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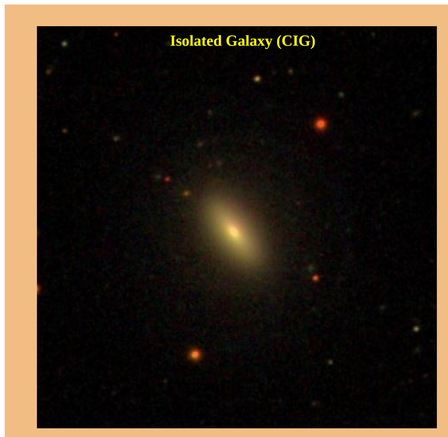
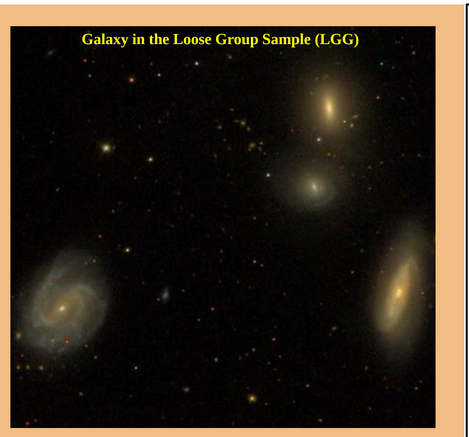
Lenticular Galaxies in Different Environments – Isolated versus Group Environment

Abstract:

We explore the properties of lenticular galaxies in different environments (isolated galaxies versus crowded environments, i.e., groups with 4-10 galaxy members). Using a Fortran code (BUDDA – Bulge Disk Decomposition Analysis), we model the photometric parameters that describe each lenticular galaxy in terms of size and light profile. We then compare the derived model-dependent measures between the two samples of galaxies to test if they are statistically different, which would hint at gravitational influences of the neighbors. This process would allow us to gain more insight into the formation and evolution of lenticular galaxies.





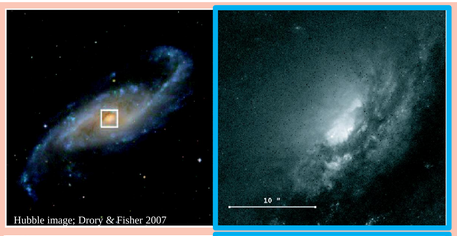
Sample: N=12 CIG (isolated) & N=28 LGG (group)

- S0 galaxies
- available images in SDSS DR8
- $1500 < V_{Recession} < 5500$ km/s
- inclination < 70°

CIG – **C**atalog of **I**solated **G**alaxies

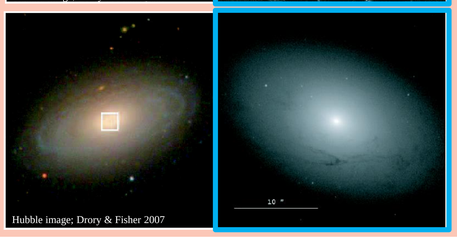
LGG – **L**yon **G**roup of **G**alaxies

PSEUDO BULGE



Pseudobulges are shaped more like a disk, similar to a miniature spiral galaxy. Typically, galaxies with pseudobulges form through secular evolution.

CLASSICAL BULGE



Classical bulges are more ellipsoidal in shape, similar to a miniature elliptical galaxy. Typically, galaxies with classical bulges are formed by mergers.

Bulge/Disk /Bar Image Decomposition

BUDDA Fortran Code (**BU**lge/**D**isk **D**ecomposition **A**nalysis)- de Souza et al. 2004

Disk: **(Exponential profile)**

$$I(r) = I_o e^{-r/h_R}$$

I_o – central intensity

h_R – radial scalelength

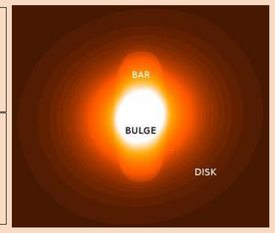
Bulge and Bar: **(Sérsic profile)**

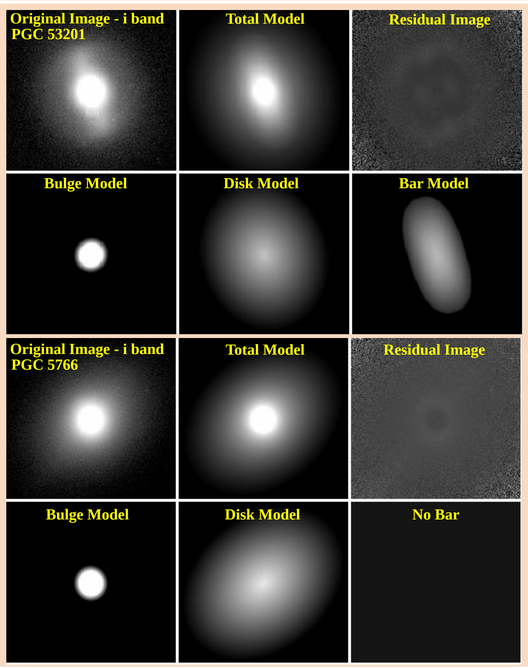
$$I(r) = I_e 10^{-b_n[(r/r_e)^{1/n}-1]}$$

