Publication Year	2018
Acceptance in OA@INAF	2020-10-15T12:38:29Z
Title	In the Shade of Dorado Group Giants: Tracing the Eventful Life of Member Galaxies in Optical and Far UV
Authors	RAMPAZZO, Roberto; MAZZEI, Paola; Marino, A.; CATTAPAN, ARIANNA; Ciroi, S.; et al.
DOI	10.5281/zenodo.1304773
Handle	http://hdl.handle.net/20.500.12386/27834

In the shade of Dorado group giants: tracing the eventful life of member galaxies in optical and Far UV

R. Rampazzo[1], P. Mazzei[2], A. Marino[2] , A. Cattapan[3], S. Ciroi[3], E. Iodice[4], A. Grado[4], E.V. Held[2], L. Limatola[4], M. Spavone[4]

[1]INAF - Osservatorio Astrofisico di Asiago (Italy)
[2]INAF - Osservatorio Astronomico di Padova (Italy)
[3]Dipartimento di Fisica e Astronomia G. Galilei, Università di Padova (Italy)
[4]INAF – Osservatorio Astronomico di Capodimonte, Napoli (Italy)

Abstract

Groups are key to understand the galaxy evolution: they contain most of the galaxies in Universe at present day, most of the stellar mass and have *their own way* to transform galaxies from active to passive. Our aim is understanding the mechanisms driving the co-evolution of galaxies in nearby groups. Rich of early-type galaxies showing shells and FUV bright rings, Dorado is a nearby (16.9 Mpc Firth et al. 2006, MNRAS, 372, 1856) loose (about 10 deg^2 , Carrasco et al 2001, AJ, 121, 148) association still non-virialized, likely a *way station* towards rich, virialized groups. **We are mapping the group via deep VST *g, r* SDSS filters *and (hopefully) Astrosat-UVIT;* Far and Near UV imaging from *GALEX and Swift-UVOT are also available*.** Our targets include the giant early-type galaxies (ETGs) marking the group backbone as well as their intermediate companions and dwarfs whose luminosity function is still largely incomplete. The optical and Far UV analysis is shedding light on the Dorado evolving phase, showing residual star formation in evolved giant ETGs.

1. Combining optical + Far UV

The investigation of the evolution of group members in the nearby Universe is of great cosmological interest because more than half of galaxies reside in groups. Furthermore, since the velocity dispersion of groups and galaxies are comparable, the probability of merging and the effects of interactions on galaxy evolution are much higher than in clusters. Consequently, groups provide a view on morphological and star-formation evolution of galaxies, before they fall into denser environments (e.g. Wilman et al. 2009, ApJ, 692, 298; Just et al. 2010, ApJ, 711, 192).

The color distribution of galaxies in the Local Universe is nearly bimodal and relates to galaxy morphology (e.g. Strateva et al. 2001, AJ, 140,1462, Balogh et al. 2004, ApJ, 615, L101). In the UV-optical (NUV-r) vs. M_r diagram (CMD), ETGs populate the Red Sequence (RS) and late-types, with active star formation, the Blue Cloud (BC) (e.g. Baldry et al. 2004, ApJ, 600,681). This bimodality is ubiquitous, extending from field galaxies to groups and clusters (e.g. Lewis et al. 2002, MNRAS, 428,476). Its physical origin is still under debate, although there is some evidence that blue and red populations are the result of transformations driven by the inner secular evolution and environment effects. The galaxy migration from BC to RS, i.e. from star-forming to quiescent galaxies, occurs crossing an intermediate zone of the CMD, the Green Valley (GV) (e.g. Martin et al. 2007, ApJS, 173, 342). UV fluxes are an excellent tracer of recent star formation, moreover RS and BC are well separated (see Figure 1) in the CMD (e.g. Schawinski et al. 2007, Wyder et et al. 2007, ApJS, 173, 512, 293, Rampazzo+ 2018). Many ETGs, widely considered evolved "red & dead" galaxies, reveal signatures of on-going star fromation in the form of inner and/or outer blue ring/arm-like structures (e.g. Marino et al. 2011, ApJ, MNRAS, 411, 311, Salim et al. 2012 ApJ, 755, 105).

