The Core of the Great Attractor; Is it behind the Southern Milky Way?

P.A. Woudt, A.P. Fairall

Department of Astronomy, University of Cape Town, Rondebosch 7700, South Africa

R.C. Kraan-Korteweg

Observatoire de Paris-Meudon, D.A.E.C., 5 Place Jules Janssen, 92195 Meudon Cedex, France

Abstract.
The nature and the extent of the Great Attractor has been the subject of much debate, not in the least due to the unfortunate position of its central part being behind the Milky Way. We here present the latest results from our deep optical galaxy search in the southern Milky Way. A full view of the southern hemisphere is emerging, revealing ACO 3627 as the most prominent concentration of galaxies in the southern sky. Our follow-up spectroscopic observations support the idea that ACO 3627 is the dominant component of a "great wall"–structure, similar to Coma in the (northern) Great Wall.

1. Introduction

Dust and stars in the plane of the Milky Way create a Zone of Avoidance (ZOA) in the extra-galactic sky. As such our Galaxy is a natural barrier severely constraining studies of the large scale structures in the Universe, the peculiar motion of the Local Group and other streaming motions which are important for understanding formation processes in the Early Universe and for cosmological models.

In the southern Milky Way, the Great Attractor (GA) area is a region of special interest in this respect. Apparent as a large-scale systematic flow of galaxies towards $(\ell, b, v) \sim (320^\circ, 0^\circ, 4500$ km s$^{-1})$ (Kolatt et al. 1995), this predicted mass excess is largely obscured from our view. Though it is generally believed to be an extended region ($\sim 40^\circ \times 40^\circ$) of moderately enhanced density (Lynden-Bell 1991, Hudson 1994 or Kolatt et al. 1995, cf. their Fig. 3b), no counterpart for the centre of its gravitational potential could be identified.

In an effort to reduce the size of the ZOA, we have been engaged for some years now in a deep optical galaxy search in the southern Milky Way: $265^\circ \lesssim \ell \lesssim 340^\circ, |b| \lesssim 10^\circ$ (see Kraan-Korteweg 1989 and Kraan-Korteweg & Woudt 1994a for details on the galaxy search). This recently led to the recognition that the cluster ACO 3627 is a very massive, nearby cluster of galaxies at the core of the GA $(\ell, b, v) = (325^\circ, -7^\circ, 4882$ km s$^{-1})$ (Kraan-Korteweg et al. 1996a), emphasizing therewith that gravitationally influential constituents of the Local Universe are indeed hidden by the Milky Way – their appearance inconspicuous due to the obscuring veil of the Galaxy.

We here present an “all-sky distribution” of the optically detected galaxies in the southern hemisphere, and a discussion of ACO 3627 and its role within the known extra-galactic structures.

2. Partially obscured galaxies behind the Southern Milky Way

One of the prime objectives of our deep optical galaxy search behind the southern Milky Way, or other galaxy surveys in the ZOA, is the derivation of a uniform whole-sky distribution of galaxies, i.e. as would have been seen in the absence of the obscuring layers of the Milky Way (Lynden-Bell 1994).

