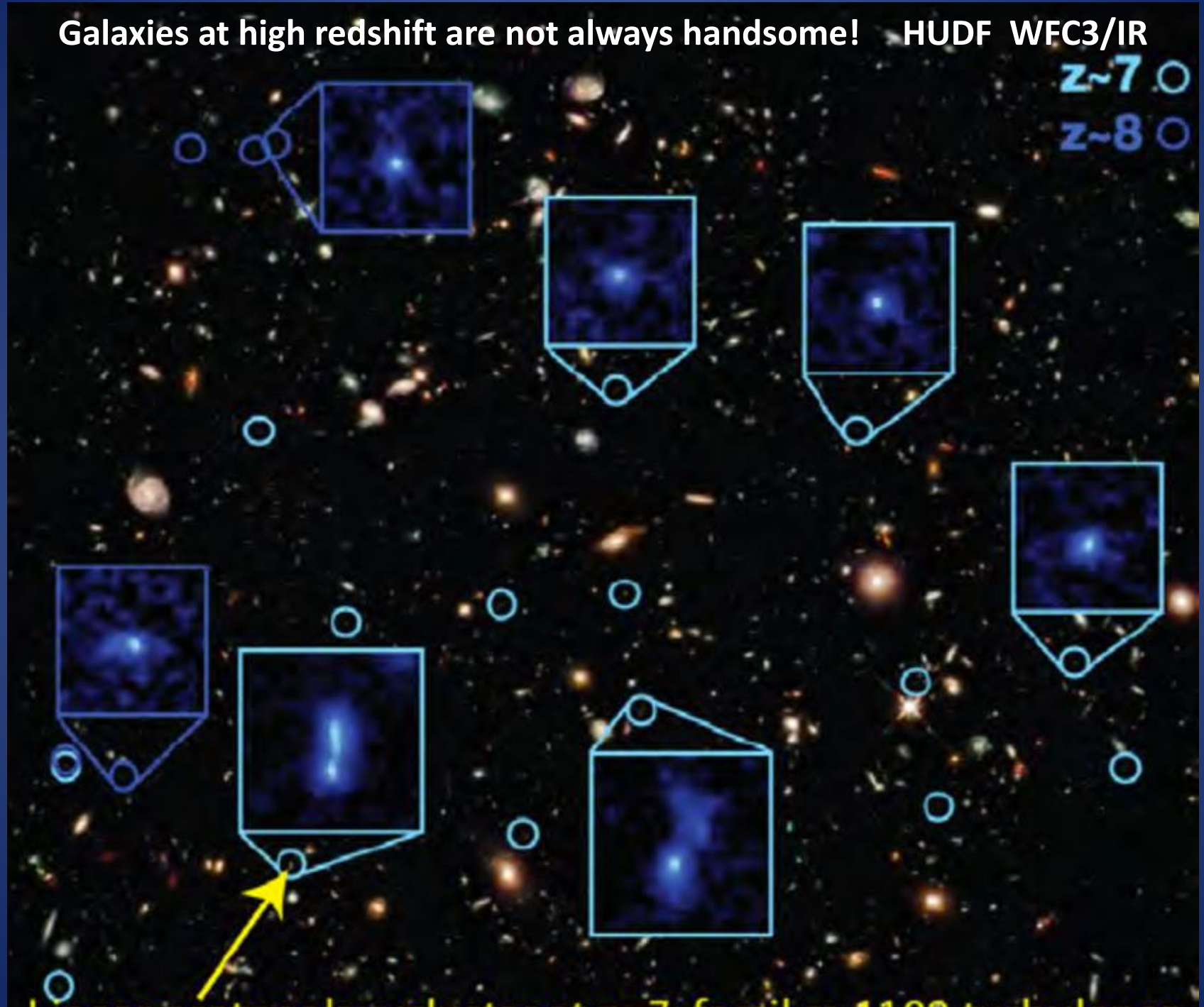
2 kpc
4.4"

1. Intro: galaxy clusters and evolution at low z
2. Strong morphological transformation: the jellyfish
3. Observing the gas component : HI and CO
4. Final remarks

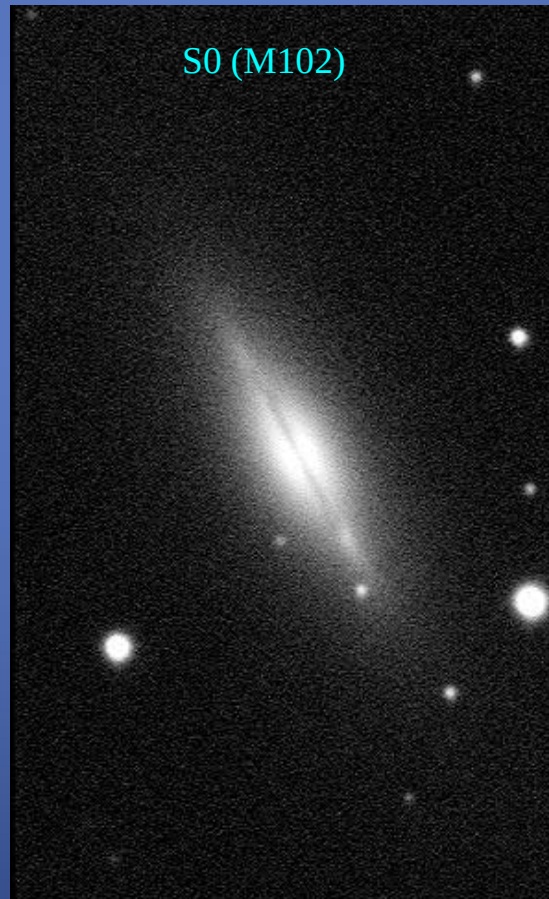
Figure 2. HI intensity contour map on a color *HST* image (F606W+F814W) of NGC 4921. Contours as in Figure 1. Note the highly asymmetric HI distribution with

Galaxies at high redshift are not always handsome! HUDF WFC3/IR

$z \sim 7$ ○
 $z \sim 8$ ○



Galaxies are well behaved at $z = 0$: the Hubble “tuning-fork” diagram



Strong transformation of spirals in clusters ($z = 0.2$)

B234908-262039 in A2667 ($z=0.2$)

HST-WFPC2 F450W, F606W, F814W

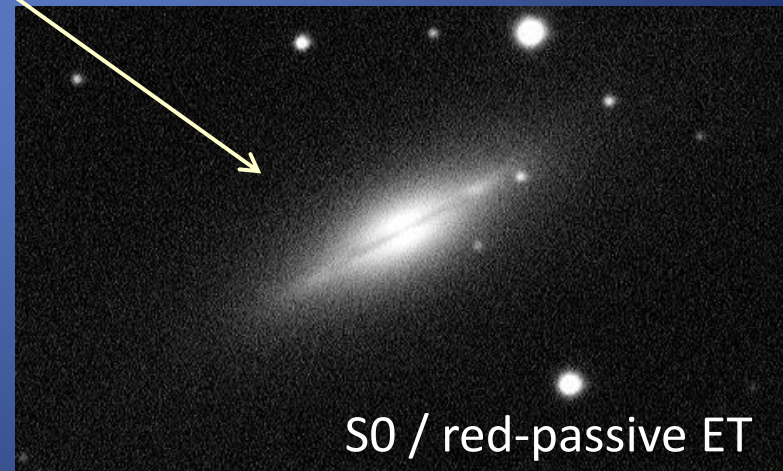
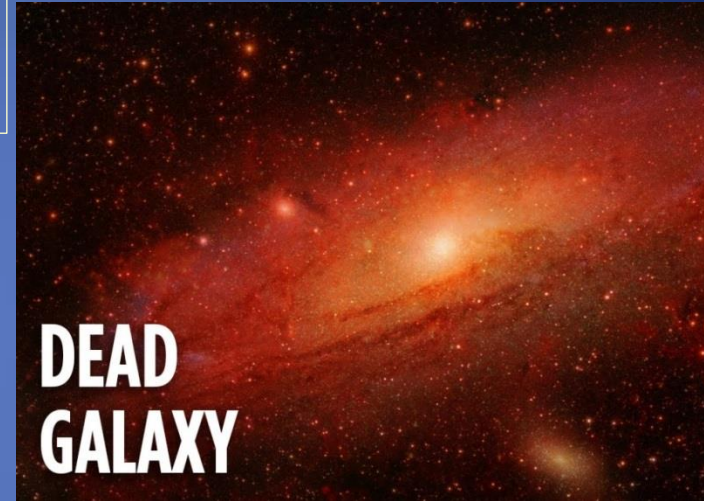
Cortese, Marcillac, Richard, Bravo-Alfaro, et al. 2007



Normal blue spiral

An evolutionary sequence?

