

Local *XMP* galaxies
 Cool Flows driven SF in *tadpoles*
Casiana Muñoz-Tuñón



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- *Bruce Elmegreen (IBM- NY)*
- *Debra Elmegreen (Vassar Colege, NY)*

Morphologies in the UHDF

Tadpoles

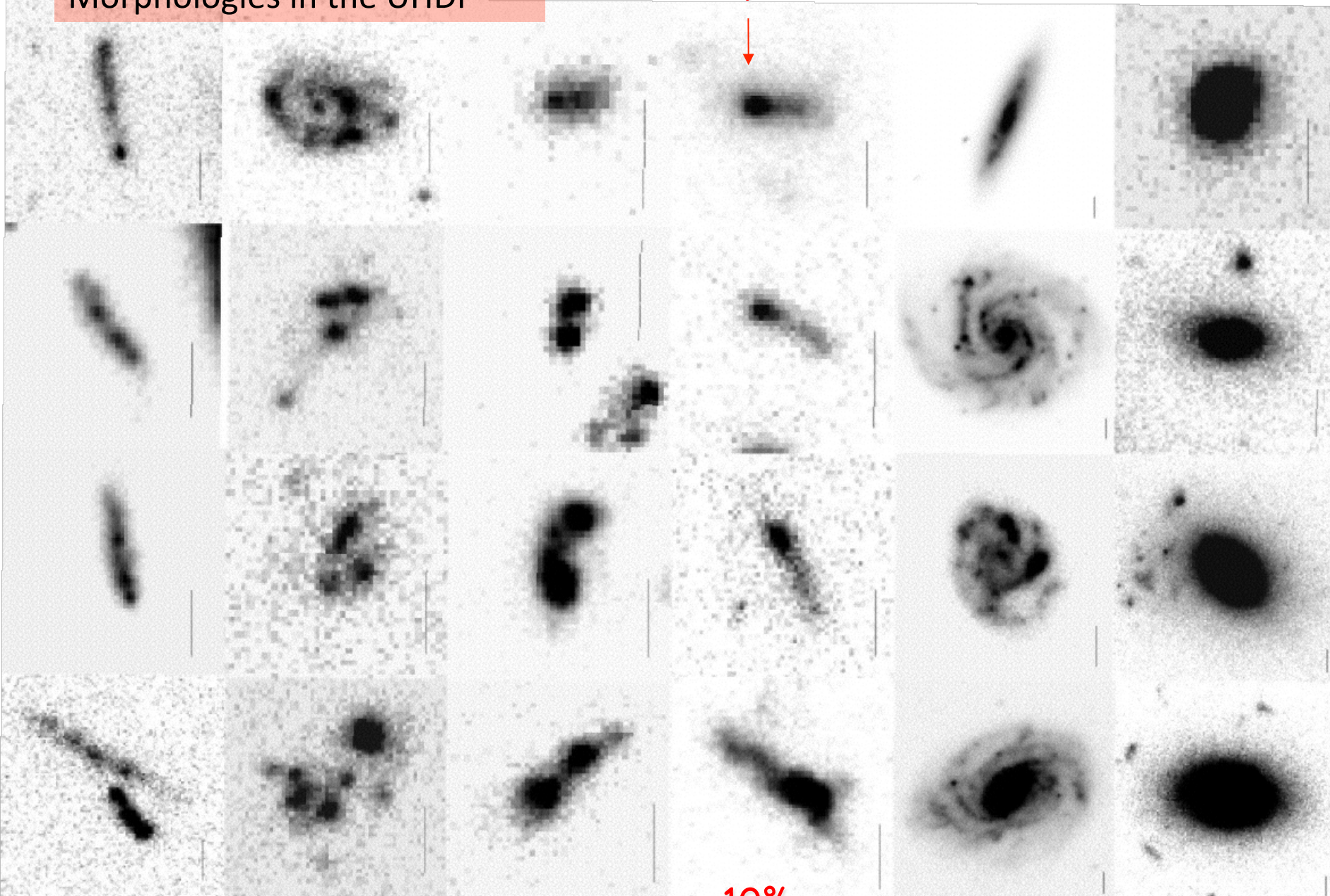
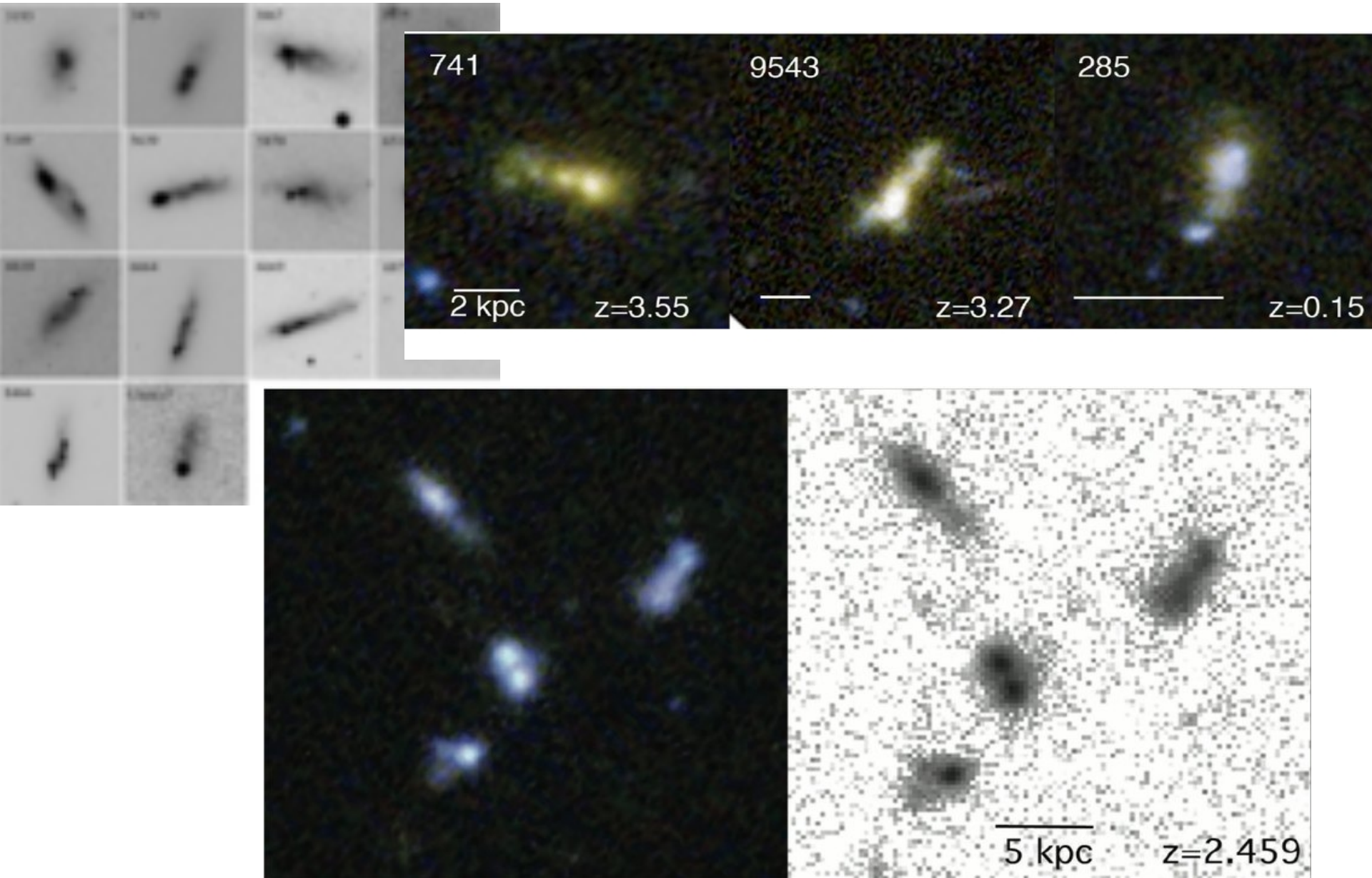
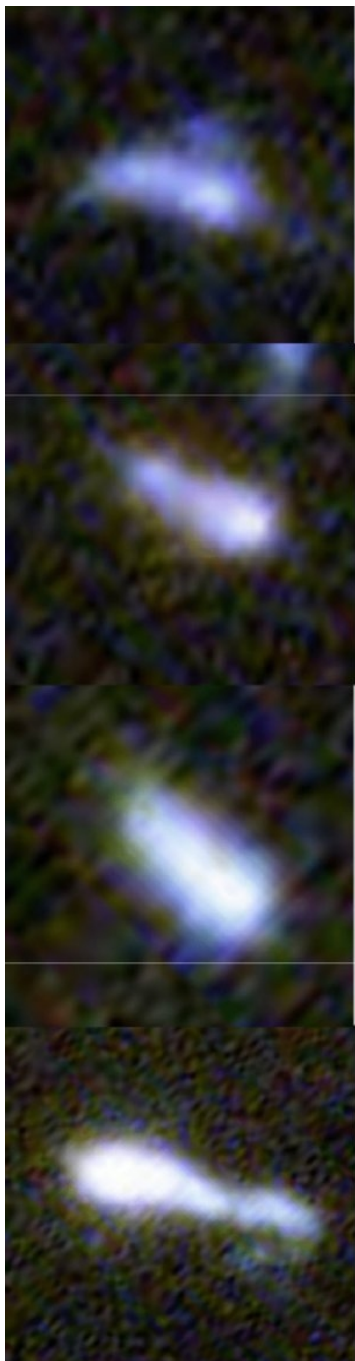


Figure 12 from Tadpole Galaxies in the Hubble Ultra Deep Field
Bruce G. Elmegreen and Debra Meloy Elmegreen 2010 ApJ 722 1895 doi:10.1088/0004-637X/722/2/1895





