Chapter 11

The Superuniverse Wall

Orvonton is the Local Group, which has a radius of approximately 4 Mly. The location of Uversa at the center of Orvonton is relatively near us. From the internal structure of the grand universe, Paradise should be about 9 Mly distant and the diameter of the superuniverse space level should be about 26.5 Mly. The primary cosmic structure of which Orvonton is a part is the superuniverse space level. This together with the Havona space level constitutes the grand universe.

In 1990 NASA created a worldwide master list of all extragalactic objects. Since its inception the number of such objects has increased more than a thousand fold, now approaching a total of 200 million unique objects. Almost 99 percent of the objects in this master list have been added since 1998. The recent dramatic increase in the number of extragalactic objects with redshift measurements finally makes it possible to identify the superuniverse space level. This structure can be directly observed as part of a great circle on the celestial sphere. This Superuniverse Wall is found within a distance of 36 million light-years.

The primary method for determining astronomic distances to large numbers of objects depends upon redshift measurements. NASA's extragalactic database includes comprehensive bibliographic information detailing all of the sources for the redshifts for each object. Using this information it can be shown that prior to 2001 there was insufficient redshift data to detect the existence of the superuniverse space level.

1. NASA's Extragalactic Database

All of the astronomic data about the large scale structure of the grand universe is extracted from 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. This database is a worldwide master list of all identified objects that are located beyond the borders of the Milky Way. It contains positions, redshift data, and bibliographic references on virtually all known extragalactic objects. It is publicly accessible at http://ned.ipac.caltech.edu. NED is updated regularly, usually every few months.

The database was initiated in 1990 and contained 375,000 extragalactic objects at the beginning of 1998, for which there were 45,000 redshift measurements. [47] By the beginning of 2001 the number of unique objects had increased tenfold to 3.7 million, including 167,000 redshifts. [48] The data used in this portion of this work was extracted in March 2011 after the December 2010 update. At that time the database contained 165 million unique objects, including redshift measurements for 2 million objects. [49] By NED's September 2012 revision these totals had increased to 177 million unique objects with 4 million redshifts. [50] Over 99.79 percent of all unique objects in NED have been added since January 1998. Over 98.87 percent of redshift measurements in NED have been added since 1998.

There were two major catalogues in 1955: the New General Catalogue (1888), which eventually contained 7,840 objects, and the Index Catalogue (1896) which added a further 5,386 objects. There were other smaller catalogues, such as Messier's, but the total number of catalogued objects in 1955 did not exceed a few tens of thousands. Over the last decade or so there has been an explosion of new data, mostly from two projects: the Two-degree-field Galaxy Redshift Survey (2dFGRS) and the Sloan Digital Sky Survey (SDSS). The 2dFGR Survey was carried out from 1997 to 2002 by the Australian Astronomical Observatory in Sydney, Australia and identified 250,000 objects with magnitudes brighter than about 19.5 over about 7 percent of the southern sky. The SDSS began in 2000 and is ongoing at the Apache Point Observatory in New Mexico. The 2011 data release (DR8) identified 500 million objects over about 35 percent of the northern sky down to magnitudes of about 22, along with one million spectra.

Six data items are extracted from NED for each extragalactic object with a redshift measurement which satisfies the distance criteria detailed below.

1. Object name
2. Longitude in galactic coordinates
3. Latitude in galactic coordinates
4. Object type (morphology)
5. Heliocentric velocity (km/s)
6. Heliocentric redshift (z)

The galactic coordinate system is used to identify the position of objects on the celestial sphere. This coordinate system uses the gravitational plane of the Milky Way as its equator and the center of the Milky Way as due north or zero degrees of galactic longitude.

Space is expanding. In the current understanding the space containing a galaxy (or galactic cluster) is moving relative to the space containing other galaxies. Galaxies are carried along by this general expansion of space, causing them to move away from our location. That motion of an object which is only caused by space expansion – the motion *of* space itself – is referred to as its proper motion. The peculiar motion of an object is its motion *through* the local space which contains the object. At a distance of several million light-years, the proper motion of galaxies due to space expansion tends to be significantly greater than their peculiar motion, and their peculiar motion can be disregarded to some extent. At a sufficient distance, a galaxy's motion is largely due to the proper motion of space expansion. The velocity of an object's proper motion divided by the expansion rate of space, the Hubble constant, gives the proper distance to the object.

Relative motion (proper or peculiar) causes a Doppler shift in the spectrum of light emitted by galaxies. This is analogous to the manner in which the frequency of sound is observed to increase for an approaching object and decrease for a receding one. The spectrum emitted by a receding object is shifted toward lower frequencies or redshifted to longer wavelengths. The light spectrum of an approaching object is shifted toward higher frequencies or blueshifted to shorter wavelengths. This Doppler spectrum shift is spectroscopically measured and is customarily symbolized by the letter z. This is the ratio of the frequency of light emitted by the object divided by the frequency of light observed, minus one.

$$z = \frac{f_{emitted}}{f_{observed}} - 1 \cong \frac{v}{c}$$

Doppler shifts are typically positive numbers, because the emitted frequency is observed as a lower frequency. Space expansion causes most galaxies to have a net receding motion, and their frequencies are redshifted. Negative Doppler shifts, blueshifts, are measured for objects with net approaching motions. For objects with velocities much less than that of light ($v \ll c$), the redshift z is approximately equal to the ratio of the object's velocity divided by the velocity of light. The above equation is an approximation for low velocity objects and is derived from the formal redshift equation.