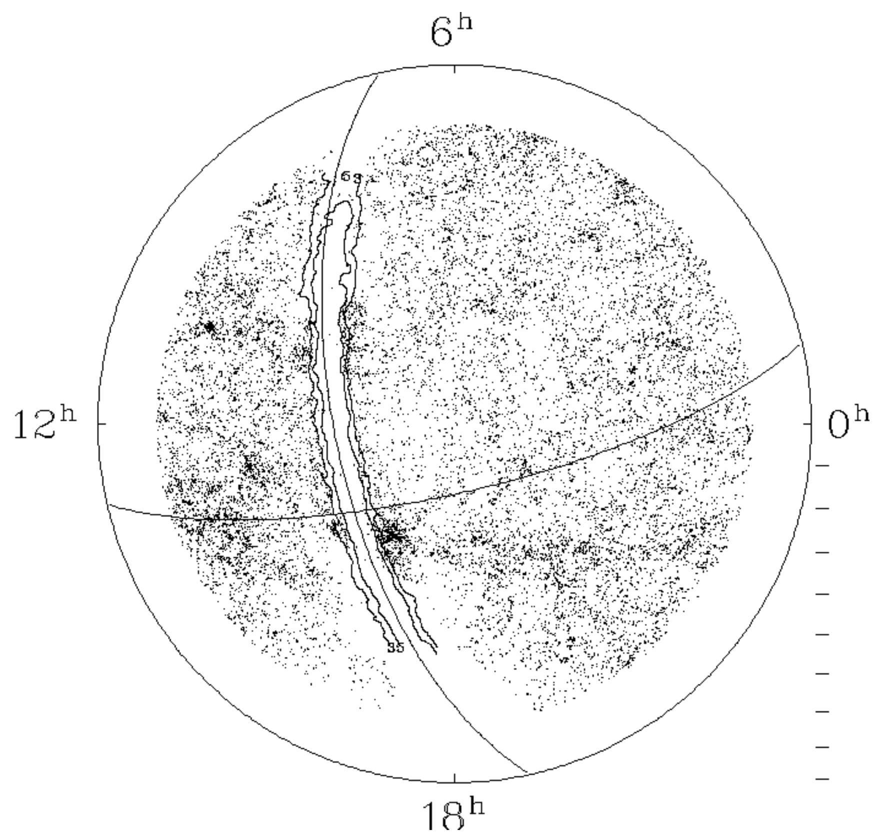

Figure 1. An equal area distribution of Lauberts galaxies ($D \geq 1'$) in the southern sky combined with galaxies from our survey that, when corrected for the galactic foreground extinction, are subjected to the same selection criterion. Both the Galactic Plane (N-S) and the Supergalactic Plane (E-W) are drawn. The contours are lines of equal extinction, deduced from the HI column densities. The outer contour marks our completeness limit (see text). The tick marks show various declinations, from 0° (outer circle) to -90° (centre) in steps of 10°.

As a first step in obtaining an all-sky distribution of galaxies in the southern sky, we have corrected the diameters of our newly found galaxies for the diminishing effects of the extinction using Cameron's (1990) law, the HI-column densities (Kerr et al. 1986) as a tracer of the dust distribution and the formalism of Burstein & Heiles (1982), assuming a constant gas-to-dust ratio. From the 10276 galaxies found to date with $D \geq 0\farcm2$, 1949 galaxies would have appeared in the Lauberts catalogue (Lauberts 1982, $D_0 \geq 1\farcm0$) were it not for the Milky Way. Of those 1949 galaxies, only 258 had been previously catalogued by Lauberts. The combined distribution of all the galaxies with $D_0 \geq 1\farcm0$ is shown in fig. 1.
The contours drawn in figure 1 are deduced from the HI-column densities. The outer contour ($A_B = 3\fm2$) corresponds to an apparent diameter reduction for spiral galaxies of $f = 5$ (Cameron 1990) and demarcates our completeness limit: below this line a galaxy with $D_0 = 1\farcm0$ would be smaller than our diameter limit and therefore go unnoticed. Above this band distinct concentrations and filaments can be recognized. The inner contour ($A_B = 5\fm0$) shows the remaining ZOA. Below this contour the Milky Way remains opaque.
The most prominent concentration of galaxies in the southern sky is centred on ACO 3627 $(\alpha, \delta) = (16^h 10^m, -60°48')$ (Abell et al. 1989), just below the Galactic Plane close to the cross-section with the Supergalactic Plane. Other major concentrations of galaxies in figure 1 are the Hydra cluster $(10^h 35^m, -27°16')$ and the Centaurus cluster $(12^h 46^m, -41°02')$.

