Abstract. We compiled an all-sky catalog of 451 nearby galaxies, each having an individual distance estimate $D \lesssim 10$ Mpc or the radial velocity $V_{LG} < 550$ km s$^{-1}$. The catalog contains data on basic optical and HI properties of the galaxies: their diameters, absolute magnitudes, morphological types, optical and HI surface brightnesses, rotational velocities, indicative mass-to-luminosity and HI mass-to-luminosity ratios, as well as a so-called "tidal index", which quantifies the galaxy environment. We expect the catalog completeness to be $\sim 75\%$ within 8 Mpc. About 85\% of the Local volume population are dwarf (dIrr, dIm, dSph) galaxies with $M_B > -17.0$, which contribute about 4\% to the local luminosity density, and $\sim (10 - 16)\%$ to the local HI mass density.

We found that the mean local barion density $\Omega_b(<8\text{ Mpc}) = 2.3\%$ consists of only a half of the global barion density, $\Omega_b = (4.7 \pm 0.6)\%$ (Spergel et al. 2003). The mean-square pairwise difference of radial velocities is about 100 km s$^{-1}$ for spatial separations within 1 Mpc, increasing to $\sim 300$ km s$^{-1}$ on a scale of $\sim 3$ Mpc.

Numerous tasks of extragalactic astronomy and cosmology require to have a quite complete and representative collection of galaxies limited by a fixed distance. In distinction to the galaxy samples limited by the apparent magnitude, creation of the distance-limited sample is an exceptionally difficult problem because of the huge difference of galaxies according to their luminosity, surface brightness and other global parameters. Over the last decade, tremendous advance has been made in searching for nearby ($D < 10$ Mpc) galaxies owing to purpose oriented efforts of different observational teams. The employment of the Hubble Space Telescope makes it possible to study the stellar population and measure accurate distances of galaxies which are situated outside the Local Group. It is time for summarizing the wealth of new observational data on
neighboring galaxies allowing us to establish some basic properties of the Local Cosmic Web.

1. Recent observations of the Local Volume galaxies

The nearest rich cluster of galaxies in Virgo is situated at a distance of $D_{\text{Virgo}} = 17$ Mpc from us. Therefore, the Local Volume (LV) of radius $D = 8$ Mpc, undisturbed by high virial motions, may be considered as quite a representative volume as to its population as well to the presence of basic structural properties: groups, voids, etc. The first step towards compiling such a “fair” sample was made by Kraan-Korteweg & Tammann (1979), who published a “Catalog of nearby galaxies within 10 Mpc”. The catalog contains 179 galaxies satisfying the condition $V_{LG} < 500$ km s$^{-1}$, where $V_{LG}$ is the galaxy radial velocity corrected for the observer movement with respect to the Local Group centroid.

Global parameters in this sample were studied by Huchtmeier & Richter (1988). Later, Karachentsev (1994) published an updated version of the LV list, which contains 226 galaxies with $V_{LG} < 500$ km s$^{-1}$. Following the same condition, Karachentsev, Makarov & Huchtmeier (1999b) enlarged the initial LV sample to 303 objects basing on new optical and HI observations. Over the past few years, special searches for new nearby dwarf galaxies have been undertaken basing on the optical sky survey POSS-II/ESO/SERC, HI and infrared surveys of the Zone of Avoidance, “blind” sky surveys in the 21 cm line, HIPASS and HIJASS. Armandroff et al. (1999) carried out automated searches for dwarf companions of low surface brightness in a wide vicinity of the Andromeda galaxy (M 31). Karachentsev & Karachentseva with collaborators undertook a visual inspection of all POSS-II/ESO/SERC plates and found more than 500 nearby dwarf galaxy candidates, mainly of low surface brightness. HI observations of these objects (Huchtmeier et al. 2000, 2001) as well as optical spectral observations (Makarov et al. 2003) revealed about 100 new galaxies with radial velocities less than 500 km s$^{-1}$. The nearest galaxy group around IC 342/Maffei behind the Milky Way was studied in the HI line and in IR that resulted in finding some new members of the group (Buta & McCall, 1999). In the region of another nearby group in Centaurus, new gas-rich dwarf galaxies were found by Kilborn et al., 2002 and Staveley-Smith et al., 1998. As a result of the joint efforts, the local number density of galaxies has been increased 2 times.

