Galaxy Multiplicity in Low-Mass Haloes: the Baryonic Content and Star Formation Properties of Dwarf Galaxy Groups

Rubén Sánchez-Janssen

w/ Ricardo Amorín (IAA), Ángel López-Sánchez (AAO), Ayesha Begum (NCRA).

Star Formation and Gas Reservoirs in Nearby Groups and Clusters

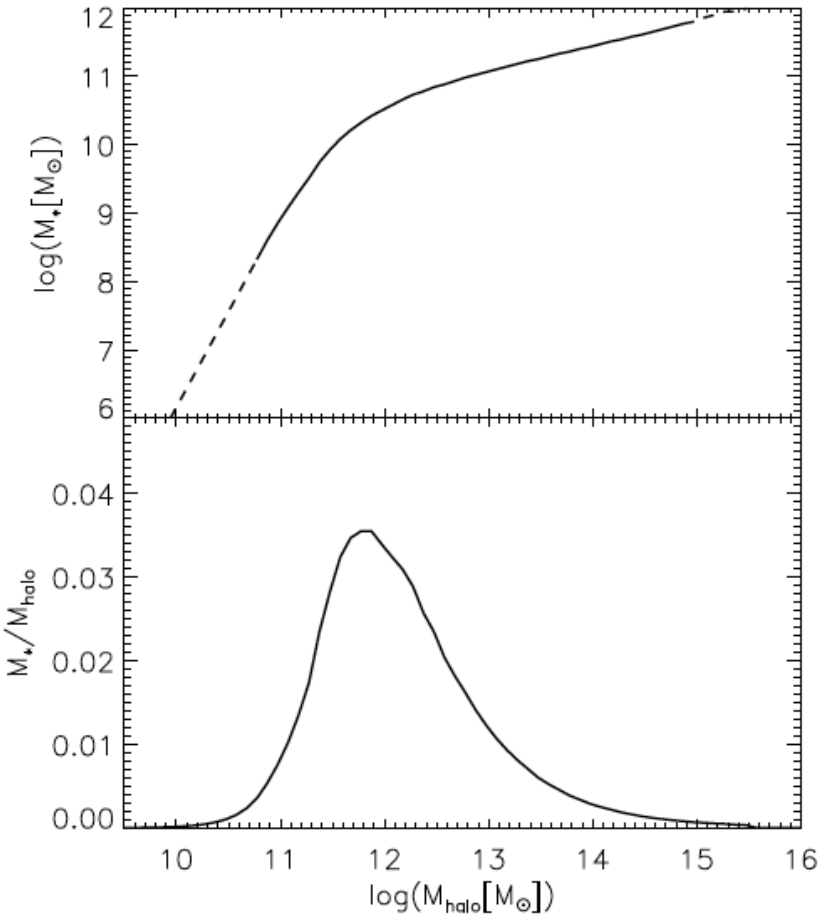
Union College, July 11, 2012

The structure of CDM haloes is self-similar...

Properly scaled, haloes of all masses have a similar amount of substructure (e.g., Moore+99).

...but galaxy formation is a complex function of M_h

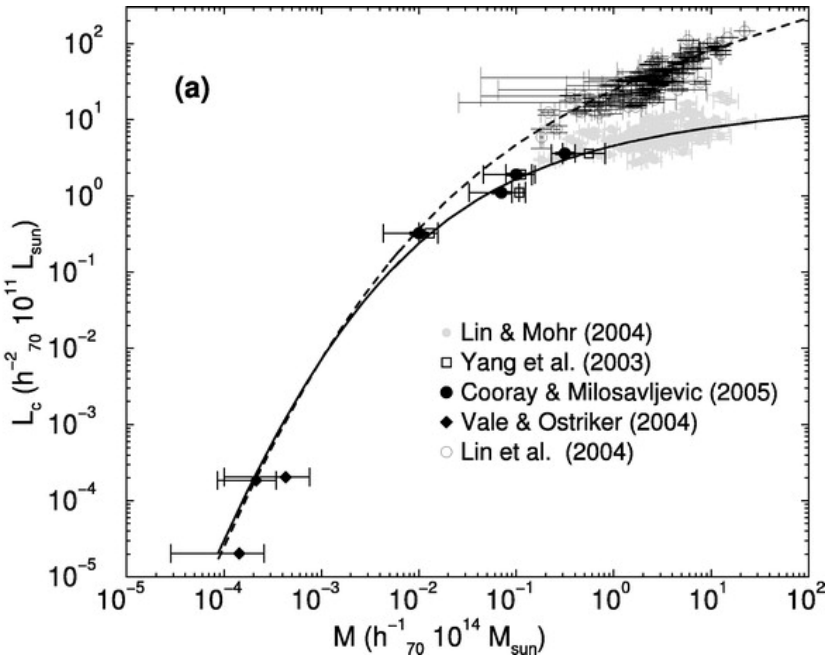
Guo+09



- Low-mass haloes inefficient at forming stars (Geha+06).
- Gas cooling inhibited in $M_h \lesssim 10^8\, h^{-1}\, M_\odot$ haloes (Kaufmann+07).
- Larger M/L ratios (Strigari+08; Walker+09).
- Low-mass haloes essentially contain **one central** galaxy and **dark satellites** (Cooray+05).

...but galaxy formation is a complex function of M_h

Cooray+05



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Associations of dwarf galaxies in the Local Volume