3819 $z=1.63$

5358 $z=2.16$

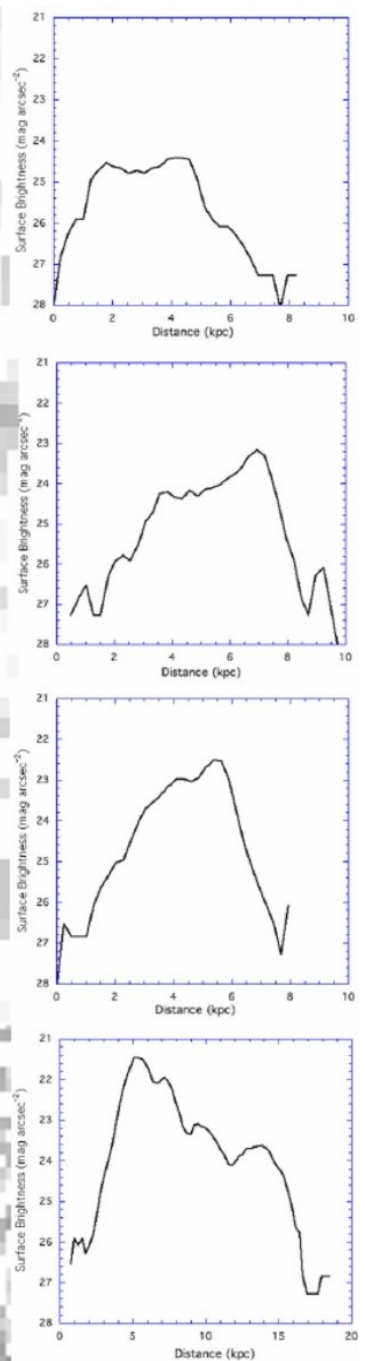
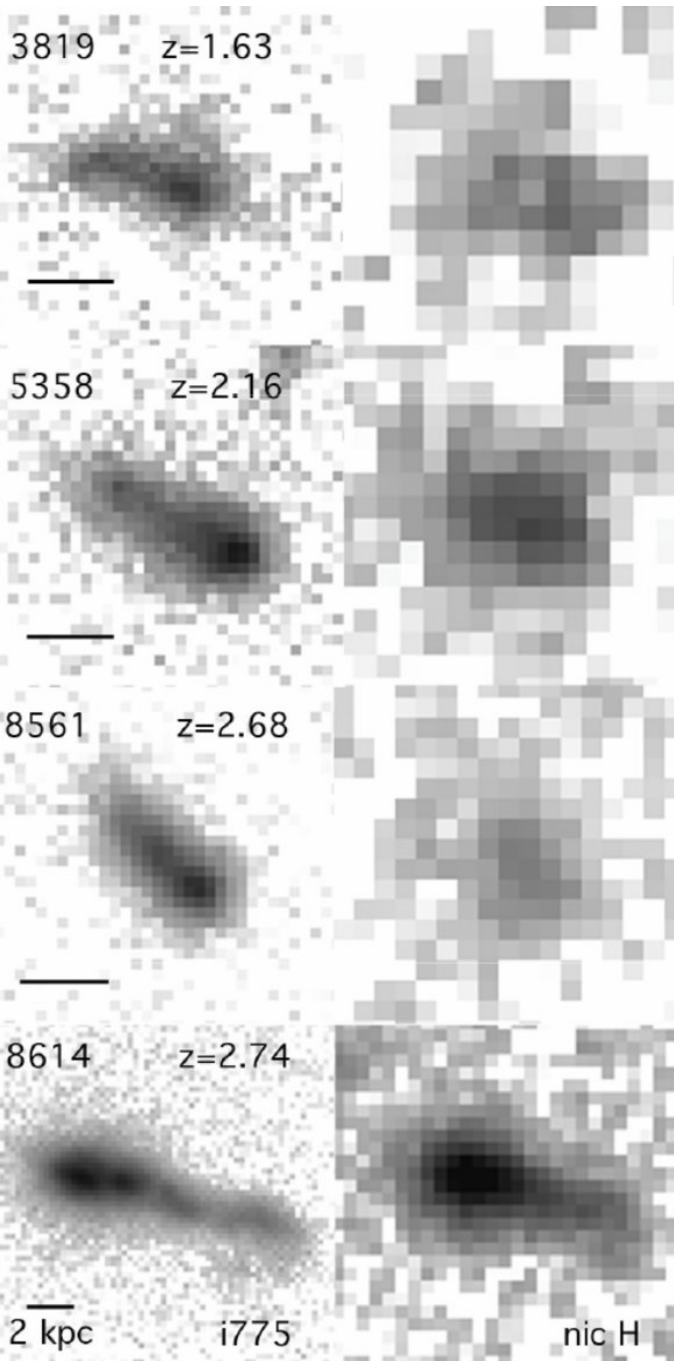
8561 $z=2.68$

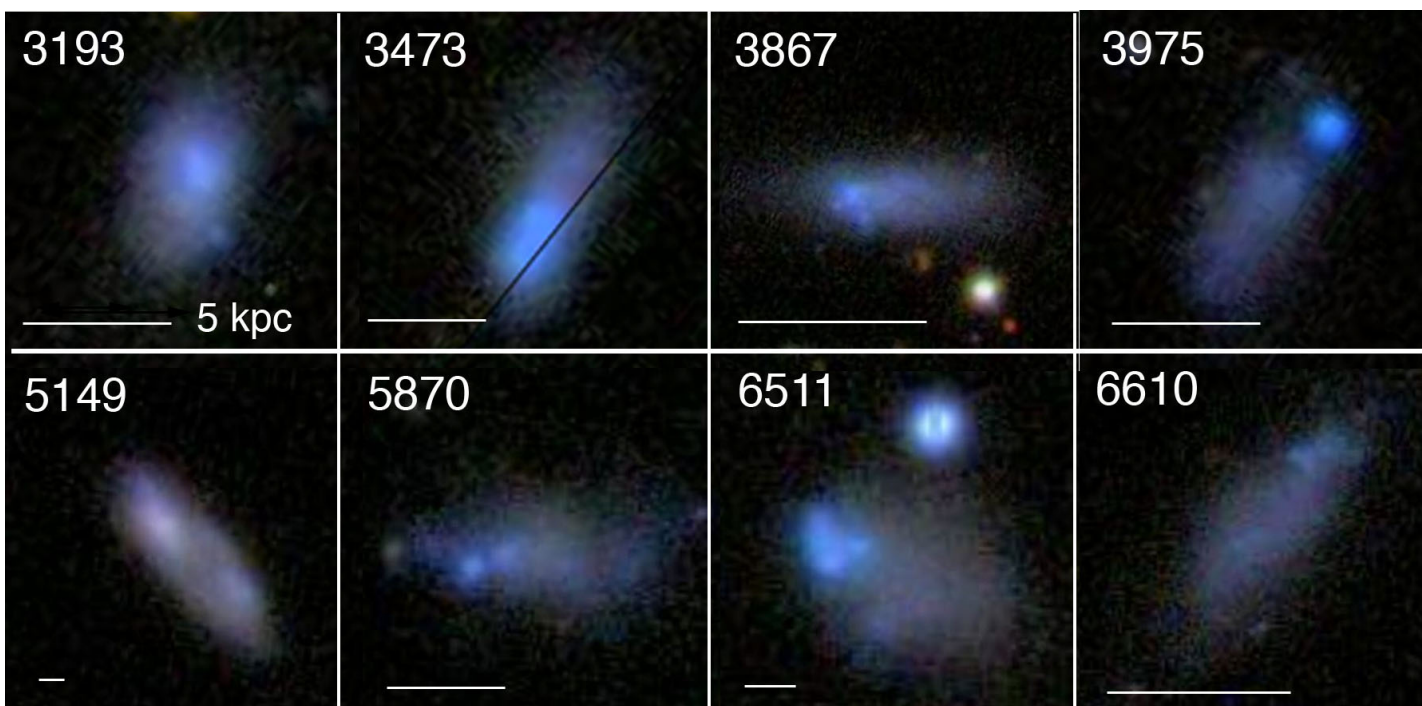
8614 $z=2.74$

2 kpc

i775

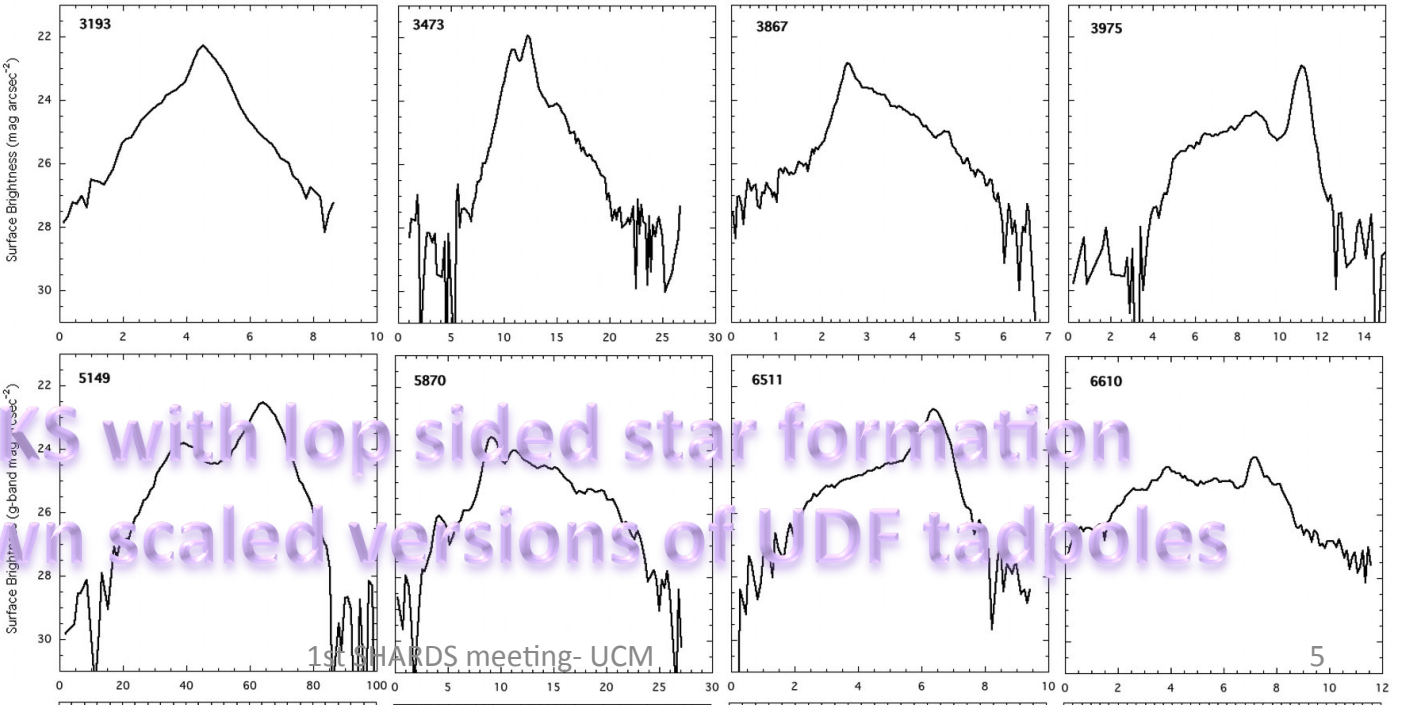
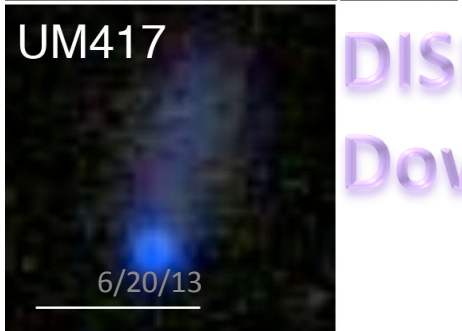
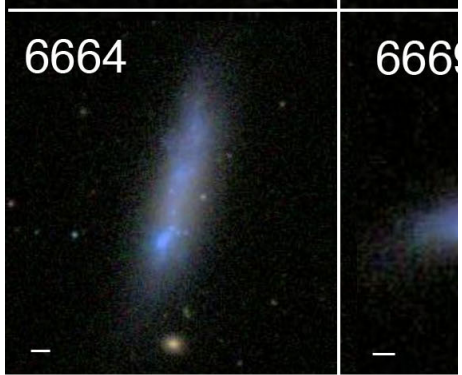
nic H





- UM and KISO archive of bright UV galaxies.
- Sloan and H-UDF

Elmegreen, D. et al.,
2012, Ap.J., 750, 95.



