Compact Star-Forming Groups (CSFGs): An ultraviolet search for a local sample

Jonathan D. Hernández Fernández

Galaxy Groups:

Laboratories to study galaxy evolution

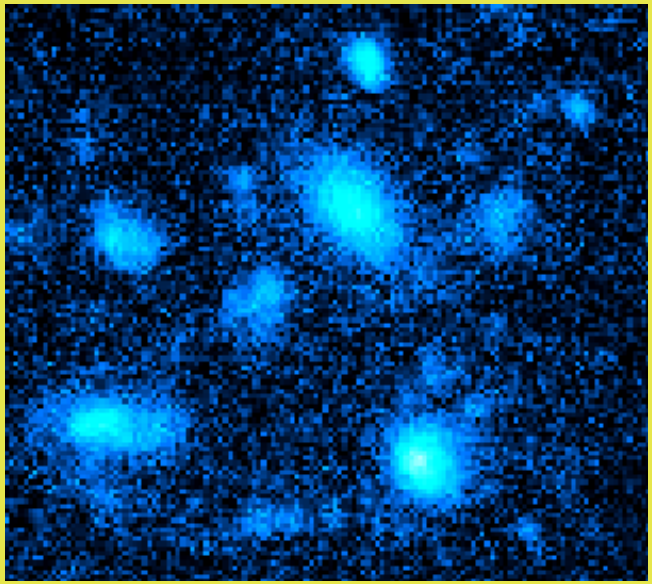
November 10-11 Oct 2014 La Serena, Chile

Compact star-forming groups

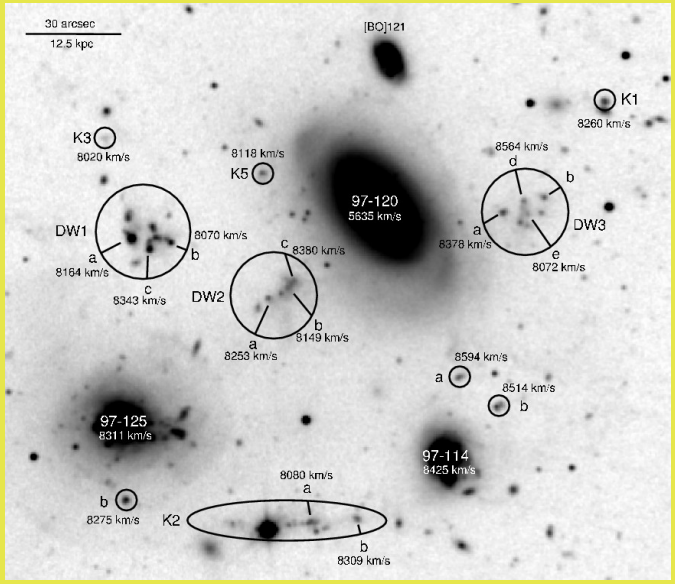
A compact group of galaxies infalling
into the dynamically young cluster Abell 1367

BIG is ”the region with the highest density of star forming systems ever observed in the Local Universe” (Cortese et al 2006).

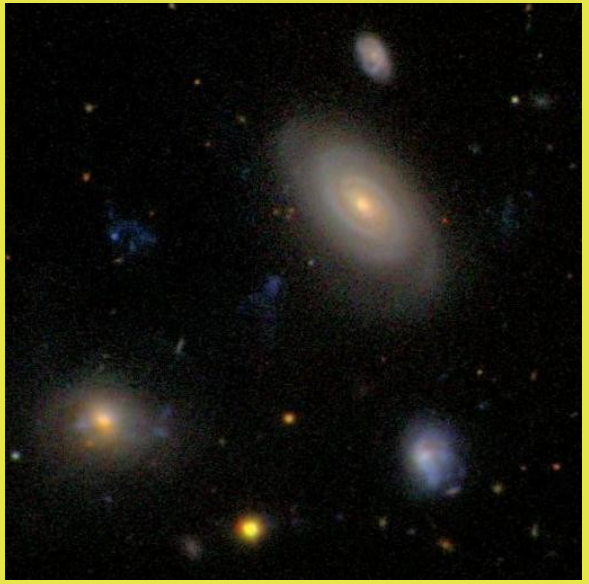
GALEX



Hα



SDSS coloured



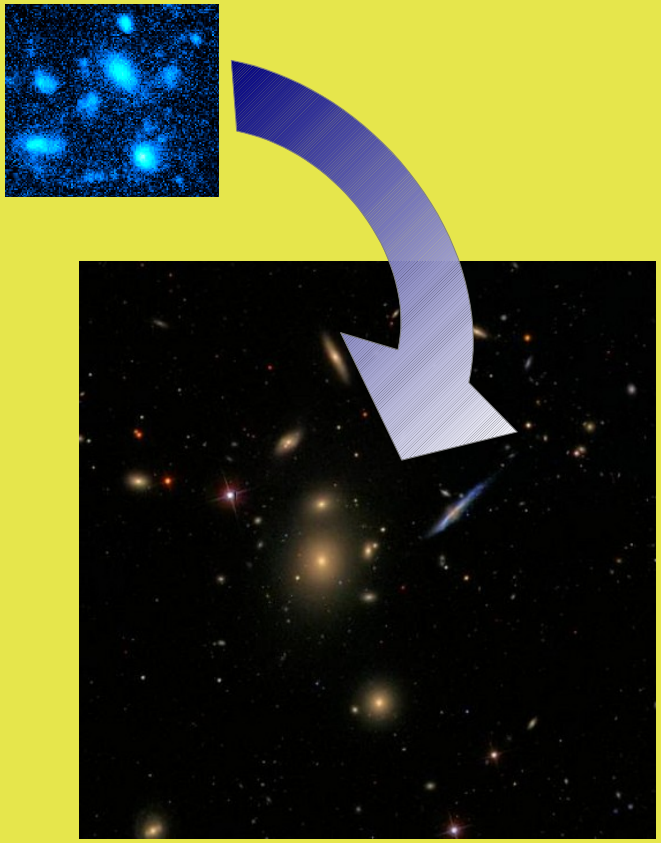
GALEX catalogues are the place to search for this kind of groups...