It is obvious that the condition $V_{LG} < 500$ km s$^{-1}$ for selection of nearby galaxies seems to be too simplified. Indeed, the kinematic distance of a galaxy in a group may be in error by several Mpc because of virial motions. Apart from peculiar motions, the kinematic distance is also affected by anisotropic expansion of the Local volume. According to Karachentsev & Makarov (1996), the local velocity field on a scale of $\sim 8$ Mpc is characterized by the Hubble tensor $H_{ij}$, which has the main values of $H_{xx} : H_{yy} : H_{zz} = (81 \pm 3) : (62 \pm 3) : (48 \pm 5)$ in km s$^{-1}$Mpc$^{-1}$. The minor axis of the corresponding ellipsoid is aligned with the polar axis of the Local Supercluster, and the major axis has an angle of $(29 \pm 5)^\circ$ with respect to the direction to the Virgo cluster core. Therefore, the effect of local anisotropy generates a considerable difference in kinematic distances of galaxies seen in different directions.
Until recently, the majority of very nearby galaxies had no reliable direct distance estimates. In the 90s many neighboring spiral and irregular galaxies were resolved into stars for the first time, which allowed determination of their distances from the luminosity of blue and red supergiants with an accuracy of $\sim 25\%$. During the last few years, about 150 nearby galaxies have been imaged with the WFPC2 on the Hubble Space Telescope (HST). Accurate distances to them (with an error $\sim 10\%$) were measured from the luminosity of the tip of the red giant branch (TRGB). A compilation of 223 galaxies situated within 5.5 Mpc from us has been presented by Karachentsev et al. (2003). About half of them have accurate distance estimates via TRGB or cepheids. The ACS camera that has recently been installed on the HST is able to measure distances of galaxies to within 7–8 Mpc in a fast “snapshot” mode (1 object per 1 orbit). This stimulated us to prepare a sample of galaxies with the expected distances within 7–8 Mpc, being as complete as possible.

2. Catalog

Taking into account the presence of non-Hubble motions, as well as distance measurement errors, we selected galaxies for our sample on the basis of two simple conditions: $D < 10$ Mpc, if a galaxy has an individual distance estimate, or $V_{LG} < 550$ km s$^{-1}$, if the galaxy distance has been estimated from its radial velocity alone. Such an approach permits us to save a maximum number of galaxies in the sample with true distances $D < 8$ Mpc, although it includes inevitably a fraction of more distant objects too.

At total, 451 galaxies satisfy the above mentioned condition (Karachentsev et al. 2004). Distributions of the LV galaxies according to their absolute magnitudes, linear diameters, and rotational velocities are presented in Fig. 1. Assuming our sample within $D = 2$ Mpc to be complete to nearly 100\%, we derive an estimate of completeness within 8 Mpc to be $\sim 75\%$. Therefore, new more careful searches for faint neighboring galaxies may lead to discovery of $\sim 100$ new galaxies within 8 Mpc around us. The absolute magnitude — the mean surface brightness relationship for 451 neighboring galaxies is plotted in Fig. 2. The mean surface brightnesses spreads over a range of 7 magnitudes. Evidently, the galaxies of very low surface brightness can easily be lost when situated in the Zone of Avoidance. McGaugh & Blok (1997) supposed that the true distribution of galaxies according to their mean surface brightness extends beyond $\Sigma_B \sim 27^m/\square''$, and, probably, about 80\% of all galaxies lie for us beyond the present threshold of detection. Fig. 2 shows that the mean surface brightness decreases from giant galaxies to dwarfs. Such tendency is expected when giant and dwarf galaxies have approximately one and the same mean volume density of stars, that corresponds to the relation $\Sigma_B \sim (M_B)/3$ shown in Fig. 2 by the dased line.

3. Galaxy distribution within 8 Mpc

The sky distribution of 451 nearby galaxies is presented in Fig. 3 in equatorial coordinates. The distribution looks extremely inhomogeneous, showing two large empty areas: the Local Void (Tully, 1988) in Hercules-Aquila and the Local Mini-
void (Karachentsev et al., 2002) in the Orion constellation. Spatial distribution of the galaxies is seen in Fig. 4 in the Supergalactic coordinates. Galaxies with the distances less and more than 8 Mpc are shown by large and small circles, respectively. One can distinguish in Fig. 4a (the Supergalactic plane projection) some relatively compact groups around the Milky Way, M 31, M 81, IC 342, Cen A, M 83, and also the Canes Venatici cloud. Remarkably, in the huge volume of the Tully void ($\sim 100 \text{ Mpc}^3$) there is not any galaxy with luminosity brighter than $L \sim 2 \cdot 10^6 \cdot L_\odot$. The dwarf galaxy KK246 ($-12^m 96$) is situated just at the edge of the Tully void, but not inside it. The Local Supercluster center in Virgo is characterized by the Cartesian coordinates: $SGX = -4 \text{ Mpc}$, $SGY = 16 \text{ Mpc}$, $SGZ = -1 \text{ Mpc}$. A small density gradient is seen towards Virgo, but it is masked by strong density fluctuations caused by voids. The majority of the groups locate in a thin layer $|SGZ| < 0.3 \text{ Mpc}$ of the Supergalactic plane. However, there are also groups around NGC 6946, M 101, M 96 (Leo-I), situated at a distance of $\sim 3 - 4 \text{ Mpc}$ from the Local “sheet”.

