Low Surface Brightness Galaxies: understanding their formation and evolution

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•Motivation is to systematically search for low surface brightness galaxies (LSBs) using SDSS DR7 optical images and to study their morphological properties. Understand their formation processes.

•LSBs are identified based on the central surface brightness in the B band to be 1mag fainter than the Freeman limit (1970, 21.6 mag/arcsec^2)

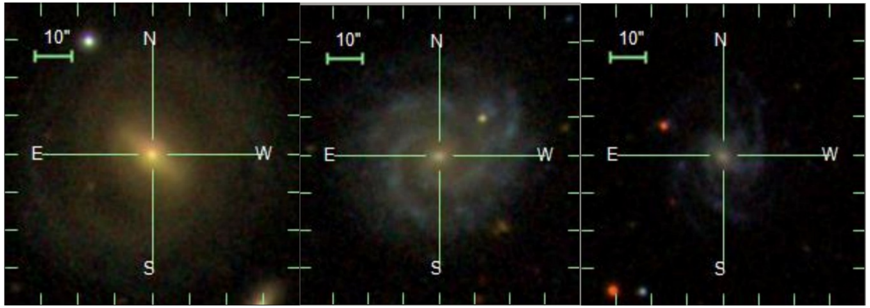
•We have used bulge/disk decomposed catalog of SDSS galaxies from Meert et. al. (2014, 2015), (GALFIT+PYMORPH)

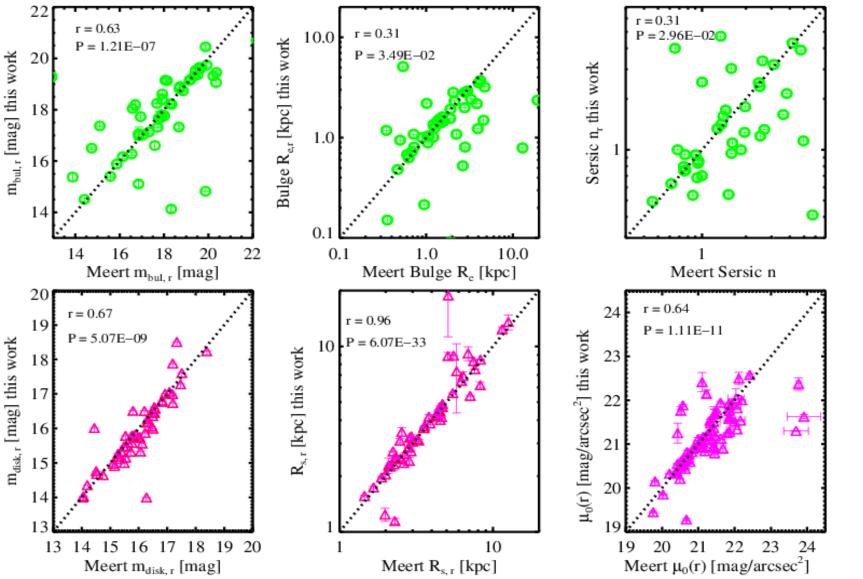
•We have also performed B/D decomposition using GALFIT for randomly selected 90 galaxies.

•Parameters obtained from Meert catalog matches with our estimates.

•To create a systematic sample comprising of large number of LSB galaxies, we have used the Meert catalog.

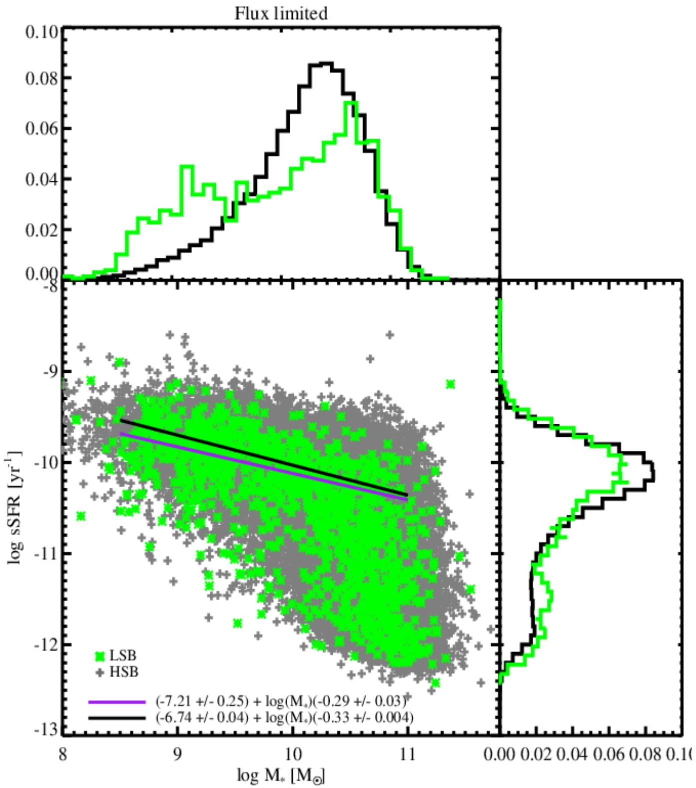
•Till date, ~7-10 Giant Low Surface brightness galaxies (GLSBs) are known in the local universe (z<0.1). They have very diffuse, extended disks. Our systematic search would increase the sample size to ~248. (Ellipticals, S0s are removed from the sample).