Compact star-forming groups

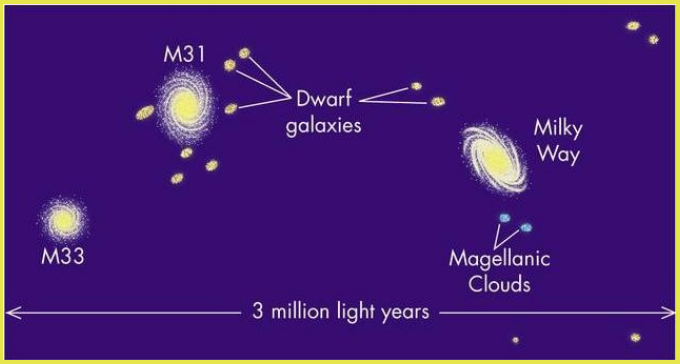
- *The **preprocessing scenario** and the **Blue Infalling Group (BIG)**.*

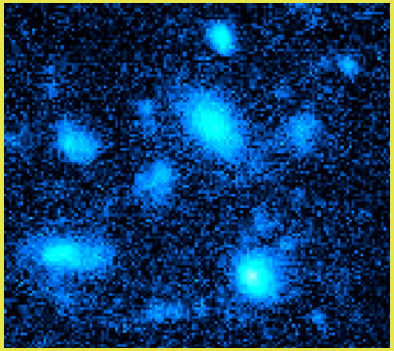
  *The unique case in the local Universe attributes to the preprocessing scenario is the BIG. This view presents some tension with Dressler+(2013) which claim **the quenching of star formation is not the main output of a previous starburst.** SFGs are analogues of the BIG, ideal to assess the significance of the starbursting-to-quenching pathway.*

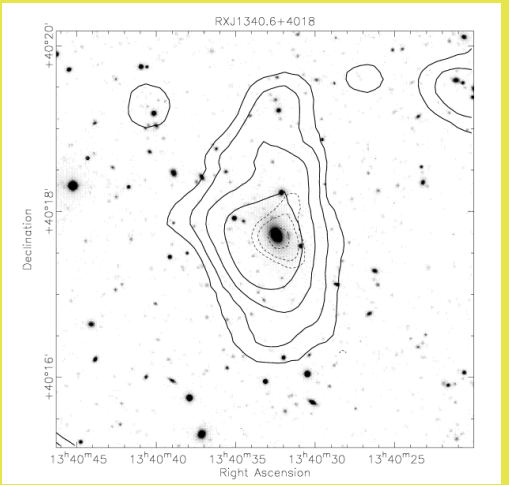
  *Infalling groups seem to be a possible place **where spiral galaxies are becoming lenticulars** (Haines+2013)*



Compact star-forming groups







- ***Enviromental evolution of galaxy population*** *in groups.*

  Galaxies in groups represent the ***half of the giant galaxy population*** *in the nearby universe.*

  Detailed studies of ***galaxy interactions and environmental processes*** *in their* ***most frequent environment*** *in* ***the very moment when they are happening*** *are key to adequately describe the galaxy evolution.*

- *Analogues of the* ***early stages*** *of* ***fossil groups / massive ellipticals*** *?*

Compact star-forming groups

SEARCH STRATREGY

(1) Compilation of an all-sky sample of UV bright sources

(2) Search for groups in the UV sample

(1) Compilation of an all-sky sample of UV bright sources

- UV sources from **All-sky Imaging Survey (AIS)**
  the largest sky area coveraged by GALEX in a homogeneous way

(1) Compilation of an all-sky sample of UV bright sources

- UV sources from **All-sky Imaging Survey (AIS)**
  the largest sky area coveraged by GALEX in a homogeneous way

- FUV (1530 A) selection: **17 < FUV < 20.5**
  FUV is even more biased toward star-formation than the NUV.
  The brightest UV galaxies in BIG are approx. in this range

– lower limit: Avoiding bright galaxies wich photometry shredded in parts.
– upper limit: Reliable sources, avoiding oversize the sample of UV sources.

(1) Compilation of an all-sky sample of UV bright sources

- UV sources from **All-sky Imaging Survey (AIS)**
  the largest sky area coveraged by GALEX in a homogeneous way

- FUV (1530 A) selection: **17 < FUV < 20.5**
  FUV is even more biased toward star-formation than the NUV.
  The brightest UV galaxies in BIG are approx. in this range

– lower limit: Avoiding bright galaxies wich photometry shredded in parts.
– upper limit: Reliable sources, avoiding oversize the sample of UV sources.

- UV color selection: **$-1.50 < (FUV-NUV)_{dered} < 2.75$**
  Avoiding blue artifacts, red stars, etc.

- nuv_artifact <=1 ~ good quality detections

- We avoid the Milky Way disk: galactic latitude modulus |b|>15°

(1) Compilation of an all-sky sample of UV bright sources

- UV sources from **All-sky Imaging Survey (AIS)**
  the largest sky area coveraged by GALEX in a homogeneous way

- FUV (1530 A) selection: **17 < FUV < 20.5**
  FUV is even more biased toward star-formation than the NUV.
  The brightest UV galaxies in BIG are approx. in this range

– lower limit: Avoiding bright galaxies wich photometry shredded in parts.
– upper limit: Reliable sources, avoiding oversize the sample of UV sources.

- UV color selection: **$-1.50 < (FUV-NUV)_{dered} < 2.75$**
  Avoiding blue artifacts, red stars, etc.

- nuv_artifact <=1 ~ good quality detections

- We avoid the Milky Way disk: galactic latitude modulus |b|>15°

925,428 UV-emitting sources

(2) Search for groups in the UV sample

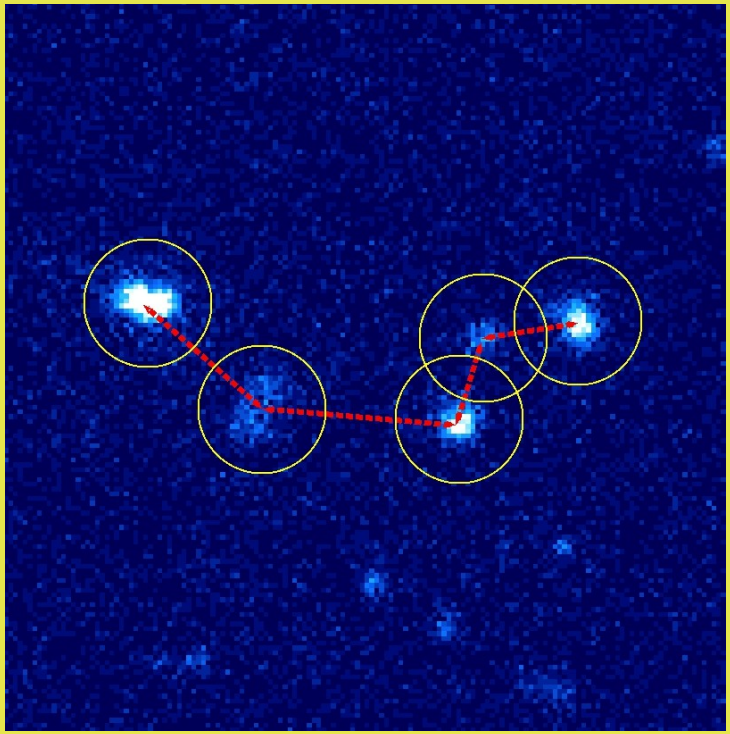
- Friends-of-Friends Algorithm applied to sky positions grouping elements with a sky separation equal or less than a **linklength = 1.5 arcmin**
  This corresponds to a physical distance of **88 kpc at z=0.05**

- **n_{UV} >= 4** UV brigth members

- Constraints over UV group members:

→ At least **three** UV brigth sources classified as **'galaxy'** by NED

→ At least **two** galaxies with a **redshift** separation **Δz<0.004**



Compact star-forming groups

This final output of the search is
a sample of Compact Star-forming Groups of galaxies of

Compact star-forming groups

This final output of the search is
a sample of Compact Star-forming Groups of galaxies of

280 groups of UV-emitting galaxies!!