3. ACO 3627

The cluster properties of ACO 3627 proof this cluster to be a rich, massive cluster of galaxies comparable to the well known Coma cluster, but closer in redshift-space (4882 km s^{-1} vs. 6960 km s^{-1}) (Kraan-Korteweg et al. 1996a). This view is supported by the recent observations of ACO 3627 with the ROSAT PSPC, which finds this cluster to be the 6^{th} brightest X-ray cluster in the ROSAT All Sky Survey (Böhringer et al. 1996).
In figure 2 we have superimposed the X-ray contours on the central part of ACO 3627, as reproduced from the ESO/SRC IIIaJ film copy of field 136. The contours of the 843 MHz radio continuum emission from 2 galaxies in ACO 3627 (Jones & McAdam 1992) are also plotted. Both the X-ray and the radio continuum emission provides substantial additional information on the cluster morphology and the Intra-Cluster Medium (ICM) of ACO 3627.
Like many rich clusters, ACO 3627 shows distinct subclustering in the X-ray morphology. In figure 2, the X-ray shows extended emission towards the SE corner (bottom-left). After the subtraction of a spherical symmetric model, a residual component remains, suggestive of a subcluster in the process of merging (Böhringer et al. 1996, Kraan-Korteweg et al. 1996b). This view is bolstered by the radio-morphology of PKS1610-608. This strong (one of the 20 strongest extra-galactic radio sources) wide-angle-tail source embraces the merging system (cf. figure 3 of Kraan-Korteweg et al. 1996b), revealing a strong motion of the cluster gas in a subcluster merger (Jones & McAdam 1996 and Burns et al. 1994).
ACO 3627 harbours two other interesting galaxies: the head-tail radio-source B1610-605 and a Seyfert 1.3 galaxy. The head-tail source shows an alignment with the 3rd contour of the main X-ray component over nearly its full extent.

Jones & McAdam (1996) find a particularly high pressure near the peak of B1610-605, indicative of the ram pressure as the galaxy moves through the ICM. The strong X-ray point source in the top-right corner of figure 2 is a Seyfert 1.3 galaxy, first discovered by spectroscopy (Woudt et al. 1996).

Figure 2. The central part (56′x 56′) of the cluster ACO 3627 as reproduced from field 136 of the IIIaJ copy of the ESO/SRC survey. Superimposed are the X-ray contours (thick contours) from the ROSAT PSPC observations (Böhringer et al. 1996), and the 843 MHz radio continuum emission of the wide-angle-tail radio galaxy PKS1610-60.8 and the head-tail radio-source B1610-60.5 (Jones & McAdam 1992). The strong X-ray point source in the top-right corner is a Seyfert 1 galaxy, also a member of ACO 3627.

4. ACO 3627 and the Great Attractor

Redshift observations are required to map the newly found galaxies in 3 dimensions. For this we have used three complimentary approaches:

- Multifiber spectroscopy with OPTOPUS and MEFOS at the 3.6-m telescope of ESO for galaxies in the densest regions (Cayatte et al. 1994, Kraan-Korteweg et al. 1994 and Felenbok et al. 1996)
- Individual spectroscopy of the brightest galaxies with the 1.9-m telescope of SAAO (Kraan-Korteweg et al. 1995)
- 21-cm Observations of extended LSB spirals with the 64-m Parkes radio telescope (Kraan-Korteweg et al. 1996b)