Tully+06

ABSTRACT

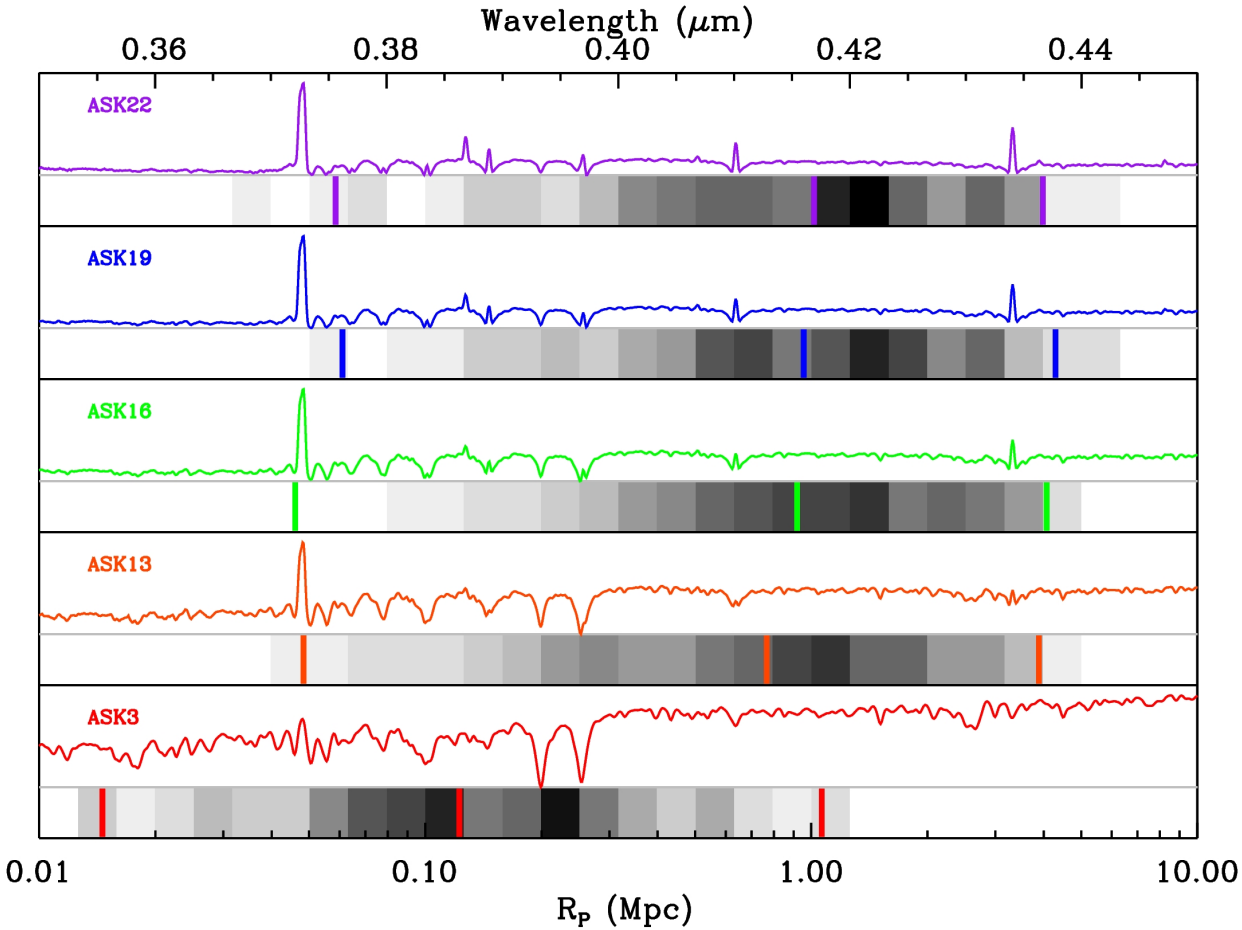
The *Hubble Space Telescope* Advanced Camera for Surveys has been used to determine accurate distances for 20 galaxies from measurements of the luminosity of the brightest red giant branch stars. Five associations of dwarf galaxies that had originally been identified based on strong correlations on the plane of the sky and in velocity are shown to be equally well correlated in distance. Two more associations with similar properties have been discovered. Another association is identified that is suggested to be unbound through tidal disruption. The associations have the spatial and kinematic properties expected of bound structures with $(1-10) \times 10^{11}\ M_{\odot}$. However, these entities have little light, with the consequence that the mass-to-light ratios are in the range $100-1000\ M_{\odot}\ L_{\odot}^{-1}$. Within a well-surveyed volume extending to a 3 Mpc radius, all but one known galaxy lie within one of the groups or associations that have been identified.

Key words: dark matter — galaxies: clusters: general — galaxies: distances and redshifts

see also D. Makarov's poster

Proximity to a massive companion results in SF quenching

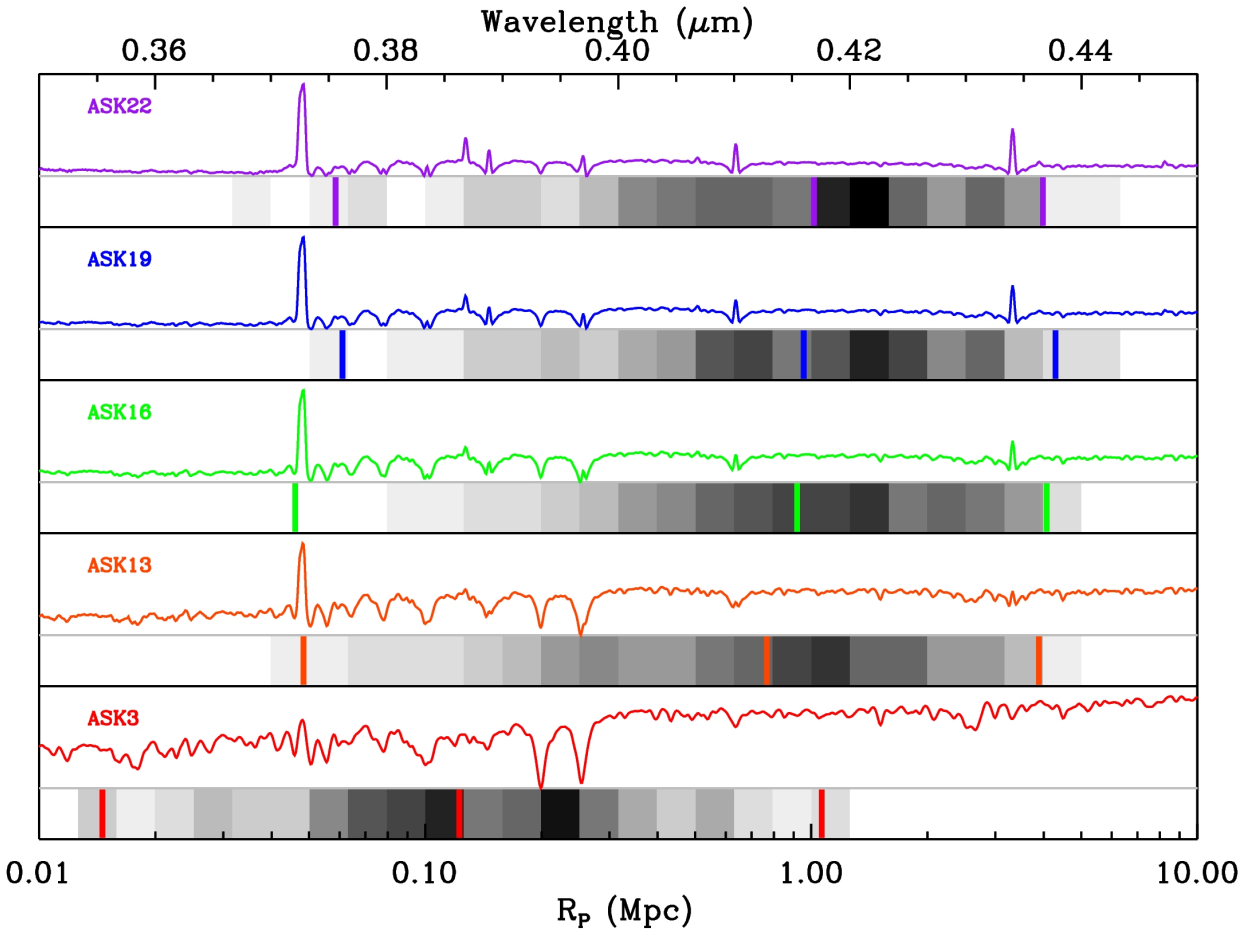
- Distance to $(M_K^* + 1)$ companions for a volume-limited sample of $\approx$6500 star-forming and quiescent, nearby dwarfs.



Sánchez-Janssen et al. (A&A submitted; see also Geha+12).