Compact star-forming groups

This final output of the search is
a sample of Compact Star-forming Groups of galaxies of

280 groups of UV-emitting galaxies!!

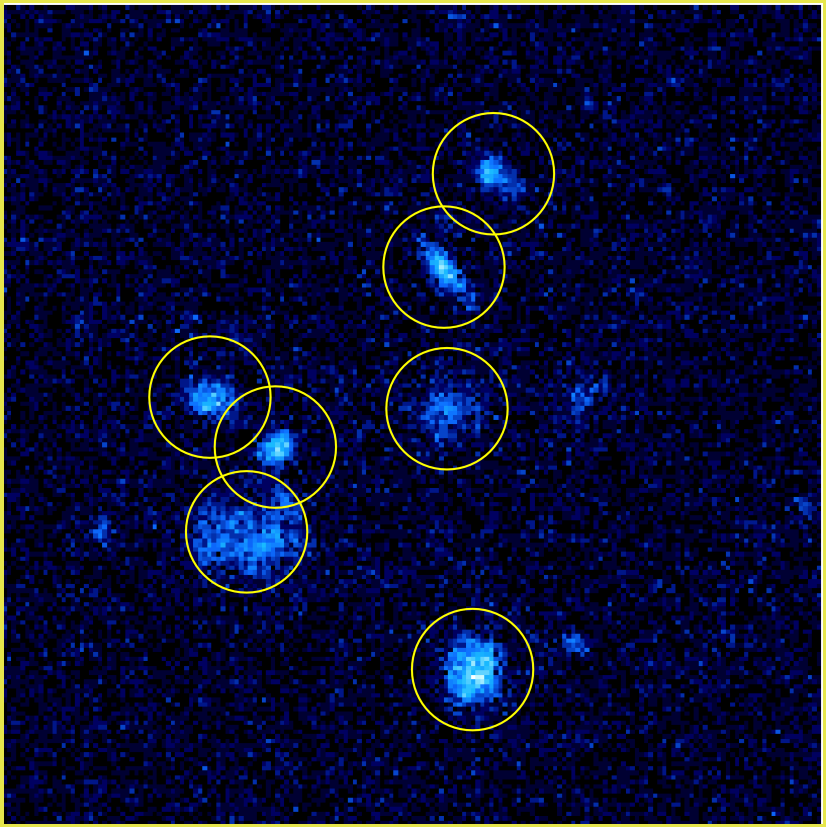
- n_{UV} "UV richness" distribution:

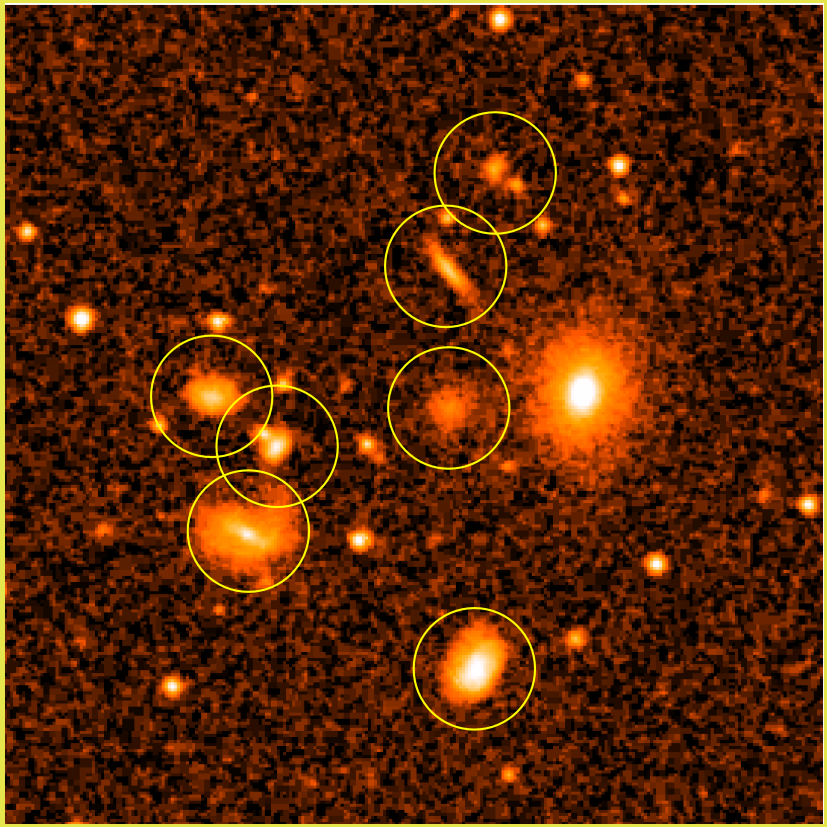
  226 groups with 4 members,
  39 groups with 5 members,
  11 groups with 6 members and
  4 groups with 7 members

$$\mathbf{N_{groups}(n_{UV}) \sim (n_{UV})^{\alpha} \ with \ \ \alpha \approx -7.53}$$

