Annual Report 2014

Jaan Einasto

1 Research

Together with Maret Einasto and collaborators I studied the morphology and galaxy content of SDSS DR8 superclusters (Einasto et al., 2014a). We found the supercluster morphology with Minkowski functionals and analysed the probability density distributions of colours, morphological types, stellar masses, star formation rate (SFR) of galaxies, and the peculiar velocities of the main galaxies in groups in superclusters of filament and spider types, and in the field. We tested the statistical significance of the results with the KS test. Our results show that the fraction of red, early-type, low SFR galaxies in filament-type superclusters is higher than in spider-type superclusters; in low-density global environments their fraction is lower than in superclusters. In all environments the fraction of red, high stellar mass, and low SFR galaxies in rich groups is higher than in poor groups. In superclusters of spider morphology red, high SFR galaxies have higher stellar masses than in filament-type superclusters. Groups of equal richness host galaxies with larger stellar masses, a larger fraction of early-type and red galaxies, and a higher fraction of low SFR galaxies, if they are located in superclusters of filament morphology. The peculiar velocities of the main galaxies in groups from superclusters of filament morphology are higher than in those of spider morphology. Groups with higher peculiar velocities of their main galaxies in filament-type superclusters are located in higher density environment than those with low peculiar velocities. There are significant differences between galaxy populations of the individual richest superclusters. We came to the conclusion that both local (group) and global (supercluster) environments and even supercluster morphology play an important role in the formation and evolution of galaxies. Differences in the inner structure of superclusters of filament and spider morphology and the dynamical state of galaxy groups in them may lead to the differences found in our study.

Also in collaboration with Maret Einasto and colleagues from Finland and Korea Institute of Advanced Studies we investigated the possibility to trace the cosmic web at high redshifts with quasar systems (Einasto et al., 2014b,c). We traced the cosmic web at redshifts that range from $1.0 \leq z \leq 1.8$ by using the quasar (QSO) data from the SDSS DR7 QSO catalogue. We applied a friend-of-friend algorithm to the quasar and random catalogues to determine systems at a series of linking length and analysed richness and sizes of these systems. Our results indicate that at the linking lengths $l \leq 30\ h^{-1}$ Mpc, the number of quasar systems is larger than the number of systems detected in random catalogues, and the systems themselves have smaller diameters than random systems. The diameters of quasar systems are comparable to the sizes of poor galaxy superclusters in the local Universe. The richest quasar systems have four members. The mean space density of quasar systems, $\approx\ 10^7$ (h^{-1} Mpc)^3, is close to the mean space density of local rich superclusters. At intermediate linking lengths ($40 \leq l \leq 70\ h^{-1}$ Mpc), the richness and length of quasar systems are similar to those derived from random catalogues. Quasar system diameters are similar to the sizes of rich superclusters and supercluster chains in the local Universe. The percolating system, which penetrate the whole sample volume appears in a quasar sample at a smaller linking length than in random samples (85 h^{-1} Mpc). At the linking length 70 h^{-1} Mpc, the richest systems of quasars have diameters exceeding 500 h^{-1} Mpc. Quasar luminosities in systems are not correlated with the system richness. We conclude that quasar system catalogues in our web pages and at the Strasbourg Astronomical

Data Center (CDS) can serve as a database for searching superclusters of galaxies and for tracing the cosmic web at high redshifts.

I participated in the search for shell-like structures in the distribution of nearby rich clusters of galaxies drawn from the SDSS DR8, initiated by Maret Einasto (in preparation). We find the maxima in the distribution of distances from rich galaxy clusters to other groups and clusters at distance of about 120 h^{-1} Mpc suggesting a density enhancement at these distances from rich clusters, and possible indication of shell-like structures. The rich cluster A1795, the central cluster of the Bootes supercluster, has the highest maximum in the distance distribution of other groups and clusters around them at distance of about 120 h^{-1} Mpc among our rich cluster sample, and another maximum at a distance of about 240 h^{-1} Mpc. However, the radius of the possible shell is larger than expected for a BAO shell ($\approx 109\ h^{-1}$ Mpc).

The book " Dark Matter and Cosmic Web Story" (Einasto, 2014) is printed by World Scientific Publishing Co. The official presentation of the book took place in Tartu University on December 2, 2013. Additional presentations were held in Princeton University Astronomy Department and in the Estonian House in New York in March 2014.

My talk on Texas Meeting in 2012 is published (Einasto, 2013).

2 Lectures

• January 31, lecture in the annual conference of Estonian Physics Society: "The Development of the World View on the Universe";
• February 22, Tartu Observatory seminar: "Formation of the Cosmic Web";
• March 24, Princeton University seminar: "Formation of the Cosmic Web";
• March 29, New York Estonian House, lecture: "The Structure of the Universe";
• April 04, Tartu University, discussion on topics: "Searching Dark Matter" with Dr. Martti Raidal;
• April 21, Tartu University, talk in honour of Prof. Ene Tiit: "Ene Tiit 80 – Pictures from the Beginning of the Path";
• May 22, Estonian Academy of Sciences visiting Saaremaa, lecture: "The Structure and Evolution of the Universe";
• June 16, Space Center Institute, Moscow, talk on conference Zeldovich100: "Yakov Zeldovich and the Formation of the Cosmic Web Paradigm";
• June 27, Tallinn, talk on IAU Symposium No. 308, 'The Zeldovich Universe: Genesis and Growth of the Cosmic Web': "Yakov Zeldovich and the Cosmic Web Paradigm";
• October 01, Yale University, Gruber Prize Ceremony talk: "Near Field Cosmology – My Way";
• October 02, Yale University Astronomy Department, seminar talk: "Evolution of the Cosmic Web";
• November 04, talk on The 6th KIAS Workshop on Cosmology and Structure Formation: "The Cosmic Web Paradigm – Status and Problems";
• November 10, talk on seminar of the Korea Institute of Advanced Science: "Cosmology in Tartu Observatory".

3 Visits

• March 22 – March 31, Princeton University Astronomy Department, New York Estonian House;
• June 15 – June 20, Moscow University Sternberg Institute, Space Research Institute to participate in the conference "Zeldovich100";
• June 22 – June 28, Tallinn, IAU Symposium No. 308, 'The Zeldovich Universe: Genesis and Growth of the Cosmic Web';
• September 27 – October 05, New Haven, Reception of the the Gruber International Cosmology Prize;
• November 1 – November 11, Seoul, Korea Institute of Advanced Science, participation in workshop "The 6th KIAS Workshop on Cosmology and Structure Formation".

4 Scientific organisations, awards

I am member of the International Astronomical Union (1961), Estonian Academy of Sciences (1981), American Astronomical Society (1981), European Astronomical Society (1990), Academia Europaea (1990), Royal Astronomical Society (1994).

I have Estonian Science Prizes (1982, 1998, 2003, 2007), The Estonian Order of the National Coat of Arms (1998), Marcel Grossmann Award (2009), honorary Doctor of Tartu University (2010), Viktor Ambartsumian International Prize (2012), Doctor Honoris Causa degree of the Turku University (2013), Gruber International Cosmology Award (2014).

References

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