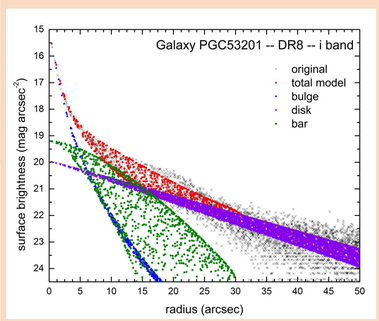
I_e - effective intensity

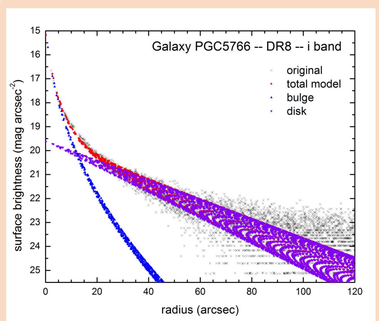
r_e – effective radius

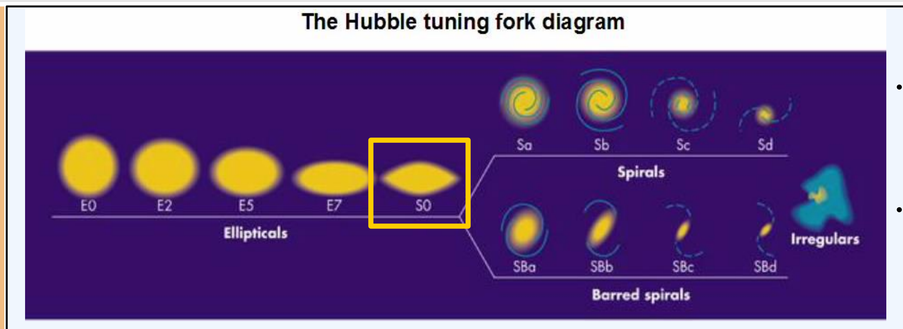
n – Sérsic index



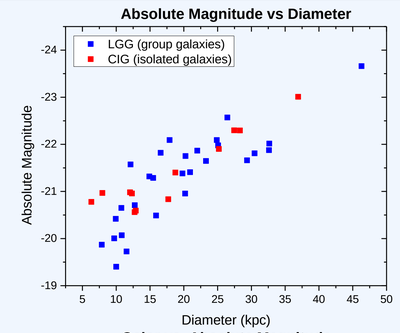


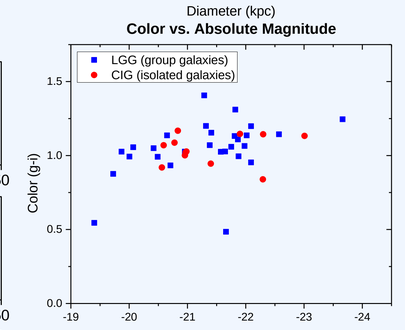


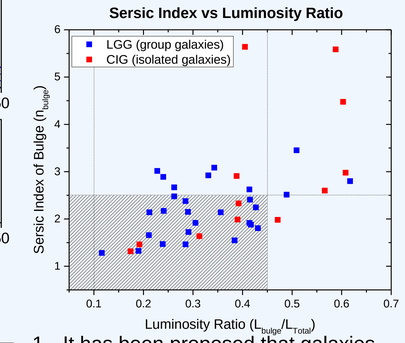


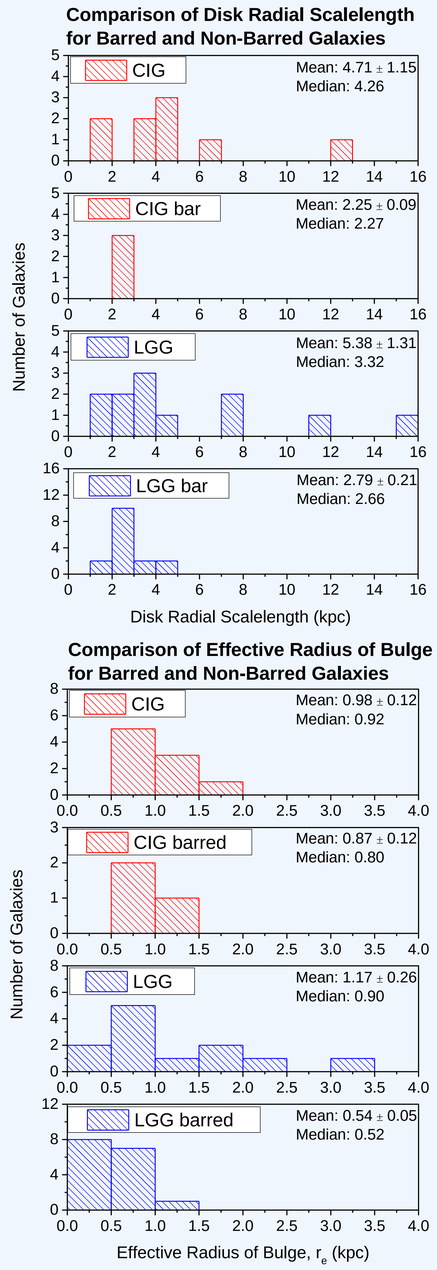


- Top Right Graph: Larger galaxies tend to be more luminous, while smaller galaxies tend to be less luminous.
- Middle Right Graph: More luminous galaxies are slightly bluer than less luminous galaxies.