Proximity to a massive companion results in SF quenching

- 99.3% of quiescent dwarfs have $L \gtrsim L^*$ companions within 1.5 Mpc



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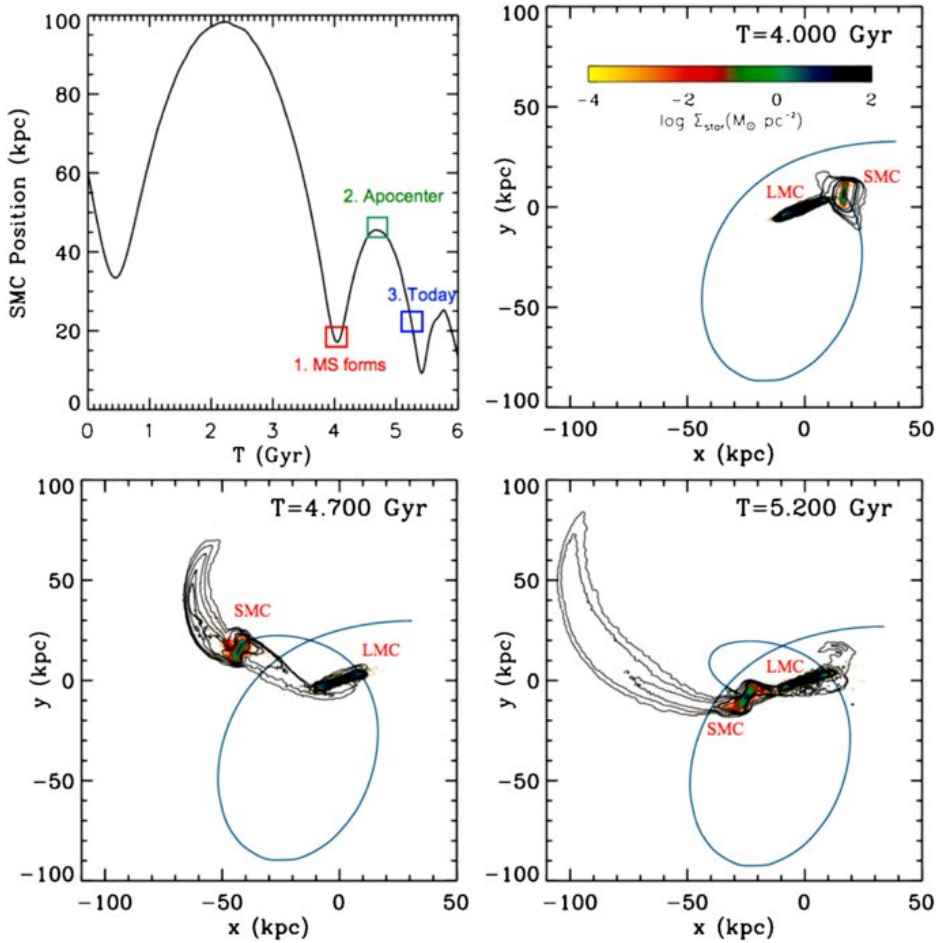
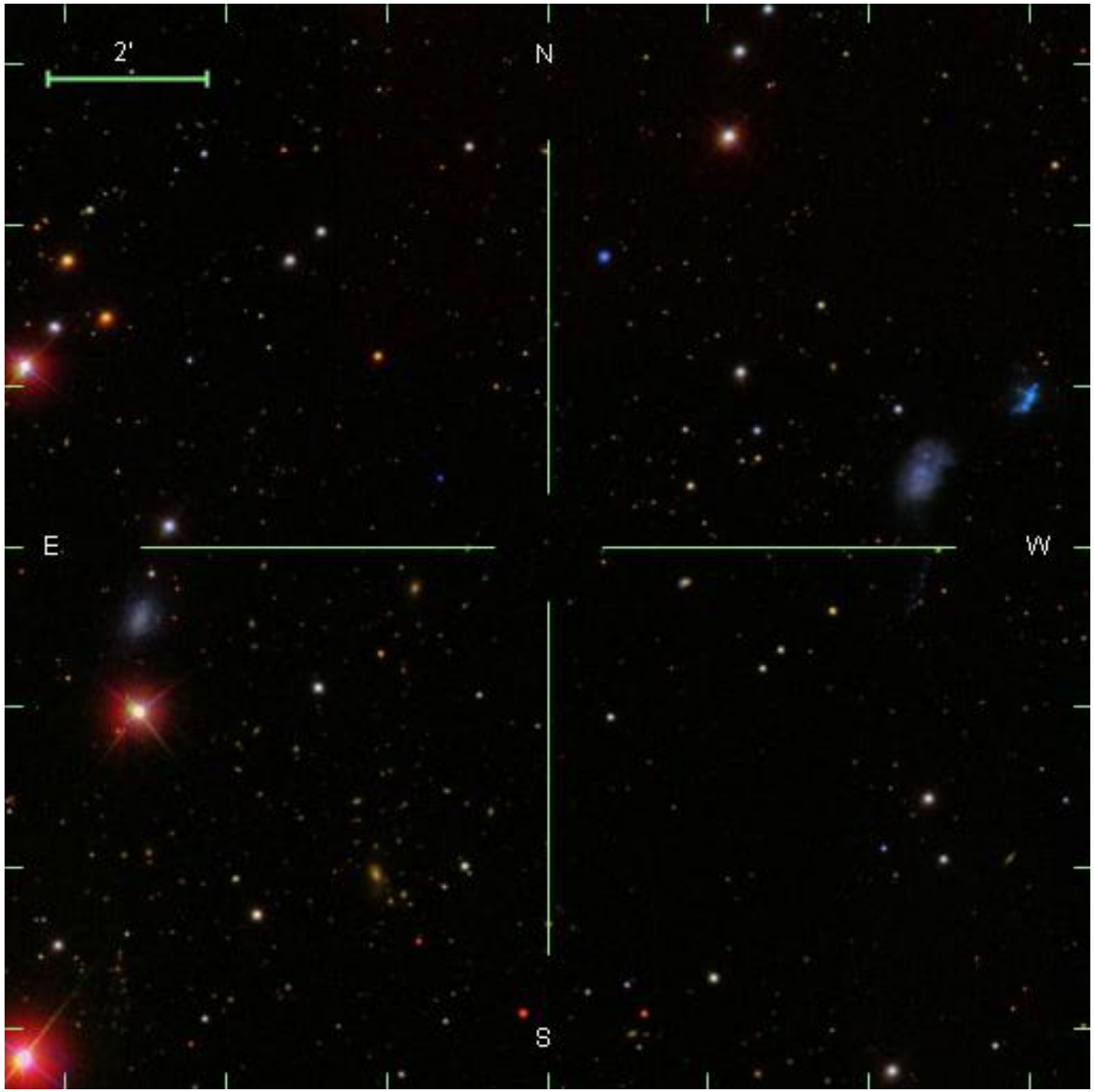
But what's the role of dwarf-dwarf interactions?

- LMC-SMC tidal interactions prior infall onto MW can explain the Magellanic Stream – a generic feature of low-mass satellite(s) accretion?

