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The Search for Galaxy Orientation in the Local Group

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Abstract. The analysis of 34 galaxies being members of the Local Group shows that their planes are distributed randomly.

1. Observational Data

The table containing equatorial coordinates and morphological types for 35 galaxies regarded as members of the Local Group (Irwin 1998) constituted the observational basis of the present study. The dimensions of the galaxy major and minor axes denoted as a and b and the position angle p of the major axis of the galaxy image were taken from NED or were measured by the present writer. Our Galaxy was omitted from the analysis, which gives the number of analysed objects in the sample denoted as S equal to 34.

The Nearby Galaxy Catalogue (Tully 1988) list 28 objects as belonging to the Local Group (Tully group denoted as 14–12 and 14+12). This smaller sample containing bigger, brighter and not diffuse members of the Local Group was analysed separately. Two additional samples, namely galaxies belonging to the group 14–12 (18 objects) denoted as sample T1 and both groups (14–12 and 14+12) together, denoted as T2 were constructed. In the sample T2 there are two galaxies (N404 and U 9128), which are not in the sample S, these are in Irwin's sample.

2. Method of Analysis

The spatial orientation of each galaxy was reckoned using the method described by Flin & Godlowski (1986), which leads to study of the orientation of normals to galaxy planes. Due to the well known ambiguity in the tilt angle i, both possible locations of galaxy normals were considered in further statistical analysis. The tilt angle was calculated with the formula (Holmberg 1946):

$$\cos^2 i = \frac{[(b/a)^2 - q_o^2]}{1 - q_o^2}$$

where a and b denote the diameter of the major and minor axis of the galaxy image and the $q_o = 0.2$ is the assumed true shape of galaxy, regarded as an oblate spheroid.

The spatial orientation of the normal to the galaxy plane is described by the polar angle δ_D between the normal and the supergalactic main plane (su-

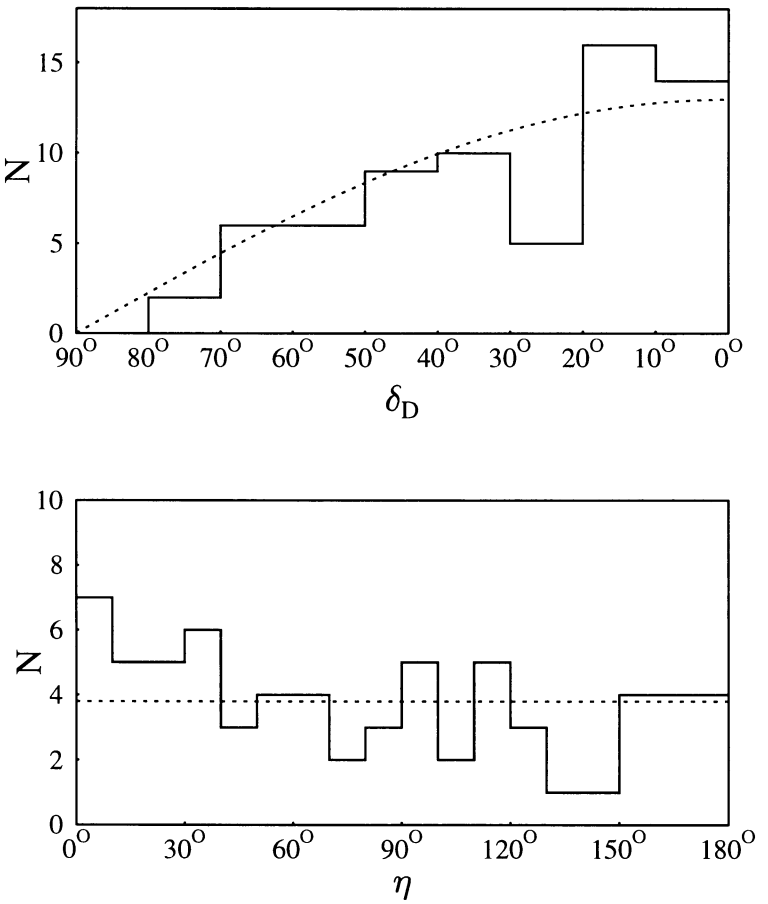

Figure 1. The distribution of the investigated angles for the S sample (34 galaxies). The broken lines denote isotropic distributions.

pergalactic equator) and the azimuthal angle η between the projection of the normal onto the supergalactic equator and the zero great circle, which is passing through the Virgo Cluster centre.

The two angles are given by the formulae (Flin & Godlowski 1986):

$$\begin{aligned} \sin(\delta_D) &= -\cos(i)sin(\delta) \pm \sin(i)\sin(p)\cos(\delta) \\ \sin(\eta) &= [-\cos(i)\cos(\delta)\sin(\alpha) + \sin(i)(\pm\sin(p)\sin(\delta)\sin(\alpha) \\ &\quad \pm\cos(p)\cos(\alpha))]/\cos(\delta_D) \end{aligned}$$

where α and δ are equatorial coordinates of a galaxy, p is its position angle, while i denotes the tilt angle.

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Table 1. The result of statistical analysis.

		the angle δ_D			the angle η		
sample	N	$P(>\chi^2)$	$P(>\Delta)$	C	$P(>\chi^2)$	$P(>\Delta)$	C
S	68	0.63	0.14	2.7	0.98	0.15	1.9
T2	54	0.86	0.31	1.0	0.99	0.31	2.7
T1	34	0.81	0.26	1.9	0.99	0.28	0.4

The existence of isotropy of these angles was checked using three statistical tests: the χ^2-test, the Fourier test and the autocorrelation test (Hawley & Peebles 1974) for binned data. The values of the angles were grouped into bins having 10^o width.

3. The Result

The observed distribution of both angles is presented in Fig. 1. Table 1 presents the result of the statistical analysis, giving the probabilities $P(>\chi^2)$ and $P(>\Delta)$ of the randomness of the investigated distributions for both applied tests. From Fig. 1, as well as all applied statistical tests, it follows that the observed distributions of both angles are isotropic. In the case of the autocorrelation test, the expected value for isotropy is $C = 0$ with $\sigma_C = 4.2$.

In the case of the Local Group, the observed isotropy in the orientation of galaxy planes is in a good agreement with the previous investigation, where the distribution of galaxy spins was studied (Helou 1984). It is also in agreement with our previous result, when the existence of anisotropy depends on the investigated region of the Local Supercluster (Flin & Godlowski 1990). The isotropy is observed for diffuse and non-diffuse galaxies.

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Discussion

Freeman: If you had looked only at the disk galaxies in the Local Group, would you have got a different result?

Flin: No the distribution for disk galaxies is also a random one.

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