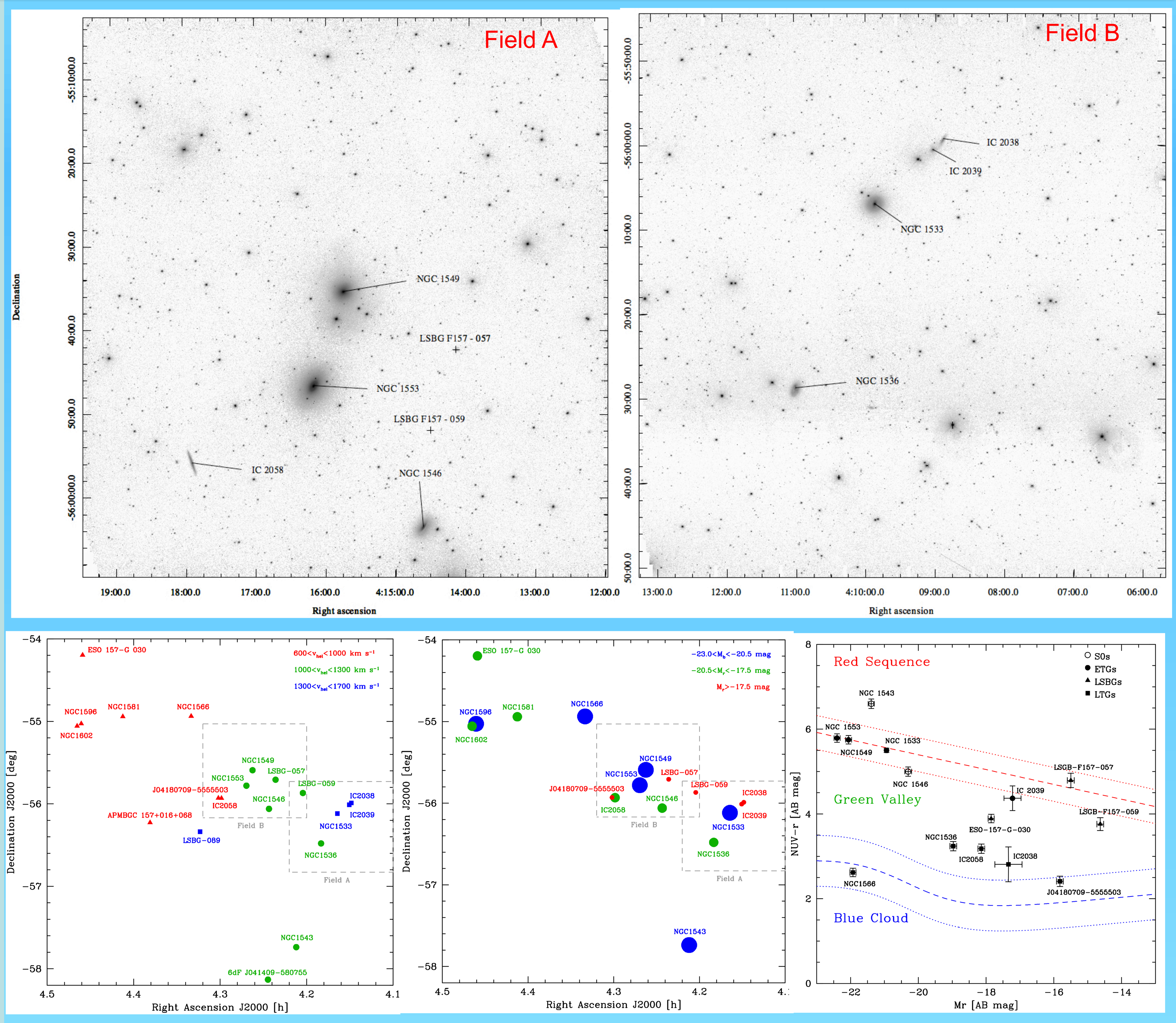

FIG.1 (top panels) The Dorado group partially covered by two VST fields. (bottom left panel) The observed fields are indicated by grey dashed lines. Member galaxies according to Firth+ (2006) **are separated in velocity bins: the dynamical analysis suggests that Dorado is not yet virialized: galaxy clumps are still present. (mid bottom panel) Giant members are divided in bins of absolute magnitude M_r , adopting the distance D=16.9 Mpc : the group backbone marked by giants is shown in blue, dwarfs in red. (right bottom panel) The (NUV-r) vs M_r color magnitude diagram. The RS and the BC in Dorado, represented by dashed lines, are averages from** Wyder+ (2007). **Member galaxies are divided by morphology (full cirlce=Es, open circle=S0s, squares= Spirals, low surface brightness galaxies=triangles).**