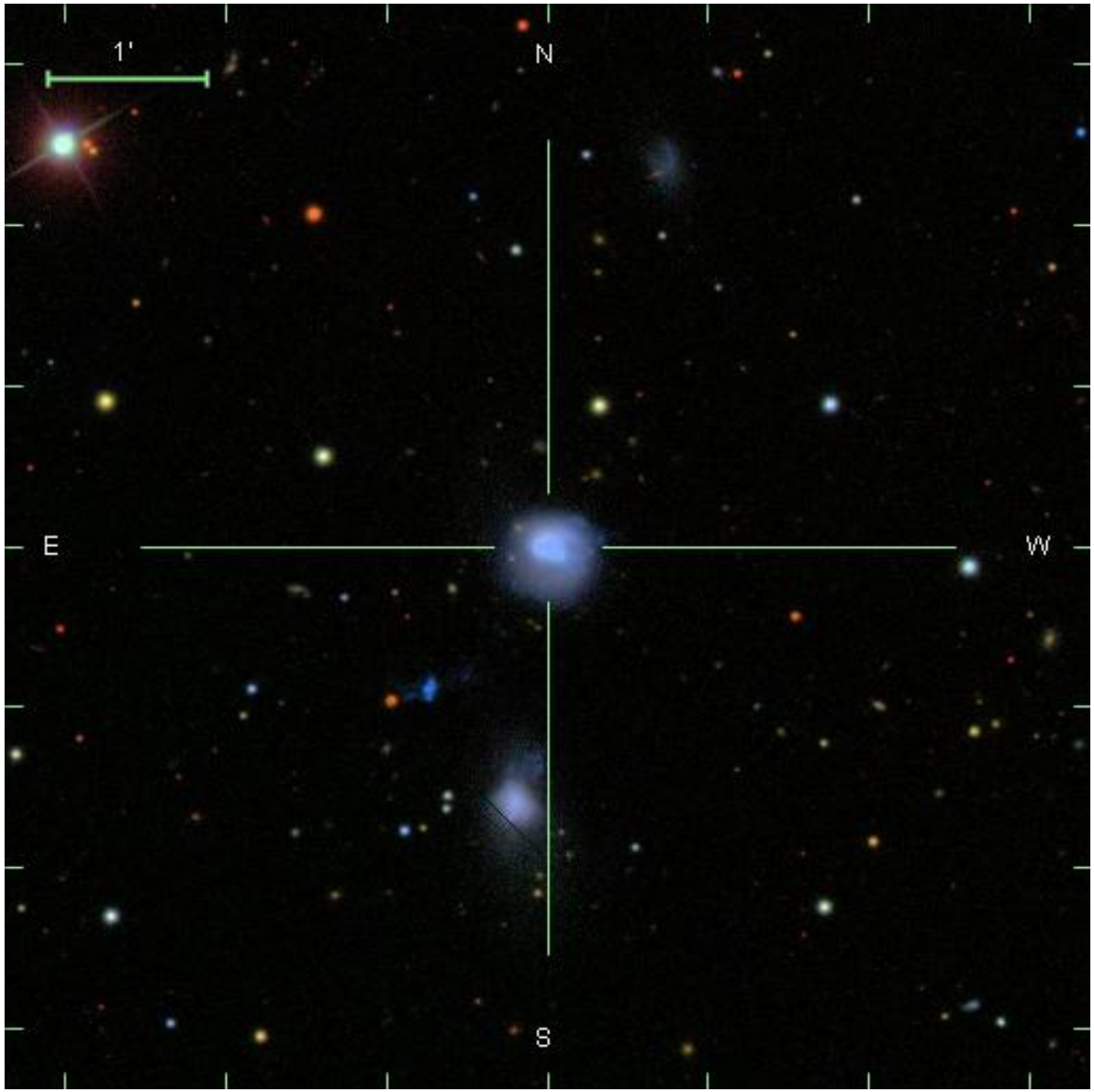


Besla+10

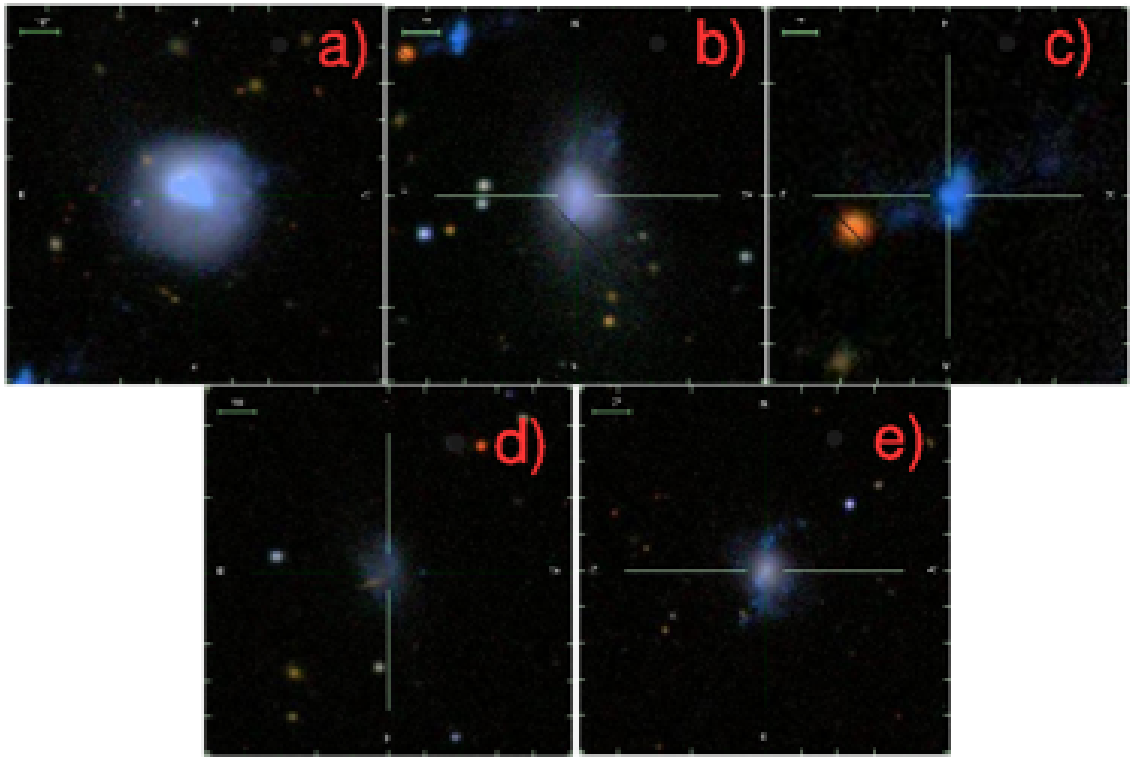
Dwarf galaxy groups in the SDSS: UGC 5205

