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The Orientation of Galaxies in Nearby Galaxy Groups

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Abstract. The statistical analysis of six nearby groups of galaxies, connected with the Milky Way, M31, M81, M101, NGC5128 and NGC5236 shows an isotropic distribution of galaxy planes, similarly to galaxies within the Local Group. Also planes of galaxies in the nearby ($V_r < 500$ km s^{-1}) region of the Local Supercluster exhibit random distribution, disregarding their membership to groups. The result shows that strong environmental effects observed among dwarf galaxies do not change generally random distribution of galaxy planes in this region.

It was shown that the distribution of planes of 35 galaxies, forming the Local Group is random one (Flin 1999). The amorphous, diffuse, low surface brightness objects, so numerous in the Local Group, are not detectable in other groups, located further away. The selection effect must be taken into account. We choose the way of discarding amorphous, diffuse, low surface brightness objects from the Local Group, which permit us to construct samples containing comparable objects. This approach allows us to check similarity of properties of galaxies in groups and the Local Group.

The groups are not numerous structures, which means that all statistics deal with small numbers (West 1989). We decided to apply several statistical tests, hoping that this approach helps in drawing more reliable conclusions. In our vicinity there are 6 galaxies with masses greater than $3 \cdot 10^{11} M_{\odot}$. The physical companions around these galaxies have been selected by Karachentsev (1996). Usually the Local Group is regarded as merger of groups connected with our Galaxy and M31. Therefore, the sum of these two groups containing 22 galaxies was constructed and denoted as LG. For comparison also the Local Group with 28 objects, as listed by Tully (1988) was considered and denoted as LGT.

The spatial orientation of a galaxy is determined considering both the position angle p of the major axis of the galaxy image and the galaxy inclination i with respect to the observer's line of sight. These two parameters allow one to determine the two possible normals to the galaxy plane (Flin & Godlowski 1986). The spatial orientation of the normals is given by two angles, the polar angle δ_D between the normal and the Local Supercluster plane and the azimuthal angle η between the projection of the normal onto the Local Supercluster plane and direction towards the Virgo cluster centre.

The randomness of the angles was checked using the χ^2 - test, the autocorrelation test C and the Fourier test (Hawley & Peebles 1975), which is checking the

Table 1. The result of the statistical analysis

		group						
		MW	M31	M81	M101	N5128	N5236	LGT
δ_D	$P(>\chi^2)$	7.73	14.25	6.87	5.88	8.54	6.80	6.08
	$P(>\Delta)$	0.19	0.76	0.87	0.99	0.51	0.81	0.31
	C	-1.2	-9.34	-6.06	-2.03	2.89	0.55	1.05
η	$P(>\chi^2)$	9.00	18.00	6.40	8.00	6.50	14.00	11.90
	$P(>\Delta)$	0.81	0.05	0.18	0.08	0.80	0.06	0.20
	C	0.0	5.33	3.40	3.50	-2.50	4.00	0.33

deviations from isotropy slowly varying with the investigated angle. Moreover, the comparison of the observed distribution and theoretical, random distribution was made, as well as the Kolmogorov-Smirnow test also was applied.

From Table 1 it follows that the angle δ_D is isotropic. In the case of the η - angle for three groups some test show only weak departure from isotropy. There is not the case where all three tests simultanously show anisotropy of the distribution. Monte Carlo simulations support our claim on the randomness of the distribution of galaxy planes in investigated groups.

We show that discarding from the analysis amorphous, diffuse low surface brightness objects does not introduce anisotropy. We conclude that in six studied groups the $\delta_{\rm D}$ and η - angles are isotropic. The isotropic distributions resulted from other applied tests too. This means that the orientation of galaxies in investigated groups is isotropic one, similarly to the distribution of galaxy planes in the Local Group. This result is not due to observational uncertainties.

The currently investigated sample differs from that by Zabludoff (2001), Zabludoff & Mulchaey (1998) by the lack of groups having cD galaxy. They noted that after the formation of cD galaxy, through merging, "the environment is relatively unimportant at the late time and that conditions during the epoch of galaxy formation dominate". Moreover, Mulchaey & Zabludoff (1998) claim that "galaxy groups have not been subject to a significant dynamical evolution recently". So our finding, the lack of influence to the orientation of galaxies in groups is consistent with Zabludoff's finding.

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