THE ROLE OF POOR GALAXY CLUSTERS FOR STUDYING SUPERCLUSTER STRUCTURE

E.A. Panko[1,2]

[1] Department of Astronomy, Odessa National University
T.G.Shevchenko Park, Odessa 65014 Ukraine, *tajgeta@sp.mk.ua*

[2] Astronomical Observatory of Nikolaev State University,
Nikolskaya, 24, Nikolaev, 54030 Ukraine.

ABSTRACT. The distribution of galaxy clusters is analyzed in regions of 6 galaxy superclusters with both measured and estimated redshifts. The positions of ACO and APM galaxy clusters in the regions are compared with the positions of galaxy clusters and groups from a new catalogue based on the Muenster Red Sky Survey. The locations of galaxy clusters and groups are shown on $10^\circ \times 10^\circ$ maps of the fields. A comparison is made between maps that include all galaxy clusters and groups, rich and poor clusters, and only rich clusters. The resulting large-scale structure in the regions is described in detail on the basis of both rich and poor clusters, and a new catalogue is produced that is convenient for further study of galaxy superclusters.

Key words: large-scale structure; galaxy supercluster; galaxy clusters: individual: SCl 16, 37c, 38c, 190, 199, 212c.

1. Introduction

The large-scale distribution of galaxy clusters as a reflection of initial density variations in the universe has attracted considerable attention during the past decade. Shapley (1933) used the term "supercluster" in his research into galaxy distributions, and identified the first 25 galaxy clusters. At present the study of networks of supercluster-voids is based upon observations in both visual and other spectral regions. Einasto et al. (1997, 2001, 2002) created catalogues of superclusters of galaxies using visual data samples from the ACO (Abell, Corwin & Olowin, 1989) catalogue of rich clusters of galaxies and from APM rich clusters of galaxies (Dalton et al., 1997). The main goal of this paper is to compare the distribution of ACO and APM clusters of galaxies with a new catalogue of galaxy clusters and groups compiled by Panko & Flin (2006, hereafter PF), and to demonstrate its usefulness for studying the supercluster-void network. We also quantify cluster richness, which is needed for future research. Note, Einasto et al. (2002) provided a list of additional superclusters of non-Abell X-ray clusters; the PF catalogue can include useful information in the optical range for such superclusters.

2. Input data

The PF catalogue of galaxy clusters and groups was based on the analysis of a homogeneous portion of the Muenster Red Sky Survey (MRSS, Ungruhe, Seitter & Duerbeck, 2003). It includes 6188 structures, both clusters and groups, with at least ten galaxies in the field of each structure. Moreover, the additional listing of galaxies in each structure field provided an opportunity to construct detailed galaxy cluster maps. A comparison of the PF catalogue with the ACO and APM catalogues made it possible to calibrate distances for the PF structures using the $z - m_{10}$ relation, where m_{10} is the brightness of the tenth brightest galaxy in the structure. The maximal redshift z for this calibration is 0.18. We selected 6 regions (listed in the Table 1) for this work, using such criteria as:

1. The region does not oincide with a large supercluster.
2. Superclusters are present in the ACO supercluster list, but are absent in the APM catalogue.
3. Superclusters must have both measured and estimated redshifts.

3. Large-scale structures in the 6 regions

The large-scale galaxy cluster distribution is show in Fig. 1. The size of each identified field was $10^\circ \times 10^\circ$. In all cases, excluding SCl 199, long elongated structures were interpreted as superclusters. PF catalogue clusters and groups contain both filaments, as chains of PF objects, and voids. The positions of such groups in the

Table 1: Selected regions parameters.

RAJ2000	DEJ2000	SCl	$N_{members}$	Dist, (h^{-1}Mpc)	z_{est}
00^h 52^m	-63^o.9	16	4	207 (204)	0.07
02 00 (02 16)	-36.3 (-40.1)	37c	2(5)	318 (296)	0.11 0.10)
02 02	-26.3	38c	4	330	0.11
21 57 (21 54)	-30.4 (-30.6)	190	5	256 (252)	0.09
22 40 (22 37)	-33.9 (-34.2)	199	3	174	0.06
23 35 (23 33)	-68.7 (-69.1)	212c	3	296 (285)	0.10

where:
RAJ2000, DEJ2000 are coordinates (J2000) of the supercluster centers;
SCl - is the supercluster number (Einasto et al., 1997), "c" denotes superclusters with estimated z;
$N_{members}$ - is the number of ACO clusters in the supercluster;
Dist - is the distance in h^{-1}Mpc;
z_{est} - is the estimated z according to the preceding column;
Bracketed data were obtained from Einasto et al.(2002).