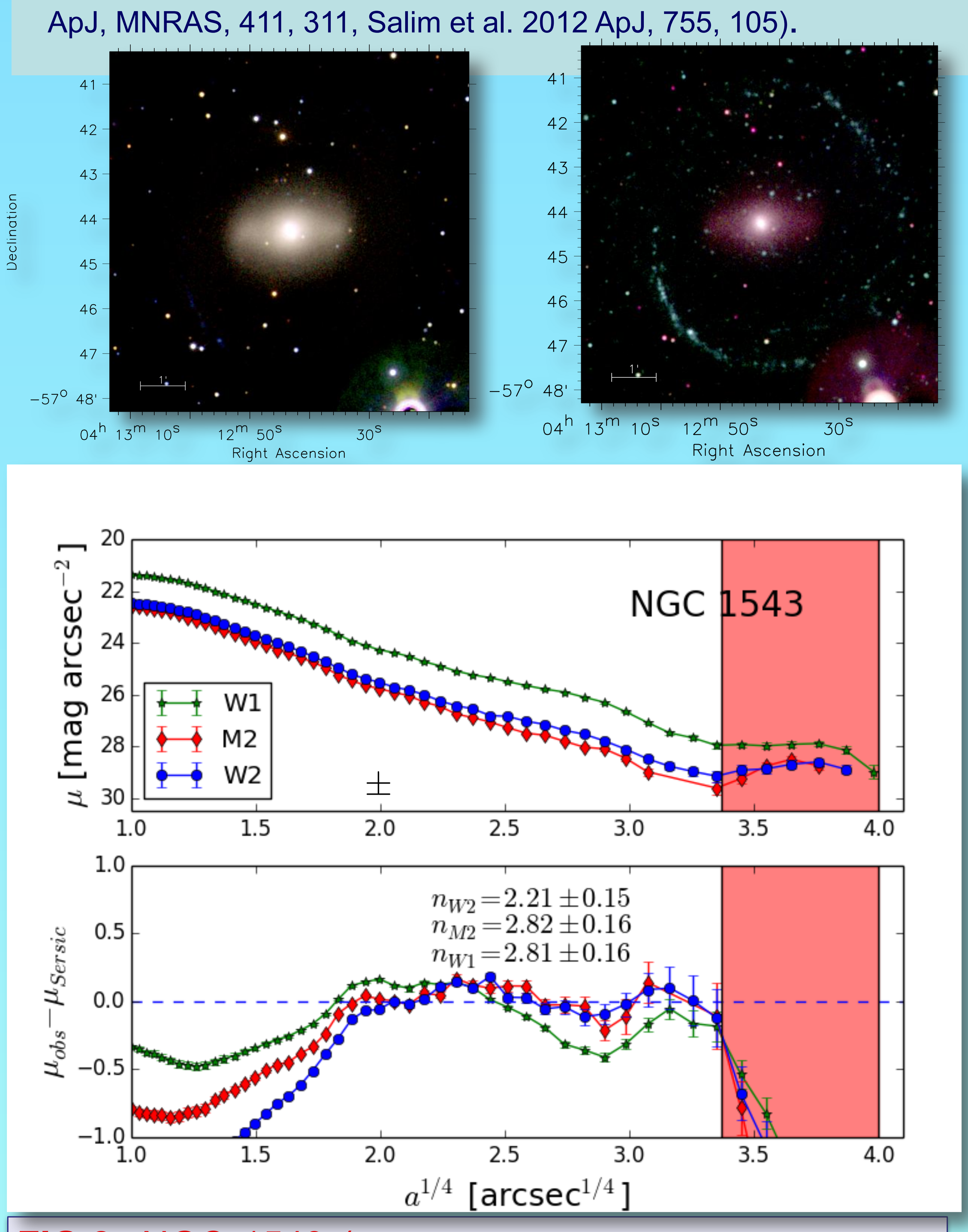

FIG.2 NGC 1543 (***left panels***)**: color composite images in the U,B,V (left U=blue, B=green, V=red) and W1, M2, W2 filters of Swift-UVOT (W2=blue, M2=green, W1=red) . The FoV is 8'x8'. (*Bottom panels*): W1, M2, W2 luminosity profiles and residuals of their best fit with a single Sersic law accounting for the filter PSF (about 3" in UV bands). Star formation regions are revealed at the edge of the optical ring** (Rampazzo+ 2017, A&A,602, A97)

2. Insights from giant ETGs

- Dorado CMD is traced only for the brightest galaxy members (Fig. 1 bottom right panel). These galaxies have nearly all abandoned the BC, even late-type galaxies. On the other hand, Dorado has a well defined RS where most of bright ETGs are located.
- It is well known that its giant ETGs reveal signatures of past interactions (shells, tails e.g. Malin & Carter 1983) .
- Moreover, some still show residual star formation, e.g. NGC 1533 and NGC 1543 (Fig. 2).

