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THE UNIVERSALITY OF THE FUNDAMENTAL PLANE FOR GALAXIES AND GALAXY SYSTEMS: M/L

H. J. Ibarra-Medel[1] and O. López-Cruz[1]

RESUMEN

Presentamos los resultados de un estudio detallado del plano fundamental (PF) para galaxias y sistemas estelares. Hemos buscado variaciones del PF y de la relación Masa-Luminosidad a diferentes escalas, que nos dan información acerca de la distribución de la materia oscura en función de la escala. Por esto, hemos analizado en una forma homogénea objetos cuyas escalas varían desde los cúmulos globulares hasta los cúmulos de galaxias. Con esto, hemos encontrado que la relación entre la masa y la luminosidad cambia a diferentes escalas. Por lo tanto, sugerimos que los grupos de halos oscuros se pierden cuando estos se incorporan en cúmulos de galaxias.

ABSTRACT

We present the results of a comprehensive study of the fundamental plane (FP) for stellar systems and galaxy systems. We have searched for variations of the FP and the mass-to-light ratio at different scales, which are indicative of variations in the Dark Matter distribution as a function of the scale. For this aim, we have analyzed in a homogeneous way data from objects whose scales varies from globular clusters to clusters of galaxies. We found that the mass-to-light ratios changes along the different scales. Therefore we suggest that groups dark halos are lost when they are incorporated into clusters of galaxies.

Key Words: galaxies: fundamental parameters

1. GENERAL

The observational properties of galaxies can be related through scaling relations(SR). Some of the best known SR can be explained in terms of virialization. Hence, It is possible to extend the formalism which has been applied to the study of galaxies (e.g., the generation of the Fundamental Plane, FP) to other stellar or galaxy systems as long as the system under consideration are in virial equilibrium.

In this study we have used galaxies from a sample of 125 Abell Clusters that were chosen from the Sloan Digital Sky Survey (SDSS) Data Release 7 (DR7). The sample was selected using the following selection criteria: (i) all the selected clusters are from Abell's (1958) statistical sample, (ii) clusters should be isolated with Abell Richness Class (ARC) greater than 0, (iii) clusters should be in the redshift range between $0.02 \leq z \leq 0.2$, and (iv) clusters should be at high galactic latitude ($|b| \geq 30°$). 125 Abell Clusters were selected. We checked photometric accuracy of the SDSS data by comparing LOCOS data, 28 clusters are in common. 19,878 galaxies were selected originally in an aperture of $30'$ from the reported cluster center. 6,137 were selected as cluster members. The remaining non-cluster members were considered field galaxies.

The determination of galaxy cluster membership was implemented using two approaches. The first method is a straightforward application of the Color-Magnitude Relation (CMR) (López-Cruz et al. 2004): at low-z galaxies on the CMR have a very high probability of being cluster members. The second method that we used was the 3σ iterative method developed by Yahil & Vidal (1977). In previous studies the preferred galaxy size indicator has been the half-light radius; this is the effective radius in a de Vaucouleurs fit to the surface brightness profile or growth curve of a given galaxy. We have adopted a non-parametric approach by implementing the Petrosian radius to characterize the size of stellar systems and clusters as a whole. For galaxies we have adopted the SDSS definition of the Petrosian radius (Blanton et al. 2001). Two methods were use to estimate the galaxy velocity dispersion, the Direct Line Profile Fitting and the Cross Correlation Metod. Our velocity dispersion determination were consitent with those reported in the SDSS velocity. With these parameters, its possible determined the galaxy surface brightness and estimate of the mass of the galaxies by direct application of the Virial Theorem (VT).

[1]Instituto Nacional de Astrofísica Óptica y Electrónica, Apdo. Postal 72810, C/Luis Enrique Erro 1, Tonantzintla, Puebla, Mexico.