ACO an APM catalogues are frequently not congruous, although we find a significant number of cluster congruities from both catalogues with the positions of the PF catalogue objects. For example, SCl 37c has three ACO clusters of five supercluster members with analogues in the APM and PF, one supercluster member has an analogue only in the PF catalogue, and one does not have analogues in either the APM or PF. However, for SCl 16, all four ACO clusters form a chain with analogues only in the PF. At the same time, at least three ACO clusters and one PF structure can belong to the same chain. For the PF catalogue we can estimate z, so PF0097-6680 and its ACO cluster analogue S112 may also be a member of SCl 16. PF0097-6680 R.A.=$0.^h97621$, Dec.= $-66°.79035$) is a rich cluster with 190 galaxies in the cluster field, 73 in the magnitude range $m_3, m_3 + 3^m$. The estimated redshift z is 0.062, while S112 has $z = 0.066500$ according to NED. Both values show good agreement with the estimated z for SCl 16 in Table 1 and this cluster can superslucter member too.

Additional maps were constructed for supercluster 16 (Fig.2). In this map only PF galaxy clusters with $N > 30$ (upper panel) and with $N > 50$ (lower panel) are shown. In the upper panel of Fig. 2 some details are lost, but a common type of large-scale structure remains. As in Fig 1, we can see the usual forms in detail, such as chains along filaments. The lower panel map displays significant differences relative to the Fig. 1 map: three ACO supercluster members do not have corresponding PF structures. The PF structures contain 29, 35, and 45 galaxies in the magnitude range $m_3, m_3 + 3^m$. At the same time we see a chain of five PF clusters with estimated redshifts z from 0.07 to 0.12, crossing the supercluster 16 chain.

Table 2: Tne number of galaxy cluster in six regions

SCl	ACO	APM	PF (all)	PF ($N > 30$)	PF ($N > 50$)
16	46	15	113	60	34
37c	43	22	123	70	28
38c	51	4	134	70	32
190	22	15	98	56	26
199	39	19	95	51	29
212c	58	12	118	66	32

The other 5 fields display similar results. The number of ACO, APM, and PF galaxy clusters in every region is listed in Table 2. As one can see from Table 2 and Fig 2, poor galaxy clusters are important in the reconstruction of large-scale structure. It is obligatory to take into consideration PF structures with $N > 30$ in our future work.

4. Conclusions

The present paper studies the large-scale distribution of galaxies in six supercluster regions. The distribution of galaxy clusters from three catalogues (ACO, APM, PF) are different; the PF clusters of galaxies trace compact high-density regions - the skeleton of the large-scale structure - in detail. Poor PF objects with $N > 30$ must be included in supercluster structure reconstruction.

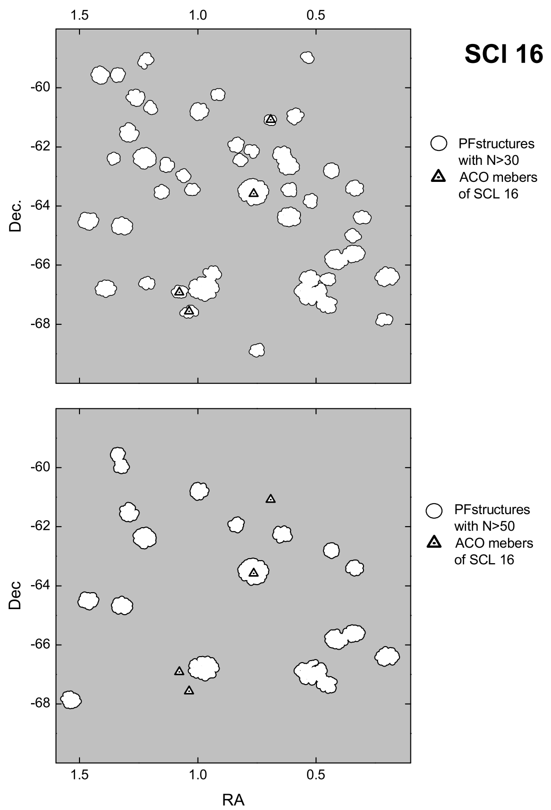

Figure 2: The distribution of PF galaxy clusters with $N > 30$ (upper panel) and with $N > 50$ (lower panel) along with ACO supercluster members in the SCl 16 region.

Acknowledgements. For this research we have used NASA's Astrophysics Data System and the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

Abell G.O., Corwin H.G., Olowin R.P.: 1989, *Astrophys. J. Suppl. Ser.,* **70**, 1.

Einasto M., Tago E., Jaaniste J. et al.: 1997, *A&A. Suppl.,* **123**, 119.

Einasto M., Einasto J., Tago E. et al.: 2001, *AJ,* **122**, 2222.