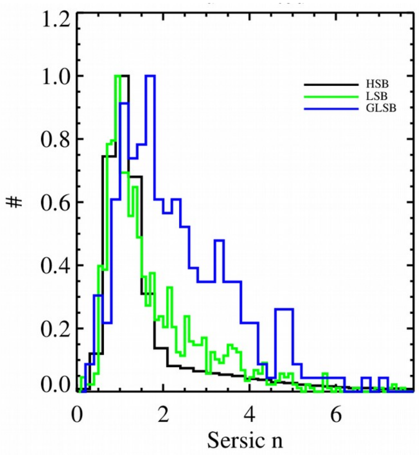


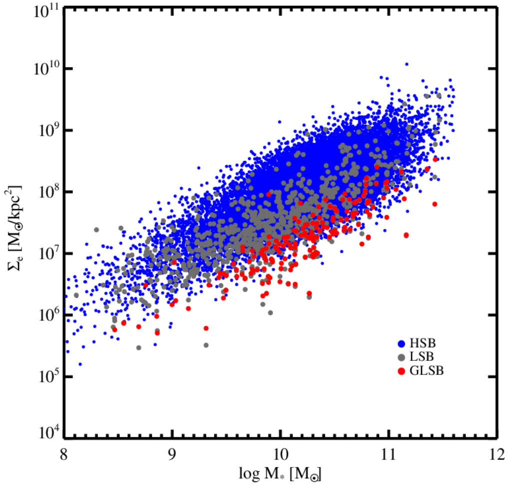


Properties and scaling relations: sSFR, Σ_e vs M_*

- A sample of 1280 LSBs were obtained from the Meert sample with $\mu_{0,B} > 22.5$ mag/arcsec^2
- About ~248 galaxies turn out to be GLSBs.
- GLSBs are selected based on the criteria : ($\mu_{0,B}$ + 5logRs > 27.6) (Sprayberry et. al. 1995), No requirement of a bulge in the criteria.
- 50% of 248 galaxies show prominent bulge with Sersic index, n>2.0 and masses > 10^{10} $M_\odot$
- Sample is cross-matched with MPA-JHU catalog (Brinchmann et. al. 2004) to obtain SFR, sSFR and stellar masses for the LSB galaxies.
- sSFR vs M* is plotted to show that LSBs are also star forming albeit slowly, when compared to its HSB counterpart with same stellar mass. For LSB galaxies, the sSFR vs M* line (purple line) lies below the line for HSB galaxies
- Stellar mass surface density, Σ_e, forms a tight relation with stellar mass and is a better indicator of mass buildup. GLSBs show smaller Σ_e than LSBs and HSBs. There is change in 3 orders of magnitude of Σ_e for HSBs while the surface density increased by ~2 orders of magnitude for GLSBs.







Mass – Size relation for LSB galaxies :

- Effective radius vs Stellar mass relation is plotted for LSBs and GLSBs, for bulges (circles) and disks (diamonds).
- For reference, the size-mass evolution of early-type galaxies at z~1.75 and z~0.25 are plotted as black lines (van der Wel et. al. 2014) obtained from CANDEL+3DHST survey of galaxies.
- Bulges are massive and disks are very large extended especially for GLSBs (blue diamonds)
- Classical bulges (n>2.0) of LSBs and GLSBs occupy locations inbetween z~0.25 -1.75. This implies like many massive ellipticals (Oh et. al. 2016) the classical bulges of LSBs and GLSBs might have formed dissipatively earlier (at z~1.0-1.75) in their evolution.
- Green dot dashed lines are mass-size relation for local Sd-Irr disk galaxies from Lange et. al. (2014) obtained from GAMA survey
- Disks of LSBs and GLSBs are shown in pink and blue colour which occupy locations higher than the local Sd-Irr galaxies.
- Disk sizes indicate dramatic size evolution of disks (since z~1.0) which could have been via several minor mergers
- Detailed studies of bulge and disk stellar population to explore various evolutionary scenarios are planned
- Deeper, higher spatial and spectral resolution IFU data covering ~4 times the effective radius of the disk would reveal the true nature of these galaxies.