4. Environment effects in the Local Volume

As it is know, the HI abundance in disk-like galaxies depends on their environment. Spiral galaxies in the cores of rich clusters demonstrate significant HI-deficiency with respect to the field galaxies of the same morphological type. However, observational data on the HI-deficiency outside rich clusters look rather controversial. To describe the local mass density around a galaxy “$i$”, Karachentsev & Makarov (1999a) have introduced the so-called “tidal index”: $\Theta_i = \max\{\log(M_k/D_{ik}^3)\} + C$, $i = 1, 2...N$, where $M_k$ is the total mass of any neighboring galaxy separated from the considered galaxy by a space distance $D_{ik}$. For every galaxy “$i$” we found its “main disturber”, producing the highest tidal action or a maximum density enhancement, $\Delta \rho_k \sim M_k/D_{ik}^3$. In order to take account of all surrounding galaxies (but not only ones with measured $V_m$), we determined the total mass of every galaxy from its luminosity. Here, we accept the mean value $M_{25}/L = 3.8 M_\odot/L_\odot$ for all morphological types, and also adopted that the total mass of each galaxy is on average 2.5 times its indicative mass, $M_T = 2.5 M_{25}$. The value of the constant $C$ is chosen so that $\Theta = 0$ when the Keplerian cyclic period of the galaxy with respect to its main disturber equals the cosmic Hubble time, $1/H$. In this sense, galaxies with $\Theta < 0$ may be considered as undisturbed (isolated) objects. To characterize the HI-deficiency of galaxies in groups, we considered two parameters: the morphological type and the HI surface brightness, $\Sigma_{HI} = M_{HI}/A_{25}^2$, having lower dispersion with respect to $M_{HI}/L$ and $M_{HI}/M_{25}$. The relations $T$ versus $\Theta$ and $\Sigma_{HI}$ versus $\Theta$ are plotted on the upper and lower panels of Fig. 5, respectively. The bulge-dominated galaxies with $(T < 4)$ are shown by large circles. As can be seen, the data on the upper panel are indicative of the known morphological segregation effect when E, S0, dSph occur usually in groups, but not in the general field. Among the most isolated galaxies with $\Theta < -2.0$ there are exceptionally objects of the latest types, $= 7 - 10$. For spiral and irregular galaxies themselves, one can see a slight (30%) decrease in the HI surface brightness from the most isolated ($\Theta < 0$) galaxies towards the most disturbed. This observational fact may be used to choose between two extreme scenarios of galaxy evolution when a)
star formation in a galaxy is driven by its gas consumption, or b) the structure of the stellar and gaseous components of a galaxy is defined by the process of recurrent merging of galaxies.

5. Some cosmologic parameters extracted from the LV sample

Based on the derived data, we estimated some parameters important for cosmology, in particular, the mean local luminosity density within a sphere of radius $D$ in $L_\odot/$Mpc$^3$. Apart from the peak produced by the Local Group, the luminosity density shows a secondary peak at $D = 3.7$ Mpc, caused by the M81 and CenA groups, and then decreases smoothly to the value $3.5 \cdot 10^8 L_\odot/$Mpc$^3$ at $D = 8$ Mpc. Subsequent decrease in the luminosity density occurs because of the fractal nature of the matter distribution, as well as because of incompleteness of our sample. The global value of $\rho_{\text{lum}}$ in the B-band was estimated on the basis of essentially deeper samples. Blanton et al. (2003) and Liske et al. (2003) have derived from the Sloan Digital Sky Survey and the Millennium Galaxy Catalogue the values: $1.23 \cdot 10^8 L_\odot/$Mpc$^3$ and $1.43 \cdot 10^8 L_\odot/$Mpc$^3$, respectively. Both the quantities are reduced to the local value of the Hubble parameter, $H = 72$ km s$^{-1}$Mpc$^{-1}$. It should be noted, however, that the global estimates of $\rho_{\text{lum}}$ were derived when internal extinction in galaxies was not taken into account. Ignoring the internal extinction, we obtain $\rho_{\text{lum}}(<8Mpc) = 2.5 \cdot 10^8 L_\odot/$Mpc$^3$, then the mean local luminosity density exceeds 1.7–2.0 times the global density in spite of the presence of the Tully void and the absence of rich clusters in the Local volume.