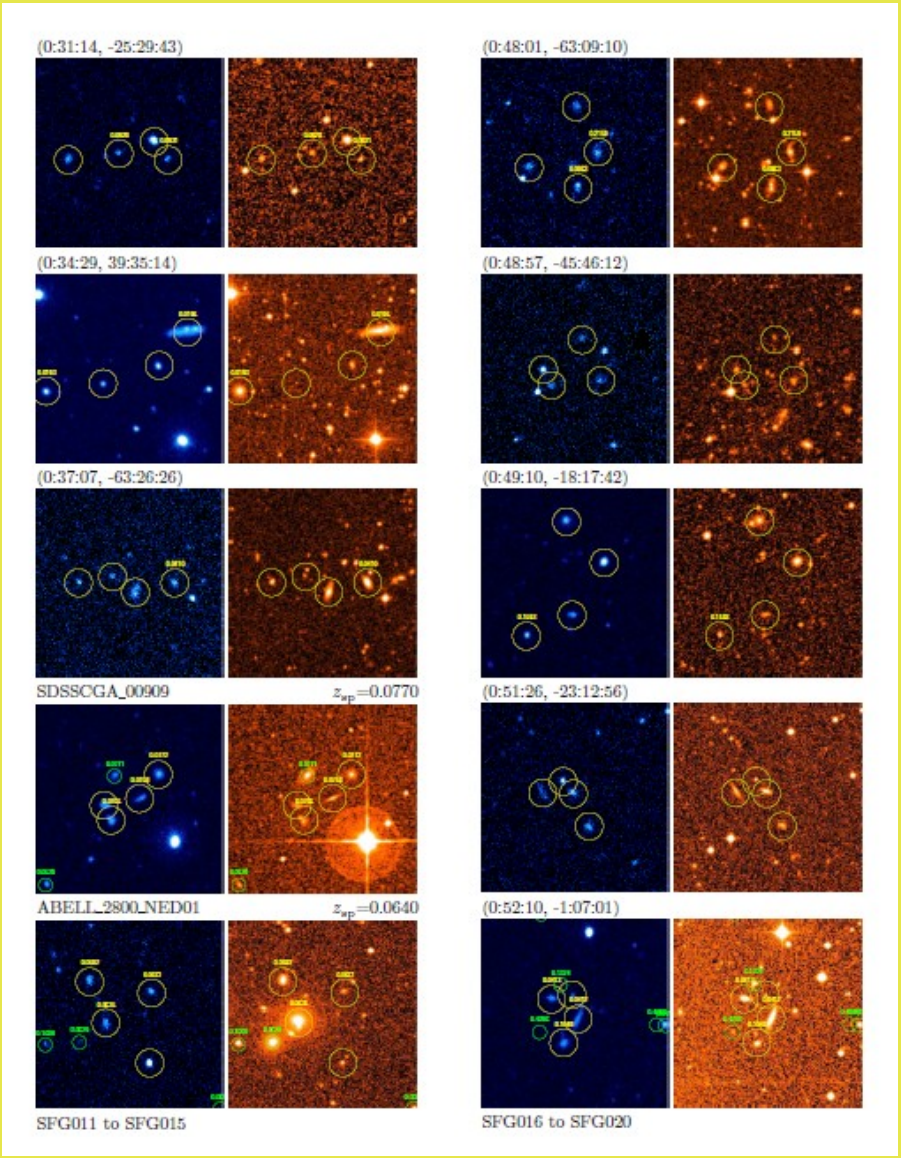
Compact star-forming groups

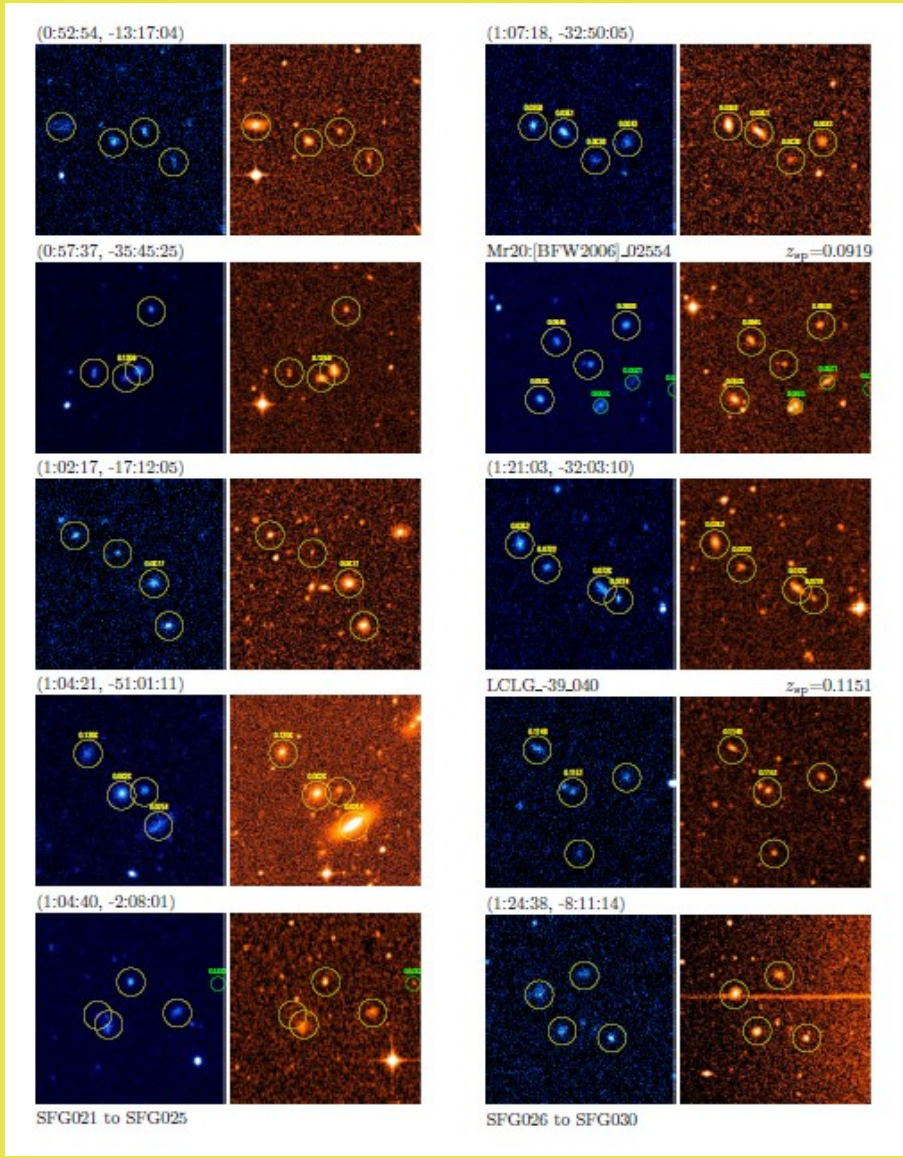
Just one example of the groups that we found...



