THE FUNDAMENTAL PLANE OF CLUSTERS AND GROUPS OF GALAXIES

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Special astrophysical observatory RAS

Gravitationally bound systems such as globular clusters, early-type galaxies, and clusters of galaxies lie on the Fundamental Plane (FP), binding their size (effective radius), luminosity (average surface brightness) and radial velocity dispersion. To determine these parameters for 172 clusters and groups of galaxies we constructed the intergrated distribution of the total number of galaxies as a function of squared clustercentric distance. Such profiles of clusters or groups of galaxies (e.g., Kopylova, Kopylov, 2016, AstBu, 71, 257) allowed us to identify the radius of the apocenters of orbits of galaxies — splashback radius R_{sp}. Also we determined the total luminosity or the total number of galaxies after background subtraction, and measure the effective radius within which half of the total luminosity or half of the total number of galaxies are contained. The work is done on archival data SDSS, 2MASX, NED catalogues. Obtained by the method of least squares the FP of clusters and groups of galaxies in the K-band along the axis $\log L_K$, is:
$L_K \propto R_e^{0.73}\sigma^{1.55}$ (Fig.1).
In the X-ray region, the FP is: $L_K \propto R_e^{0.73}L_X^{0.28}$ (Fig.2). The slopes of FPs of early-type galaxies and clusters of galaxies are in good agreement with each other, and the zero-points are different (Fig.3). A comparison with the FP of another clusters of galaxies from D'onofrio et al. (2013, AN, 334, 373) showed that the Fundamental Plane parameters within errors are consistent. The existance of the FP is an indication that globular clusters, galaxies and galaxy clusters have similar formation processes (in the context of the hierarchical structure formation scenario). Also trend of cluster mass-to-light ratio must be taken into account for a proper interpretation of the observed scaling relations. Other scaling relations obtained by us for clusters and groups are:
$L_K \propto R_e^{0.74}\sigma^{1.69}(M_X/L_K)^{0.28}$;
$L_K \propto \sigma^{2.13\pm0.13}$, the Faber-Jackson relation;
$L_K \propto R_e^{1.41\pm0.12}$, the Kormendy relation.

Fig.1
The FP in the K-band for groups and clusters of galaxies shown along the axis $\log L_K$. The rms scatter of the FP is 0.11.
Fig.2
The combined X-ray and K-band FP for groups and clusters of galaxies shown along the axis $\log L_K$. The rms scatter of the FP (for clusters with $\sigma > 400\ km\ s^{-1}$) is 0.13.
Fig.3
The FP (SDSS r-band) derived by the regression relative to the axis $\log L_r$ is shown along the axis $\log R_e$. The red circles show the early-type galaxies, the blue circles show the clusters of galaxies with $\sigma > 400\ km\ s^{-1}$, and the green circles show the groups of galaxies with $\sigma < 400\ km\ s^{-1}$.

Fig.1

Fig.2

Fig.3