CLUSTERS AND VOIDS IN GENERAL GALAXY FIELD

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In our previous works (Anosova 1987, Anosova,Iyer,Varma 1994), we developed a new method for determination of the structure of a clustered distribution. In this work, we apply this method studying the observed distribution of galaxies in the Universe.

Using the theory of probability, we carry out a quantative statistical analysis and find parameters which characterize differences in the distributions of galaxies in the sky and objects in an artificial uniform random field.

We are able to consider the phase space for objects in the field (for example, for stars), but in the case of galaxies, we consider the cut phase space taking into account observational data simultaneously - angular separations ρ between galaxies, and their radial velocities V.

We assume that the radial velocities of these objects indicate their Hubble distances and do not consider the peculiar velocities of galaxies.

We use the following classification of the objects:

1. members of clusters with different multiplicities;
2. uniform random distributed single objects in the galaxy field;
3. single objects inside voids.

We suggest a definition of the probability P_{nch} for objects to belong to these classes, and the critical values of P_{nch} for this classification. The relative uncertainties in the observations can be take into account.

In this paper, we consider only an area of the sky with coordinates approximately given by $0° < \alpha < 1°$ and $-90° < \delta < +90°$, and study a distribution of galaxies in the CfA-Catalogue. The number of galaxies with known redshifts inside this area is 116.

Our statistical analysis involves the number $N = 4.5 \times 10^7$ of objects in the celestial sphere with the radius corresponding to the maximum value $V_{max} = 45\ 000$ km/s of velocities of galaxies from CfA-Catalogue.

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We take the mean number density of galaxies in the field $\nu = 0.05 gal/Mpc^3$ and the Hubble constant $H = 75 km/s/Mpc$.

For every object under consideration , we calculate the probability P_{nch} and classify its. We identify the confident and probable members of galaxy groups and clusters.

As a result, we have found 19 new confident and probable galaxy groups with multiplicity $n < 7$ and one new 'supercluster' with $n = 31$ containing a few small clusters.

The members of the galaxy clusters are determined, on the average, with the probability P_{nch}=0.932 . For every cluster and different samples of galaxies we define the average values of basic characteristics - a angular separation ρ and a difference dV of radial velocities V of objects.

Between clusters and single galaxies often are confidently determined empty regions (voids) with the mean value of $P_{nch} = 0.995$.

Our calculations produce a highly skewed distributions of P_{nch} for galaxies which have above mean values of P_{nch}, and about 95% of galaxies have $P_{nch} = 0.85$ or more .

We conclude that 75.0% of the galaxies under study are members of clusters. Other galaxies in the field are either confident single ones (15 galaxies- 12.5%) distributed randomly in the field or belong (14 galaxies- also almost 12.5%) to voids.

We have here the cluster-void structure; sometimes in the field we observe few close clusters, connected with each other; between clusters and single galaxies we have often confident voids.

We have found also the number of chance pairs of galaxies in an artificial 'galaxy' field with an uniform random distribution of objects and the mean values of their characteristics ρ and dV: the number of confident chance pairs of 'galaxies' in this field with $V_{max} = 45\,000$ km/s and $N = 4.5 \times 10^7$ is 8.3×10^6; for such pairs with $V = V_{max}$ the mean values $< \rho_{ch} >= (3.0 \pm 1.2)'$ and $< dV_{ch} >= (1289 \pm 1087)$ km/s .

We also have found two confident real compact galaxy groups with large differences dV for their members: the values dV are equal to 2090 and 2076 km/s.

References

Anosova,J.P.1987,*Astrofizika,* **27**,535.

Anosova J.P.,Iyer S.,Varma R.K.1994.*Astrophys.J.* (submitted).