The stages:
Starbursts?
Post-starbursts?
Disrupted?



The mechanisms:
RPS or tidal interactions?
Where?

The strategy

- A sample of nearby clusters ($z \leq 0.2$)
- Different physical conditions (L_x , mass, relaxation, etc.)
- Observe the whole volume (imaging) the HI
- Image the same field with opt-NIR telescopes.
- Analyse/quantify galaxy stellar asymmetries.
- Observe selected galaxies on CO
- Analyse the ICM (X-ray) distribution.
- Detect cluster substructures →

... hints on galaxy evolution,
individually and statistically

Part 2. Strong transformation seen in the optical



A dozen more in Coma

Yagi et al. 2010 (@ Subaru)

Extended emission line regions in Coma

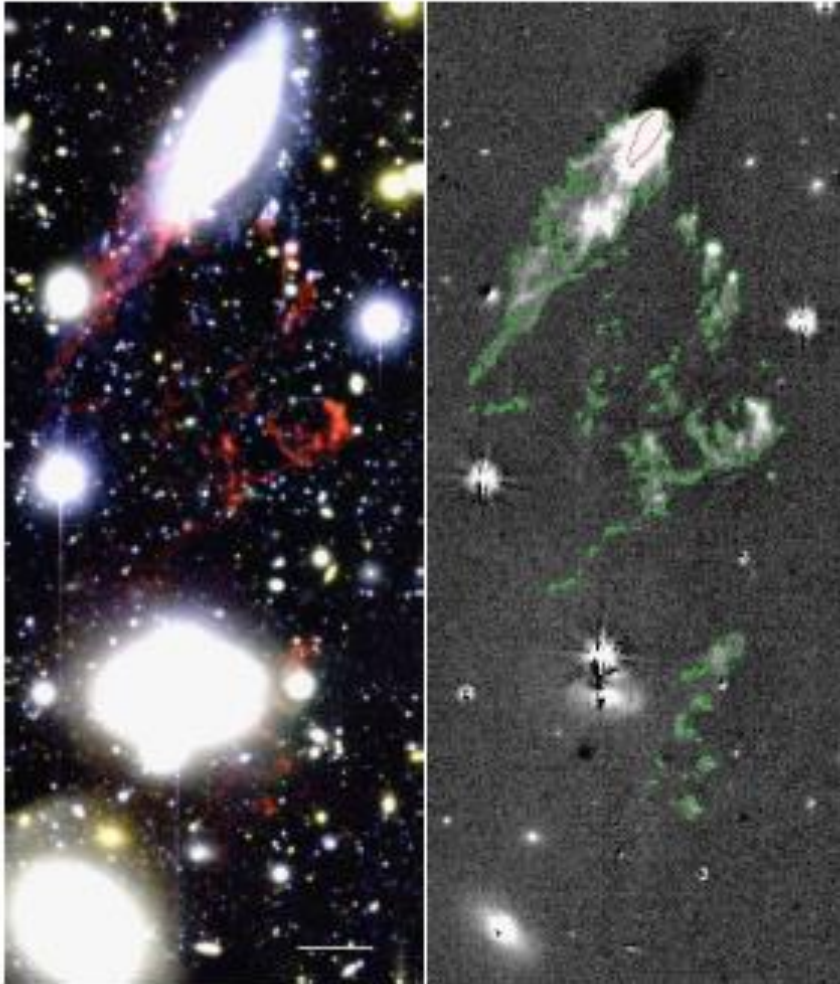


FIG. 4H.— Same as Figure 4A, but of GM12559.

16

Yagi et al.

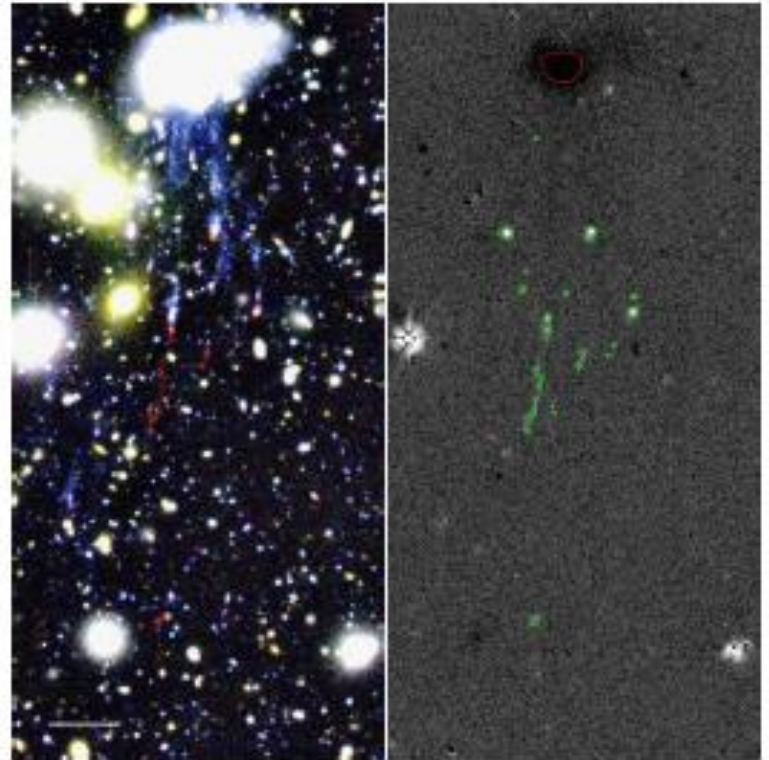


FIG. 4L.— Same as Figure 4A, but of GM14091.

