Chapter 12

Gravitational Plane of the Grand Universe

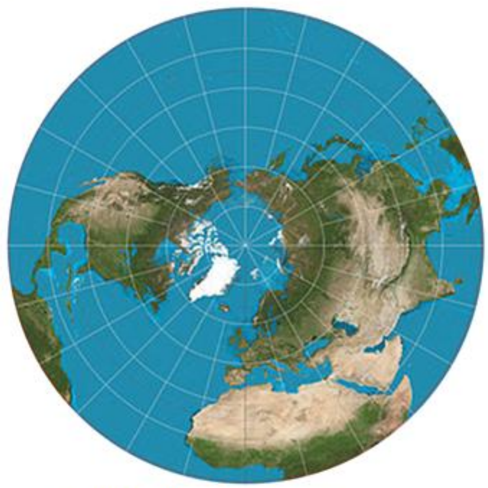
The Superuniverse Wall is a well-defined arc on the celestial sphere. This wall is made up of thousands of galaxies and follows the sinusoidal form of a great circle on the celestial sphere. Since we can observe this great circle, we must be located on its plane. The galactic longitude and latitude of the arc's maximum height above the plane of the Milky Way can be identified with a good degree of accuracy. From the apex of this arc an equation for the plane of a great circle running along the upper border of the Superuniverse Wall can be derived. This permits the definition of a spherical coordinate system which uses the upper plane of the Superuniverse Wall as its equator.

Out of all objects with distances of 5-36 million light-years, 57 percent are located in the Superuniverse Wall. The density of galaxies within the volume of this wall is more than 35 times greater than it is in a shell with a radius of between 5 and 36 million light-years. The gravitational plane within the Superuniverse Wall can be determined, which establishes the equator for the spherical coordinate system of the grand universe. When plotted in grand universe coordinates, the overwhelming majority of all 18,891 objects with redshifts of $z < 0.0039$ are concentrated in long, straight, narrow structures similar to the Superuniverse Wall. These walls all run parallel to the gravitational plane of the grand universe. Gravitational rotation about a single point is the only credible cause for the form and orientation of these structures on the celestial sphere.

1. Determining the Upper Surface of the Plane

The superuniverses on the opposite side of the grand universe form an arc on the celestial sphere which has upper and lower borders separated by about 9 degrees of galactic latitude. Thu upper border of this arc has a maximum height above the galactic plane, an apex, at about 65 degrees of galactic latitude and 300 degrees of galactic longitude. If this arc is truly a portion of the Superuniverse Wall of galaxies, it must follow the path of a great circle on the celestial sphere. To determine whether this arc conforms to this path, it is first necessary to find the apex of the arc with better accuracy. This cannot be accomplished by the simple inspection of a Cartesian plot of galactic longitude and latitude.

Fig 50: **Azimuthal Equidistant Projection**



Credit: Strebe, wikimedia commons

A method for obtaining a fairly accurate determination of the coordinates of the apex is to plot the objects making up this arc using an azimuthal equidistant projection. This type of map projection can be centered on any latitude and longitude to form equidistant rings of latitude about this center. Putting the North Pole at the center (polar projection), northern hemisphere latitudes are shown as equally spaced concentric circles centered on the North Pole with the equator as the largest encompassing circle (figure 50). In this type of map projection the shortest distance from the North Pole to any point in the northern hemisphere can be directly measured with a ruler. Any point on a sphere can be defined as the center of the projection, which makes azimuthal equidistant projections very useful for aerial navigation.

A related feature of this map projection is that all longitudes, which are great circles, are drawn as straight lines radiating outward from and intersecting at the center of the map. The arc of the Superuniverse Wall is curved when plotted on a Cartesian graph using galactic coordinates. If this arc is the Superuniverse Wall, it must follow the path of a great circle, since we are on the plane of the grand universe. If this arc is a portion of a great circle, then it will be transformed into a straight line of longitude when mapped using an azimuthal equidistant projection which has the correct apex coordinates at its center. The upper border or plane of the Superuniverse Wall will be coincident and aligned with the horizontal line of the equator in this type of projection.

Spherical coordinates, such as galactic coordinates, can be transformed to azimuthal equidistant coordinates with the following procedure. If $\emptyset_0$ and λ_0 are the longitude and latitude of the projection's center, then the azimuthal equidistant coordinates (x, y) for spherical coordinates $(\emptyset, \lambda)$ are:

$$x = k \ \cos\emptyset \sin(\lambda - \lambda_0)$$

$$y = k\ [\cos\emptyset_0 \sin\emptyset - \sin\emptyset_0 \cos\emptyset \cos(\lambda - \lambda_0)] \text{ where}$$