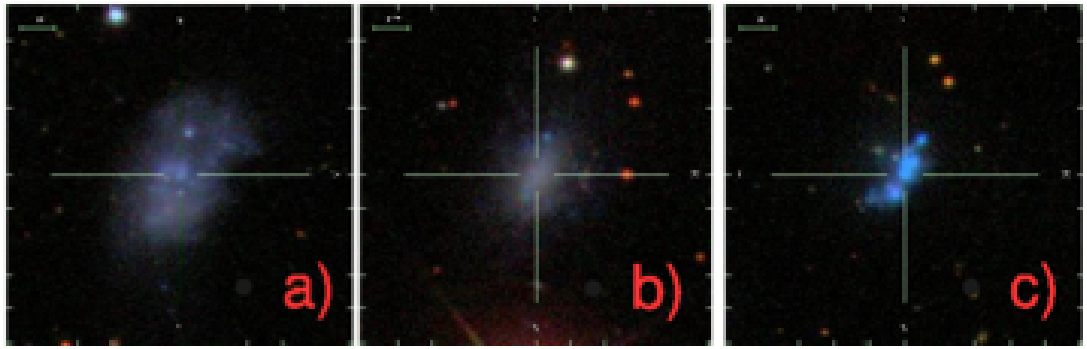


Dwarf galaxy groups in the SDSS: UGC 10200



Groups are late-type dominated: SF activity





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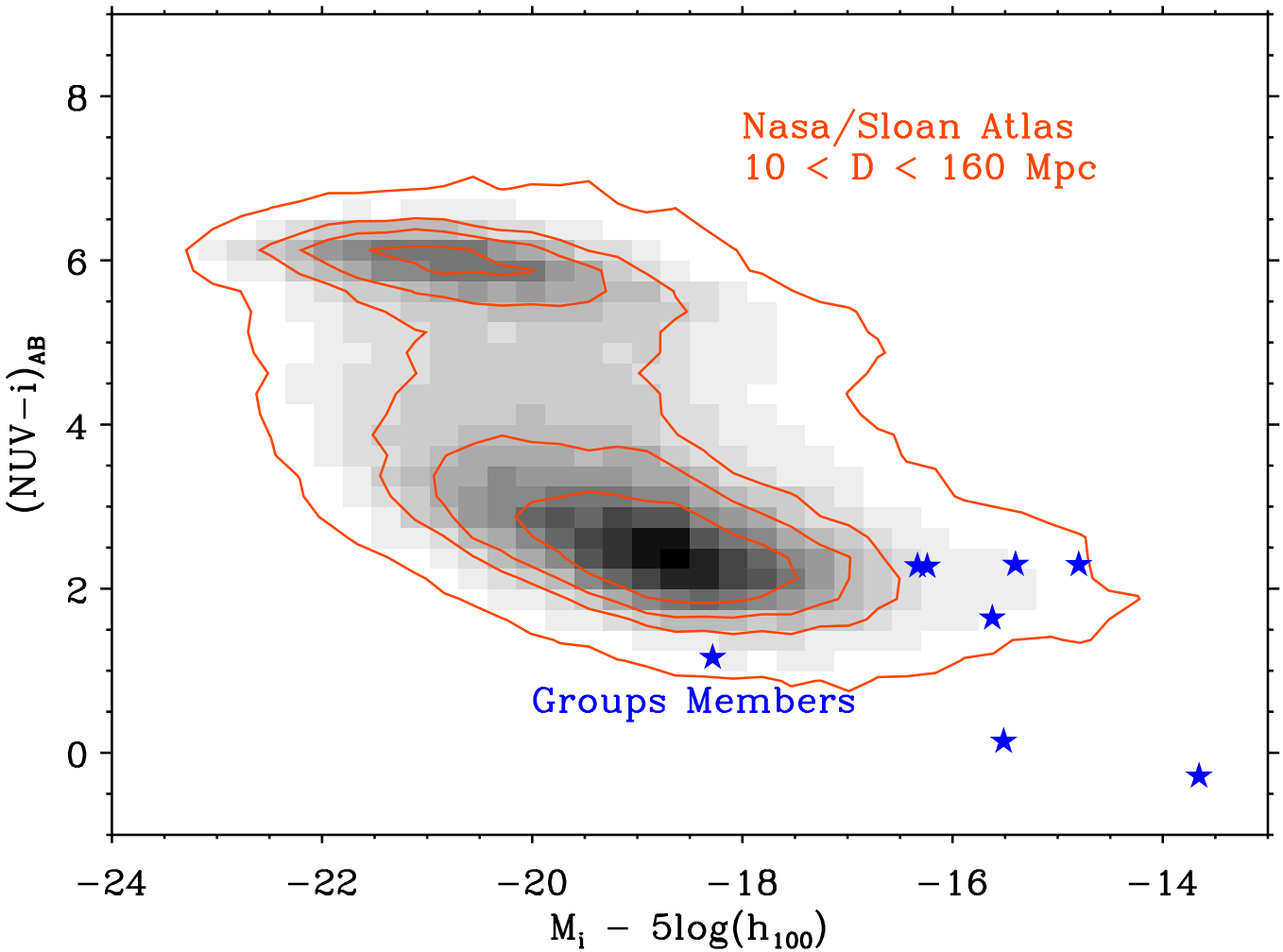
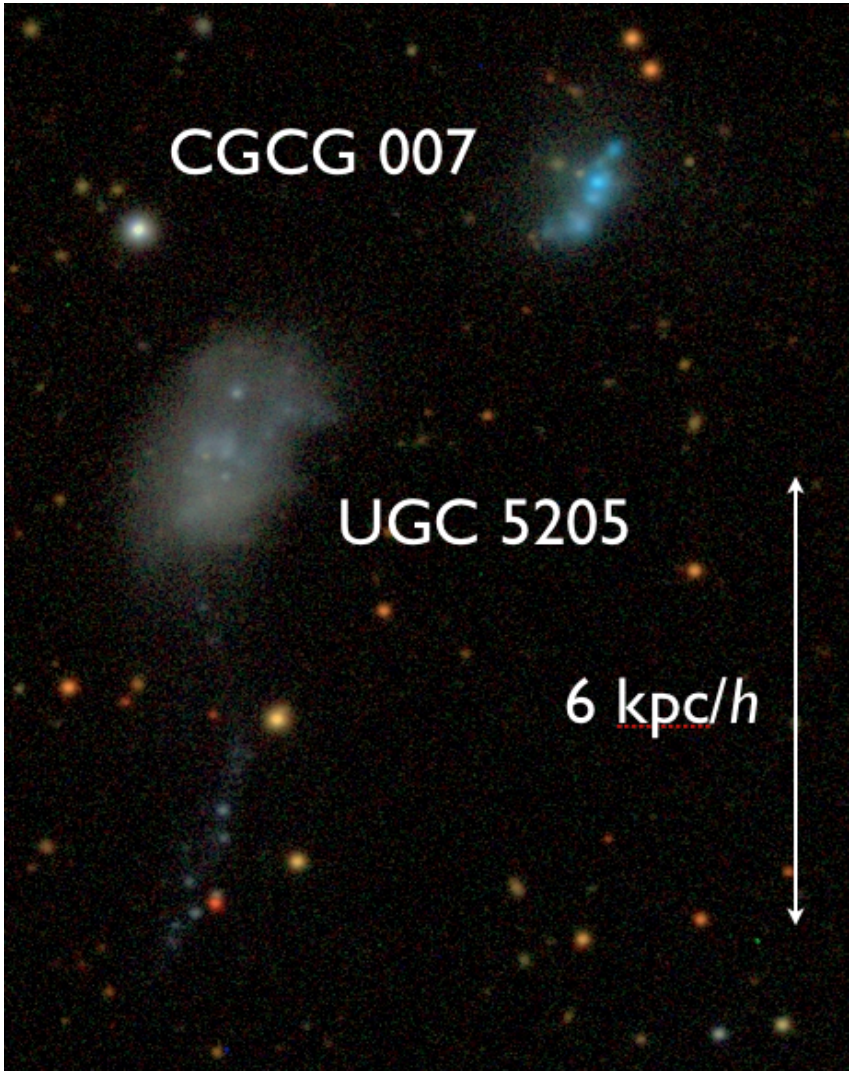


