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VARIATION OF SPATIAL ORIENTATION WITH INCREASE IN RED SHIFT

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Abstract

The main aim of this article is to analyze non-random effect s in galaxy orientation. The result of is based on the analysis of the spatial orientations of SDSS (Soloan Digital Sky Survey) galaxies of red shift 0.10000 to 0.1001 (radial velocity: 30000km/s to30030km/) using seventh data rel ased in October 2008. The position angle inclination method is used to find the polar and azimuthal angles of galaxy rotation axes. To analyze the distribution of the polar and azimuthal angle of the galaxy rotation axes and to check for an isotropy or anisotropy the three statistical tests have carried out: chi- square, Fourier and auto correlation. It was done assuming the spatially i ropic distribution to examine non-random effects. It was found that the spin vector orientations of the galaxies in the sample Z1and Z2 are almost isotropic.

Key words

Galaxy cluster; isotropic; redshift; cosmology polar angle; azimuthal angle

Introduction

Galaxy clusters are gravitationally bound large scale structures in the universe. To understand the evolution of these aggregates it is essential to know when and how they have formed and how their structures and constituents have been changing with time. Gamow (1952) made it clear that the observed rotations of galaxies are important for cosmology. According to them, the fact that galaxies rotate might be a clue of physical conditions under which these systems formed. Thus, understanding the distribution of spatial orientations of the spin vectors of galaxies is very important. It could allow us to know the origin of angular momenta of galaxies.

Contemporary theories advocate three different predictions concerning the spatial orientation of the SVs of galaxies. These three predictions or theories are the 'pancake model,' the 'hierarchy model,' and the 'primordial vorticity theory.' The 'pancake model' predicts that the SVs of galaxies tend to lie within the cluster plane. According to the 'hierarchy model' (Peebles 1969), the directions of the SVs should be distributed randomly. The 'primordial vorticity theory' (Ozernoy 1971, 1978; Stein 1974) predicts that the SVs of galaxies are distributed primarily perpendicular to the cluster plane.

In the pancake scenario, formation of clusters took place first and it was followed by their fragmentation into galaxies due to adiabatic fluctuations. According to hierarchy model, galaxies were first formed and then they obtained their angular momenta by tidal forces while they were gathering gravitationally to form a cluster. In the turbulence scenario, flattened rotating proto-clusters formed first due to cosmic vorticity in the early universe. Subsequent density and pressure fluctuations caused galaxies to form (Arayal, 2006).

These three existing theories are contradictory as to their predictions are completely different from each other. However, it is interesting to note that the predictions made by all three existing theories are based on cosmology. Thus, it is very important to test these theories by a very good and carefully controlled database using appropriate methods and methods of analysis. In the next three paragraphs, the evolution schemes predicted by the three scenarios are discussed.

According to the non-linear gravitational instability theory (Zeldovich 1970, Zeldovich & Novikov 1975, Zeldovich & Sunyaev1976), a growth of small inhomogeneities leads to the formation of thin, dense, and gaseous condensations that are called 'pancakes.' These condensations are compressed and heated to high temperatures by shock waves causing them to quickly fragment into gas clouds. The later clumping of these clouds results in the formation of galaxies and their clusters. Thermal, hydrodynamic, and gravitational instabilities arise during the course of evolution. It leads to the fragmentation of gaseous proto-clusters and, subsequently, clustering of galaxies takes place. The pancake scheme follows three simultaneous processes: first, gas cools and new clouds of cold gas form; secondly, these clouds cluster to form galaxies; and thirdly, the forming galaxies and, to an extent, single clouds cluster together to form a cluster of galaxies.

In the hierarchical scenario, galaxies form and grow by subsequent merging of protogalacticcondensations even by merging of already fully formed galaxies (Mihos & Hernquist, 1996). In this scheme, one could imagine that large irregularities like galaxies grew under the influence of gravities from small imperfections in the early universe (Gamow & Teller 1939; Peebles 1965). The angular momentum transferred to a developing proto-galaxy by the gravitational interaction of the quadrupole moment of the system with the tidal field of the matter (Peebles, 1969).