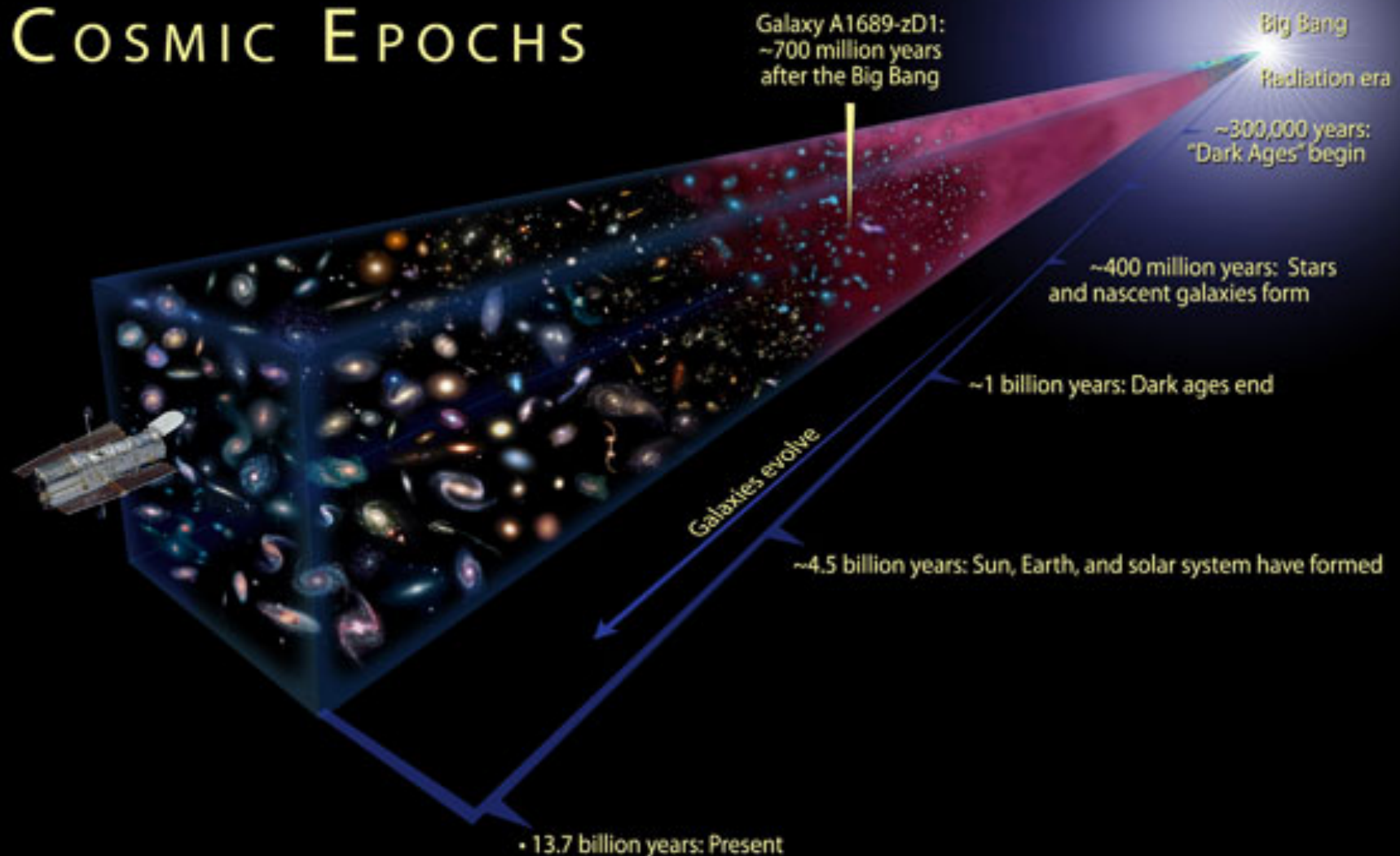
DISKS with lop sided star formation
Down scaled versions of UDF tadpoles

