Research Journal of Recent Sciences _____ ISSN 2277-2502
Vol. 3**(ISC-2013),** 420-422 **(2014)** *Res. J. Recent. Sci.*

Disks in Early-Type Galaxies from NIR observations

Dhanya Joseph, Ravikumar C. D and Preetha A.U.
Department of Physics, University of Calicut, Malappuram, Kerala, INDIA

Available online at: www.isca.in, www.isca.me
Received 30th November 2013, revised 6th January 2014, accepted 7th February 2014

Abstract

We report results from morphological analysis of 54 nearby ($z < 0.018$) early type galaxies, mainly from field, observed in near infra-red K band. Fitting their surface brightness profile with Sérsic bulge and exponential disk, we find that majority of the sample galaxies, selected based on the detection of ionized gas, contains significant amounts of disk components. We find that 74% of our early-type galaxies are having a bulge to total luminosity ratio in K band. B/T, less than 0.5 while only 26% of the early-type galaxies are actually bulge dominant. The average value of bulge to total luminosity ratio (B/T) is 0.425 ± 0.145. The scale length of disk correlates well with its central surface brightness. We also find that the nature of disks in early-type galaxies resembles that observed in field spirals, and actually is with much lesser scatter, suggesting a much more coherent scenario for formation of disks in different types of galaxies.

Keywords: Early-type galaxies, 2d decomposition, B/T ratio, Disc scale length, Near infra-red.

Introduction

Wide range of morphologies are exhibited by galaxies which could be the result of different formation mechanisms in diverse environments. Early-Type galaxies (ETG) which include the ellipticals and lenticulars are normally seen in clusters or in groups. These systems contain older populations and are homogeneous in nature. Earlier studies suggested that the early-type galaxies were featureless and very quiescent systems. However, recent studies reported the presence of some faint features and disturbances in early type galaxies indicating recent star formation[1-3].

According to the morphology-density relation, early type galaxies are located in denser regions[4]. The properties of galaxies such as mass and luminosity also depend on the environment. The ETG in the denser regions are less luminous than those in the field[5]. From these studies we expect that the environment plays a role in explaining the formation of galaxies. The galaxies present in the isolated region might be less affected by the external physical processes.

The structural analysis helps to understand the formation of galaxies. Photometric methods can be used to extract the structural parameters of galaxies. The quantitative analysis of light profiles of galaxies are done by fitting isophotes to the galaxies. Compared to the one dimensional method two dimensional fitting is more beneficial because of its better accuracy giving the detailed information about the galaxies. This method helps to improve the fitting on non-axisymmetric components present in the galaxies. A number of two dimensional methods are available each being different from the other depending on the specific problems[6,7,8,9]. This method of profile fitting is based on the χ^2 minimization technique.

Compared to the optical observations, the advantage of near infra-red observations in the K-band (2.2μm) is less attenuated by the dust[10]. In this paper we try to analyze the nature of early-type galaxies located in low density regions and also emphasize the advantage of near-infrared observation in analyzing the dominant nature of disc in early-type galaxies.

Material and Methods

Data: For studying the photometric properties of early type galaxies we used the K-band images of Two Micron All Sky (2MASS) observations. The sample of our analysis includes 54 early-type galaxies in the nearby observations. The galaxies show ISM traces in particular bands. The redshift of each of these galaxies are measured directly from their spectra. Our sample contains all galaxies from Annibali et al.[11] and more details about the sample can be had from their paper.

Data Reduction: In our initial analysis we estimated the value of ellipticity, position angle and axis ratio of each of the galaxies by fitting the elliptical isophotes to the surface brightness profile of galaxies. This was done using the ELLIPSE task within STSDAS package provided by IRAF[12]. However we assumed that sample galaxies contain multiple components and extracted the structural components of bulge and disk of each using the code GALFIT[13]. The decomposition on all the galaxies in our sample were carried out by fitting the central spheroidal bulge component modeled using Sérsic law[14] and the outer extended component fitted with an exponential law[15]. GALFIT uses a non-linear least square fitting Levenberg algorithm and it determines the goodness of fit by analyzing the reduced χ^2 value. For first iteration the input values of GALFIT is taken from the output of ellipse fit and is given to the code as free parameters.

Results and Discussion

Quantitative study of light distribution in galaxies are important in understanding the formation of galaxies and identifying the components present in galaxies. This study is concentrated on early type galaxies, mainly in low density regions. From the two dimensional bulge disk decomposition analysis we identified that our samples are showing disk dominated nature. From this analysis we report that the samples have lesser value of Sérsic index ($n < 2$), and bulge to total luminosity ratio ($B/T < 0.5$). The mean value of B/T for our sample is 0.425 ± 0.145. The lesser value of n and B/T are seen normally in later-type systems[16]. The lesser value of B/T for elliptical galaxies suggests the presence of extended features like discs and tidal debris.

Relationship between μ_d0-r_d: The relation between the central surface brightness of disk (μ_d0) and disk scale length (r_d) is shown in figure-1. The linear correlation coefficient of this relation is 0.774 with a significance level exceeding 99.99%. The relation between central surface brightness of disk and disk scale length exhibited by spirals was reported by Mollenhoff and Heidt[17]. The linear relation for spiral galaxies is expressed as $16.6 + 2.02 \log (r_d/\text{kpc}) \pm 0.64$. The similar correlation in our early type galaxies can be expressed as $16.286 + 2.119 \log(r_d/\text{kpc}) \pm 0.157$ with a less scatter. The disks present in S0 galaxies and spirals are similar and are located in the same region in $\mu_d0 - r_d$ diagram[18]. This μ_d0-r_d correlation suggests that more disks are present in the galaxies showing fainter disk central surface brightness.