The idea that galaxy formation is initiated by primordial turbulence has a long history (Gamow, 1952). Ozernoy (1978) proposes that galaxies form from high density regions behind the shocks produced by turbulence. According to the primordial vorticity theory, the presence of large chaotic velocities generates turbulence, which, in turn, produces density and pressure fluctuations. Density fluctuations on the scale of clusters of galaxies could be gravitationally bound, but galactic mass fluctuations are always unbound (Stein, 1974). Galaxies form when unbound galactic mass eddies, expanding faster than their bound cluster background. So, forming galaxies collide with each other as clusters start to recollapse. These collisions produce shocks and, thus, high-density proto-galaxies at the eddy interfaces. As clusters recollapse, the system of galaxies undergoes a violent collective relaxation (Stein, 1974).

Methods

To study variation of spatial orientation of galaxies, sample 1 and 2 were taken from the seventh data released by SDSS galaxies that have red shift range from 0.10 to 0.11, which were divided into 201 sub samples. Here Z1 is sub sample with redshift 0.10000 to 0 .10005

Table 1: Statistics of polar and azimuthal angle distribution

Sample	value	P(>X2)	c/c(σ)	Δ11/σ(Δ11)	P(>Δ1)	result
Z1	θ	0.53	-1.39	-0.53	0.8532	isotropic
	ϕ	0.6220	0.9236	0.6033	0.43	isotropic
Z2	θ	0.714	-o.824	0.6329	0.8153	isotropic
	ϕ	0.2676	00.4239	0.913	0.506	isotropic

consisting of 167 galaxies of different types. Z2 is another sub sample of red shift 0.10005 to 0.1001 consisting of 230 different types of galaxies.

The image of the galaxy was obtained with help of ground based telescope or satellite based telescope is two dimensional projection of galaxy in celestial sphere. The major diameter, minor diameter, position angle etc. are two dimensional data of the three dimensional galaxy. Conversion of two dimensional data to three dimensional data Inclination angle (i) of the galaxies was found by using the formula,

$$\cos^2 i \quad \frac{(q^2 \quad q*^2)}{(1 \quad q*^2)}$$

Where, q=b/a, a is major diameter, b is minor diameter, q* is flatness factor whose value is 0.1 for Sd spirals and 0.23 for elliptical. For the galaxies with unknown morphology q*= 0.20 is assumed

Azimuthal and polar angle (θ) of galaxies in term of equatorial co-ordinate system are given by

Sinθ= -cosisinδ±sinisinpcosδ ,------ (2)
Sinϕ= (cosΘ)-1[-cosicosδsinα+sini (sinpsinδsinαcospcosα)]-----------(3)

Where, P is position angle. δ; is angle of declination. i angle of inclination,α is right ascension. We have performed numerical simulation to minimize the selection effect due to position angle and inclination creating 10^6 virtual galaxies for whole data by using MatLab-6.1. In this case, we used simulation by two ways: fitting linear equation and not fitting linear equation.

Limit for Anisotropy

In the chi-square test: Chi-square prob (>X^2) <0.050.

In the auto- correlation test; The auto-correlation coefficient (c/c(σ))>±1In the Fourier test;

The 1st order Fourier coefficient {Δ11/σ(Δ11)}>±1.5

The 1st order Fourier probability {p (>Δ1)}<0.15

Result and discussion

Table 1 gives statistical parameters for polar and azimuthal angle and above figures shows the polar angle and azimuthal angle distribution of galaxies of sample Z1 and sample Z2 of the SDSS data. Also above fig shows the azimuthal angle. In both cases it is clear that the cluster is isotropic. In all the cases value of chi square probability are more than 0.05 i.e., isotropic. In case of auto- correlation test value of c is less than 1 for polar angle shows isotropic while value of azimuthal angle for Z1 shows weak anisotropic and for Z2 it also shows isotropic. All value of 1st order Fourier - coefficient shows isotropic.

Value of Δ11/σ (Δ11) lies between -1.5 and +1.5, this indicates that random orientation of spin vector and obey Hierarchy Model. According to Hierarchy Model (Peeble, 1969), the direction of the spin vector is randomly oriented. Galaxies were 1st formed and then they obtained their angular momenta by tidal force while they were gathering gravitationally to form a cluster. Those galaxies grow by subsequent merging of protogalactic condensation or even by merging of already fully formed galaxies (Mihos & Hernquist, 1960). In this scheme, one could imagine that large irregularities like galaxies grew under the influence of gravities form small imperfections in the universe. Few statistics such as c/c (σ) for azimuthal angle shows anisotropic .The study about the cause of an isotropic in few cases in future work by dividing the data in to several samples.

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