1st CHAIDS meeting - UCM

5

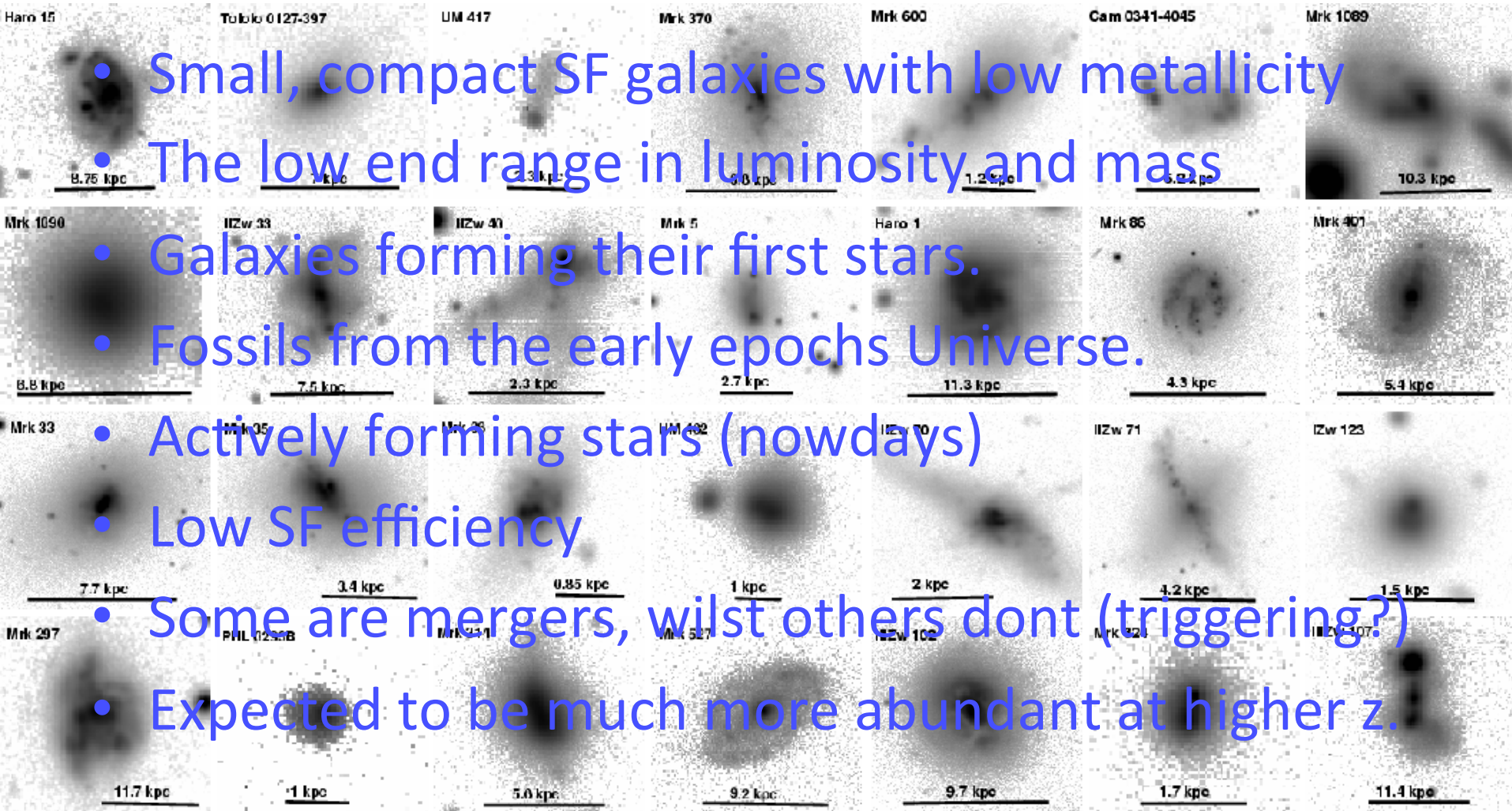
Dwarf Galaxies

COSMIC EPOCHS



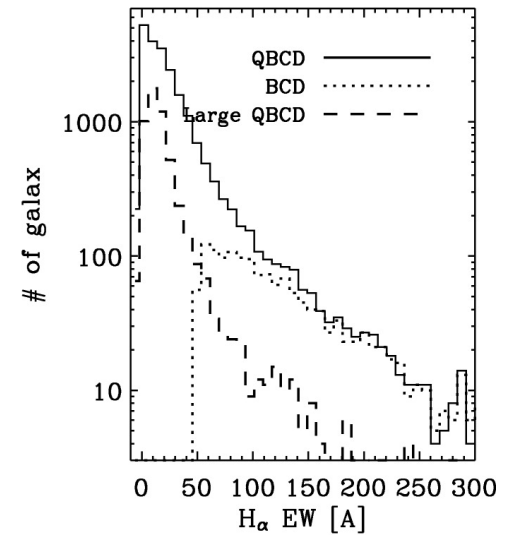
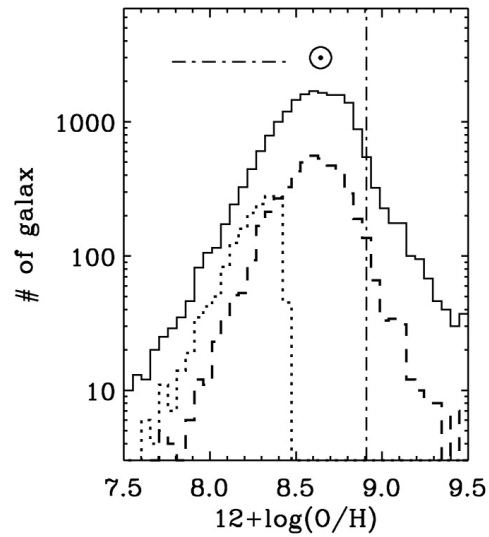
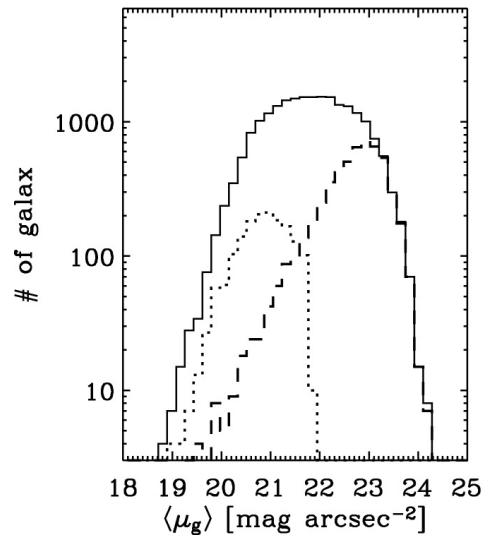
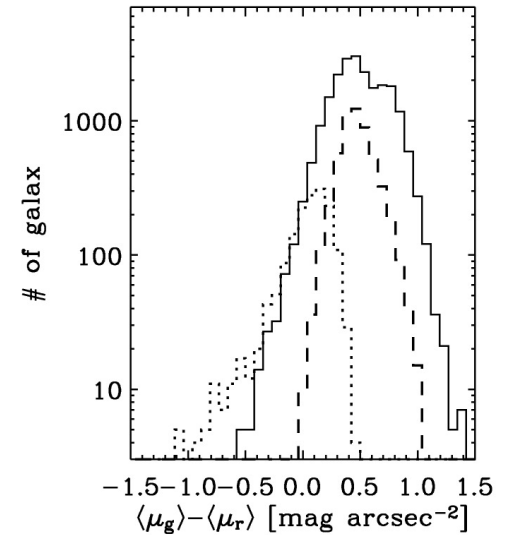
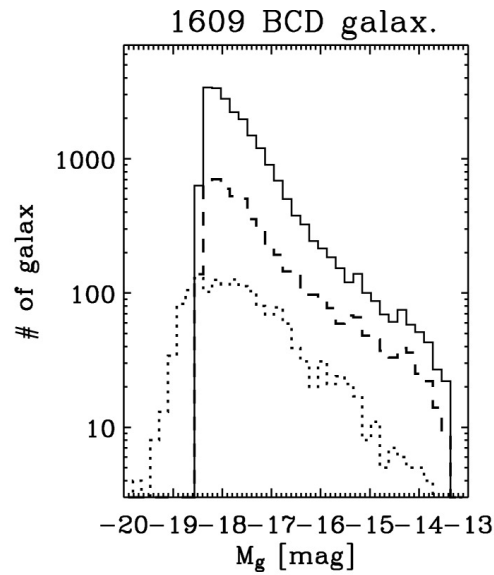
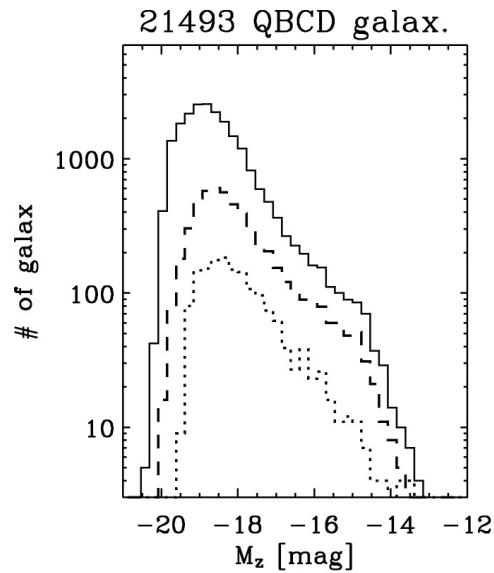
Blue Compact Dwarfs (BCDs) (Cairós sample; Amorín)

- Small, compact SF galaxies with low metallicity
- The low end range in luminosity and mass
- Galaxies forming their first stars.
- Fossils from the early epochs Universe.
- Actively forming stars (nowdays)
- Low SF efficiency
- Some are mergers, whilst others dont (triggering?)
- Expected to be much more abundant at higher z.



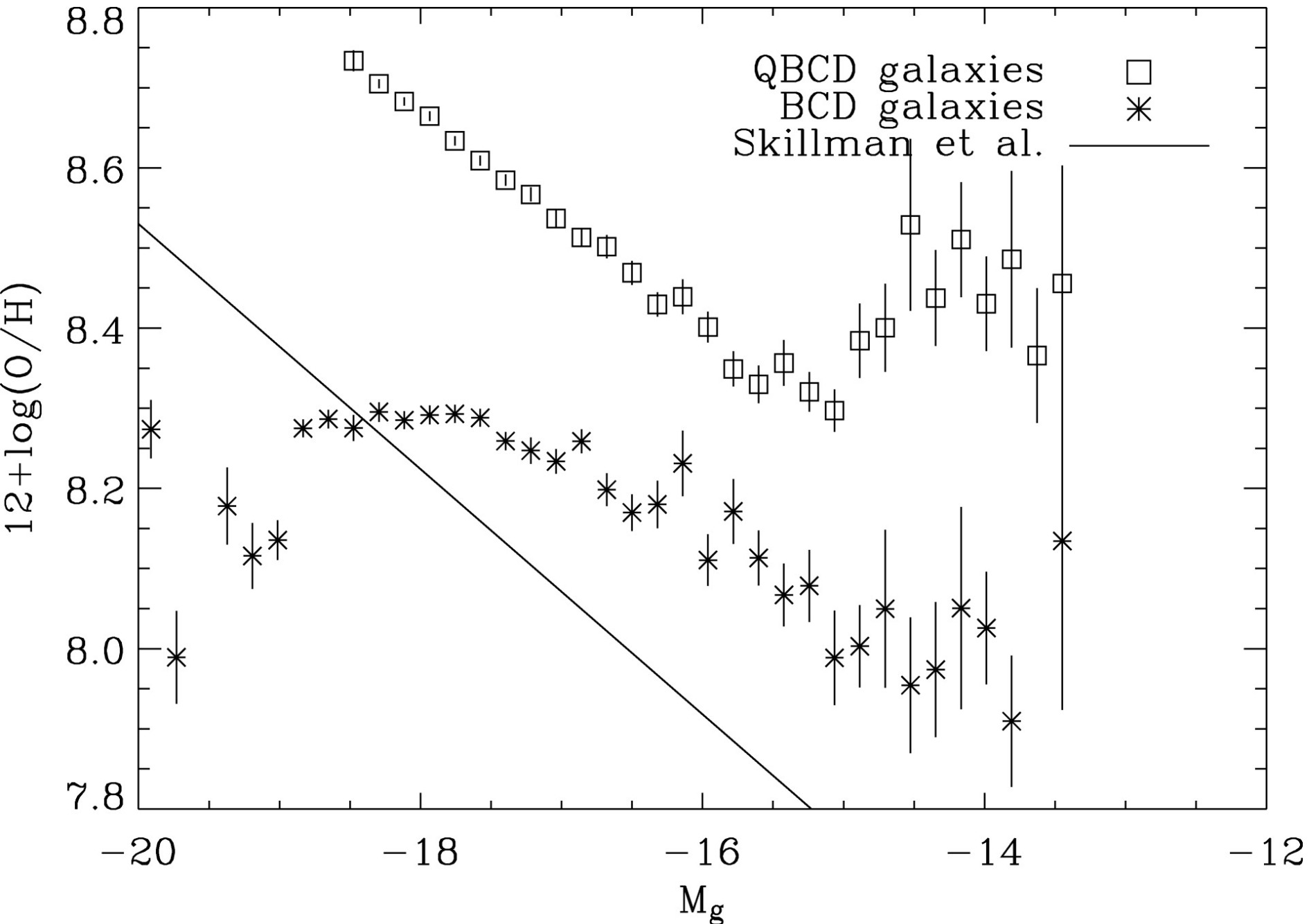
Search using the SDSS

- Blue Compact Dwarf Galaxies (BCDs) (DR6)
- Systematic Search for Quiescent BCDs (21.500 glxs)
- Automatic Classification of Sloan Spectra (DR7)
- Search for XMP targets.
- Complete census of the nearby BCDs, QBCDs and XMPs



BCDs and QBCDs in SSDS DR6

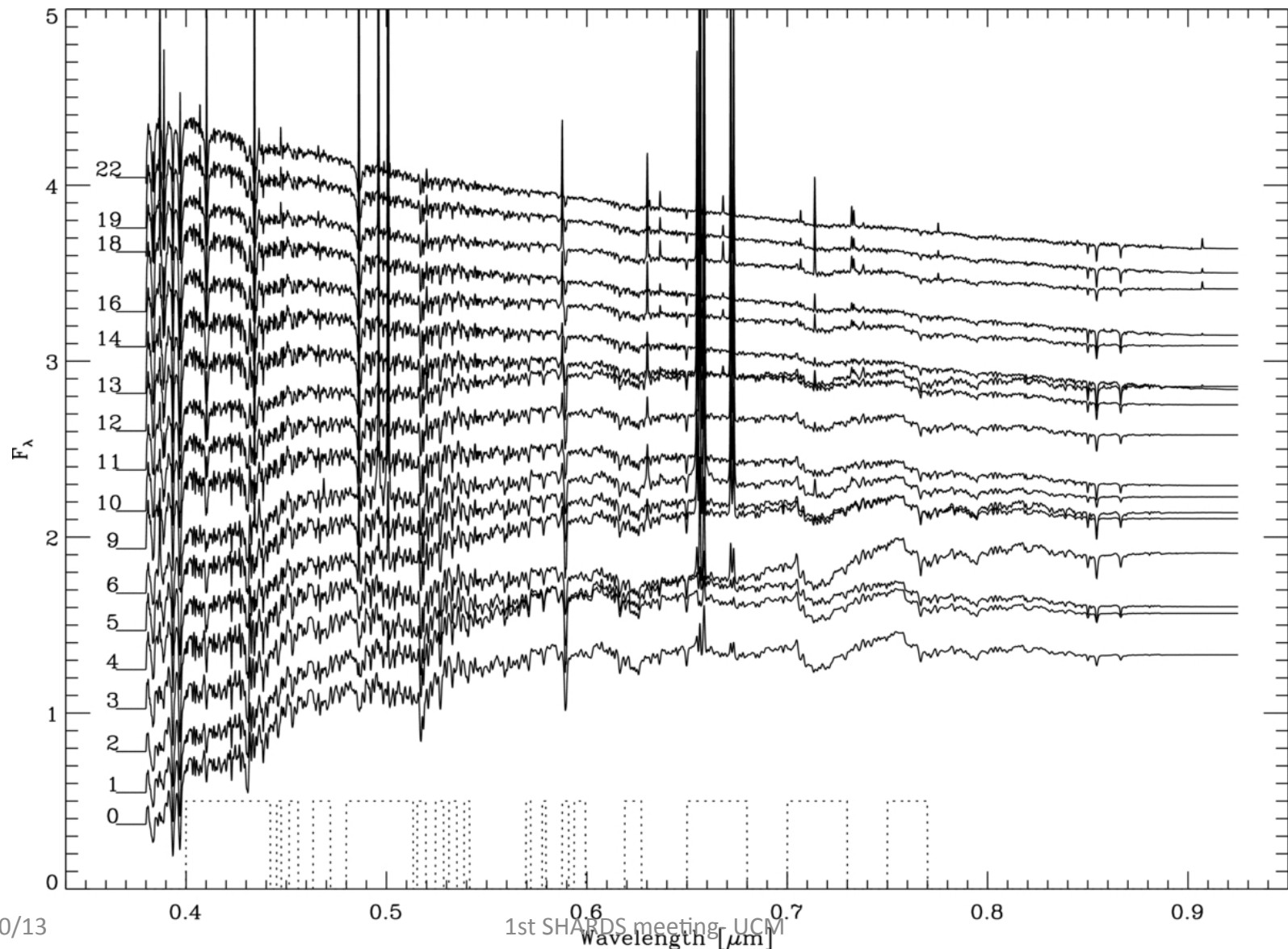
(SA, MT *et al*, 2008, *ApJ.*, 685, 198-210)