Abell 2667
HST F606W

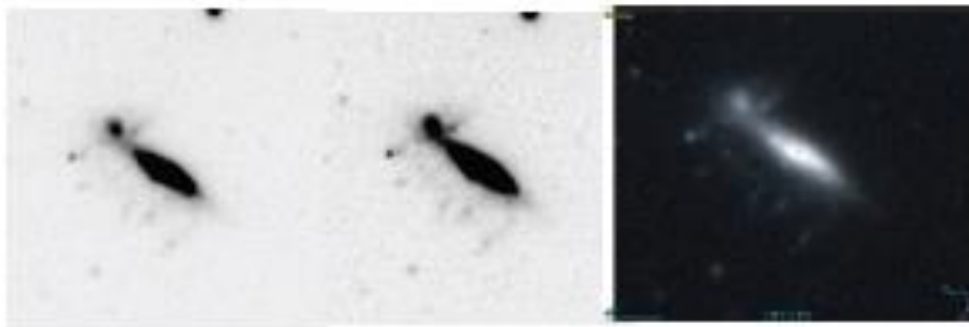
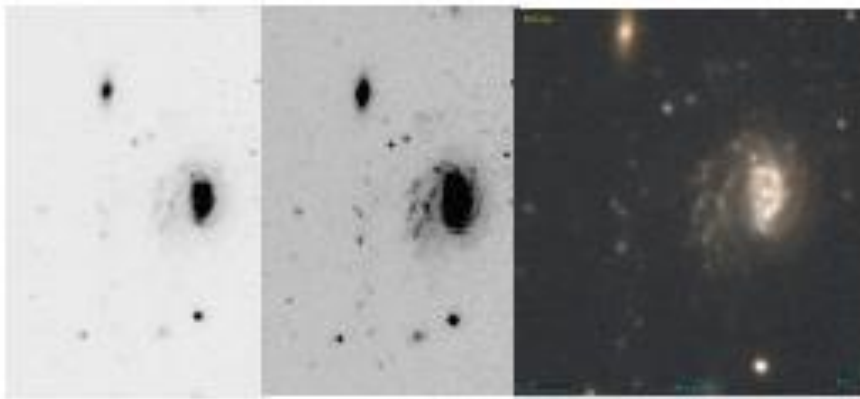
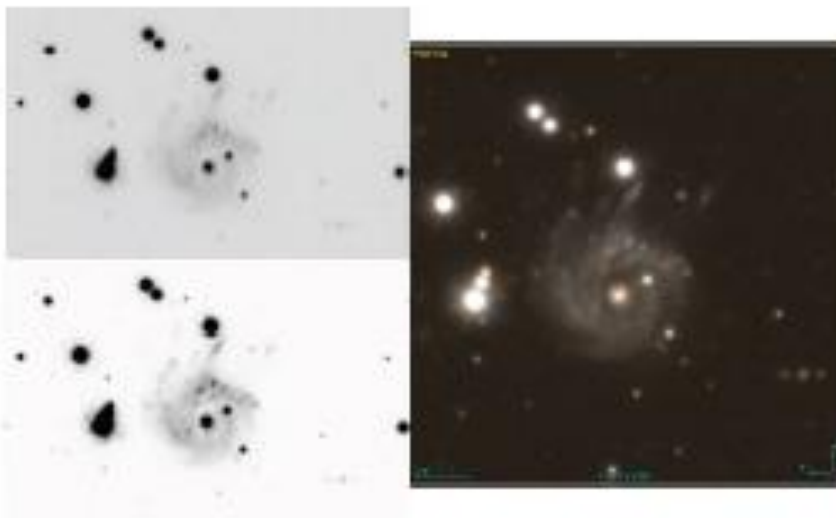


20 arcsec

A2667_A
Pos.Angl 89°

A2667_B
Pos.Angl 96°



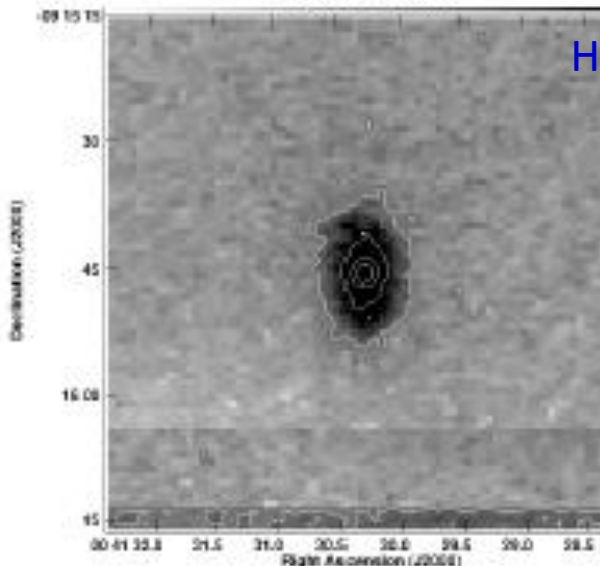
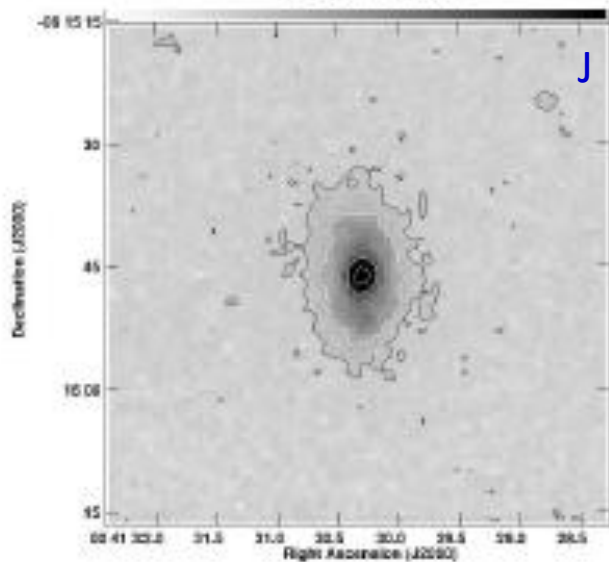
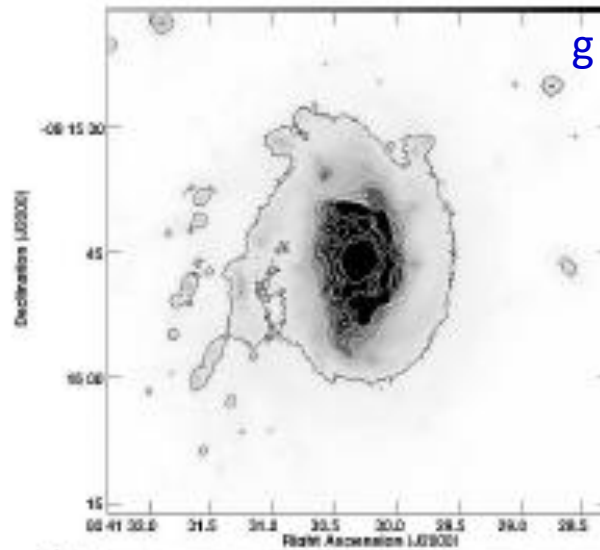
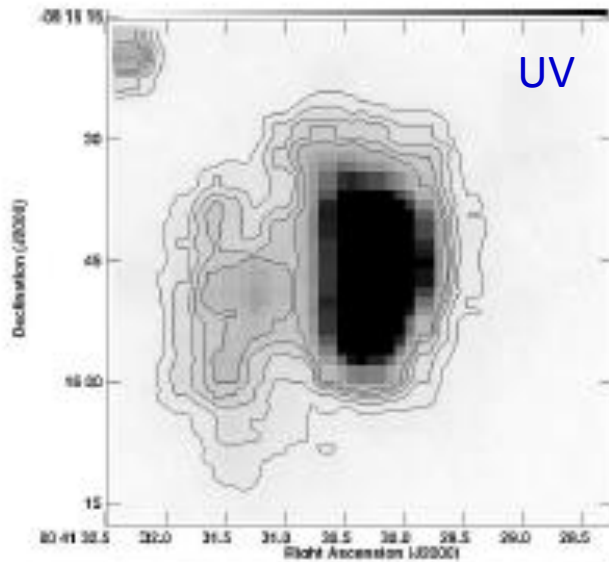