Interactions trigger starbursts and can strip mass



SDSS gri image

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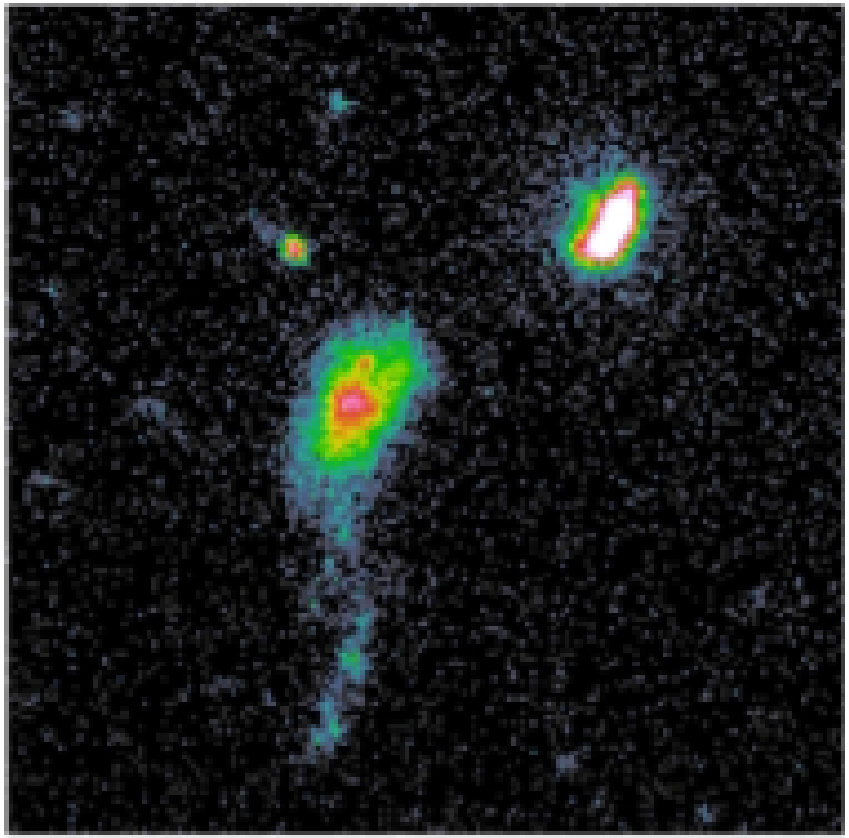
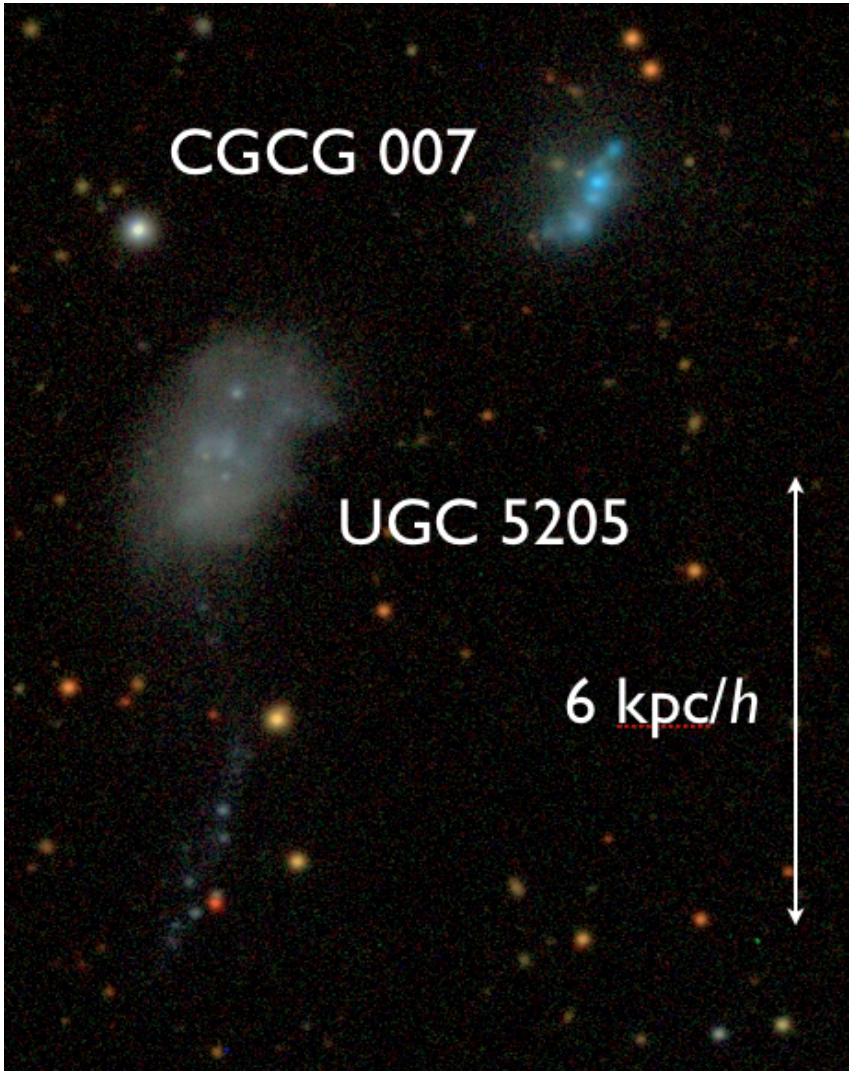
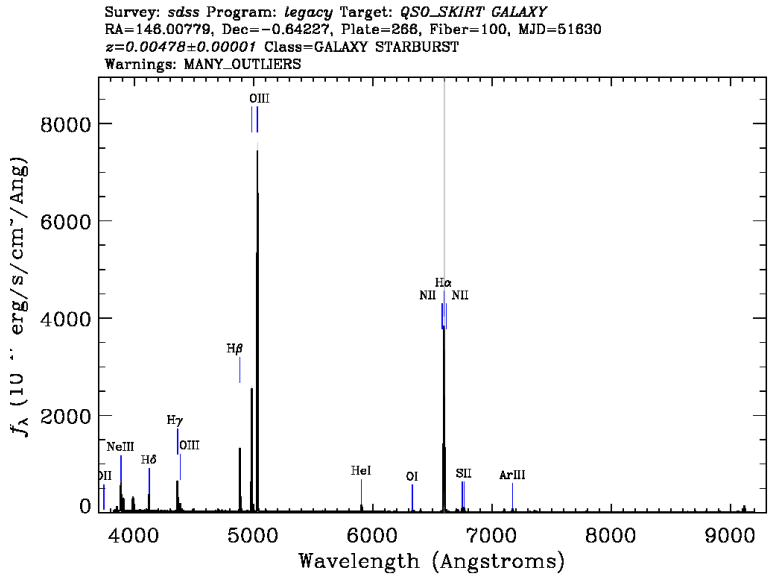
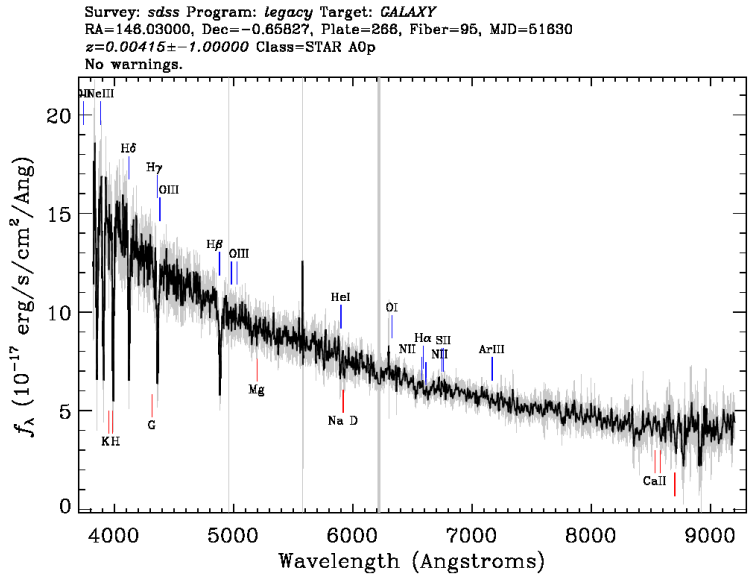