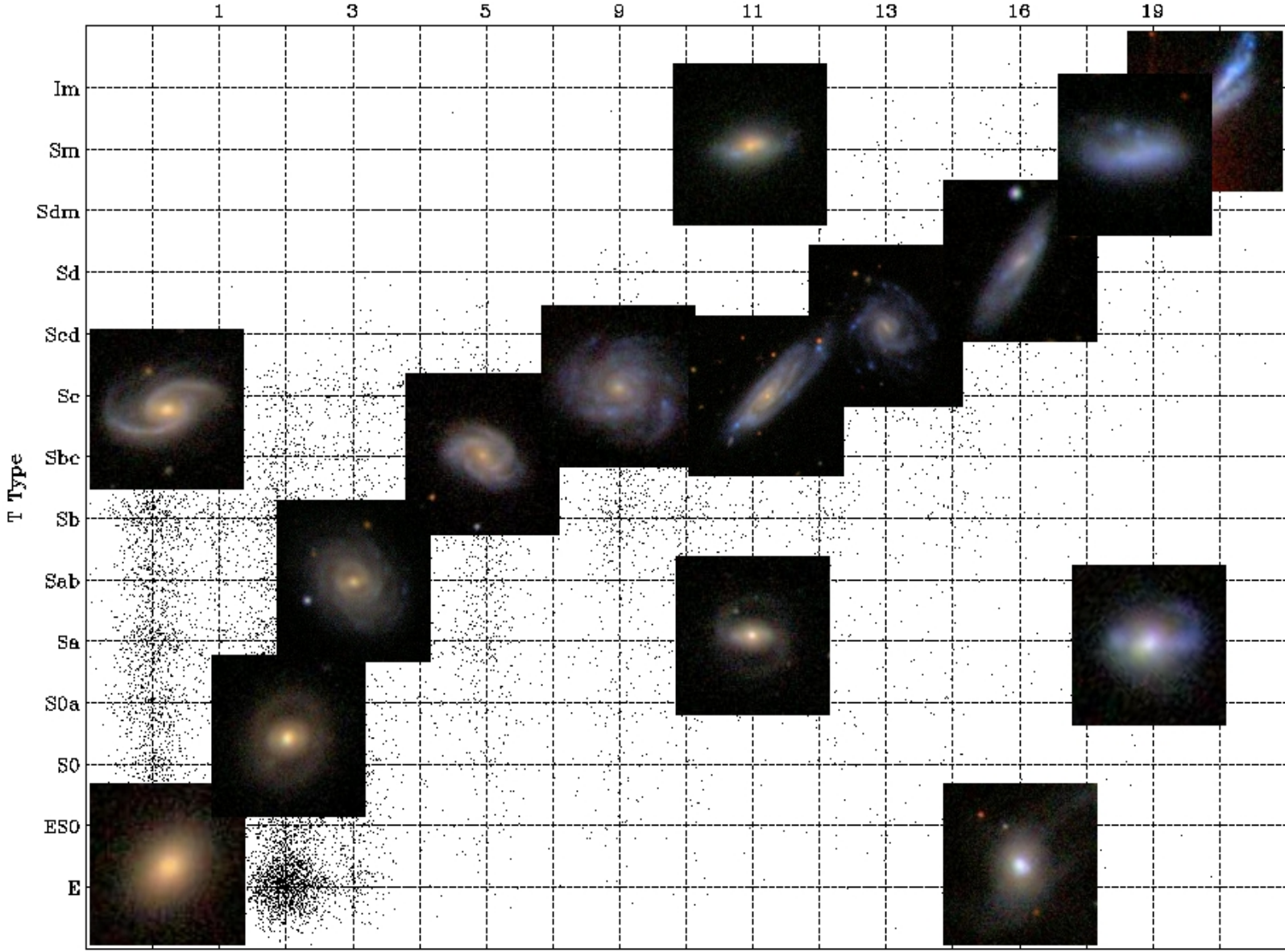
Automatic Unsupervised Classification of All Sloan Digital Sky Survey DR 7 Galaxy Spectra

