Abstract

According to the most widely accepted model of the evolution of the Universe - the ΛCDM model - we are living in the Universe fulfilled mainly by non-relativistic dark matter and undergoing now an accelerated expansion under effect of so-called dark energy. The evolution of density field of matter - both dark and baryonic, forming so-called large scale structure, is driven by gravity. One way to test the ΛCDM model and understand its detailed features is the analysis of the statistical properties and evolution of the large scale structure. However, we do not observe dark matter directly - we have to rely on observations of galaxies, which are made from baryons. Galaxies roughly trace the dark matter field, but they do it in a biased way, which depends on the properties - mass, luminosity, type of a given population of galaxies. Moreover, galaxy properties evolve with time, and this evolution depends on their local environment. Consequently, one of the most important problems of modern cosmology is to understand the relations between galaxy properties and their position in the large scale structure. This thesis is dedicated to the evolution and clustering of a population of dust-obscured galaxies detected at the 24 µm range.

Using the data from the AKARI North Ecliptic Pole (NEP) Deep Field down to 150 µm, we construct a new method of star/galaxy separation in the mid-infrared surveys, and we then use the obtained galaxy sample to measure and interpret the clustering properties of these galaxies. Our method of star-galaxy makes use only of the available infrared information and it uses support vector machines (SVM) to study the distribution of stars and galaxies in the infrared multicolour space. The accuracy of so-obtained classifier reaches 90 % for galaxies and 98 % for stars.

Galaxy samples obtained by this method were used to measure angular correlation function for these objects. We computed their photometric redshifts, using a new method based on the Spectral Energy Distribution fitting in the infrared by the CIGALE code. So-obtained photometric redshifts were then used to recover the spatial clustering of the NEP 24 µm galaxies by the Limber inversion.

The photometric redshift distribution reveals peaks at $z \sim 0.6, 1.2$ and $2$. It indicates that 24 mm selected galaxies are actually a mixture of at least three different populations of galaxies observed in different cosmic epochs. The correlation length derived using the Limber inversion is $r_0 = 4.93 \pm 0.49 h^{-1} \text{Mpc}$ for the full catalogue.

For the global population, the amplitudes of the flux limited samples increase with the increase of their brightness, which may be interpreted as a mixed effect of physical effects and observational biases: brighter galaxies might reside in more massive dark matter halos, but in the same time they are more nearby and hence stronger clustered than more distant sources.

The low redshift galaxies (in the intervals of $0.5 \leq z$ and $0.5 < z \leq 0.9$) are characterized by $r_0$ equal to $6.20 \pm 0.69$ $h^{-1}$ Mpc and $5.91 \pm 0.66$ $h^{-1}$ Mpc, respectively, which suggests that out to redshift $\sim 0.7$ we are dealing with one population of dusty star-forming galaxies, possibly local luminous infrared galaxies (LIRGS). The higher-$z$ population ($0.9 \leq z \leq 1.3$) displays a correlation length of $5.87 \pm 0.79$ $h^{-1}$ Mpc which suggests that these galaxies represent a population of ancestors of the lower-$z$ infrared galaxies. The correlation function of galaxies at $z \leq 1.3$ has revealed a strong clustering signal at small scales despite the large redshift range. This indicates an existence of a separate, highly clustered population(s).

In this thesis, we have shown that 24-mm galaxies selected from deep catalogues are heterogeneous and strongly evolving population of galaxies, differently related to dark matter large scale structure at different cosmic epochs. At the same time, the methods of infrared source classification we have introduced should be useful for next generations of infrared surveys, like the ones provided by SPICA.