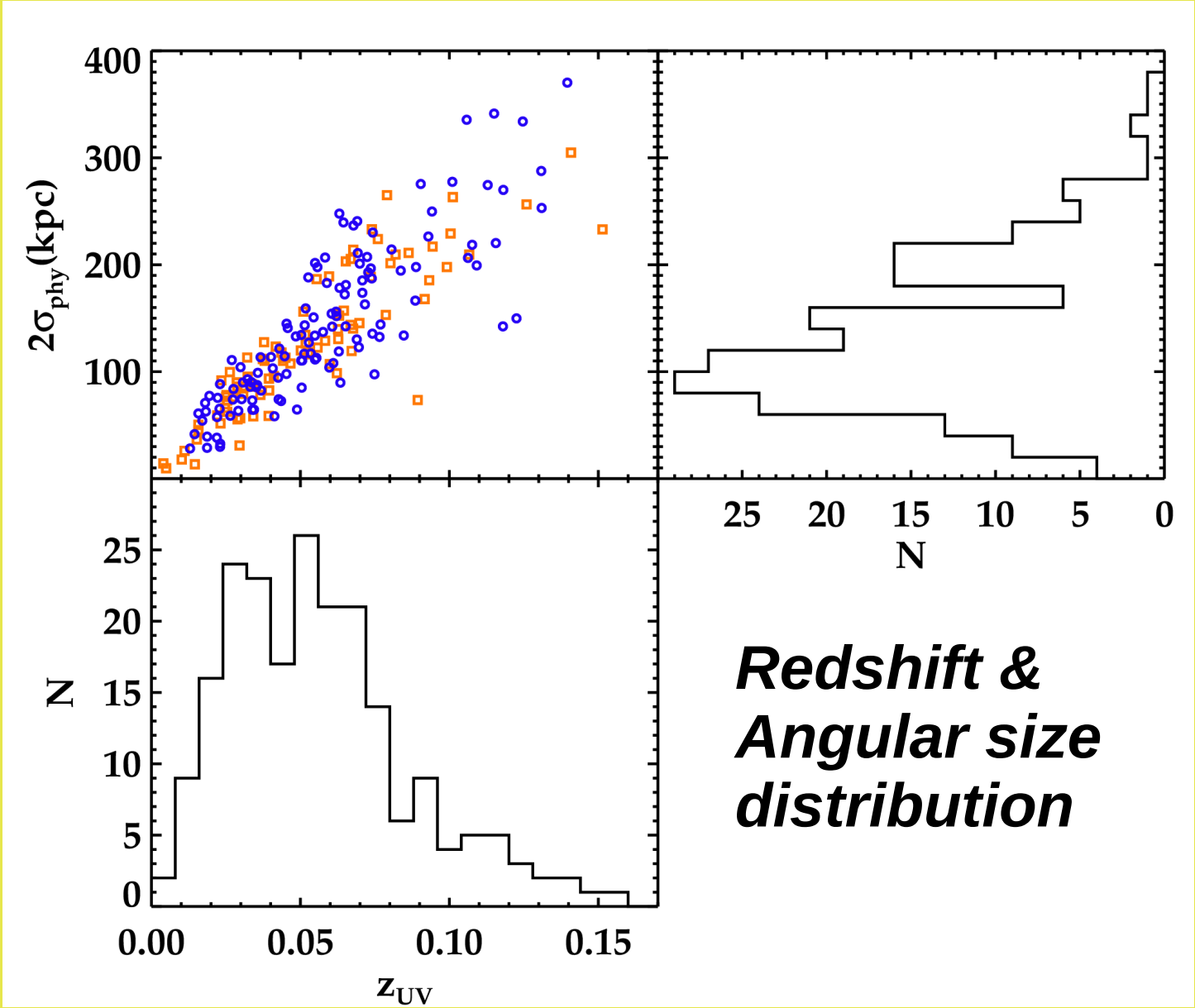


Compact star-forming groups



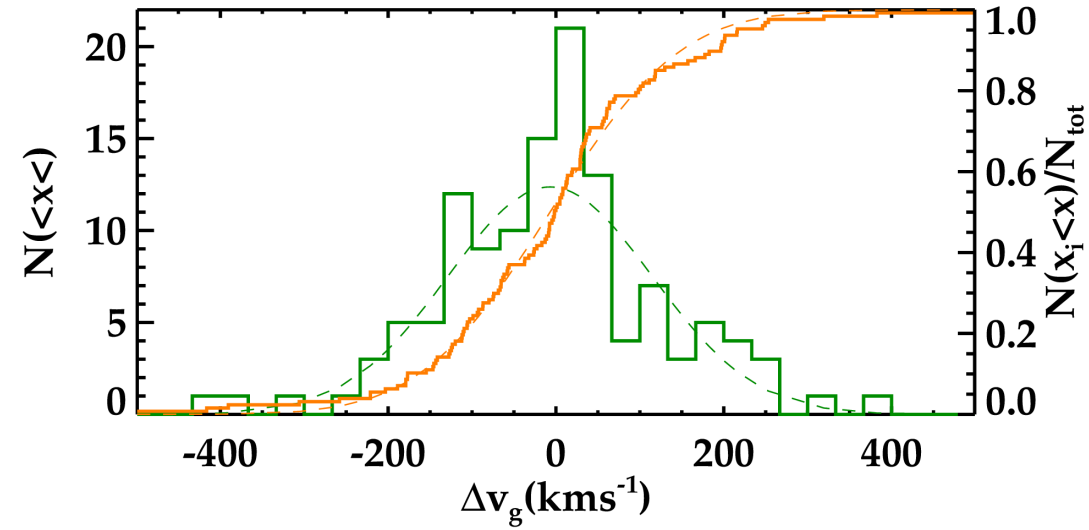


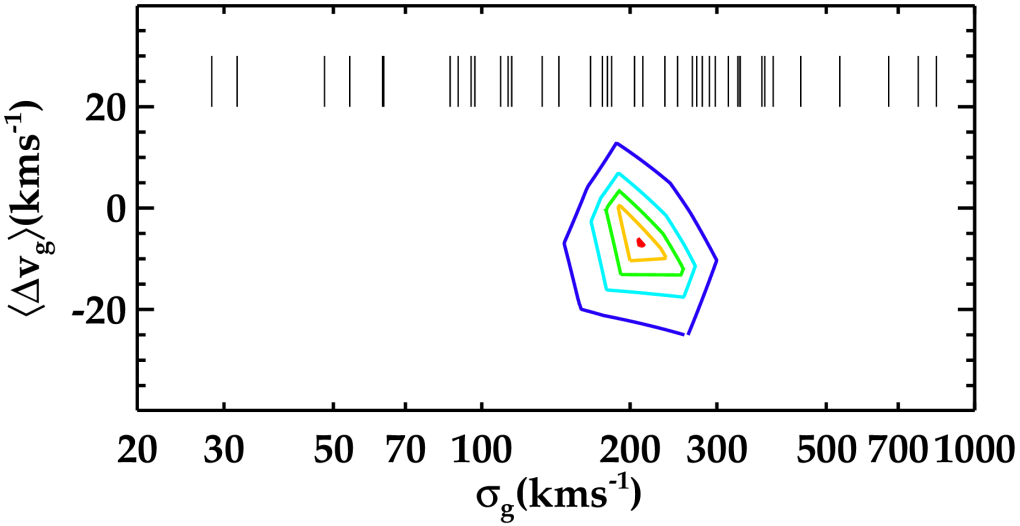
Compact star-forming groups



Redshift & Angular size distribution

Compact star-forming groups





Stacked sample

$\sigma_{1D} \approx 120$ km s^{-1}

$\sigma_{3D} \approx 210$ km s^{-1}

Compact star-forming groups

We have just the HCG100 in common with the original sample of Hickson (1982,+1992)

Why???

