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# Groups of Galaxies in Local Filamentary Structures

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The filamentary structures of nearby galaxies between $23^h < \text{R.A.} < 3^h$ are constructed to study the relationship of the morphologies of groups of galaxies in the redshift space and their evolutional stages.

The local region is laced with a network of connected filaments as stated by Tully (1987). Haynes and Giovanelli (1986) has shown in their Perseus-Pisces survey that there is a thin filament extending from N628 to the Pegasus cluster (hereafter Pegasus filament). Figure 1 shows the projection of the Pegasus filament onto the meridional plane of $\text{R.A.} = 22^h$. The filament clearly extends from N628 to N1023. On the midway, another filament branches off and extends toward M31 and us (hereafter Andromeda filament).

The most interesting fact is the coldness of both the filaments, which are 50 km/s thick in the redshift space. Assuming that the filaments do not expand transversely, the upper limit to the transverse velocity dispersions are estimated at 25 km/s. Thus, they may be the coldest large-scale structures in the universe. Probably such filaments were born cold and the longitudinal Hubble expansion keeps them cold. We know a case that a very hot Perseus-Pisces filament is forming from two merging cold filaments at $\text{R.A.} = 0^h40^m$ (see Figure 4 of Giovanelli et al. 1986). If we admit that filaments evolve from cold to hot, a very cold filament would be the relic of a proto-filament.

Bright galaxies (M31, N1023, N628, N7814, N7625, and N7448) lie roughly at intervals of 660 km/s (6.6 Mpc) on the filaments. All galaxies except N7625 ($M = -18.6$) are brighter than $-19$ mag. (here $H_0 = 100$). It is assumed that the universe was once made of cubic lattices having a bright galaxy at each vertex and that the side of the lattice is now 660 km/s long. The present number density of bright galaxies of $M < -19$ should be $1/6.6^3\ \text{Mpc}^{-3}$, i.e., the integrated luminosity function:

$$\phi(M < -19) = 0.0035\ \text{Mpc}^{-3}.$$

Brown and Peebles (1987) give the integral of Davis and Huchra's (1982) luminosity function derived from the CfA redshift survey to $M = -19$:

$$\phi_{\text{CfA}}(M < -19) = 0.0044\ \text{Mpc}^{-3}.$$

Davis and Huchra used $H_0 = 100$. Thus, the lattice model is consistent with the *luminosity function of bright galaxies*, The Andromeda filament extends, via the M31 group, to the Centaurus group. It is defined by 16 galaxies (N672, U1249, N784, U1241, N404, M33, M32, M31, N205, N185, N147, IC10, [Our Galaxy], N5237, UKS1346–358, UKS1424–460, and N5253). Our Galaxy stands at a crossroads of the Andromeda filament and the Sculptor-CV$_n$ I filament, while our Galaxy seems to belong to the latter filament. The coldness of the Andromeda filament implies that M31 is approaching us along it.

Groups of galaxies are expected to evolve through three stages: expanding, collapsing, and virialized stages. Figure 2 shows the filamentary structures of nearby galaxies around R.A. $= 2^h$, projected onto the meridional plane of R.A. $= 1^h$. We try to classify the evolutional stages of groups in Figures 1 and 2 according to their morphologies in the redshift space.

1) expanding groups

N1023 group is so peculiar in its very low line of sight velocity dispersion of 30 km/s as pointed out by Tully (1980). Figure 2 shows that N1023 group is forming at a contact point of two cold (expanding) filaments: the Pegasus filament and a filament connecting N1023 and N1068. It is probable that N1023 group is at the maximum expansion or before. In fact, this group falls on the region $T_c/2 > H_o^{-1}$ in the virial diagram.

2) collapsing groups

In general a collapsing group has a few collapsing branches around the central galaxy and does not show so high velocity dispersion. This is the case with N628 group in Figure 1. It has three branches in the redshift space as well as in the projected view and falls on the region $T_c/2 < H_o^{-1} < 3T_c/2$ in the virial diagram. N1068 group in Figure 2 has two collapsing branches around a relaxed core of four galaxies. The back-ground members N1087 and DD0 30 are eliminated because they surely belong to a western extension of N936 group. As a result, N1068 group falls on the collapsing region $T_c/2 < H_o^{-1} < 3T_c/2$.

