KINEMATICS OF THE LOCAL COSMIC VOID

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Available data on the distances and radial velocities of galaxies are systematized in order to study the
distribution of peculiar velocities in neighborhoods of the Local cosmic void lying in the direction of the
Aquila and Hercules constellations. A sample of 1056 galaxies is used, with distances measured in terms
of the luminosity of the tip of the red giant branch (TRGB), the luminosity of the cepheids, the luminosity
of type Ia supernovae, surface brightness fluctuations (SBF), and the Tully-Fisher relation. The amplitude
of the outflow velocity of the galaxies is found to be ~300 km/s. The average number density of galaxies
inside the void is roughly a factor of five lower than the average outside it. The Local void population is
characterized by lower luminosities and later morphological types, with medians of \( M_B = -15.7 \) and
\( T = 8 \) (Sdm), respectively.

Keywords: galaxies: large-scale structure of the universe

1. Introduction

Since the discovery of the first cosmic voids [1-3] it has gradually become clear that numerous voids, with
sizes of ~10-50 Mpc, are the principal architectural element of the large-scale structure of the universe [4]. Tikhonov
and Karachentsev [5] have shown that the Local void \( (D < 10 \) Mpc) contains smaller voids and bubbles with
diameters of ~1-5 Mpc. The closest of the existing cosmic lacunae was discovered by Tully and Fisher [6] during
compilation of their Nearby Galaxies Atlas. It is centered in the Aquila/Hercules constellations in a high galactic
absorption zone. Nevertheless, the visible deficiency of galaxies in this region is only partially caused by optical
absorption. Surveys of the region of the Local cosmic void in the 21 cm hydrogen neutral line at Parkes and Arecibo
[7-10] have confirmed a low local number density of galaxies with radial velocities below 3000 km/s. The
identification of IRAS sources and measurements of their radial velocities [11,12], along with searches for low-surface brightness dwarfs [13], have not eliminated the observed dearth of nearby galaxies in the Local void zone, which occupies about 1/6 of the area of the entire sky.

The size of the Local void and the depth and degree to which it is filled with galaxies are debated. Tully, et al. [14] have pointed out that the low density region extends to distances of ~(40-60) Mpc. Kraan-Korteweg, et al. [8] assume that the Local depression region may be even larger, merging with a more distant void in the Miroscopium and Sagittarius constellations. They note the presence of several filaments in this volume which separate a “supervoid” into 2 or 3 smaller voids with sizes of 20-30 Mpc.

This entire extended region with a low number density of galaxies lies roughly along the north pole of the supergalactic coordinate system, which emphasizes the concentration of nearby galaxies toward the equator of the Local supercluster. ΛCDM-model numerical simulations [14-16] show that the expansion of cosmic voids occurs at higher rates and is characterized by a local excess in the Hubble constant \( \Delta H \approx 0.2 \, H_0 \). In a typical cosmic void with a radius of ~15 Mpc the peculiar velocities of the galaxies at its periphery are about ±(200-250) km/s. It has been argued [14] that the presence of an extended local void in the + SGZ direction generates a velocity component \( \langle v_{pec} \rangle_{LG} = 260 \text{ km/s} \) relative to the cosmic microwave radiation in the local group. The – SGZ direction of this component immediately explains the well known phenomenon of the “local velocity anomaly” [17], which has been a riddle for the past 20 years.

Observational data in the Aquila/Hercules region with coordinates RA = [11^h 0, 21^h 0] and Dec = [-30°, +40°] [8,13] show that there are almost no galaxies with radial velocities below 1500 km/s. This section of the sky is shown in Fig. 1, where a diffuse diagonal strip indicates the strong absorption zone \( A_g > 2^m.0 \) [18]. Galaxies with radial

![Fig. 1. Distribution of galaxies in the sky in the region of the Local cosmic void in equatorial coordinates. The numbers indicate the radial velocities of the galaxies relative to the center of mass of the Local group. The diffuse strip outlines the strong galactic absorption zone.](image)