Compact star-forming groups

We have just the HCG100 in common with the original sample of Hickson (1982,+1992)

Why???

We go to apply the same search methodology over the sample of 463 galaxies in the Hickson group catalogue

Compact star-forming groups

Check the search methodology against the Hickson group catalogue

• From a total of 463 Hickson galaxies, only 91 galaxy members fulfill the constraints about FUV brightness, UV color and GALEX photometric quality.

On average, less than one UV bright galaxy per group.

Compact star-forming groups

Check the search methodology against the Hickson group catalogue

• From a total of 463 Hickson galaxies, only 91 galaxy members fulfill the constraints about FUV brightness, UV color and GALEX photometric quality.
On average, less than one UV bright galaxy per group.

• **Just three Hickson groups** have four or more Hickson galaxy members fulfilling the UV GALEX constraints;
HCG23, HCG89 and HCG100
with four UV bright galaxy members each of them.

Compact star-forming groups

Check the search methodology against the Hickson group catalogue

• From a total of 463 Hickson galaxies, only 91 galaxy members fulfill the constraints about FUV brightness, UV color and GALEX photometric quality.
On average, less than one UV bright galaxy per group.

• **Just three Hickson groups** have four or more Hickson galaxy members fulfilling the UV GALEX constraints;
HCG23, HCG89 and HCG100
with four UV bright galaxy members each of them.

• There is **no Hickson groups with four or more UV bright members fulfilling the compactness criterion:**
a maximum angular distance of 1.5 arcmin to some of the rest of Hickson galaxy members.

Compact star-forming groups

Check the search methodology against the Hickson group catalogue

• From a total of 463 Hickson galaxies, only 91 galaxy members fulfill the constraints about FUV brightness, UV color and GALEX photometric quality.
On average, less than one UV bright galaxy per group.

• **Just three Hickson groups** have four or more Hickson galaxy members fulfilling the UV GALEX constraints;
HCG23, HCG89 and HCG100
with four UV bright galaxy members each of them.

• There is **no Hickson groups with four or more UV bright members fulfilling the compactness criterion:**
a maximum angular distance of 1.5 arcmin to some of the rest of Hickson galaxy members.

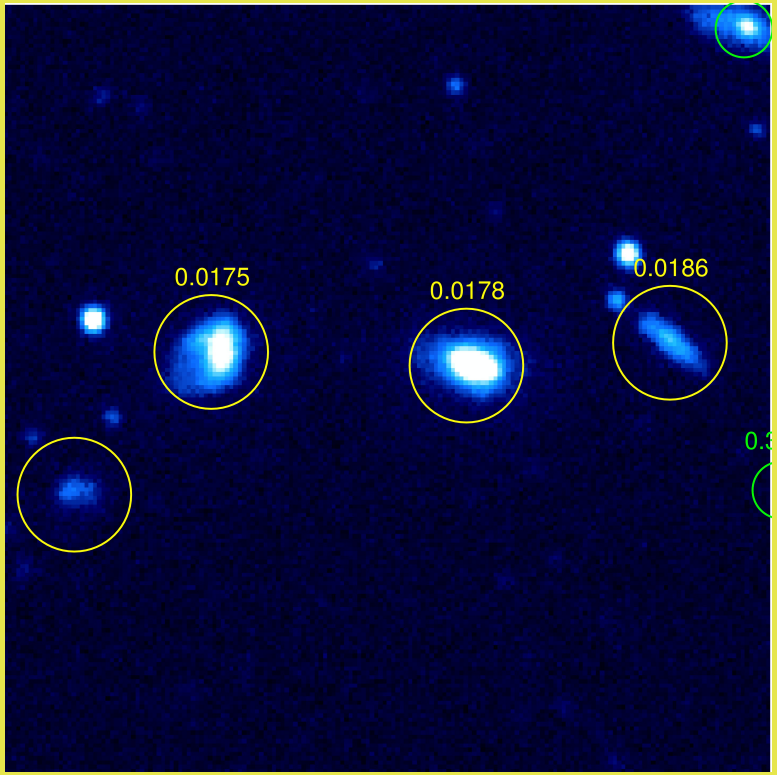
• The output of this test just gives **HCG100** as a compact group of bright UV emitting galaxies but only **with three UV bright members close enough.**

Compact star-forming groups

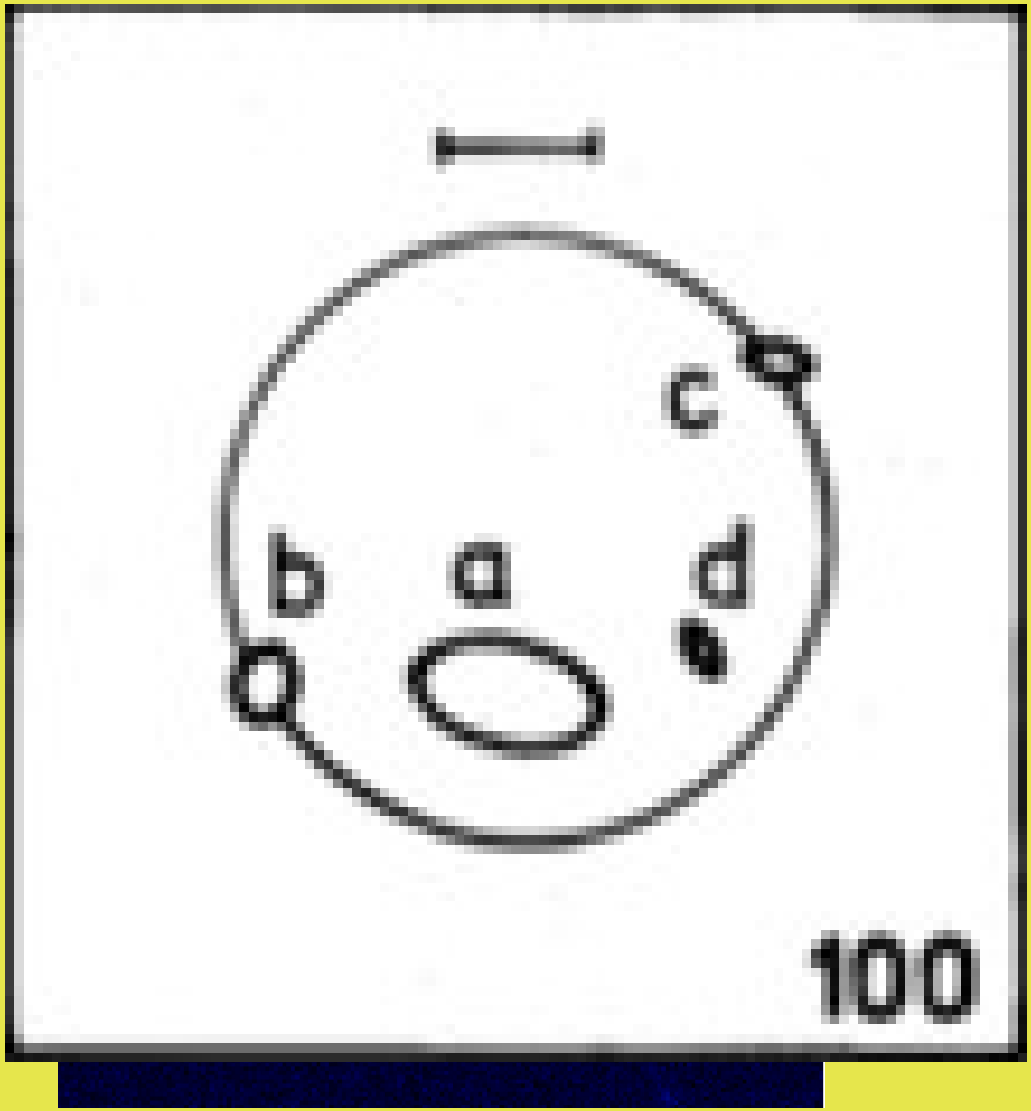
We have just the HCG100 in common with the original sample of Hickson (1982,+1992)