3) virialized groups

A virialized group usually has an elongated structute along the line of sight in the redshift space, i.e., a finger of God, together with a relaxed structure in the projected view. We can easily distinguish the finger of God from the relevant filaments if they tilt to each other. N524 group is the most prominent virialized group in Figures 1 and 2. N7448 group in Figure 1 and N936 group in Figure 2 are also virialized. All of them fall on the virialized region $3T_c/2 < H_o^{-1}$.

These few examples show that the redshift morphology is a good clue to an understanding of the evolution of groups of galaxies.

Virialized groups should have a cD galaxy in a Hubble time if the member galaxies have huge halos (Ishizawa 1986, 1987). This is the problem of overmerging. The survival of galaxy cores is to be explored in the gravitational clustering theory like the cold dark matter theory (White et al. 1987; Frenk et al. 1987, 1988) There is a related problem of over-friction that a barred galaxy can not rotate long in a live missing halo. (Matsushita 1988).

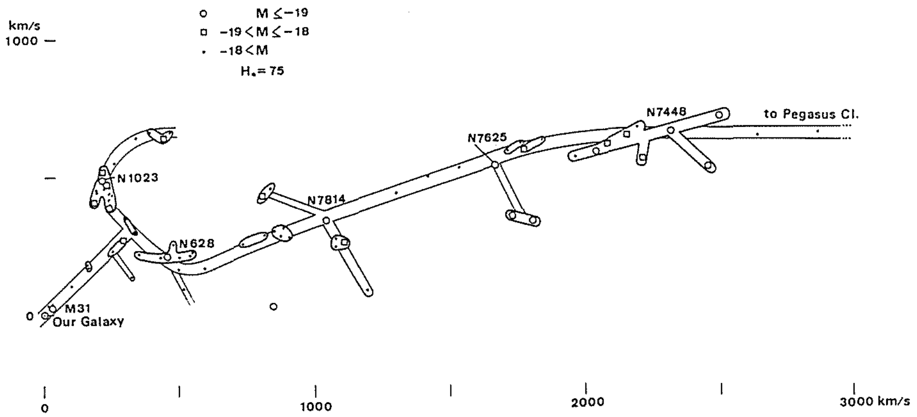

Fig. 1.

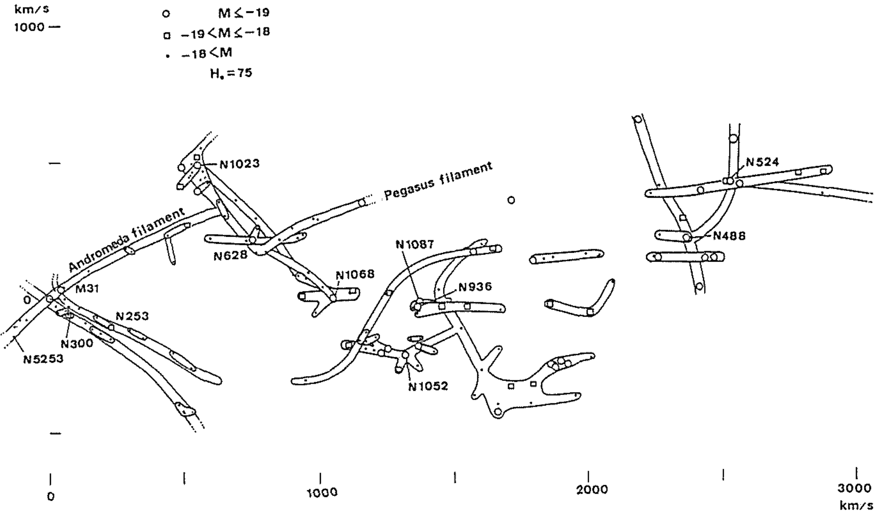

Fig. 2.

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