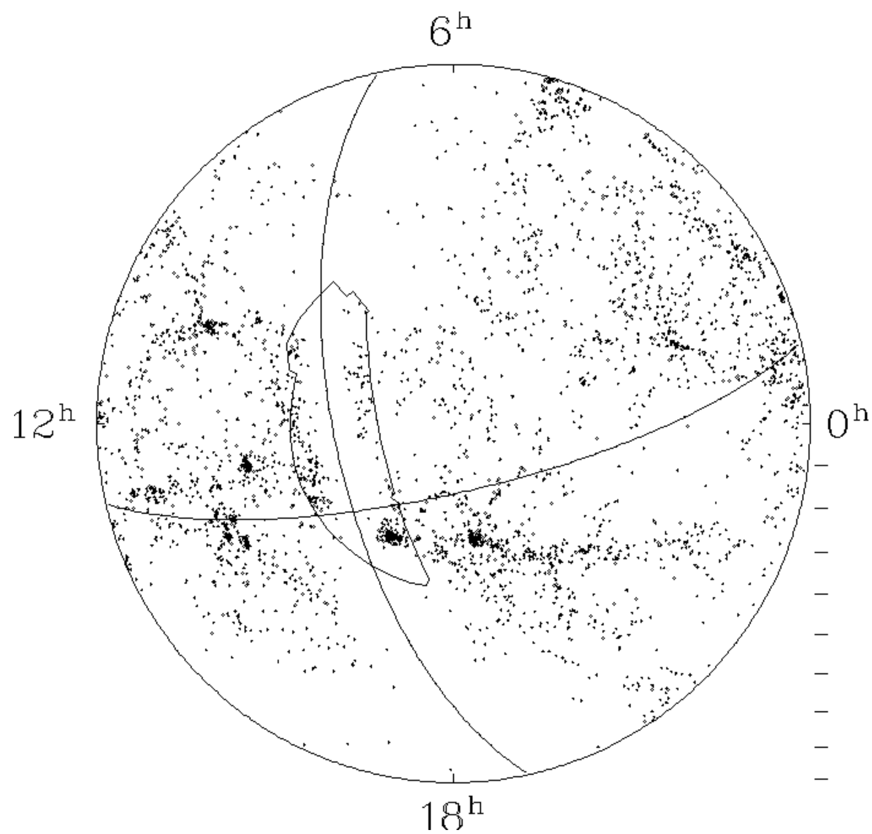

Figure 3. An equal area distribution of all the galaxies in the southern sky within redshift interval: $3500 \leq v_{obs} \leq 6500$ km s^{-1}. Published redshifts are taken from the Southern Redshift Catalogue (Fairall 1996) and are complemented by data from our follow-up spectroscopic survey of galaxies behind the southern Milky Way. Our search area is outlined, the Galactic and Supergalactic Plane are marked. The tick marks on the right are as in fig. 1.

Figure 3 shows an equal area distribution of all the galaxies in the southern hemisphere with $3500 \leq v_{obs} \leq 6500$ km s^{-1}, i.e. centred on the approximate redshift-distance of the GA.

In this redshift range ACO 3627 is seen to be the central, dominant component of a "great wall"-like structure, a broad structure including the Indus group $(\alpha, \delta, v) = (21^h03^m, -47°21', 4842$ km s$^{-1})$, the Pavo cluster (18^h43^m, $-63°23'$, 4167 km s^{-1}) crossing the central part of the GA region towards (12^h, $-55°$, 5500 km s^{-1}) where it possibly merges with the Vela supercluster at (10^h15^m, $-49°20'$, 6000 km s^{-1}) (Kraan-Korteweg & Woudt 1994b).

The here emerging picture of the galaxy distribution supports the earlier suggestions that the GA is an extended region of moderately enhanced density with the cluster ACO 3627 now marking the previously unidentified core of the Great Attractor.

5. Future prospects

Due to its proximity, the cluster ACO 3627 provides an excellent sample to investigate environmental effects on its galaxies. Our presently ongoing ATCA observations of four selected regions in ACO 3627, in combination with our other observations, will allow a detailed study of the ICM in ACO 3627.

Is ACO 3627 at rest with respect to the Cosmic Microwave Background? Here, the Tully-Fisher relation for spirals and the $D_n - \sigma$ analysis of early type galaxies – although difficult due to the foreground extinction (Mould et al. 1991) – will give us the answer.

A further reduction of the remaining ZOA ($|b| \leq 5°$) will be achieved with the forthcoming MultiBeam ZOA-survey at the Parkes 64-m radio telescope. It will yet be another step towards a true all-sky distribution of galaxies. Only then can we trace the full extent of the Norma (ACO 3627) Supercluster.

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