$$z = \sqrt{\frac{1 + \frac{v}{c}}{1 - \frac{v}{c}}} - 1$$

For redshifts $z < 0.01$ the recessional velocity is approximately equal to the velocity of light multiplied by the redshift: $v \cong cz$. At $z = 0.01$ this simple equation gives a recessional velocity of $0.01c$ or 2,997.9 km/s, which is about 0.5 percent too fast when compared with the formal redshift equation. At $z = 0.10$, the velocity given by cz is 5.3 percent faster than the actual velocity. The simple equation $v \cong cz$ is accurate to within two percent at distances of less than ~50 Mly ($z = 0.04$). The proper distance D to an object equals the object's proper velocity v (from its redshift) divided by the Hubble constant H_0.

$$D = \frac{v}{H_0}$$

A recent estimate for the Hubble constant of 71 ± 2.5 $\mathrm{kms^{-1}}$/Mpc (kilometers per second per megaparsec) was published in 2010, based upon extensive cosmic microwave background readings from the WMAP project. [51] The data acquired from the Hubble space telescope was analyzed to reach a 2011 determination of 74.3 ± 2.1 $\mathrm{kms^{-1}}$/Mpc. [5] NASA's Extragalactic Database (NED) uses a default value of 73 ± 5 $\mathrm{kms^{-1}}$/Mpc for Hubble flow distance calculations.

The megaparsec (Mpc) is a common measure of cosmic distances and equals 3.26 million light-years (Mly). For every 3.26 Mly of distance, the proper motion of space expansion (Hubble flow) causes a galaxy to recede from us at a velocity of 73 km/s, using NED's value for H_0. This is a simple linear relationship. An object which is 6.52 Mly (2 Mpc) distant has a proper recessional velocity of 146 ± 10 km/s due to space expansion.

The observed heliocentric velocity is the radial velocity with which an object is either moving directly toward or away from the sun. This heliocentric measurement of proper distance using the Hubble relation of $D = v/H_0$ does not take into account the motion of the sun relative to the cosmic microwave background (CMB). This radiation is thought to originate some 14 billion years ago near the limiting surface of the expanding universe. Under the current concept, space is expanding away from every location in every direction in the same way. This places the sun at the center of this limiting surface. Relative to the expanding universe, there is no proper motion of space expansion at our location. The CMB radiation should have exactly the same temperature in every direction, because we are located at the center of this co-moving frame of space expansion. However, relative to the sun, CMB temperatures are not exactly uniform. Temperatures slightly increase around a peak temperature measured at longitude $\boldsymbol{l} = 264.14 \pm 0.15°$ and latitude $\boldsymbol{b} = 48.26 \pm 0.15°$ in galactic coordinates. [6] This systematic change in measured temperatures can be explained if the sun has a peculiar motion relative to the co-moving reference frame of the CMB radiation of 371 ± 1 km/s in this direction. This velocity toward the CMB dipole causes a blueshift in measured frequencies for objects observed in the direction of the CMB dipole. For objects in the opposite direction, the sun's motion causes a redshift in frequencies.

In order to calculate the proper Hubble flow distance from the heliocentric redshift, the sun's peculiar velocity of 371 ± 1 km/s relative to the CMB must be taken into consideration. By factoring out this peculiar motion, the velocity of an object is measured relative to the co-moving frame of the CMB. NASA uses a standard formula to convert the observed velocity of an object calculated from its heliocentric redshift into a velocity relative to the CMB reference frame.

$$V_{CMB} = V_{obs} + V_{dpl}[\sin(\boldsymbol{b})\sin(\boldsymbol{b}_0) + \cos(\boldsymbol{b})\cos(\boldsymbol{b}_0)\cos(\boldsymbol{l} - \boldsymbol{l}_0)]$$

The observed velocity (V_{obs}) of an object is its heliocentric redshift times the velocity of light: $V_{obs} = cz$ ($z < \sim 0.01$). The velocity of the sun towards the CMB dipole (V_{dpl}) is constant at 371 km/s. The portion of the formula in brackets gives the cosine of the angle of separation between the direction to the object and the direction to the CMB dipole. The cosine of this angular separation gives that portion of the sun's peculiar velocity toward the dipole which is directed toward the object. The longitude and latitude of the dipole, $\boldsymbol{l}_0$ and $\boldsymbol{b}_0$, are the constant values given above. The longitude and latitude of the object are represented by $\boldsymbol{l}$ and $\boldsymbol{b}$.

Adding the observed heliocentric velocity (V_{obs}) to the cosine of the sun's peculiar velocity toward the CMB dipole (V_{dpl}) gives the velocity of the object relative to the CMB (V_{CMB}). The distance to the object in Mpc is then simply $D_{CMB} = V_{CMB}/H_0$. This is the Hubble flow distance as measured against the CMB.

The actual velocity of the object will differ from this value, depending upon the object's peculiar motion in the neighborhood of its local space. Where a positive CMB velocity results, dividing this by the Hubble constant gives the distance to the object relative to the CMB frame of reference. Where a negative CMB velocity is found, no valid CMB distance can be calculated.