GALEX NUV

All flavours of star formation activity







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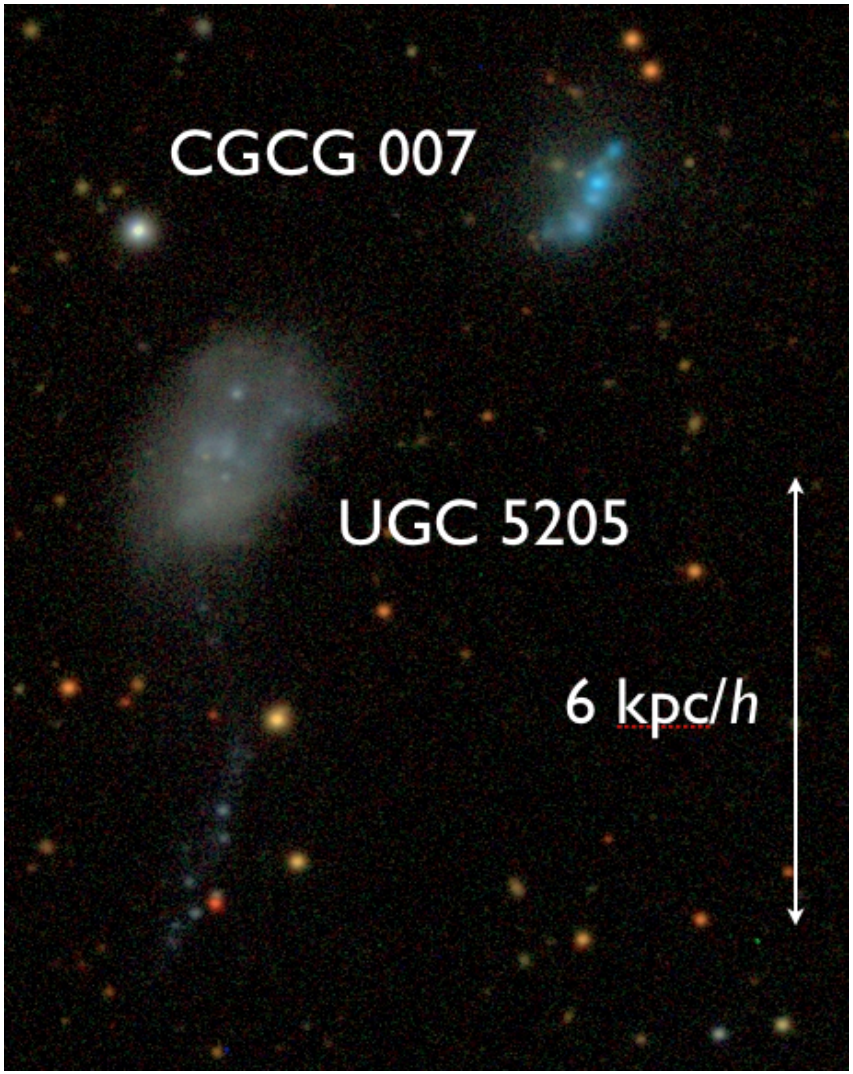
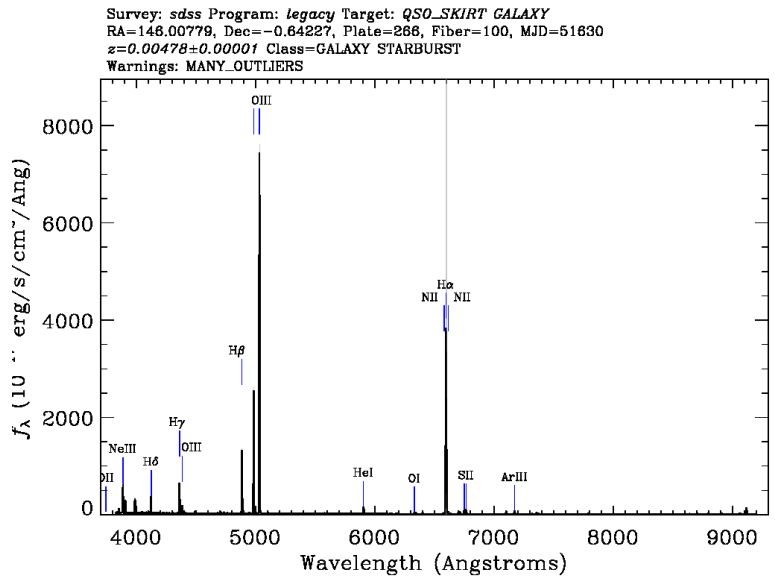
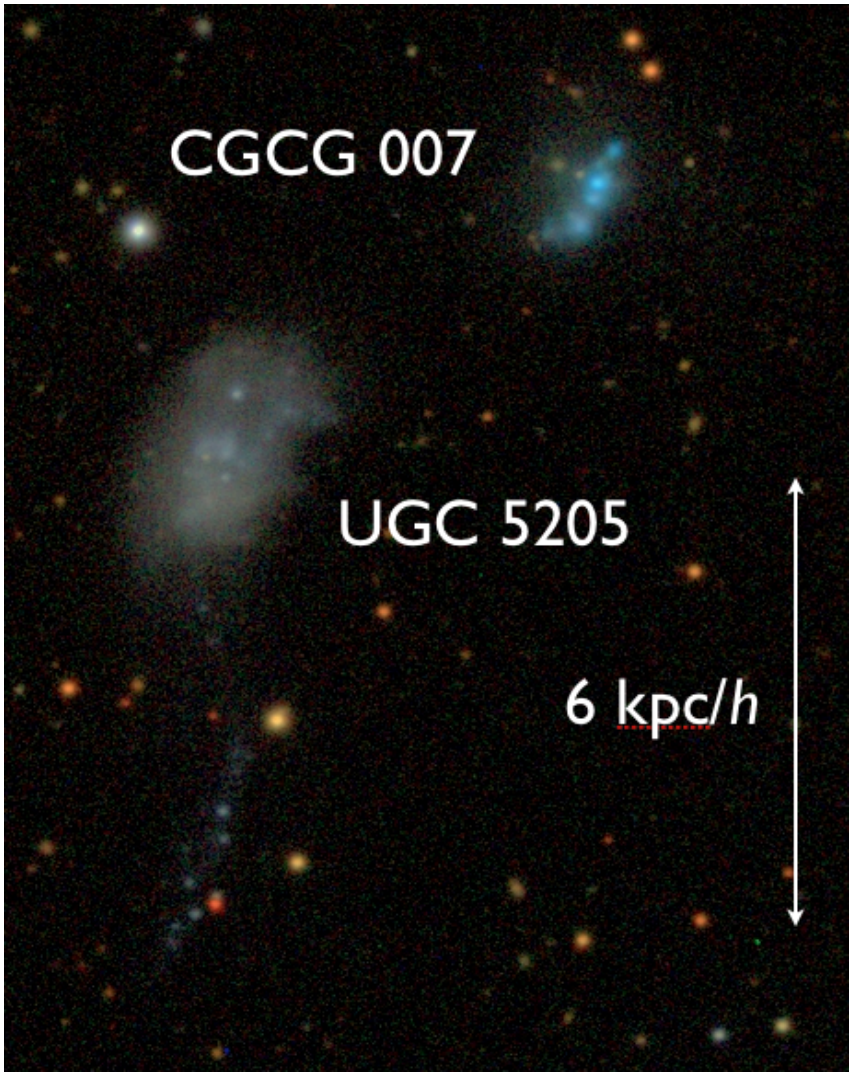