SA et al. 2010 ApJ 714 487

Some 930.000 galaxies Using K-means cluster analysis algorithm

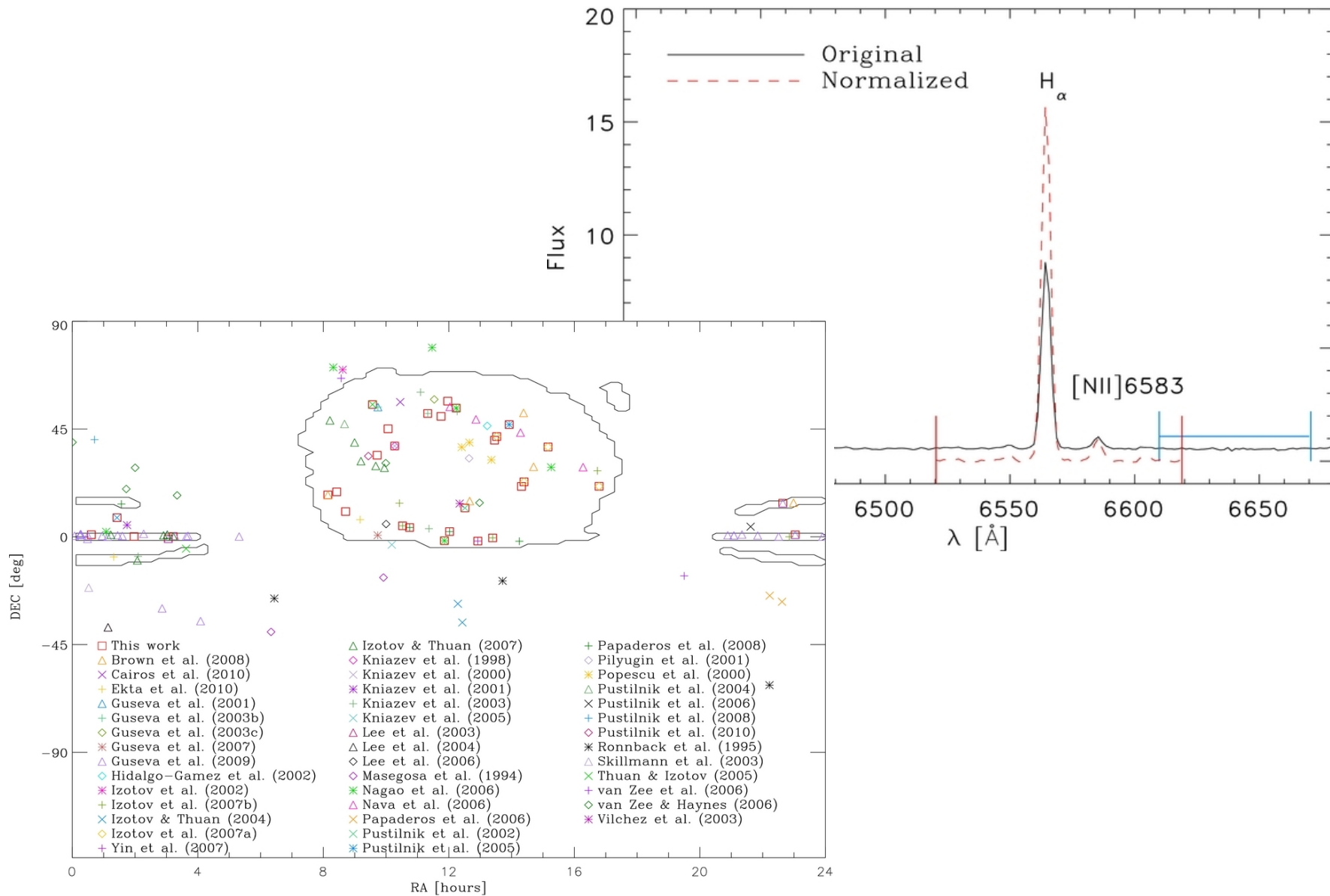


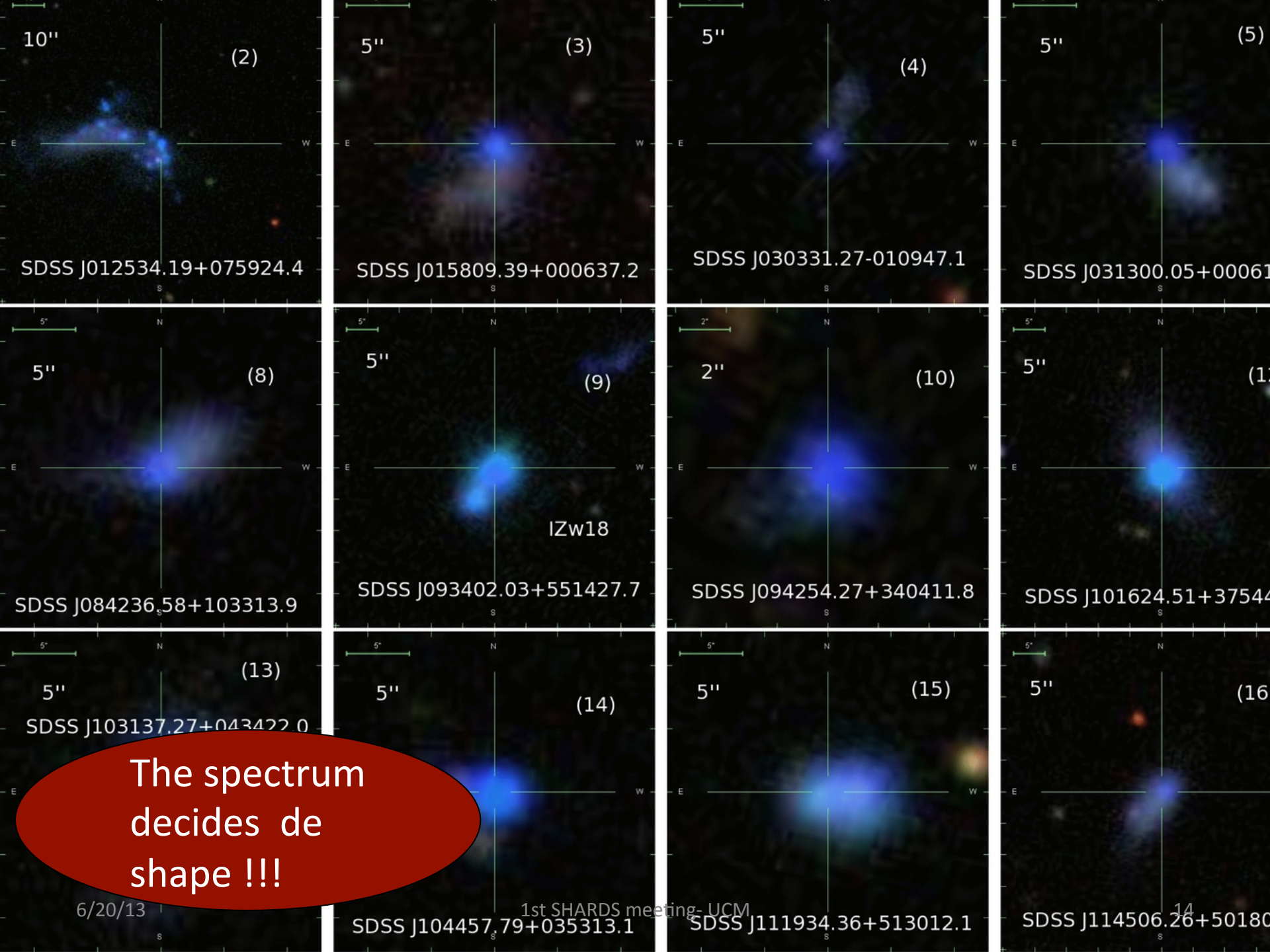
Spectra and morphological types match



1 3 5 9 11 13 16 19

Im
Sm
Sdm
Sd
Scd
Sc
Sbc
Sb
Sab
Sa
S0a
S0
ESO
E

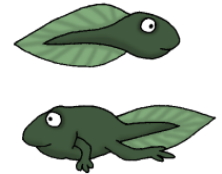




Why are XMP galaxies tadpole-cometary galaxies?

We do not know yet ...

but answering the question is of interest beyond the field of XMP galaxies



Why is this question interesting at all?
(more than a mere curiosity)

-Tadpole (cometary) galaxies are rare objects in the local universe (0.1% of the Kiso galaxies; Elmegreen et al. 2012), but very common at high redshift (10% of galaxies larger than 10 pix in the UDF Elmegreen et al. 2007).

-They may be disks in an early phase in the process of formation: gas falling in, self excited gravitational instability, interaction with DM clumps or dwarf galaxies, ram pressure stripping ...

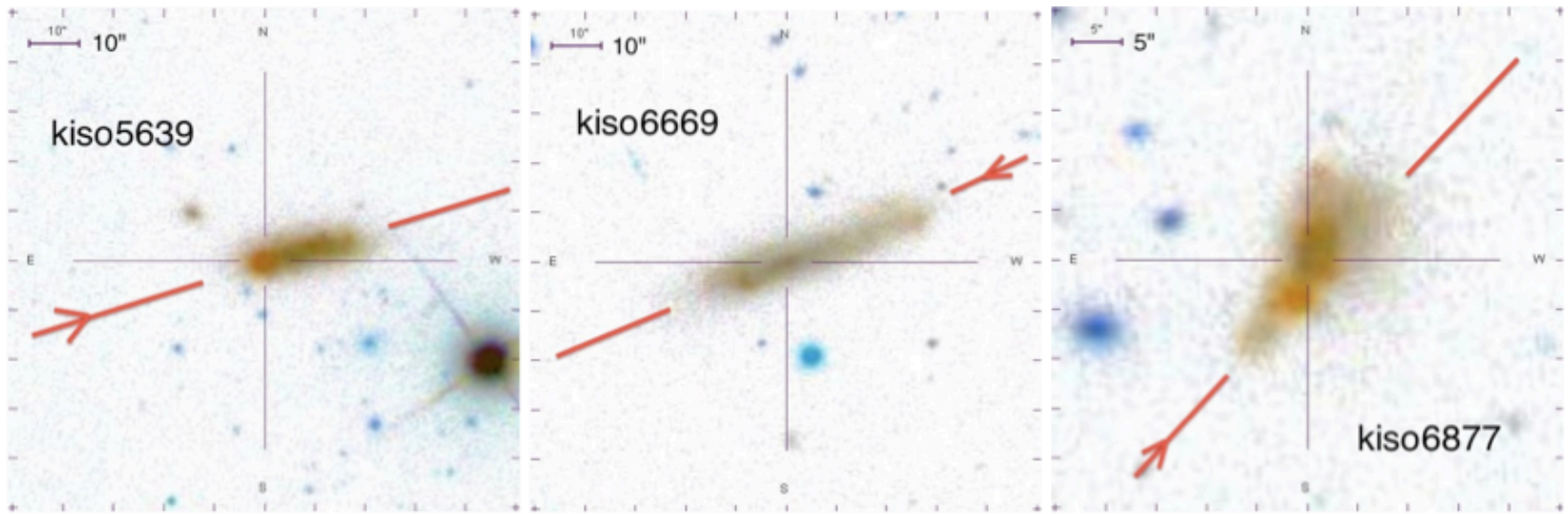
-XMP are primitive objects from a chemical point of view, but they may also be primitive with a dynamical point of view.

-Do XMP Gs represent disk-forming systems?

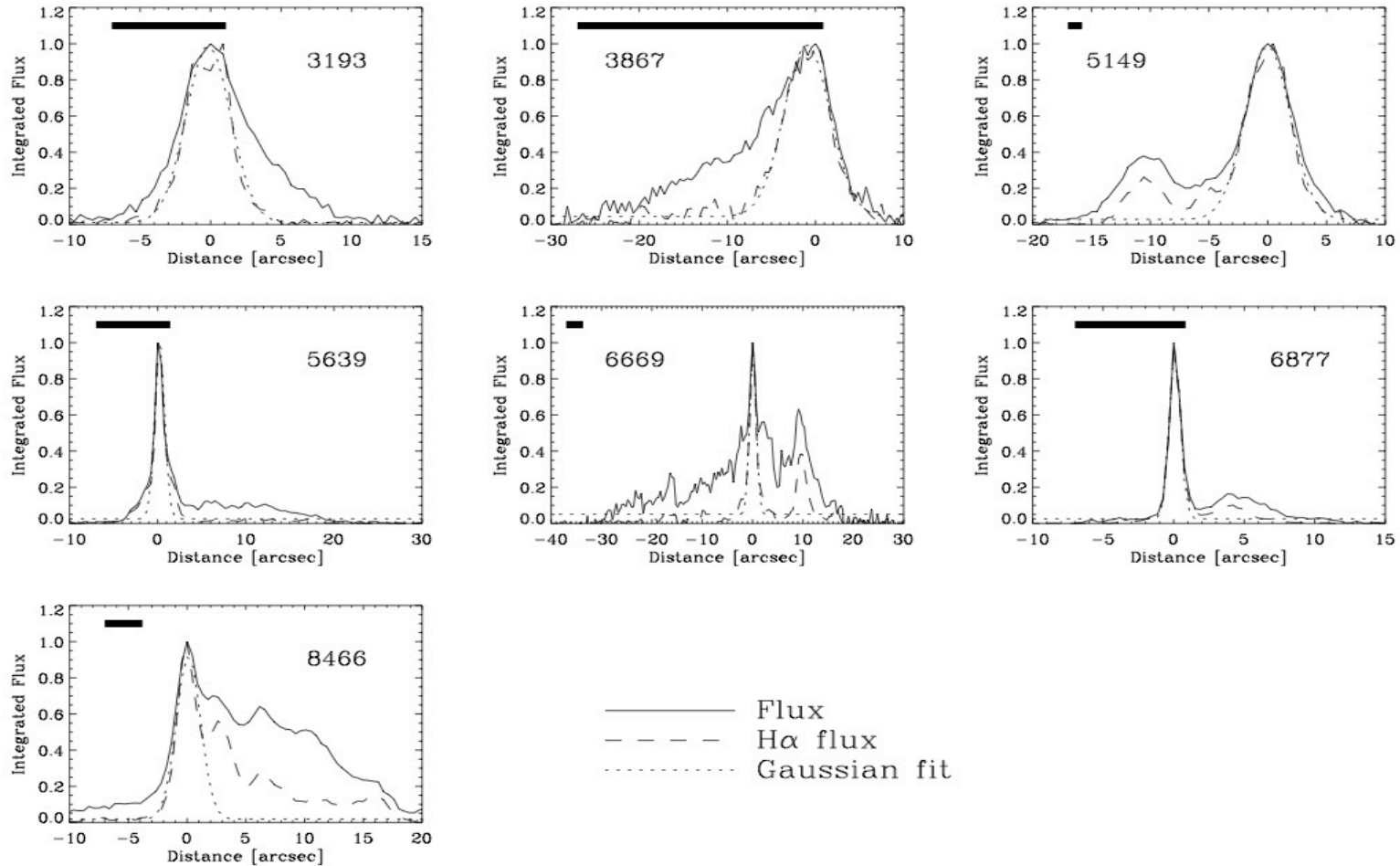
- Do XMP Gs represent nearby laboratories to study disk formation? (in pristine conditions?)

local tadpole galaxies (chemo-dynamics)

- High spectral resolution 1D spectra around H α ($R \sim 10000$)
- [IDS@INT](#) and ALFOSc@NOT
- 7 tadpoles (50%) of the sample
- spectrograph slit along then head-tail direction