Redshift can be used to calculate proper distance in an approximate way for objects beyond the Local Group. Redshift only measures net relative velocity. A galaxy which has a negative heliocentric blueshift may actually have a positive redshift, if the sun has a peculiar motion of approach toward the galaxy. This difficulty is overcome by accounting for the sun's peculiar motion relative to the reference frame defined by the CMB radiation. The above equation transforms heliocentric redshift velocities into CMB-centric redshift velocities. Positive CMB-centric velocities measure net motion of distant objects, most of which is due to space expansion.

2. Selection Criteria

In looking for evidence of the Superuniverse Wall, the single criterion of heliocentric redshift is used to extract objects from NED. Although NED contains over 165 million objects, there are redshift measurements for only 1.87 million of these (as of Dec. 2010). All objects with a redshift of less than $z < 0.0039$ and greater than $z > -0.0039$ are selected. There are 18,891 objects in NED with redshifts of $-0.0039 < z < 0.0039$ as of March 2, 2011. This redshift limit corresponds to a maximum proper distance of 52.2 Mly for an object with a redshift $z = 0.0039$.

$$D = \frac{cz}{H_0} = \left[\frac{299{,}792.5(c) * 0.0039(z)}{73\ \mathrm{kms^{-1}/Mpc}}\right] * \frac{3.26\ \mathrm{Mly}}{\mathrm{Mpc}} = 52.2\ \mathrm{Mly}$$

However, an object with a heliocentric redshift of $z = 0.0039$, which also lies in the same direction as the sun's peculiar motion toward the CMB dipole, will have a calculated distance measured relative to the CMB frame which is 16.6 Mly greater than this (since $\cos 0° = 1$) because of the sun's motion.

$$D_{CMB} = \frac{cz + 371 \cos 0°}{H_0} = 68.8 \text{ Mly}$$

An object lying in exactly the opposite direction from the CMB dipole ($\cos 180° = -1$) will have a calculated distance of 35.6 Mly ($52.2 - 16.6$). There are a few thousand objects with redshifts $z \leq 0.0039$ that have calculated CMB distances greater than 36 Mly. These are excluded, leaving only those objects which are within 36 Mly. Of the 18,891 remaining objects, one-half (9,447 objects) have valid CMB distances of less than 36 Mly, and one-half (9,444 objects) have invalid (negative) CMB distances.

The internal structure of the grand universe predicts that the distance to the far periphery of the grand universe is 5.62 times the radius of Orvonton. The maximum radius of the Local Group is possibly about 4.4 Mly, which equates to a distance of 24.7 Mly to the far periphery. If the far border was 36 Mly distant, the radius of Orvonton would be 6.4 Mly. A distance of 36 Mly is more than sufficient to encompass the whole of the grand universe, based upon its revealed internal structure.

This radius of 10-11 Mpc (33-36 Mly) also defines what is astronomically referred to as the Local Volume. The Local Volume consists of a concentration of galaxies surrounded on almost all sides by large voids, which are regions with few or no galaxies. A significant exception to this is the region lying in the general direction of the Virgo Cluster of galaxies about 54 Mly (16.5 Mpc) distant. In this direction an apparent stream of galaxies extends from our location out toward the Virgo Cluster.

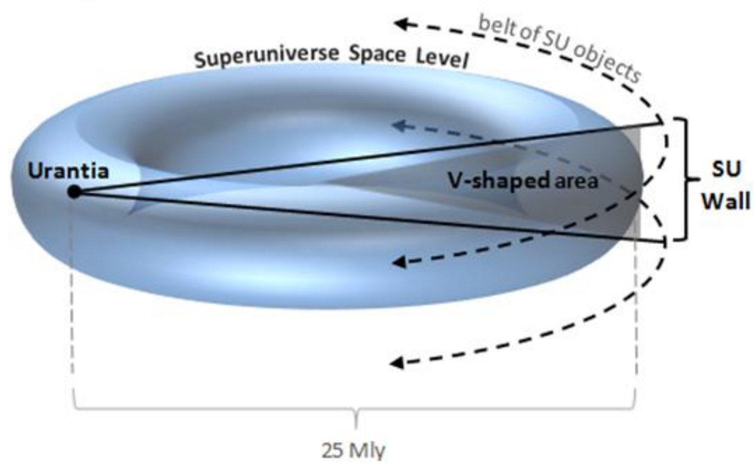
Modern theory understands that the expansion of space, the Hubble flow, is conditioned by the force of gravity. Within a certain distance of the center of the Local Group, referred to as the zero-velocity surface, members are bound together by a gravitational force that is strong enough to effectively negate the expansion of space. For this reason the Hubble constant (H_0) is assumed to have a value of zero within the Local Group; gravitational binding prevents the proper motion of space expansion from occurring between members of the Local Group. Distance calculations based upon redshifts are invalid for objects within the zero-velocity surface. The observed heliocentric velocities of these objects are just their peculiar motions, since there is no proper motion due to space expansion within the Local Group.

For example, the Large Magellanic Cloud is known to be about 160,000 ly distant, but the proper distance calculated from its redshift gives a value of 14.6 Mly. For this reason all Local Group members are excluded from the list of selected objects. There are 997 objects with calculated distances of less than 5 Mly or which are known members of the Local Group, and these are excluded. This leaves a total of 8,450 objects with valid CMB distances of between 5 and 36 Mly out of an original total of 9,447.

3. Emergence of the Superuniverse Wall

The grand universe is a torus-shaped structure which thickens as the distance from Paradise increases, similar to a V-shaped area pointing toward and pivoting about Paradise. A rotation of this V-shaped plane roughly outlines the upper and lower boundaries of the grand universe.