Poggianti et al. 2016 (WINGS,
BUDHIES... GASP @ MUSE

Our data... so far

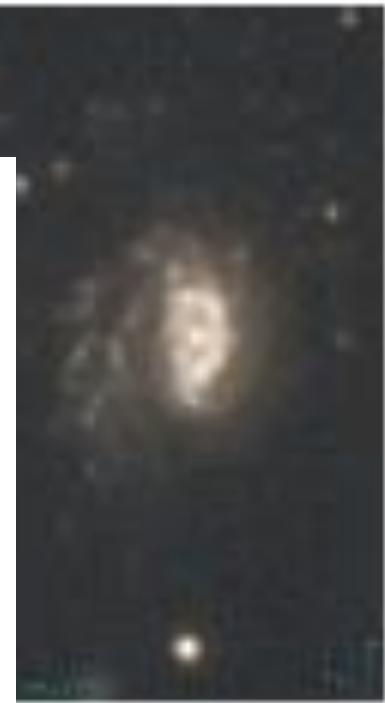


KAZ 364 @ A85



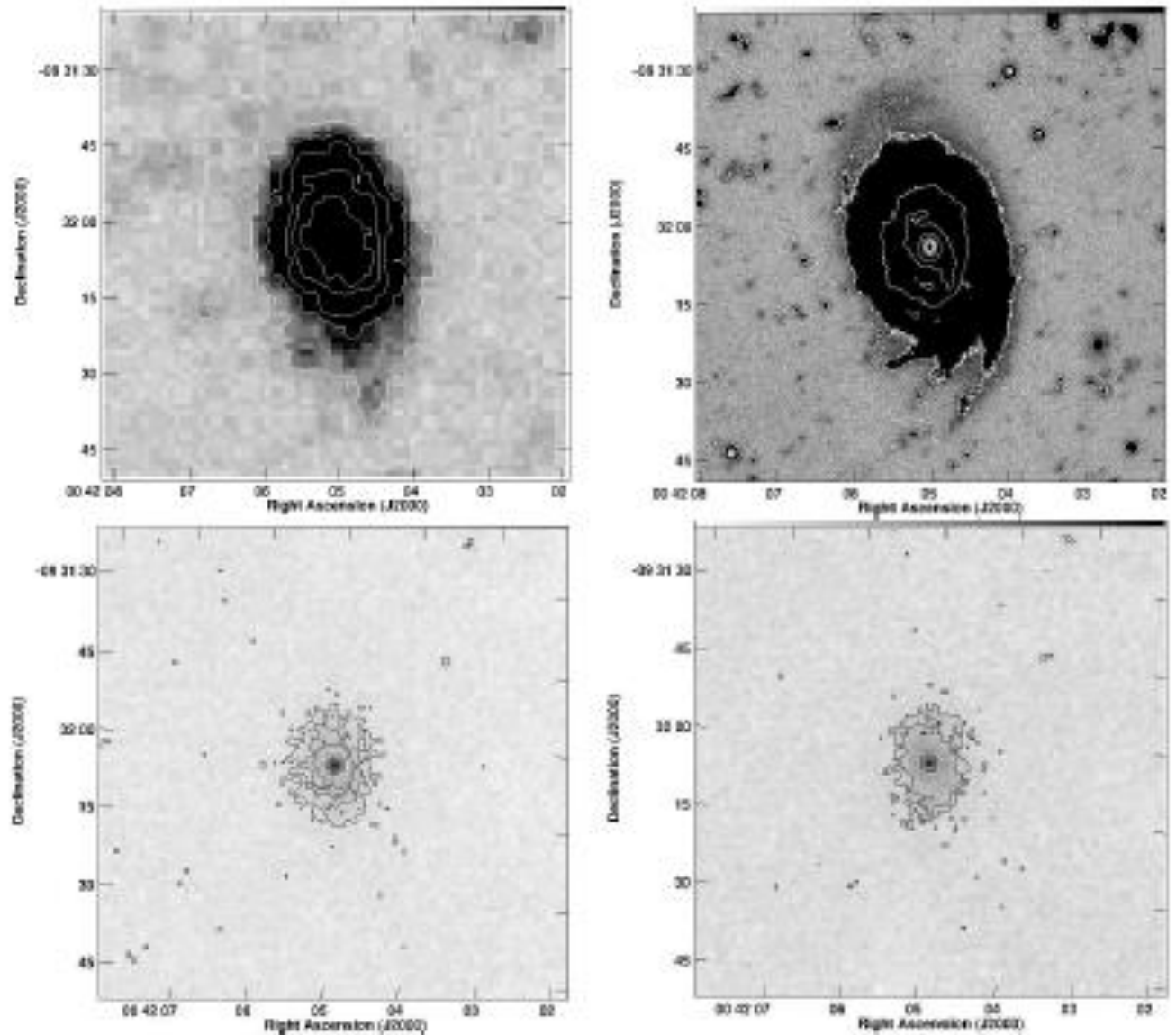
No old stars found
along the filaments

→ the blue stars
must be formed in
situ, after a strong
gas sweeping
event (RPS)



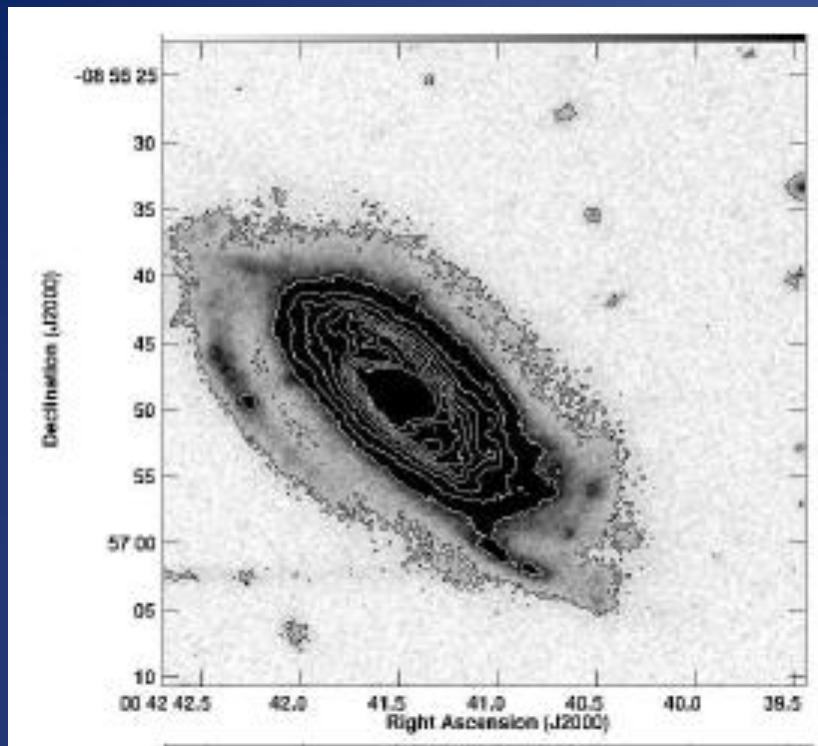
A85[ADF98]286

A second jellyfish, seen in a “younger” stage than KAZ364. This is a very HI deficient object.



In total three jellyfish galaxies in A85 have no red stars along the peculiar arms (until our limit of $22.4 \text{ mag arcsec}^{-2}$ in J-band) → **RPS seems to be very active in A85**

But.... !!