3. Simulating giants ETGs evolution

- From a large grid of physically motivated SPH simulations of galaxy encounters/mergers starting from triaxial halos composed of dark matter and gas (Mazzei & Curir, 2003, ApJ, 591, 784) we selected those best-fitting the global properties, that are absolute magnitude, morphology, SED (from far-UV to far-Infrared), kinematics and gas X-ray emission, of the brightest ETGs in our sample. Simulations include self-gravity of gas, stars and dark matter, radiative cooling, hydro-dynamical pressure, shock heating, viscosity, star formation and feedback from evolved stars and type II Sne, and chemical enrichment (Mazzei et al. 2018, A&A, 610, A8); Mazzei et al. 2014a,b (ApJ, 782, 53; AdSpR, 53, 95; 2018)). In Fig.3 we show the case of NGC 1543 member of the group observed with ***Swift-UVOT*** (Mazzei et al. 2018 in prep.).
- SPH simulations with chemo-photometric implementation shows that NGC 1533 and NGC 1543 are the result of a merging (1:1 and 5:1 respectively).

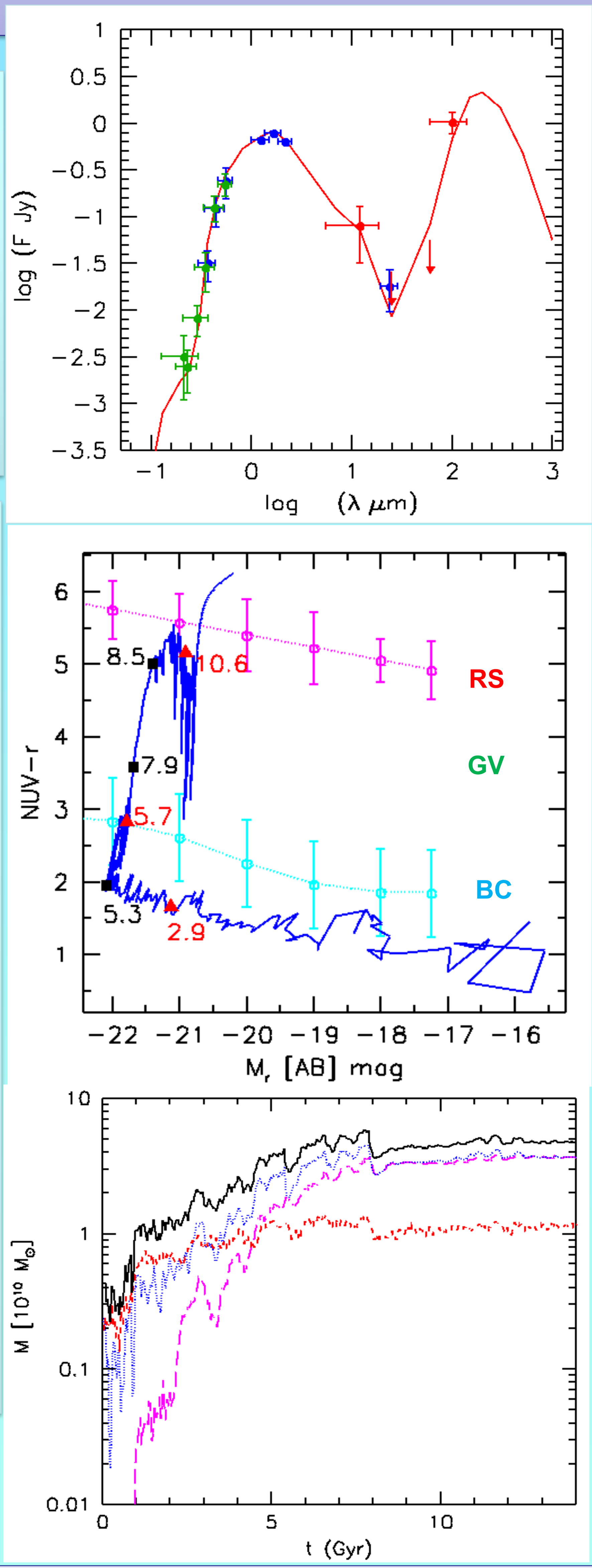

FIG.3: (top) the global observed SED of NGC 1543 (dots) and that predicted (solid red line) by a minor merger (5:1) of total initial mass 2.4x10^{11}M$_\odot$ at the age of 10.6 Gyr. **(middle)** The predicted evolution