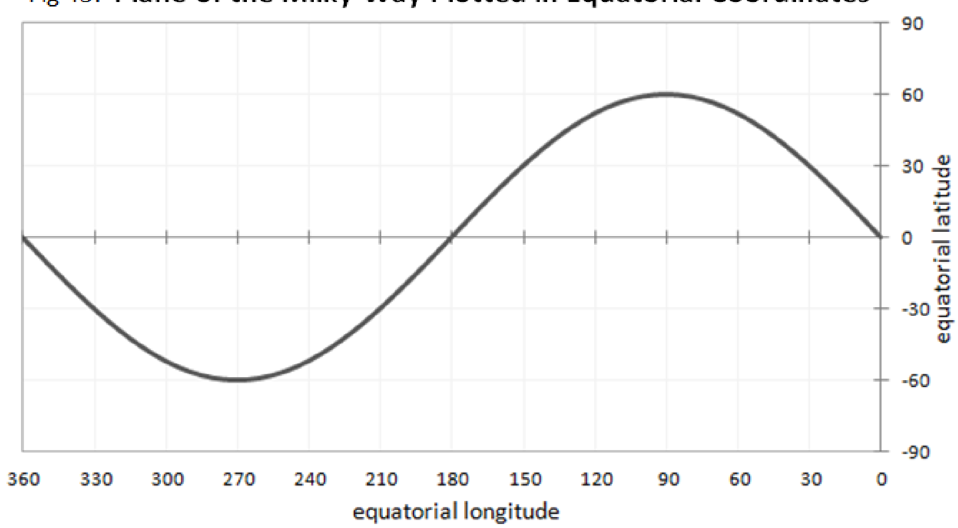
Fig 42: **Apparent Belt formed by the Superuniverses**



We are located upon the gravitational plane of grand universe, so the far portions of the grand universe should appear as a concentrated belt of objects forming a great circle on the celestial sphere. We are located several million light-years away from the geometric center of the superuniverse space level at Paradise, so the upper and lower boundaries of this V-shaped area sweep over and beneath us on our side of the grand universe. Because of this, the nearer superuniverses will not appear to us as a well-defined belt of objects. In addition, any objects within 5 Mly have been excluded from the data set.

We are located inside the Milky Way, which forms a great circle on the celestial sphere. If Milky Way objects are plotted using galactic coordinates, they are concentrated about the great circle of the galactic equator (figure 29). If these same objects are plotted using the equatorial coordinate system, which uses the earth's equator as its reference plane, the Milky Way will take the form of a single complete sine wave on the celestial sphere (figure 43).

Fig 43: **Plane of the Milky Way Plotted in Equatorial Coordinates**



The plane of the Milky Way is inclined at about 60 degrees to the equatorial plane, which is why the maximum amplitude of the sinusoidal form of the Milky Way occurs at this latitude above and below the celestial equator of the earth. It is most probable that the plane of the grand universe is inclined to the plane of the Milky Way to some degree. The expectation is that the portion of a great circle traced out by objects on the far side of the grand universe should take the form of a portion of a single sine wave with some amplitude. The more the great circle of the grand universe is tilted to the plane of the Milky Way, the greater will be the amplitude (latitude) of the peak and valley of the sine wave formed by this belt of objects.

Although the distances for a few objects can be found using other means, such as Cepheid variables, redshift measurements are critical for obtaining large numbers of distances. The first significant extragalactic redshift measurement was made of the Andromeda galaxy (M31) in 1912 by Vesto Slipher at Lowell Observatory in Flagstaff, Arizona. According to a 1995 briefing presented to the National Research Council, there were about 100,000 redshift measurements at that time. This briefing also remarks that there were only about 2,700 in 1975. [52] A comprehensive list of all available redshift measurements was published in April of 1956, [53] about half a year after the publication of *The Urantia Book*. This study has redshifts for just 806 nebulae.

This 1956 paper by Milton Humason, a close associate of Edwin Hubble at Mt. Wilson Observatory, contains the findings of a 20 year project from 1935 to 1955 and is the oldest redshift reference cited in NED. Prior to 1935 the quality of the photographic plates used to measure redshift was found to be questionable, requiring re-measurement with newer and more accurate photographic techniques. This re-measurement was done over a 20 year period and included new redshift measurements. This study reports that a total of 146 nebulae had redshift measurements in 1936, two years after Part I was indited and one year after Parts II-III were indited. A total of 96 of the 806 nebulae in Humason's 1956 list are also found in the 18,891 objects identified in 2011 with redshifts of $z < 0.0039$ ($v < 1{,}170$ km/s) and valid CMB distances of less than 36 Mly.