Einasto M., Einasto J., Tago E. et al.: 2002, *AJ,* **123**, 51.

Dalton G.B., Maddox S.J., Sutherland W.J. et al.: 1997, *MNRAS,* **289**, 263-284.

Panko E. & Flin P.: 2006, *J. Astron. Data,* **12**, 1.

Shapley H.: 1933, On the Distribution of Galaxies. *Proceedings of the National Academy of Sciences of the United States of America,* **19**, 389.

Ungruhe R., Seitter W.C., Duerbeck H.W.J.: 2003, *J. Astron. Data,* **9**, 1.

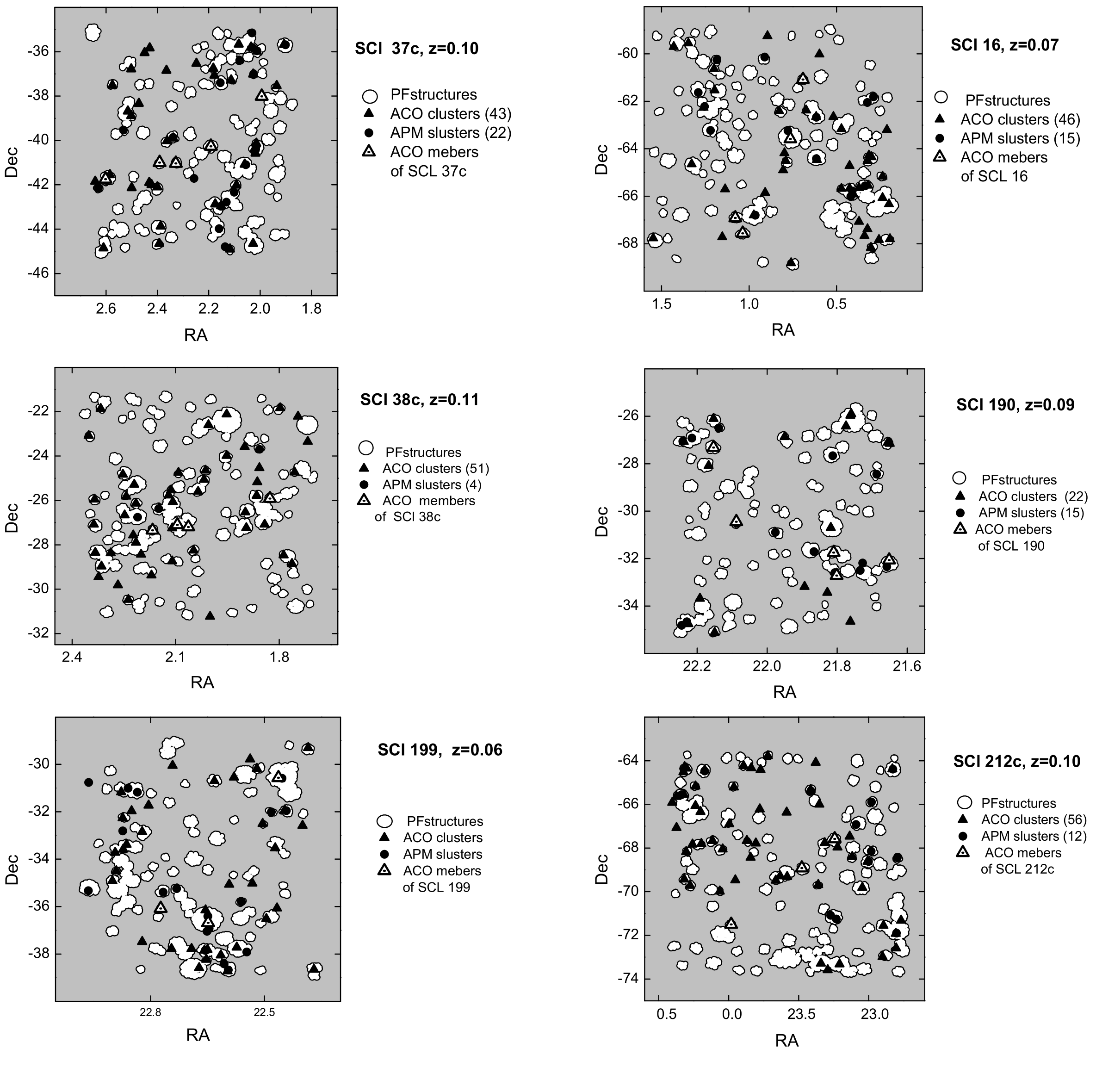

Figure 1: The distribution of galaxy clusters in the studied supercluster region. White regions represent PF structures; the number of ACO and APM clusters for each field is noted in brackets.