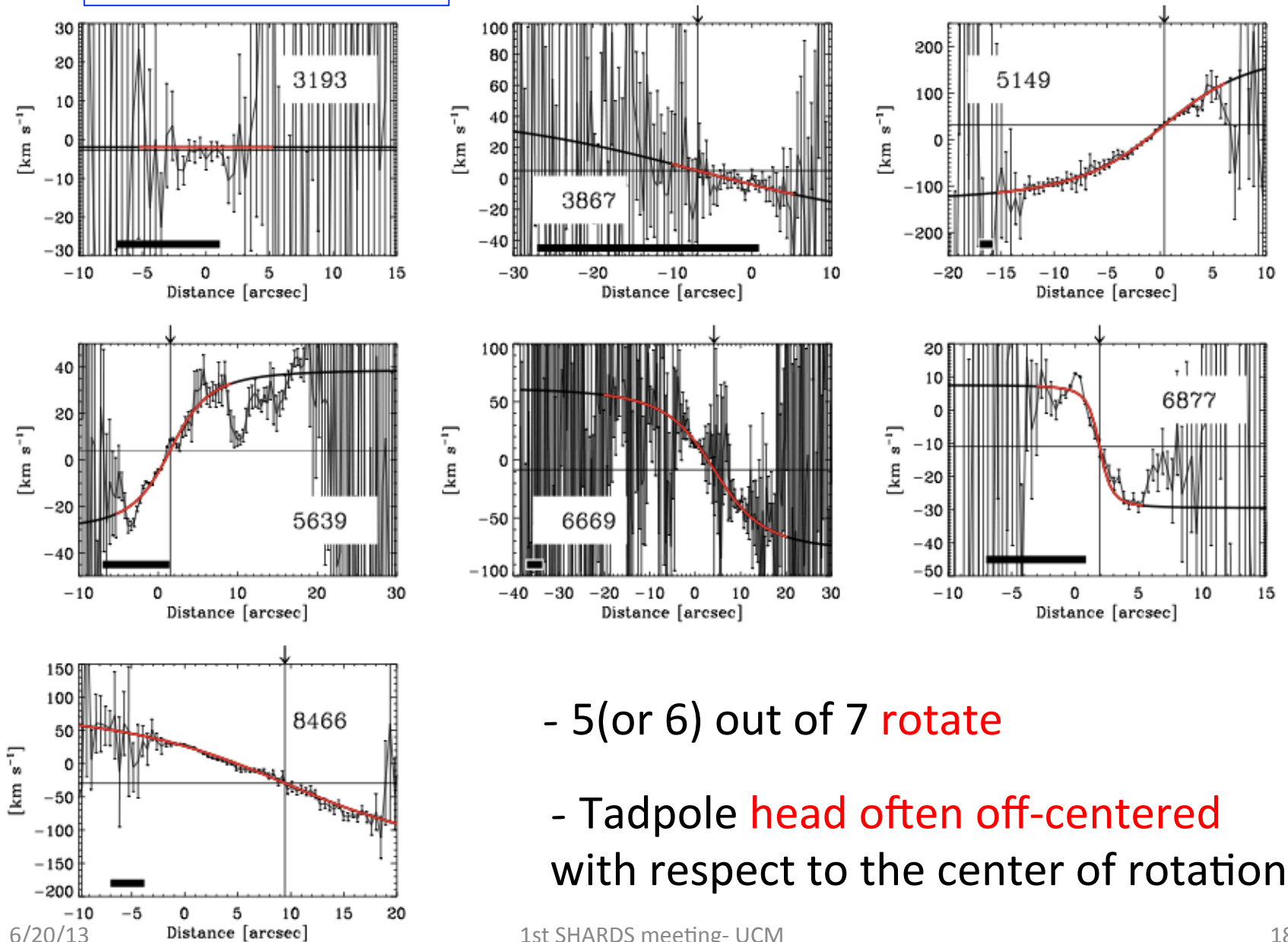


Brightness Profiles



- lopsided light distribution (as expected)
- Tadpole **head** defined to be **at zero** distance

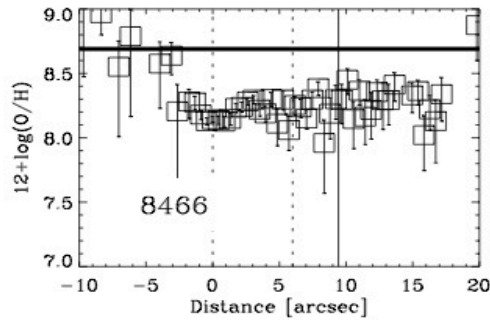
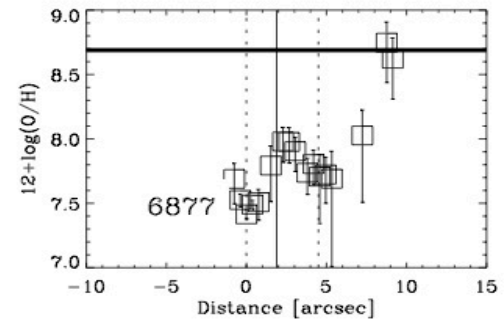
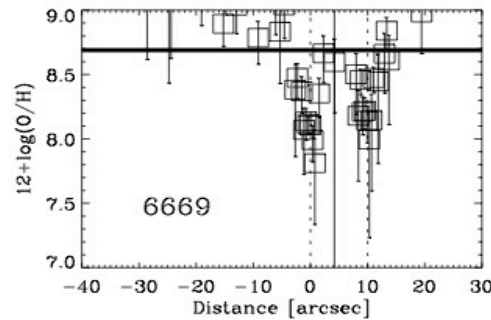
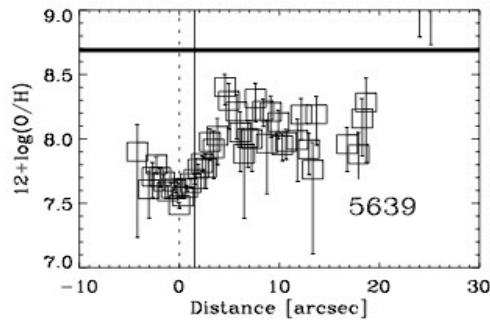
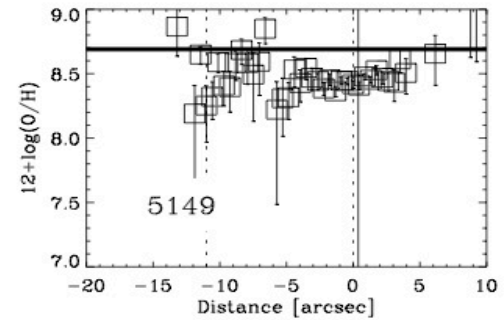
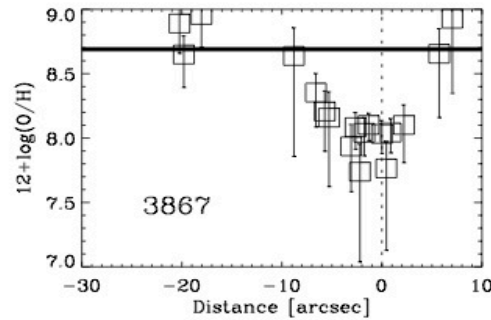
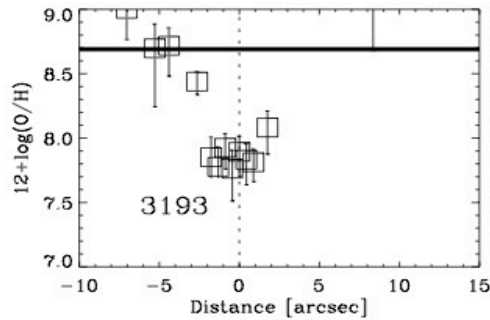
Velocity Curves



- 5(or 6) out of 7 rotate

- Tadpole head often off-centered with respect to the center of rotation

Metallicity (Oxygen abundance)



- O/H based on [NII]6583/H α

- H α Flux Peaks
- Rotation Center
- Solar Abundance

- Metallicity **gradients**, lower at center and **increasing outwards**
- **two of them XMP** (extremely metal poor) galax!
- outliers of the mass-metallicity relationship

Cold-flow accretion as a mode of galaxy growth

UDF galaxies are different from the Local Universe's ones, more patchy and “amorphous” (no big mergers).

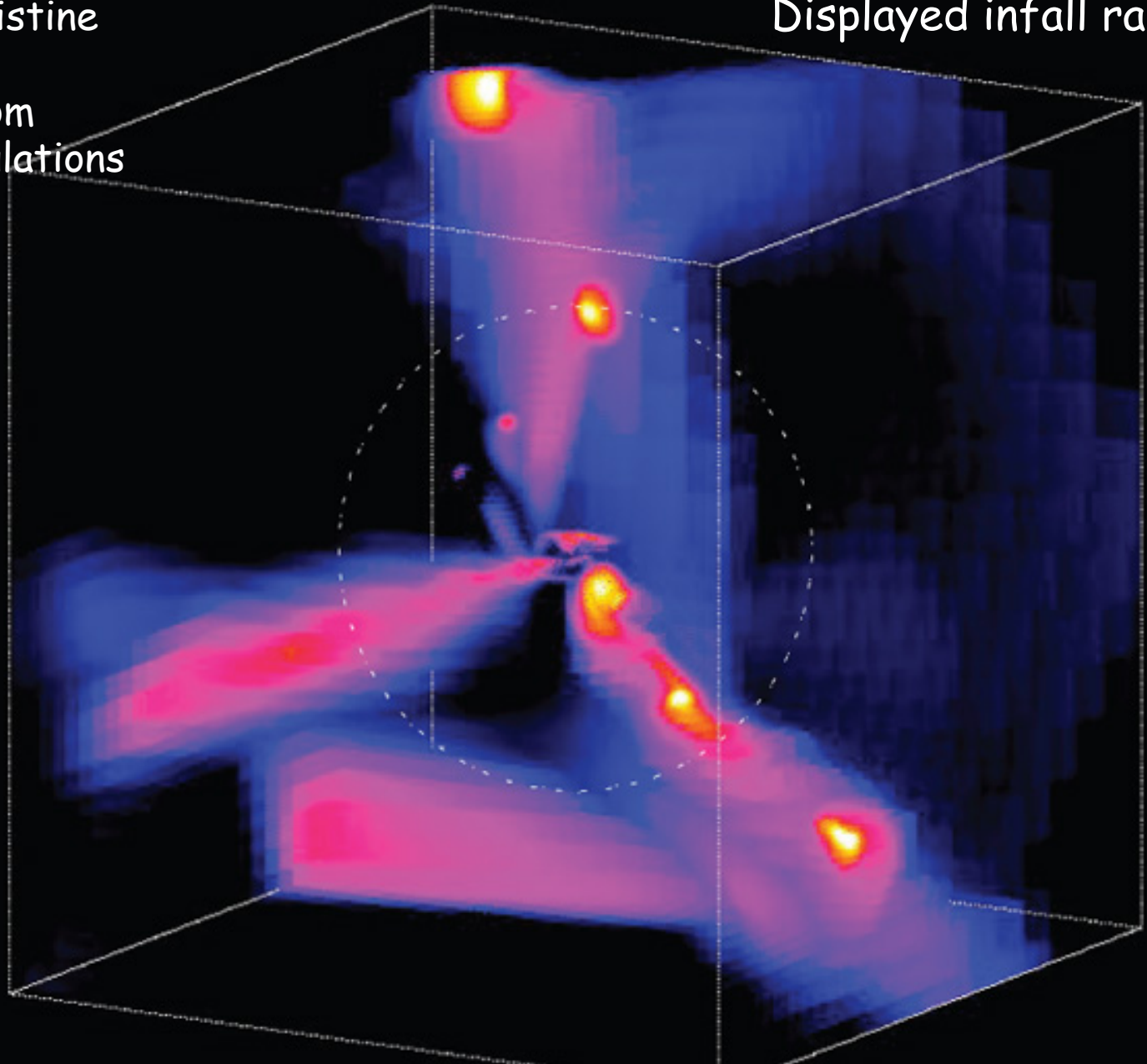
The luminosity profiles – thick clumpy disk's like (e.g., Elmegreen et al. 2005), with some rotation (e.g., Genzel et al. 2008)