Table 9: **96 out of 806 objects in 1955 with z < 0.0039**

object	*gal long*	*gal lat*	*velocity (km/s)*	*distance (Mly[a])*
IC 10	118.96	-3.33	-348	
Messier 31	121.17	-21.57	-300	
Messier 86	279.08	74.64	-244	3.85
Messier 110	120.72	-21.14	-241	
Messier 90	288.47	75.62	-235	3.98
IC 1613	129.74	-60.58	-234	
NGC 604	133.76	-31.18	-226	
NGC 185	120.79	-14.48	-202	
Messier 32	121.15	-21.98	-200	
Messier 33	133.61	-31.33	-179	
Messier 98	265.43	74.96	-142	8.46
WLM	75.86	-73.62	-122	
NGC 1569	143.68	11.24	-104	
NGC 4208	268.89	74.36	-81	11.26
NGC 6822	25.34	-18.40	-57	
NGC 404	127.04	-27.01	-48	
Messier 81	142.09	40.90	-34	2.16
IC 1308	25.43	-18.39	-30	
NGC 4236	127.42	47.36	0	3.66
NGC 2976	143.91	40.90	3	4.03
NGC 3077	141.90	41.66	14	4.45
NGC 6503	100.57	30.64	25	
IC 342	138.17	10.58	31	

Table 9: **96 out of 806 objects in 1955 with z < 0.0039**

object	*gal long*	*gal lat*	*velocity (km/s)*	*distance (Mly[a])*
Fornax Dw Irr	237.30	-65.61	35	
NGC 1049	236.66	-65.72	40	
NGC 6946	95.72	11.67	40	
IC 2574	140.21	43.61	57	6.62
NGC 4438	280.35	74.83	71	17.88
NGC 2366	146.42	28.54	80	4.98
IC 3483	286.83	73.65	129	20.49
NGC 55	332.88	-75.73	129	
NGC 2403	150.57	29.19	131	8.03
NGC 4216	270.46	73.74	131	20.80
NGC 4605	125.33	55.47	136	11.56
Holmberg II	144.28	32.69	142	8.40
Holmberg IV	103.70	60.80	144	12.15
NGC 300	299.21	-79.42	144	
NGC 247	113.95	-83.56	156	
NGC 5204	113.50	58.01	201	14.37
Messier 82	141.41	40.57	203	12.58
NGC 4449	136.85	72.40	207	19.01
NGC 4150	190.45	80.47	226	22.81
NGC 7793	4.52	-77.17	227	
Messier 101	102.04	59.77	241	16.17
NGC 253	97.37	-87.96	243	
NGC 4244	154.57	77.16	244	22.15
NGC 5474	100.83	60.20	273	17.68
NGC 4214	160.26	78.08	291	24.55
NGC 5585	101.00	56.48	293	17.56
NGC 5461	101.89	59.76	298	18.71
Messier 94	123.36	76.01	308	23.69
NGC 4395	162.10	81.53	319	26.15
Messier 89	287.93	74.97	340	29.75
IC 1727	137.95	-33.90	345	3.11
NGC 7640	105.24	-18.94	369	2.74
NGC 4178	271.86	71.37	374	31.93
NGC 1156	156.31	-29.20	375	7.77
NGC 4550	288.09	74.63	381	31.62
NGC 5253	314.86	30.11	407	30.44
Messier 64	315.68	84.42	408	31.21
Messier 59	294.36	74.36	410	32.80
NGC 2683	190.46	38.76	411	28.52
NGC 672	138.03	-33.78	429	6.88
NGC 5949	100.57	44.97	430	20.46
NGC 2537	173.81	32.96	431	25.94
Messier 106	138.32	68.84	448	29.21
NGC 4526	290.16	70.14	448	35.01
Messier 51a	104.85	68.56	463	28.42

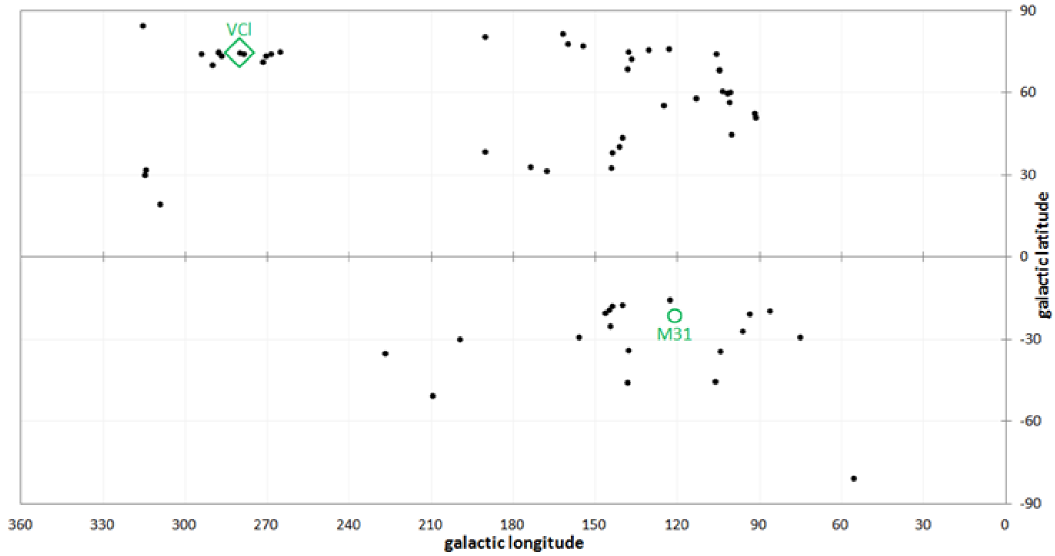
Table 9: **96 out of 806 objects in 1955 with z < 0.0039**