Why???

Compact star-forming groups



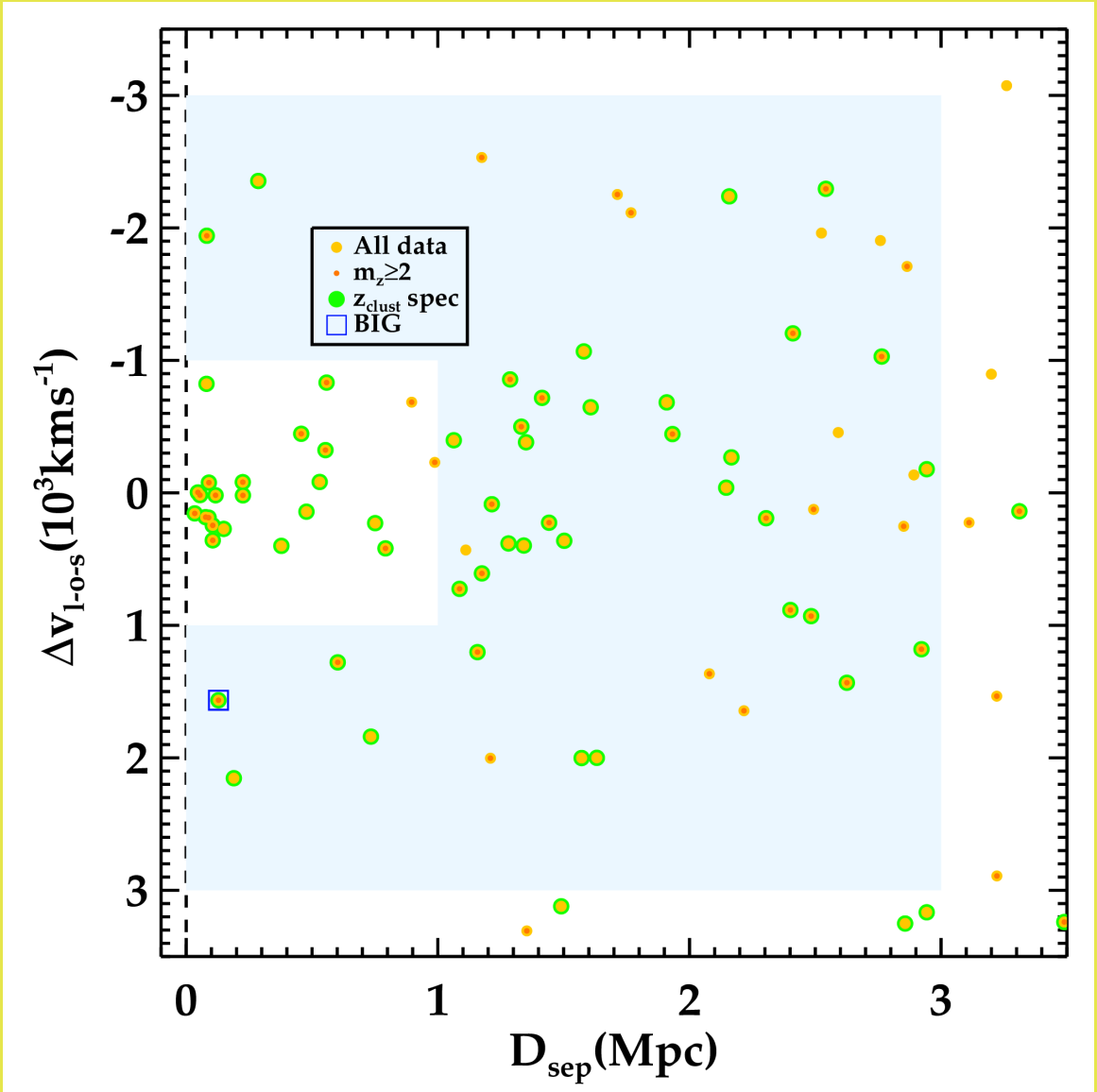
Compact star-forming groups



Compact star-forming groups

Search for star-forming compact groups infalling to galaxy clusters

It was preliminary identified
50 candidates of groups infalling to closed clusters



Summary

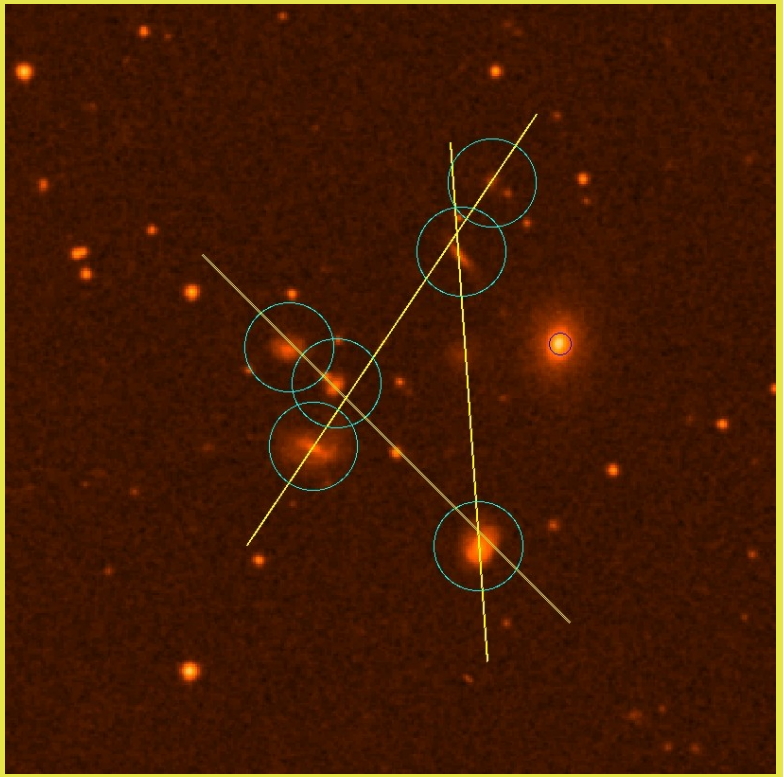
- Compilation of a sample of 280 compact groups of star-forming galaxies
- Ready for publication
- 50 candidates of star-forming compact groups close to galaxy clusters $\rightarrow$ $\rightarrow$ analogues of BIG