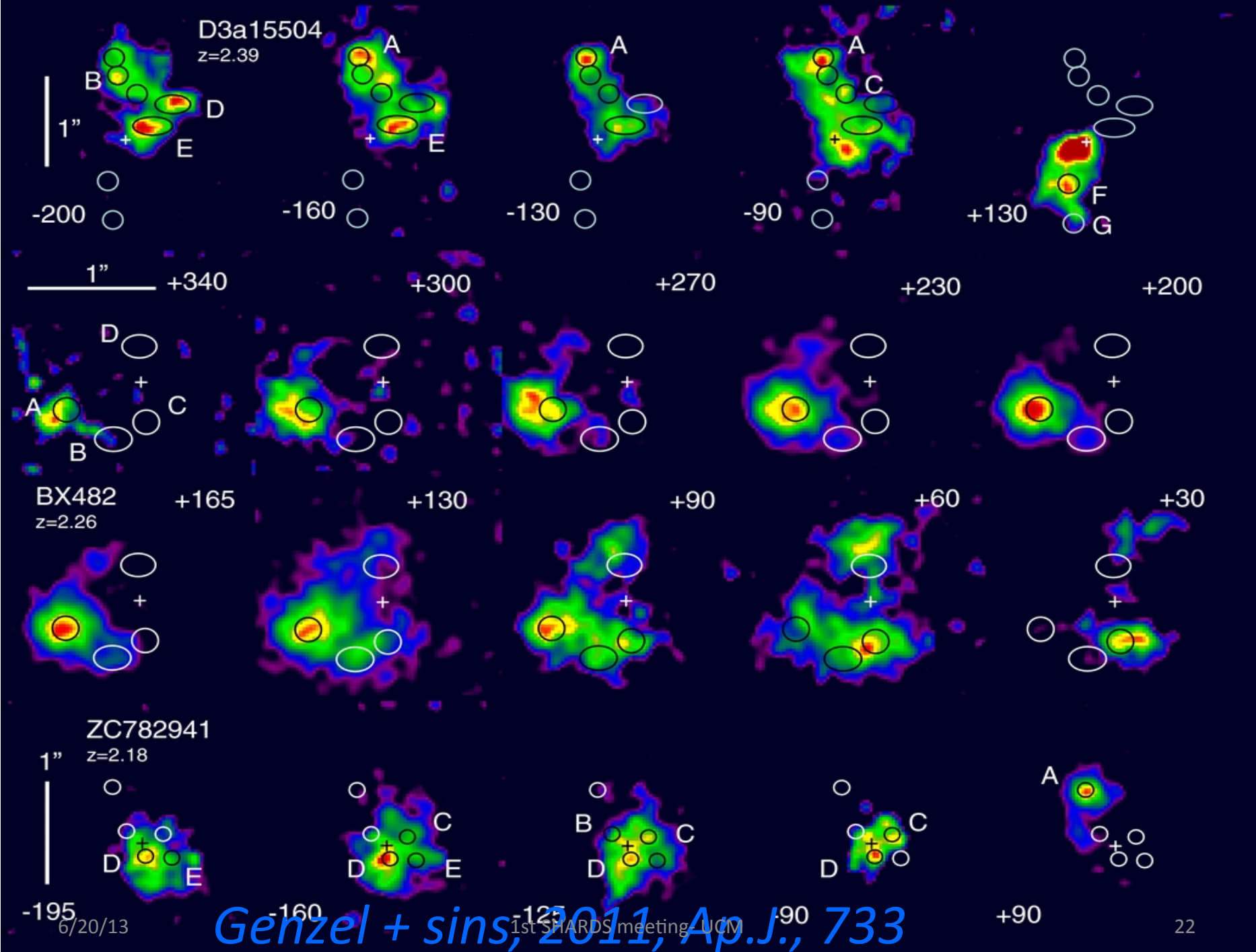
Accretion of external flows of pristine gas (cold-flows), which numerical simulations predicts is thought to be the main mode of disks growth at high z .

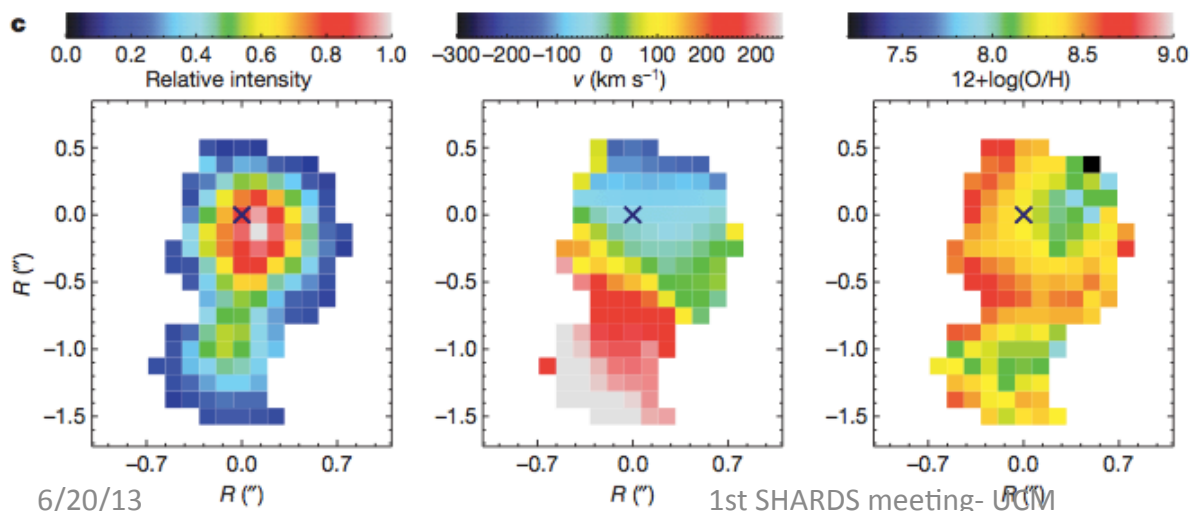
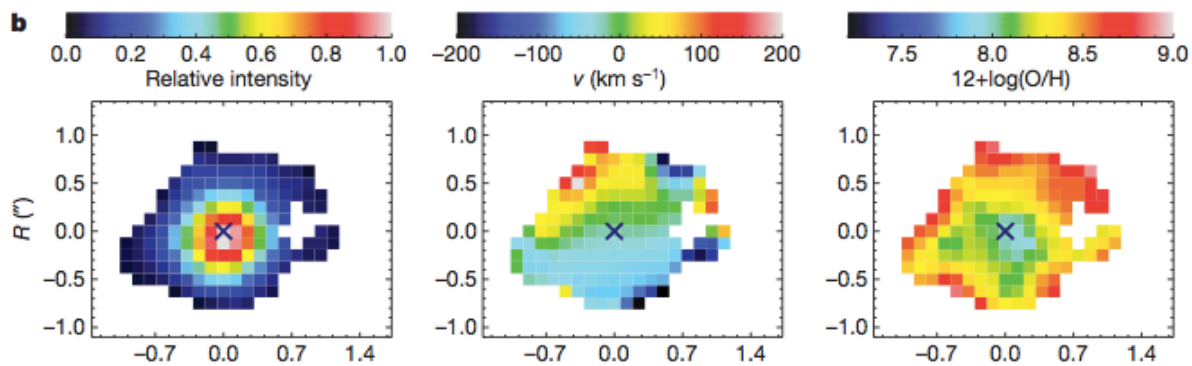
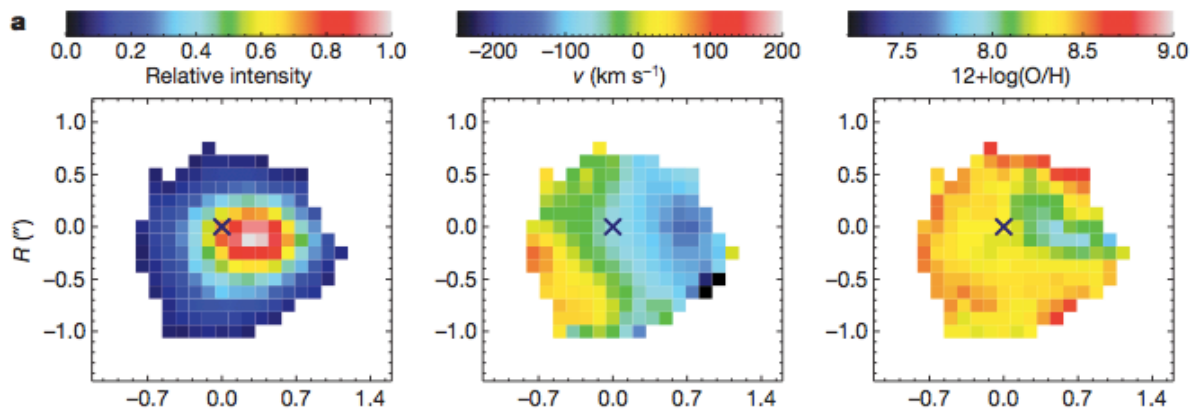
The incoming gas hit and heats the proto-disk, and is expected to form giant clumps that spiral in and merge into a central spheroid (Noguchi 1999; Genzel et al. 2008; Elmegreen et al. 2008).

Streams of pristine
gas in three
dimensions from
numerical simulations

Displayed infall rate







Evidence for cold-flows at high redshift

Cresci et al., Nat. 2010,

z	$\log(M_*/M_\odot)$
3.065	$10.68^{+0.16}_{-0.54}$
3.219	$10.03^{+0.40}_{-0.08}$
3.288	$10.86^{+0.18}_{-0.41}$

Conclusions

- Tadpoles are rare in local universe, but common at high- z , where they are commonly interpreted as disks being assembled
 - Extremely metal poor (XMP) are chemically primitive objects, and, surprisingly, they turn out to have tadpole or cometary morphology
 - Local Tads follow the scaling relations of high- z ones
 - Local Tads rotate with the head displaced from the rotation center.
 - Metallicity drops at the head (largest SFR)
- ★ All this results combined suggest that **XMP-tadpoles** are **disks in early stages of assembling** with its **star-formation sustained by accretion of external metal poor gas.**
- **Cold-flows**, expected from numerical simulations of galaxy formation, **observed for the very first time the local universe**

COMING SOON

- Extremely Metal-Poor Galaxies: The HI content. (Fihlo et al. Submitted)
- Search for the cool flows in HI maps.
- Complete characterization of a representative local sample (GTC observations).
- Revise previous Sloan results with new eyes.

Our extended team: M. Fihlo, A.B. Morales-Luis, J.A.L. Aguerri, R. Amorin, P. Papaderos, Y. Ascasibar, J.M. Gomes, P. Lagos, A. Humphery, J.M. Vilchez, J. Méndez-Abreu.

(IAC, Porto- Portugal; UAM- Madrid, IAA- Granada)

Thanks
THANKS



Fishing TADs in Shards
FISHING TADs in SHARDS