object	*gal long*	*gal lat*	*velocity (km/s)*	*distance (Mly[a])*
Messier 51b	104.88	68.49	465	28.50
NGC 45	55.90	-80.67	467	7.09
NGC 4387	278.85	74.47	472	35.86
Messier 63	106.00	74.29	484	30.75
NGC 2500	168.00	31.57	504	27.99
Messier 83	314.58	31.97	513	35.43
NGC 1058	146.41	-20.37	518	14.03
NGC 891	140.38	-17.41	528	14.04
NGC 4618	130.56	75.83	544	34.44
NGC 5128	309.52	19.42	547	35.87
NGC 925	144.89	-25.17	553	14.57
NGC 1400	209.71	-50.57	558	19.45
NGC 4490	138.00	74.87	565	35.49
NGC 1003	144.01	-17.55	626	18.96
NGC 278	123.04	-15.32	627	16.44
NGC 1023	145.02	-19.09	637	19.34
Messier 74	138.62	-45.71	657	16.03
NGC 5907	91.58	51.09	667	32.55
NGC 5866	92.03	52.49	672	33.19
NGC 2787	144.05	38.05	696	34.37
NGC 1637	199.56	-30.02	717	29.95
NGC 1744	226.99	-35.02	741	33.22
NGC 7741	104.51	-34.37	750	17.99
NGC 7457	96.22	-26.94	812	21.06
NGC 7331	93.72	-20.72	816	21.91
NGC 7217	86.51	-19.71	952	27.99
NGC 7814	106.41	-45.18	1050	30.94
NGC 7177	75.37	-28.96	1140	35.41

[a] valid CMB distance less than 36 Mly using H_0 = 73 km/s

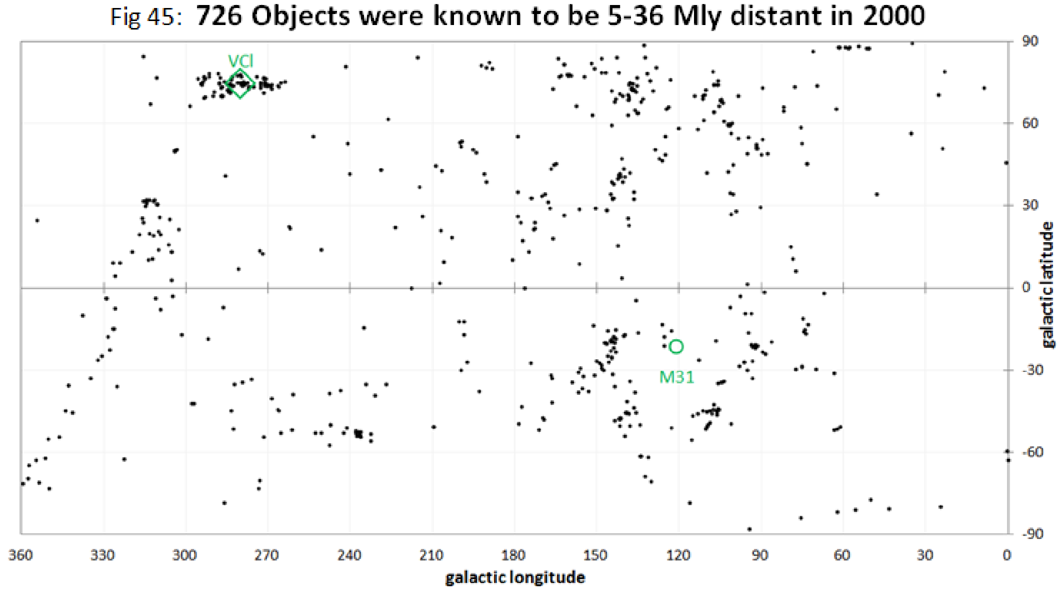
Only 58 out of these 96 nebulae are within the 5-36 Mly distance range. These 58 objects were the only ones which could have been known to be within this distance in 1955. Plotting the galactic coordinates of these objects on a simple Cartesian graph, where the x-axis is galactic longitude and the y-axis is galactic latitude, does not reveal any overall pattern. These few objects are scattered randomly across the celestial sphere. There was no scientific evidence in the 1950s of the expected wall of galaxies formed by the superuniverses. The location of the Virgo Cluster (VCl) and the Andromeda Galaxy (M31) are shown for the purpose of providing some sense of orientation. Humason's 1956 paper concludes that the age of the universe is 5.4 billion years and the expansion rate is 180 $\text{kms}^{-1}/\text{Mpc}$.

Fig 44: **58 Objects were known to be 5-36 Mly distant in 1955**



NED maintains a list of bibliographic references for all redshift measurements for each object. The publication date of the oldest redshift measurement for each object can be found going back as far as 1956. Knowing the first redshift measurement for each of the 8,450 objects within 5-36 Mly (as of March 2, 2011) makes it possible to identify all of the objects within this distance range which were knowable in any given year. Between 1955 and 2000 the number of known objects within 5-36 Mly increased more than tenfold from 58 to 726.