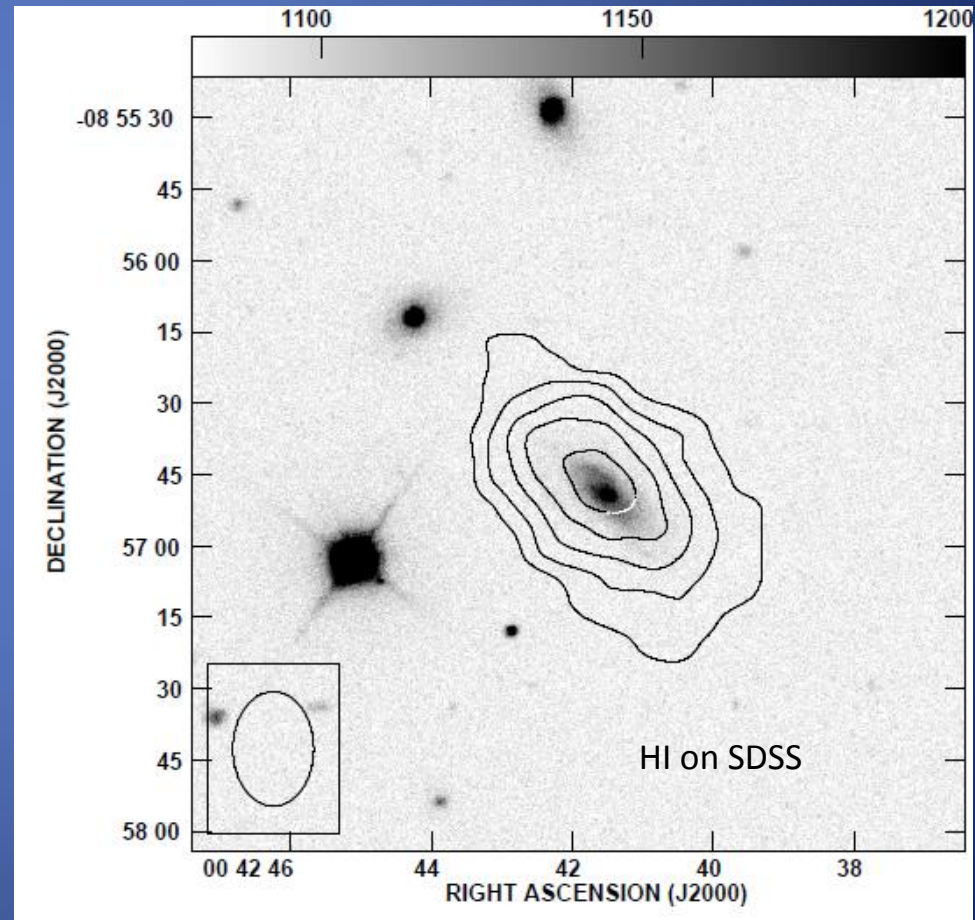


CFHT-g

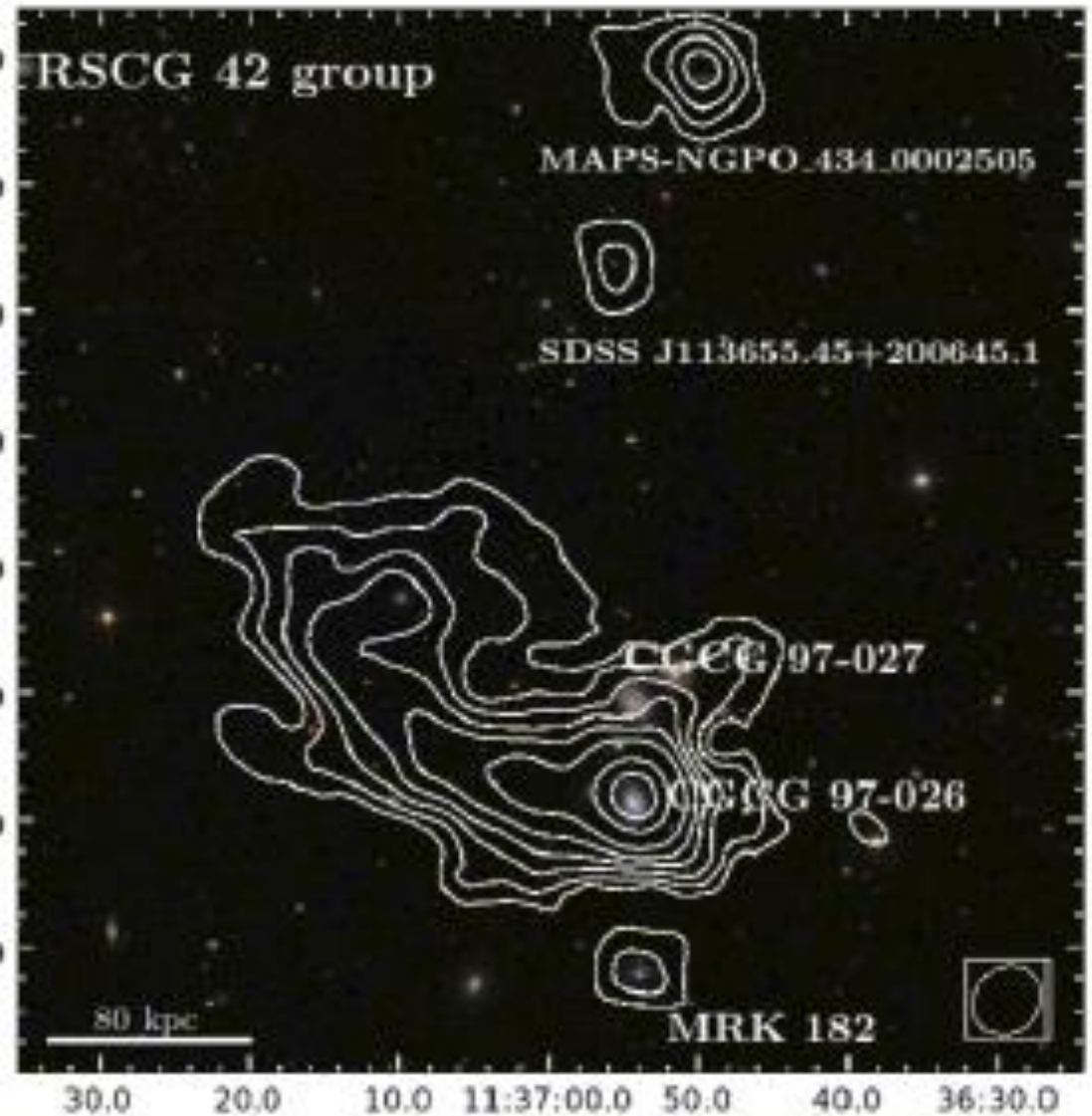
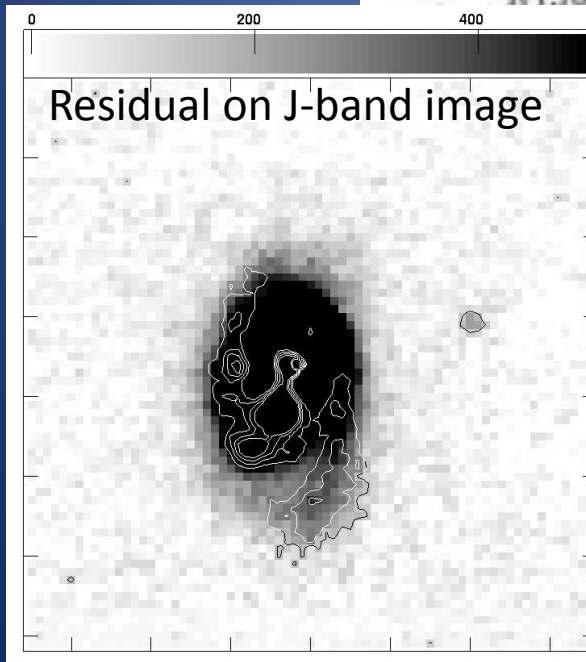
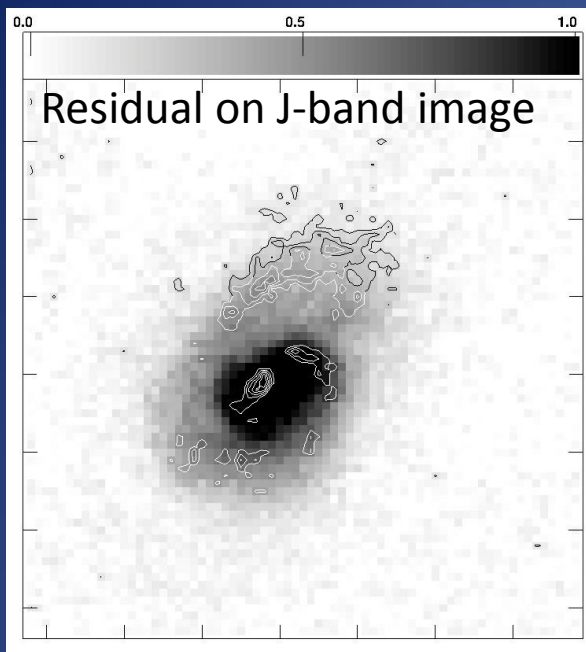
A85[ADF98] 374