Using the 3σ output, the velocity dispersion (σ_i) was estimated using the standard deviation by the use of a χ^2 test with 95% of confidence (assuming a Gaussian velocity distribution). To obtain the cluster's surface brightness we considering the fact that clusters are ellipsoids, and galaxies could be used as tracers of the cluster's luminosity. We estimated the centroids and ellipticities of the clusters and trace a concentric elliptical isopleths. The clusters size was parametrized using the Petrosian radius. An $\eta_r = 0.5$ magnitudes radius was used for all clusters. Then we proceed to estimate virial masses for every cluster. Total luminosities were estimated by integrating the light from all galaxy members corrected for incompleteness using the galaxy luminosity function for each cluster.

To explore the FP of Compact Groups (CGFP) we use the catalog of Hickson that have 100 CG. The SDSS have observations for 47 Hickson CG (HCG) in which only 44 have well know redshift measurements. The velocity dispersions reported by Hickson et al. (1992) were used instead of the 3σ. The membership criteria in this case was the selection of the red-sequence galaxies of the CMR. An $\eta_r = 0.5$ magnitudes was used, the masses and luminosities were generated with the same method used with groups.

We use data of Mateo (1998) for 29 dwarf galaxies of the local group. To get the value of the average surface brightness, we assumed that most of the light in dwarf galaxy comes is inside the core radius. Most of the photometric measurements are reported in the V band, we transformed them to the r band using the transformations in Jester et al. (2005), Smith et al. (2002) and Fukugita et al. (1996). The kinematics and the masses where taken from Mateo (1998).

In the case of globular cluster (GC), we found 12 GC in the SDSS RD7 imaging data. We used the SDSS direct imaging data to generate SB profiles. We used the SB data to generate the Petrosian radii and the total magnitudes for each globular cluster. To enlarge the sample of clusters for this study, we also used the data for 48 Milky Way GC from Harris (1997) for photometric measurements and Djorgovski & Meylan (1993) for kinematic measurements. GC Petrosian radii and total luminosity were generated from King's profile fits provided in Harris (1997).

2. RESULTS

We obtained the $\mathcal{M} - \mathcal{L}$ relations for each of the stellar and galaxy systems mentioned above, see Figure 1. We found changes in the slope of the FP along the different scales; however, we note a continuity across all the scales covered from CG up to clusters of galaxies. We found that galaxies in clusters and clusters of galaxies have the same slope in $\mathcal{M} - \mathcal{L}$ plane; groups of galaxies seem to act as a bridge that connects these two scales (Kpc for galaxies and a few Mpc for clusters). While GC seem to be devoid of dark matter haloes, the haloes in the most massive structures seem to scale in the same fashion. The different histories of formation and evolution towards virialization for cluster galaxies and cluster of galaxies are reflected differences in the zero-point for each SR. The most disperse objects in Figure 1 are dwarf galaxies in the local group and groups of galaxies. These large dispersions are due to discrete distribution of tracers and observational errors. However, they could provide us with important clues about how dark matter haloes are occupied as dwarf galaxies and groups of galaxies merge into larger structures.

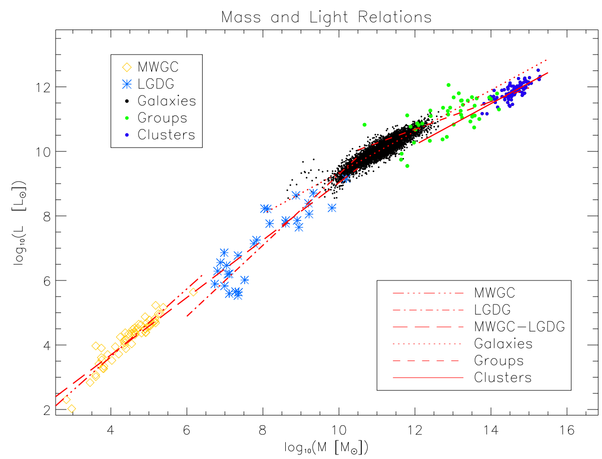

Fig. 1. The mass and light for all stellar systems.

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