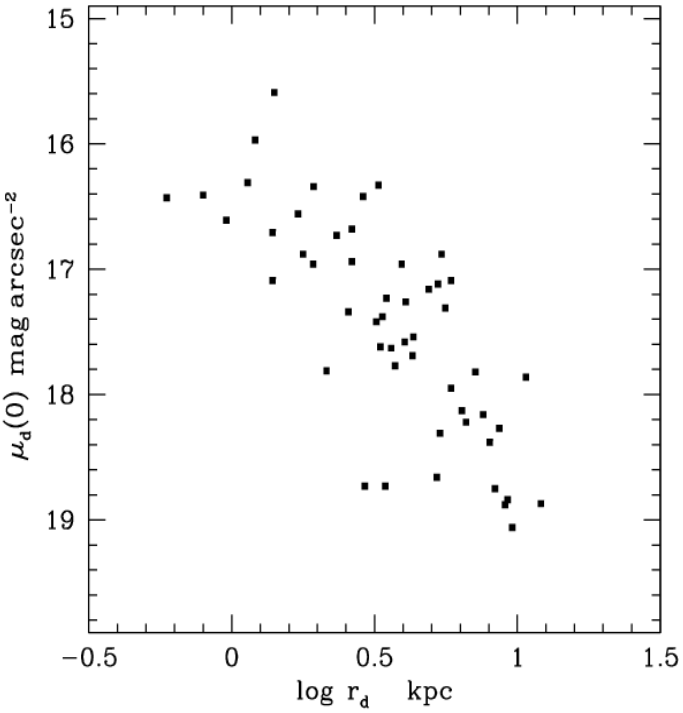

Figure-1
Correlation between disc scale length and disc central surface brightness

Conclusion

The structural parameters are extracted by two dimensional bulge disk decomposition method. The studies of near IR K-band images of early-type galaxies show the disc dominated nature of our sample galaxies. The presence of disk in the elliptical galaxies is clearly observable in near IR observations as it is less affected by dust attenuation. Assuming that the environments of the galaxies affect the size and structure, the strong disk exhibited by galaxies in low density regions may be destroyed in high density regions. Hence, we intend to study the structural variation of early-type galaxies in different environments.

Acknowledgement

Acknowledges UGC-BSR for financial assistance. Our acknowledgement is also extended to IUCAA for the hospitality and the facilities availed.

Reference

1. Canalizo G. and Bennert N., Spectacular shells in the host galaxy of the QSO MC2 1635+11, *ApJ*., **669**, 801-809 (**2007**)

2. Sikkema G., Carter D. and Peletier R. F., et al., HST/ACS observations of shell galaxies: inner shells, shell colours and dust, *AandA*., **467**, 1011-1024 (**2007**)

3. Michard R. and Prugniel P., Peculiarities and populations in elliptical galaxies, 1. An old question revisited, *AandA*., **423**, 833-847 (**2004**)

4. Alan Dressler., Galaxy morphology in Rich clusters: Implications for the Formation and evolution of galaxies, *ApJ.*, **236**, 351-365 (**1980**)

5. Bernardi M., et al., Early-Type galaxies in the sloan digital sky survey. II. Correlations between observables, *AJ.*, **125**, 1849 (**2003**)

6. F. R. Marleau and L. Simard., Quantitative Morphology of Galaxies In the Hubble Deep Fild, *ApJ.*, **507**, 585-600 **(1998)**

7. R. E. de Souza, D. A. Gadotti and S. Dos Anjos., BUDDA: A New Two- Dimensional bulge/Disk Decomposition code for Detailed Structural Analysis of Galaxies, *ApJS*., **153**, 411-427 **(2004)**

8. E. Pignatelli, G. Fasano and P. Cassata., GASPHOT: a tool for Galaxy Automatic Surface PHOTometry, *AandA.*, **446**, 373-388 (**2006**)

9. J. Mendez-Abreu, J. A. L. Aguerri, E. M. Corsini, and E. Simonneau., Strucural properties of disk galaxies I. The intrinsic equatorial ellipticity of bulges, *AandA.,* **478**, 353-369 **(2008)**

10. Ravi Kumar C.D. et al., Photometric scaling relations for

bulges of galaxies, *A and A*., **446**, 827-838 **(2006)**

11. Annibali F. et al., Nearby early-type galaxies with ionized gas. IV. Origin and powering mechanism of the ionized gas, *A and A*., **519**, A40 **(2010)**

12. Jedrzejewski R. and Schechter P.L., Minor-axis rotation in elliptical galaxies, *AJ*., **98**, 147-165 **(1989)**

13. Peng C.Y et al. Detailed structural decomposition of galaxy images, *ApJ*., **124**, 266-293 **(2002)**

14. J. L. Sérsic., Atlas de Galaxies Australes, Cordoba, Observatorio, Astronomica **(1968)**

15. K.C. Freeman., On the disks of Spiral and S0 galaxies, *ApJ.*, 160, 811- 830 **(1970)**

16. Dimitri A. Gadotti., Structural properties of pseudo-bulges, classical bulges and elliptical galaxies: a Sloan Digital Sky Survey perspective, *MNRAS*., **393**, 1531-1552 (**2009**)

17. C. Mollenhoff and J. Heidt., Surface photometry of spiral galaxies in NIR: Structural parameters of disks and bulges, *A and A*., **368**, 16-37 (**2001**)

18. E. Laurikainen et al., Photometric scaling relations of lenticular and spiral galaxies, *MNRAS.,* **405**, 1089-1118 (**2010**)