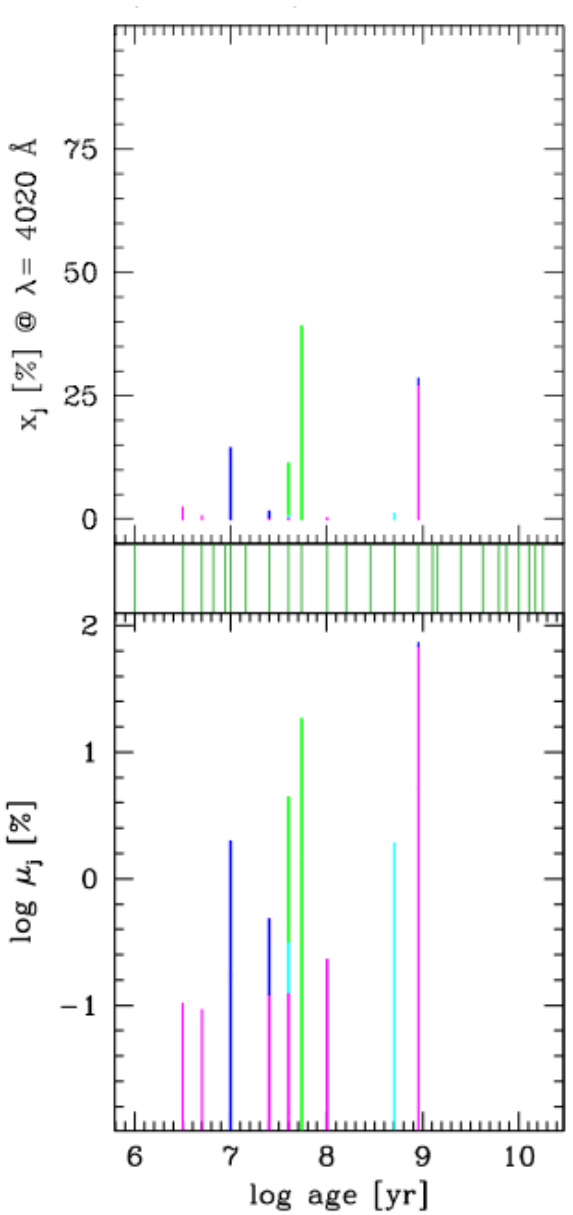


CGCG 007

- $12+\log(O/H) = 7.78 \pm 0.05$
- $EW_{H\alpha} = -1800$ Å

All flavours of star formation activity





Starbursts in gas-dominated systems

Group	Galaxy Name	α (J2000)	δ (J2000)	cz (km s^{-1})	M$_\star$ (10^7M$_\odot$)	EW$_{H\alpha}$ (Å)
UGC 10200	UGC 10200	241.4412	41.3447	1991	41	-145
	CGCG 223-037	241.4459	41.3182	1496	10	+3
	KOSS NP7 033	241.3108	41.1884	2123	7	-17
	SDSS J1605+4123	241.4245	41.3843	1933	3	-35
	LEDA 214461	241.4580	41.3300	1667	0.4	–
UGC 5205	UGC5205	146.0300	-0.6583	1486	7	+4
	HIPASS J0944-00b	146.1926	-0.6883	1221	5	-40
	CGCG 007-025	146.0078	-0.6422	1449	3	-1800

- 4/7 are starbursts (EW$_{H\alpha} > 100$ Å) *or* post-starburst systems
- UGC 5205 $\rightarrow$ M$_{\rm HI} = 6 \times 10^8$ M$_\odot$ $\rightarrow$ $f_{gas} = 0.80$
- UGC 10200 $\rightarrow$ M$_{\rm HI} = 3 \times 10^9$ M$_\odot$ $\rightarrow$ $f_{gas} = 0.82$

Dwarf galaxy groups are ideal sites to study dwarf galaxy interactions in the absence of massive companions

- Late-type dominated, star-forming systems.
- Starbursts appear to be a common mode (at least in these rather compact associations).
- Interactions between dwarfs can result in extended tidal tails $\longrightarrow$ implications for (potential) subsequent accretion onto more massive companions?
- Appear to be gas-dominated systems $\longrightarrow$ how do the gas properties vary among these different dwarf types?
  - GMRT interferometric observations of both systems.
  - Spatial and kinematical properties of the gas.
  - Distribution of total, baryonic and stellar masses.

Low mass haloes are extremely inefficient in converting baryons to stars (Geha+06)