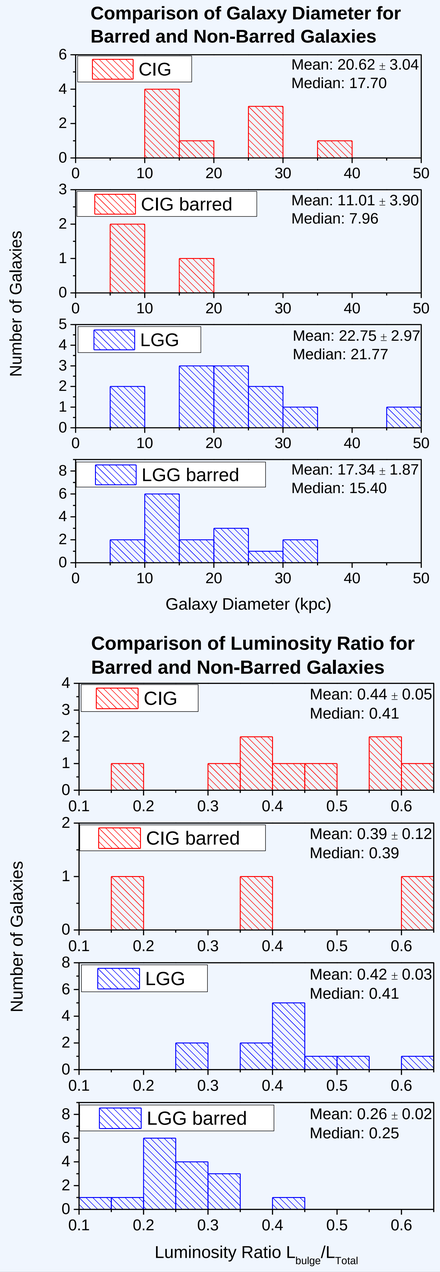




3 out of 12 (25%) of CIG galaxies have bars.
12 out of 28 (43%) of LGG galaxies have bars.

- Left Histograms: The LGG (group) sample and CIG (isolated) sample have similar disk scalelengths overall. However, galaxies without bars have larger disk scalelengths than barred galaxies.
- Right Histograms: The LGG (group) sample galaxies are similar to the CIG (isolated) sample overall. Additionally, the non-barred galaxies for each sample are larger than their barred counterparts.

- Left Histograms: Compared to CIG (isolated) galaxies, the LGG (group) galaxy bulges tend to be smaller overall. Galaxies without bars have larger bulges than barred galaxies. This effect is more prominent in the LGG (group) sample.
- Right Histograms: The luminosity ratio is smaller overall for LGG (group) galaxies compared to CIG (isolated) galaxies. Galaxies without bars have more luminous bulges compared to barred galaxies. In the CIG (isolated) sample it is unclear whether this is meaningful, due to poor statistics.



1. It has been proposed that galaxies with bulge contribution $L_{bulge}/L_{total} < 0.1$ (10%) contain pseudobulges. None of our galaxies meet this criterion.
2. A less restrictive criterion contains the proposal that all bulges characterized by $n_{bulge} < 2.5$ and $L_{bulge}/L_{total} < 0.45$ (45%) are pseudobulges; our CIG (isolated) galaxy sample then contains 42% and our LGG (group) sample 68% pseudobulges.

➢ For SOa/Sa/Sab galaxies the CIG (isolated) sample contains 48% and the LGG (group) sample 28% pseudobulges. An isolated sample of Sb/Sbc/Sc galaxies contains 94 % pseudobulges using criterion 2.

➢ For E galaxies, both the LGG (group) sample and CIG (isolated) sample contain 0% pseudobulges.

Conclusions and Future Work

- Lenticular galaxies in group (nurtured) environments tend to have smaller bulges and a higher percentage of pseudobulges than those in isolated environments. This difference is not noticeable for spiral morphological types. This might suggest that lenticular galaxies in group environments are more likely to form secularly than isolated galaxies. Typically, galaxies in group environments form by mergers and isolated form by secular evolution. This suggests that isolated lenticulars more likely have consumed all of their neighbors more recently. Another possibility is that pseudobulges could also be formed by mergers for lenticular morphological types.
- Non-barred galaxies are larger and have more luminous bulges than barred galaxies, suggesting that bars take away material from the bulge during the galaxy's formation.
- The color of the galaxies correlates with the absolute magnitude.
- In the future, we could perform bulge-disk-bar decomposition of each galaxy in the g-band, and compare the colors for the bulges.

Acknowledgements

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