A candidate to jellyfish in A0085,
appears NORMAL in HI....!!

So far, very few jellyfish have
been observed in HI.



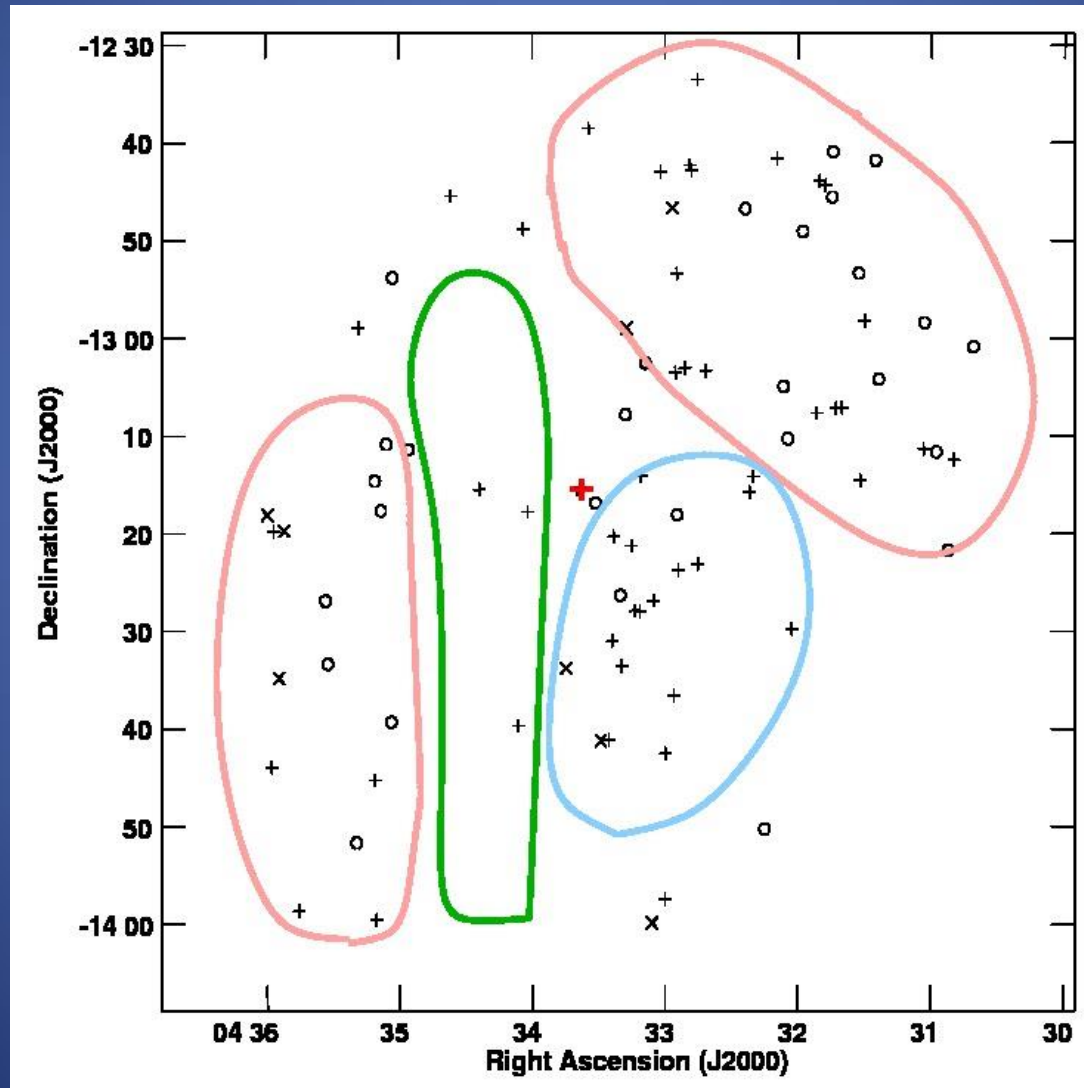
Asymmetry analysis on Abell 1367 (Coma super cluster)



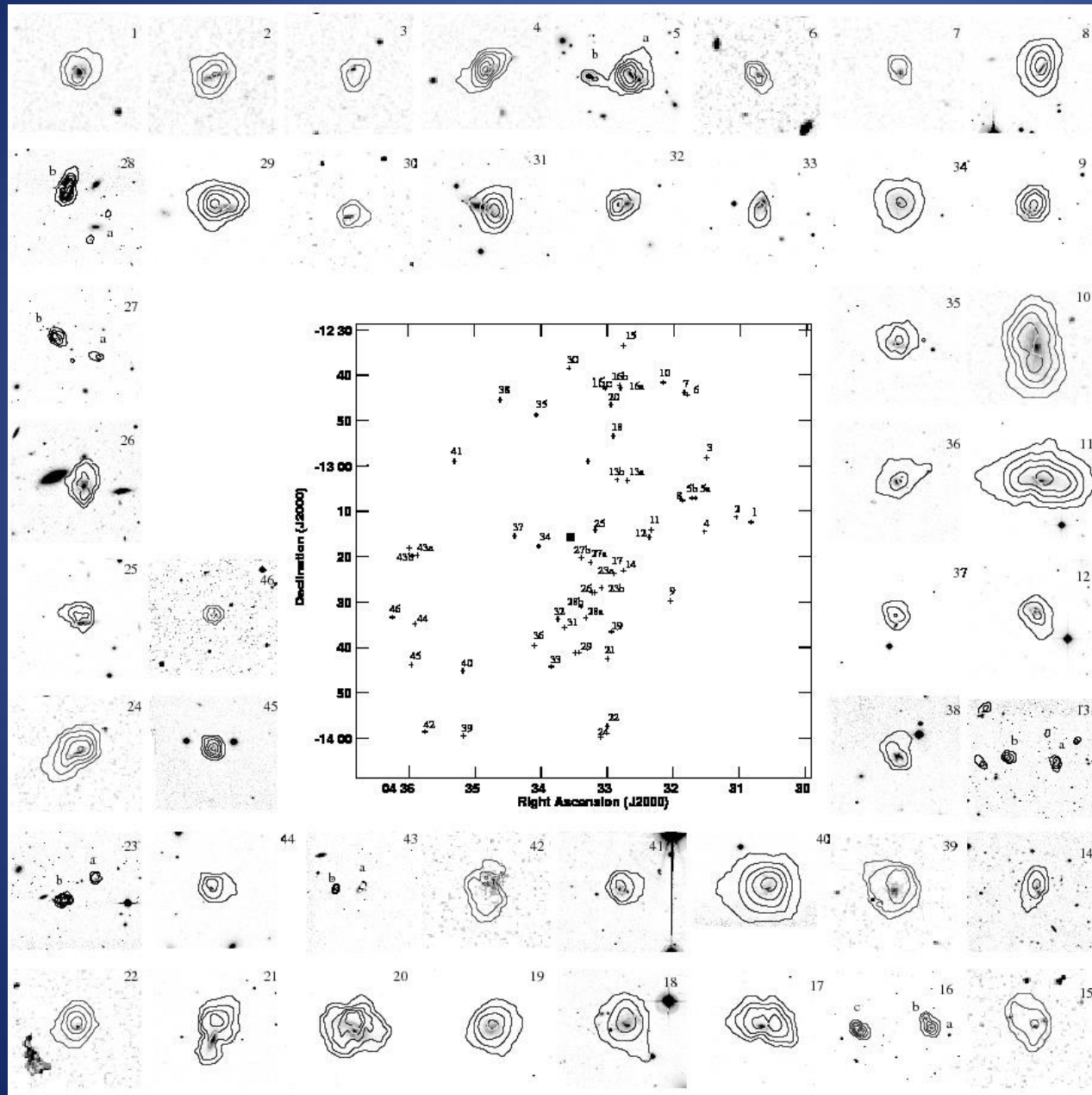
Scott, Bravo-Alfaro, Venkatapathy et al. in prep.)