Future work

- Membership confirmation of group galaxies:
  SOAR observations

  - 5 groups already observed with slits

  - 6 groups (applied) for being observed

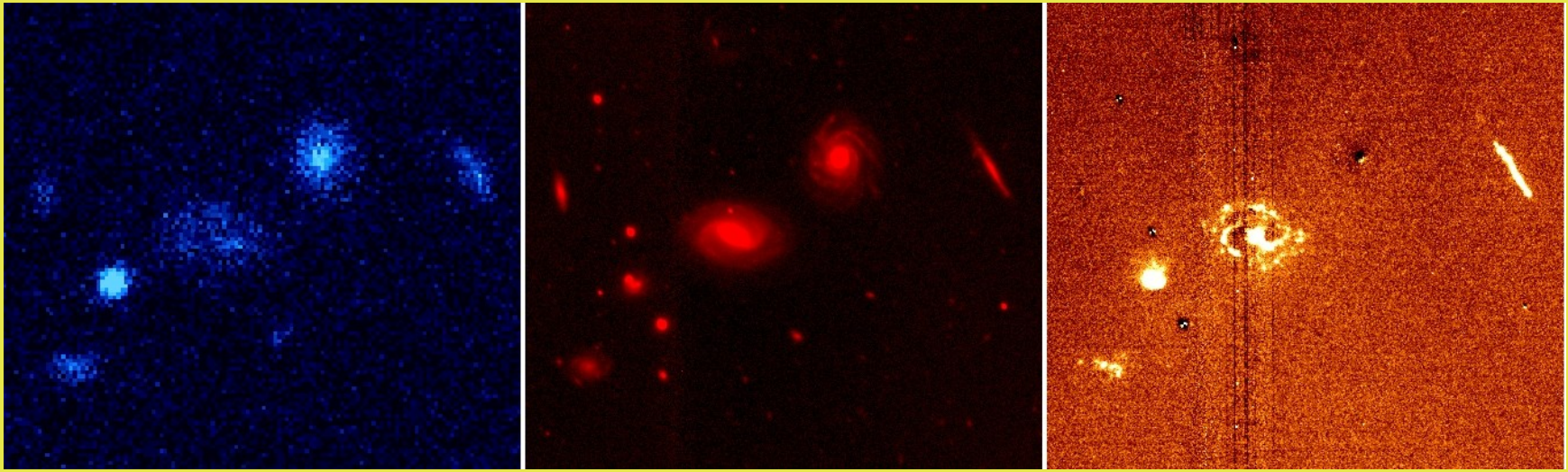


Future work

- Spatial distribution of star-formation
  Hα observations:

- CAHA 2.2m (Spain): 8 groups already observed
  #G182 G197 G12 G181 G9 G224 G280 G2

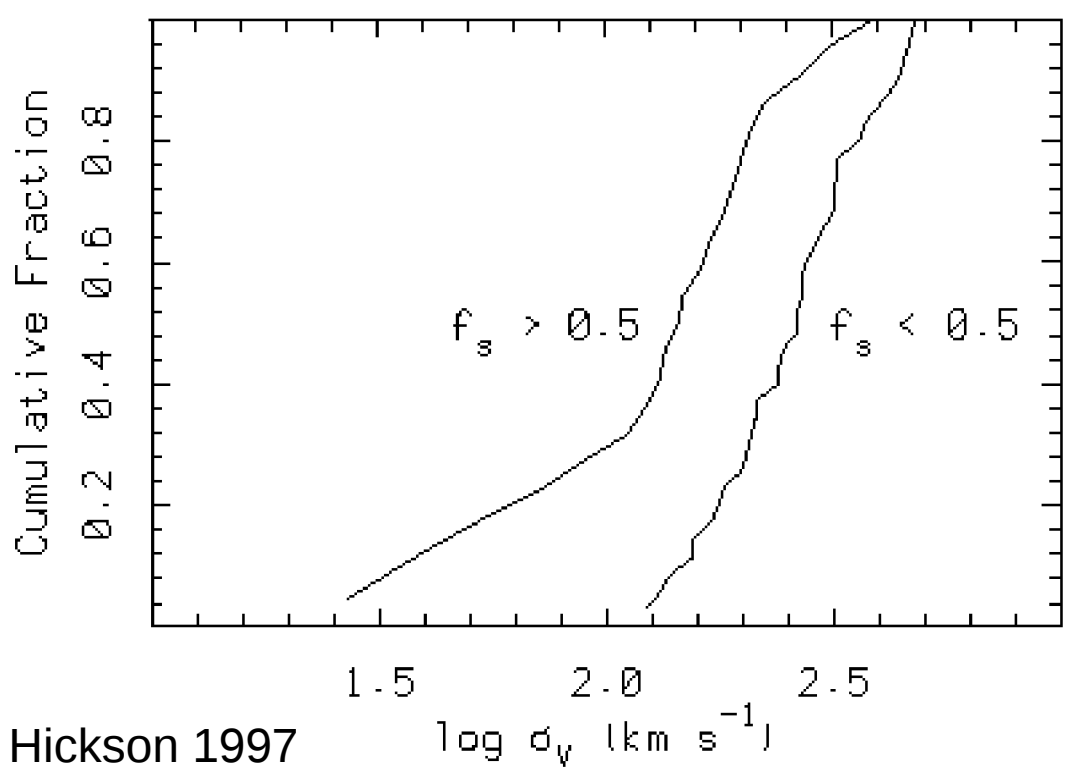
- MPG 2.2m (Chile): 16 groups resqueted to be observed



Thanks for your attention!

Background slides!

Compact star-forming groups



Hickson 1997

Stacked sample

$\sigma_{1D} \approx 120$ km s^{-1}

$\sigma_{3D} \approx 210$ km s^{-1}

Compact star-forming groups

We search for similar examples of BIG:

(1) applying a Friends-of-Friends algorithm in sky coordinates with a ***linking-length of 1.5 arcmin***

(2) with a minimum number of ***four members***

(3) in a GALEX-AIS catalogue of ***bright UV emitting sources***

(4) in the magnitude range ***17<FUV<20.5***