There is a pessimistic opinion that about 80% dwarf galaxies are hidden from us because of their extremely low surface brightness (McGaugh, 1996; Impey & Bothun, 1997). Such a strong argument can be checked in principle by observations. Dwarf galaxies having absolute magnitudes fainter than -17.0 with their relative number of 85% make a minor contribution, $\sim (2 - 5)\%$, to the integrated luminosity or integrated “indicative” mass of the neighboring galaxies. However, their contribution in the HI mass (10-16)%, as well as in the sky area covered by galaxies (31%), turns out to be more significant. The supposed presence of an about 5 times larger population of ELSB dwarf galaxies would lead to an unusually high number of absorption lines seen in QSO spectra.

To characterize the average virial galaxy motions on different scales, the mean-square difference of radial velocities of two galaxies, $<\Delta V_{12}^2(R_p)>$, as a function of their projected linear distance is often used. It is supposed that this quantity allows one to estimate the dark matter density on corresponding scales. The existing estimates of $<\Delta V_{12}^2(R_p)>$, obtained from different catalogs of galaxies and surveys, differ essentially from each other but lie in the range from 200 km s$^{-1}$ (Branchini et al. 2001) to 600 km s$^{-1}$ (Zehavi et al. 2002), which leads to $\Omega_{DM} \sim (0.1-0.3)$ on a scale of $\sim 1$ Mpc. It should be emphasized that the derived quantities were obtained for galaxy samples restricted by the flux, but not the distance. Based on the data of our Catalog, we calculated $<\Delta V_{12}^2>$ as a function of space separation as well as projected separation between the galaxies. The mean-square difference of radial velocities changes slightly from 110 km s$^{-1}$ to 90 km s$^{-1}$ on a scale of $R < 1$ Mpc, apparently reflecting the Keplerian motions in tight galaxy pairs. The increase in $<\Delta V_{12}^2>$
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to $\sim 300$ km s$^{-1}$, seen on scales of 1–4 Mpc, is caused by the increasing role of the systematic Hubble component at larger mutual galaxy separations. As one can see, the projection effects distort essentially the observed behaviour of $<\Delta V^2_{12}(R)>$, which makes the interpretation of the relation in terms of $\Omega_{DM}$ rather uncertain.

Acknowledgments. This work was supported by RFFI grant 04-02-16115 and DFG-RFBR grant 02-02-04012. This search has made use of the NASA/IPAC Extragalactic Database (NED), the Lyon Extragalactic Database (LEDA), the HI Parkes All Sky Survey (HIPASS), and the Two Micron All-Sky Survey (2MASS).

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Figure 1. Distribution of the neighboring galaxies according to their absolute magnitudes (the lower panel), linear diameters (the middle panel), and rotational velocities (the upper panel) versus distances. The solid line corresponds to the sliding median. The dotted and dashed lines on the bottom panel show limiting apparent magnitudes $B_1 = 15^{m}5$ and $17^{m}5$ for CGCG and Karachentsevs’ survey, respectively. The dotted and dashed lines on the middle panel correspond to limiting angular diameter $I'$ and $0'4$ characteristic of Nilson’s catalog (UGC) and Karachentsevs’ survey, respectively.
Figure 2. Mean surface brightness of 451 nearby galaxies versus their absolute magnitudes in the B-band. The sliding median is shown by the solid line.
Figure 3. All-sky distribution of 451 neighboring galaxies from Table 1 in equatorial coordinates. The galaxies with distances $D > 8$ Mpc are shown as small circles. The shaded area marks the Zone of Avoidance in the Milky Way.
Figure 4. Panorama of the Local volume within a radius of 8 Mpc in Cartesian Supergalactic coordinates. Galaxies from Table 1 with $D > 8$ Mpc are shown as small circles. a) SGX - SGY, galaxies projected onto the plane of the Local Supercluster; b) SGX - SGZ, the distribution in Z (perpendicular to the plane of the Local Scl) is dominated by the galaxies concentrated toward this plane. The Local Void in the upper part of the diagram is evident; c) SGY - SGZ, see the asymmetric distribution in the plane of the Local Scl towards Virgo. Some known groups are marked by names of their brightest members.
Figure 5. Plot of morphological type (upper panel) and the mean HI surface brightness (lower panel) versus the “tidal index” defined in the text. The medians for disk-like galaxies (small circles) are shown by solid lines.