Full LTG distribution across A496

- Pink zone: perturbed in HI and normal in NIR : RPS
- Blue zone: perturbed in HI and perturbed in NIR : tidal



Part 3: what does the gas can tell

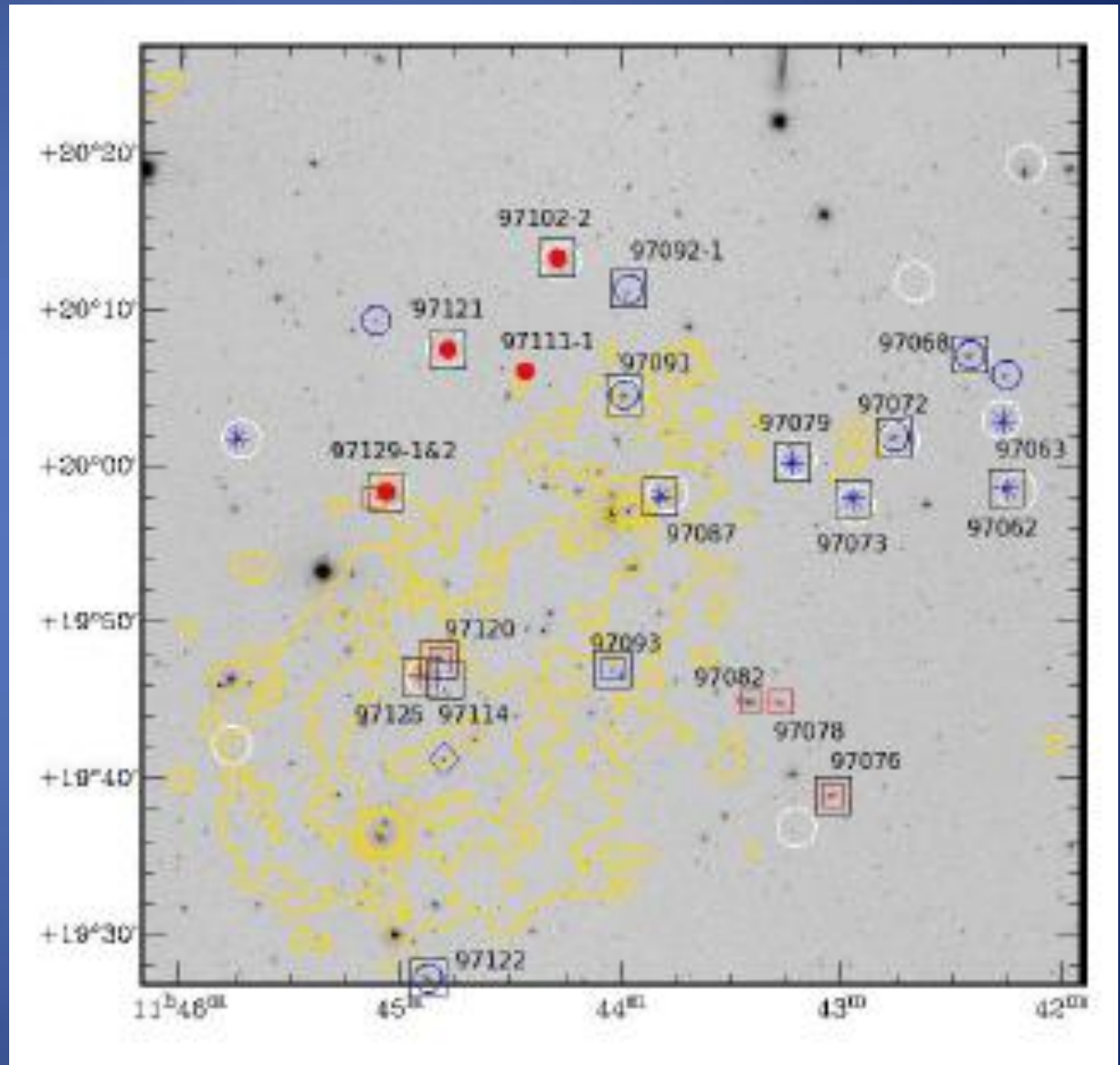


The full HI in Abell 496

- 58 HI detections
- 20% - 30% show disruptions :
- Gas deficiency, asymmetry, and/or optical offset.

30m IRAM survey: H₂ content, gas asymmetries.