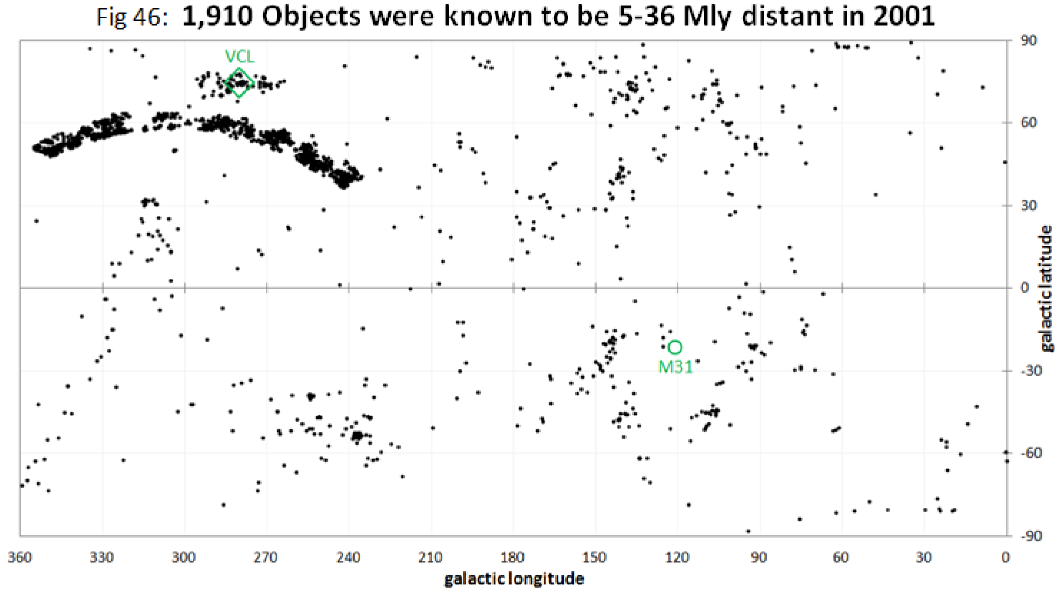
Fig 45: **726 Objects were known to be 5-36 Mly distant in 2000**



A plot of these 726 objects shows a random distribution across the celestial sphere. At the turn of this century there was still no evidence of the Superuniverse Wall which revelation predicts should be here. At this time almost all of the available evidence appeared to refute revealed cosmology. Galaxies seemed to be distributed in a homogeneous and isotropic manner throughout the universe on the largest scales, in agreement with the cosmological principle. This fundamentally contradicts the revealed description of their distribution about a universal plane of creation. Cosmologists were eagerly anticipating the results of new measurements of the CMB radiation, which they believed would show a significant degree of curvature in the spacetime of the universe, in agreement with the predictions of general relativity.

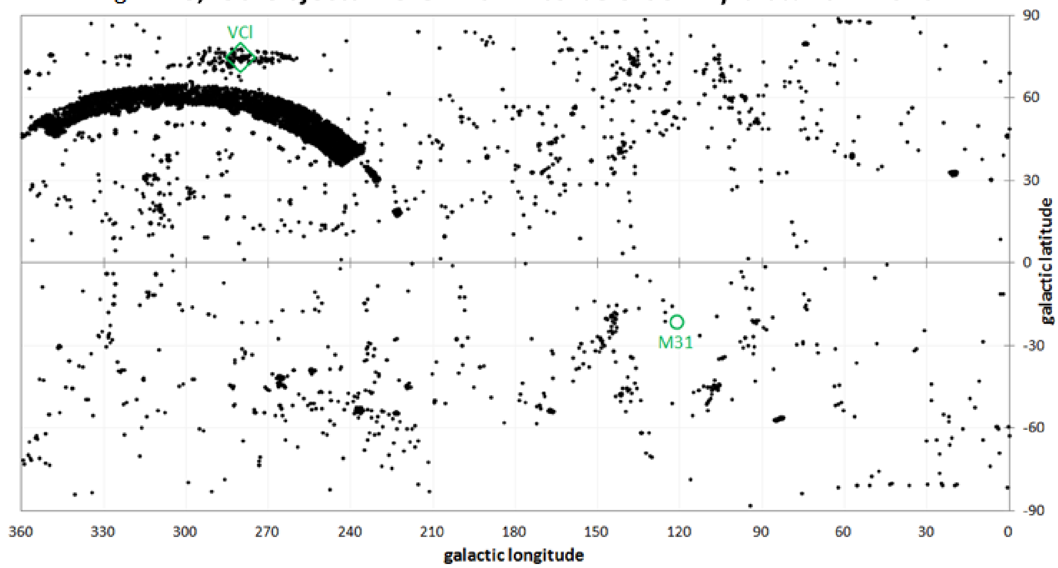
In 2001 the Sloan Digital Sky Survey (SDSS) and the Two-degree-field Galaxy Redshift Survey (2dFGRS) began publishing their findings. These two surveys employ sophisticated electronics, such as charge-coupled devices, which are capable of automatically identifying objects and measuring their redshifts without the need for significant human intervention. As of 2012 SDSS had taken spectrum measurements for almost 1.5 million galaxies, and 2dFGRS had measurements for about one-quarter million galaxies. These two surveys added millions of galaxies with redshift measurements to NED, and suddenly everything changed.

Fig 46: **1,910 Objects were known to be 5-36 Mly distant in 2001**



By the end of 2001 an additional 1,184 objects were identifiable as being within a distance of 5-36 Mly. For the first time a clear pattern emerges on the celestial sphere which corresponds to the predicted shape of the Superuniverse Wall. There is a concentration of galaxies in a long narrow arc stretching from about $\boldsymbol{l} = 240°$ to $\boldsymbol{l} = 350°$ in galactic longitude. Over 90 percent of the new objects (1078/1184) added between 2000 and 2001 are concentrated in this arc.