in the rest-frame (galaxy frame) CMD (red triangles correspond to z=1, 0.5 and 0, respectively). **(bottom)** The mass assembly, computed inside, R_{25}: (magenta) stars, (red) dark matter, (blue) gas, and (black) the total mass (Mazzei et al. 2018 in prep).

4. New insights from the dwarfs in groups

- The Firth+ (2006) group definition includes very few dwarf galaxies (one LSBG is shown in Fig.4): do we miss most of the faintest ones (see e.g. Tully 2015, AJ 149, 54)? Multi-band VST observations will be crucial in defining a candidate sample. We have devised ***Astrosat-UVIT*** Far UV observations to detect star forming dwarfs around giants.

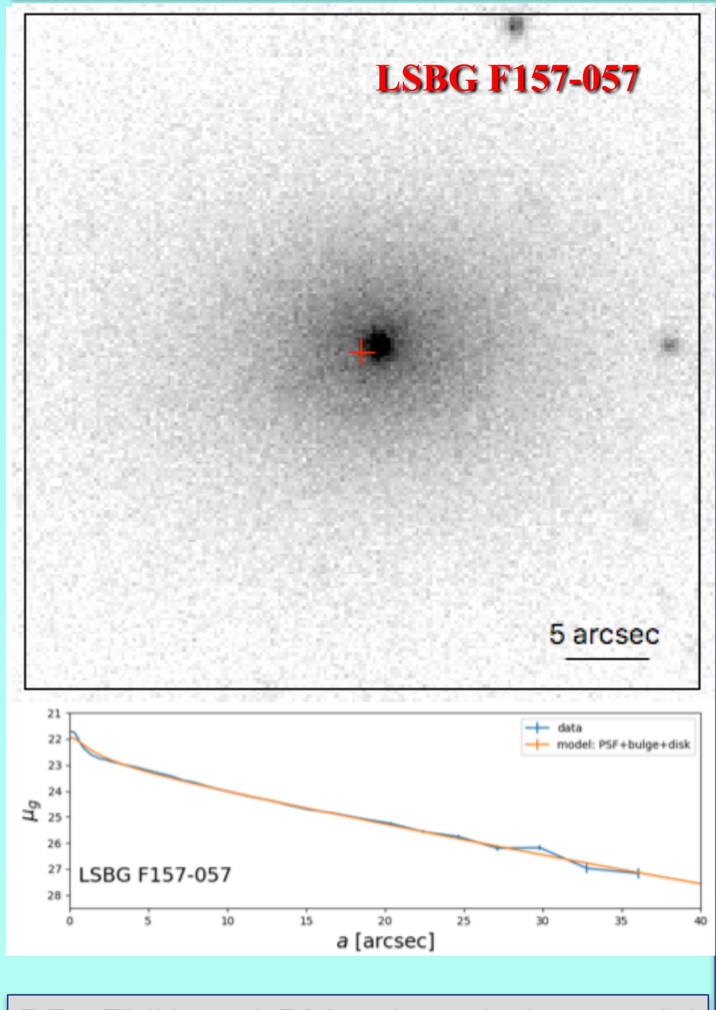

FIG.4 (top panel) **VST g-band image (PSF=0.7") and** (bottom panel) **surface brightness profile of a LSBG (M_r= -15.5) in the list the Firth et al. (2006: the cross is the RA and Dec. catalogued). The redshift is compatible with Dorado. The dwarf lacks a classical ($r^{1/4}$ law) bulge and shows an extended exponential disk. Its global (NUV–r)=4.79 color locates this LSBG on the RS. (Fig 1 bottom right panel). No obvious interaction signatures are revealed in the galaxy structure.**

RR, EVH and PM acknowledge partial support of PRIN-INAF eSKApe-HI (PI Leslie Hunt).