19 CO detections , 5 H₂ deficient ones and 3 non-detections (Scott et al. In prep)



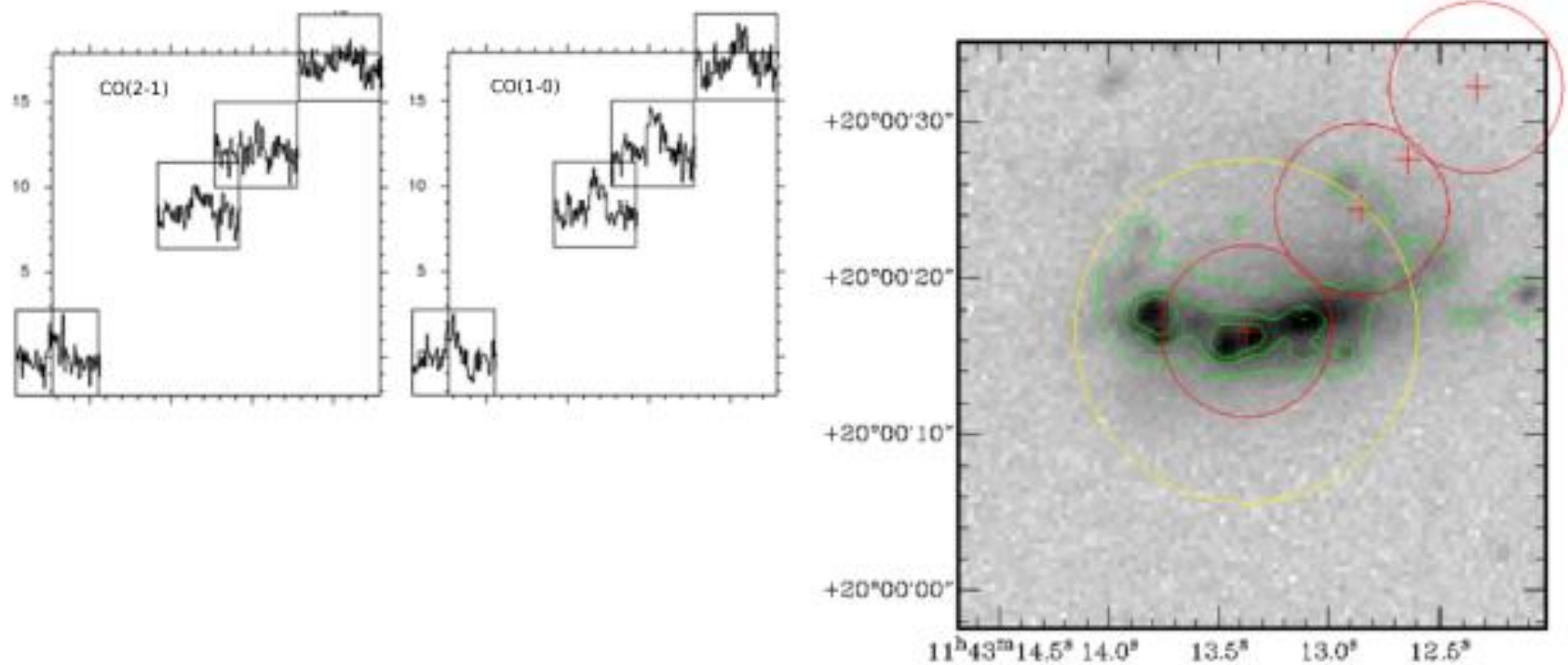
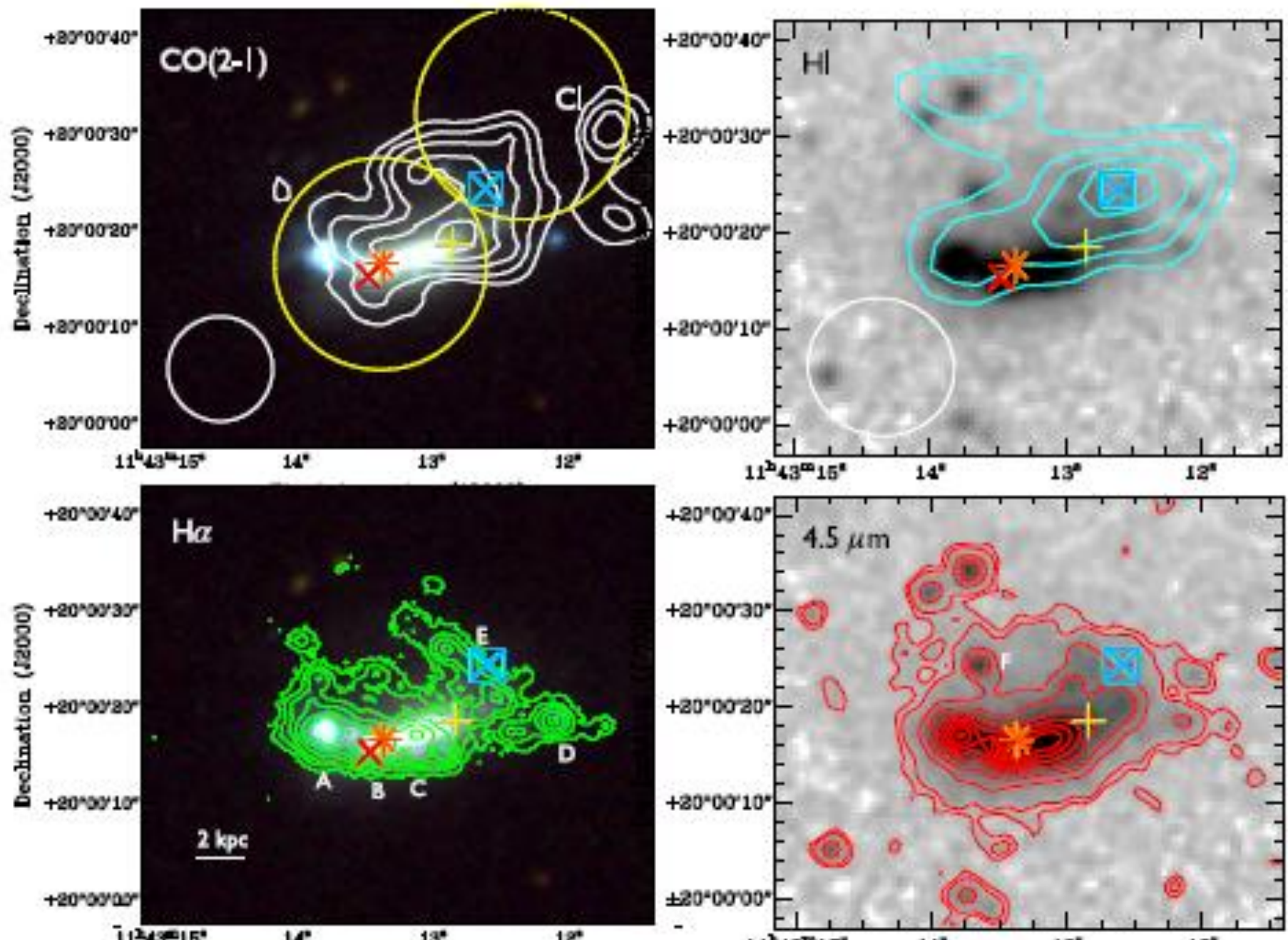


Figure A4. CGCG 097-079 CO ($J = 2 \rightarrow 1$) spectra (left) and CO ($J = 1 \rightarrow 0$) spectra (centre), with the (0,0) position at the galaxy's optical centre; the α and δ offsets are in arcseconds. The image is an SDSS r -band. The yellow circle indicates the size of the 2.6 mm beam at the central pointing position. Red crosses indicate the position of a 1.3 mm observation with a red circle added to indicate the size of the 1.3 mm beam if CO ($J = 2 \rightarrow 1$) was detected at that position. Green contours trace H α emission from GOLDMine.

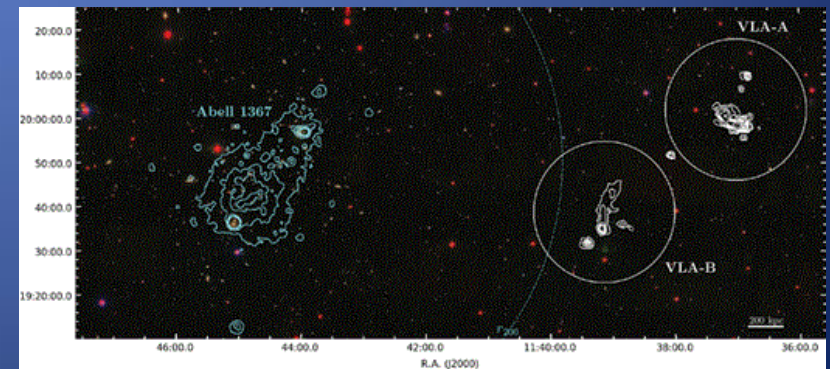


Thoughts and ideas

Many galaxies have
some secrets.....



FGC 1287 triplet. NRAO-
VLA HI map :
250 kpc gas tail
(Scott et al. 2012)



Thoughts and ideas

- Not all interesting stuff is happening at high redshift!!
- Multi- λ
- Deep imaging in NIR (rather than opt) to inspect for tidal interactions
- MOS (optical) and LMT

Questions

- Disrupted galaxies: is it a rather common phenomena?
- What are the physical conditions around jellyfishes?
- If RPS is to blame... why some appear with normal HI ?
- How RPS can be so strong without a dense/hot ICM?
- Pre-processing or LSS environment?

Gracias!
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