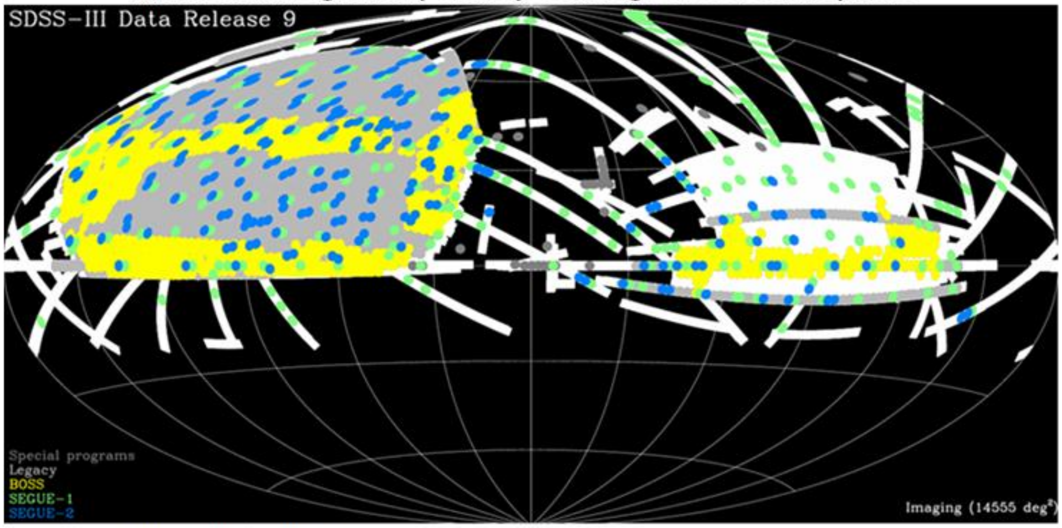
Fig 47: **8,450 Objects were known to be 5-36 Mly distant in 2010**



By the end of 2010 there are 8,450 objects within 5-36 Mly. More than half of all objects within this range are concentrated in the arc between about 225 and 355 degrees of longitude. This arc has the appearance of a significant portion of a great circle which is tilted at about 60 degrees to the gravitational plane of the Milky Way. It traces out part of a single complete sine wave, which spans the whole celestial sphere. The Superuniverse Wall has finally become directly observable.

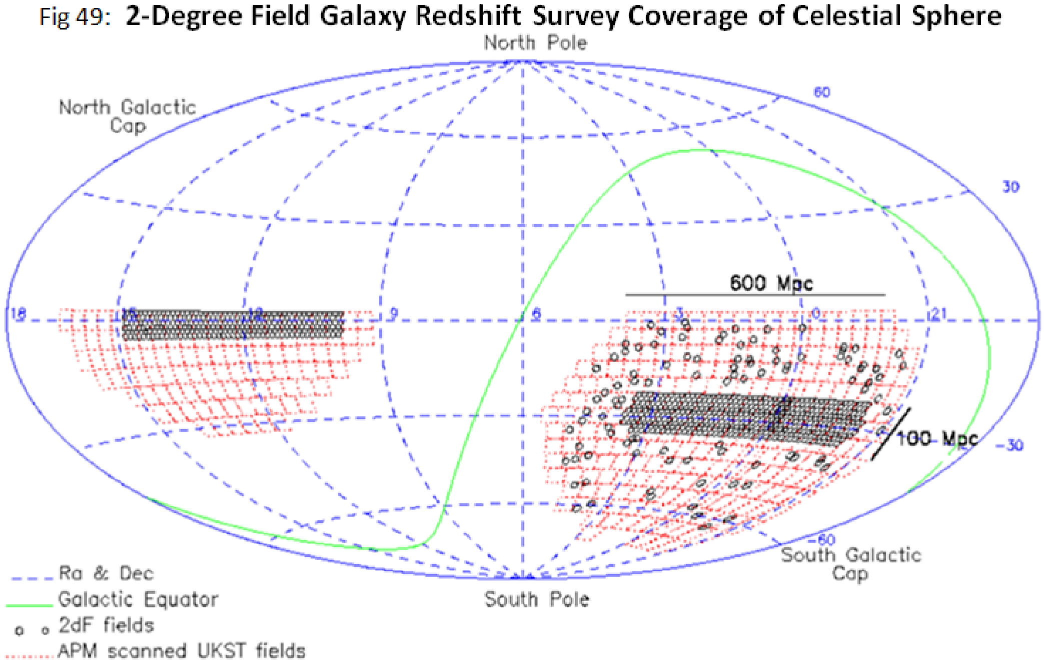
Only a portion of the Superuniverse Wall is visible, in part, because the two major surveys providing the overwhelming majority of the objects making up this structure cover only parts of the celestial sphere. The zone of obscuration around the galactic plane of the Milky Way is apparent in the lack data running vertically through the center of both coverage maps. (Both maps chart positions using the earth's equatorial plane.) The SDS Survey conducted from New Mexico is limited mostly to the Northern hemisphere. It only extends about 5-10 degrees of latitude below the celestial equator. The 2dFGR Survey is limited to selected portions of the Southern hemisphere.

Fig 48: **Sloan Digital Sky Survey Coverage of Celestial Sphere**



http://www.sdss3.org/dr9/scope.php

Fig 49: **2-Degree Field Galaxy Redshift Survey Coverage of Celestial Sphere**



http://www2.aao.gov.au/~TDFgg/Public/Survey/description.html