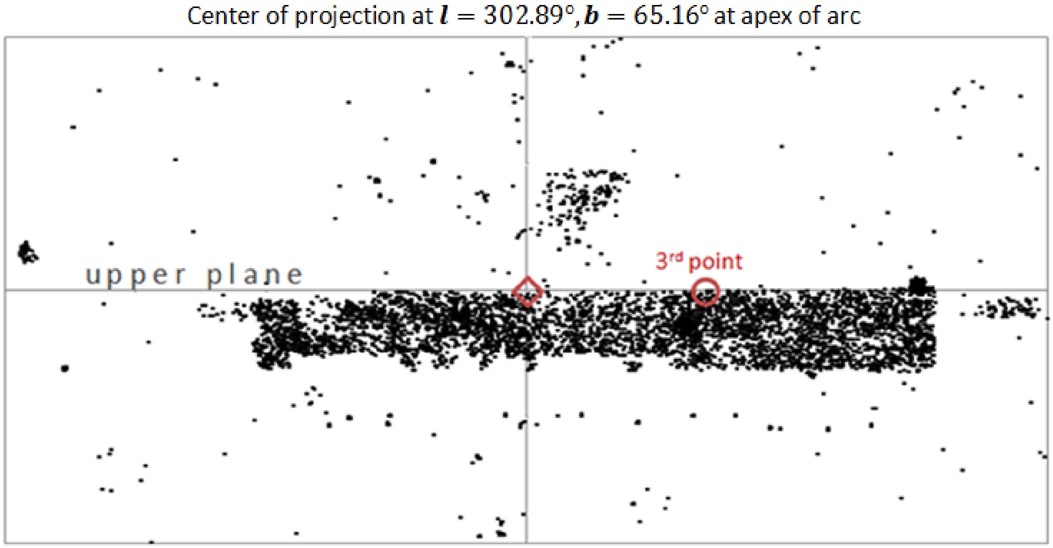
$$k = \frac{c}{\sin c} \text{ and}$$

$$c = \cos^{-1}[\sin\emptyset_0 \sin\emptyset + \cos\emptyset_0 \cos\emptyset \cos(\lambda - \lambda_0)]$$

note: $c = \sqrt{x^2 + y^2}$ is the radial distance to the coordinates

Carrying out this transformation with an initial center of $\boldsymbol{l}$ = 300° and $\boldsymbol{b}$ = 65° in galactic coordinates and then refining the longitude and latitude to bring the upper border into horizontal alignment with the equator of the projection gives the coordinates of the apex.

Fig 51: **Azimuthal Equidistant Projection of the Superuniverse Wall**
Center of projection at $\boldsymbol{l} = 302.89°, \boldsymbol{b} = 65.16°$ at apex of arc



The arc seen in the Cartesian graph is transformed into a long straight belt of galaxies. The upper border of this belt aligns very closely with the great circle of the equator in the map projection when the apex is located at $\boldsymbol{l} = 302.89° \pm 0.04$ and $\boldsymbol{b} = 65.16° \pm 0.02$. There is a small margin of error in the determination of the longitude and latitude of the apex. There are thousands of galaxies in this belt, and the alignment of the upper border with the equator is relatively sensitive to small changes in the coordinates of the apex. The straightness of the upper border and its degree of alignment with the equator confirms that this upper border follows the path of a great circle on the celestial sphere.

The center of a great circle always coincides with the center of a sphere and defines an equatorial plane separating two hemispheres. Any plane can be defined with just three points. The upper plane of the Superuniverse Wall apparent on the far side of the grand universe traces out a great circle relative to our location, so we are located on this plane at the coordinates of its origin, which is one point. The apex is a second point. A third point on the upper border can be identified to enable a definition of the upper plane. This third point is the object SDSS J114253.97+021152.7 with galactic coordinates of $\boldsymbol{l} = 266.667°$ and $\boldsymbol{b} = 60.15199°$.

The equation for a plane uses Cartesian coordinates. The galactic longitude and latitude ($\boldsymbol{l}$, $\boldsymbol{b}$) of the apex and third point can be converted to three-dimensional Cartesian coordinates (x, y, z) using the standard formulae:

$$x = r\cos(\boldsymbol{b}) * \cos(\boldsymbol{l})$$

$$y = r\cos(\boldsymbol{b}) * \sin(\boldsymbol{l})$$

$$z = r\sin(\boldsymbol{b})$$

By convention, the celestial sphere has a unit radius of one, so r can be set to one in this case, and the Cartesian coordinates of the apex and the third point can be calculated from their longitude and latitude. We are located at the center of the galactic coordinate system, so the Cartesian coordinates of our location are (0, 0, 0). Since one of the three points is located at the origin, the formula for the upper plane is a simple linear equation: [54]

$$\boldsymbol{a}x + \boldsymbol{b}y + z = 0$$

There are five unknowns in this equation, but the coordinates for two points (apex and third point) are known which satisfy the equation. These two sets of coordinates can used to simultaneously solve two equations to find the coefficients $\boldsymbol{a}$ and $\boldsymbol{b}$. The resulting equation for the upper plane is:

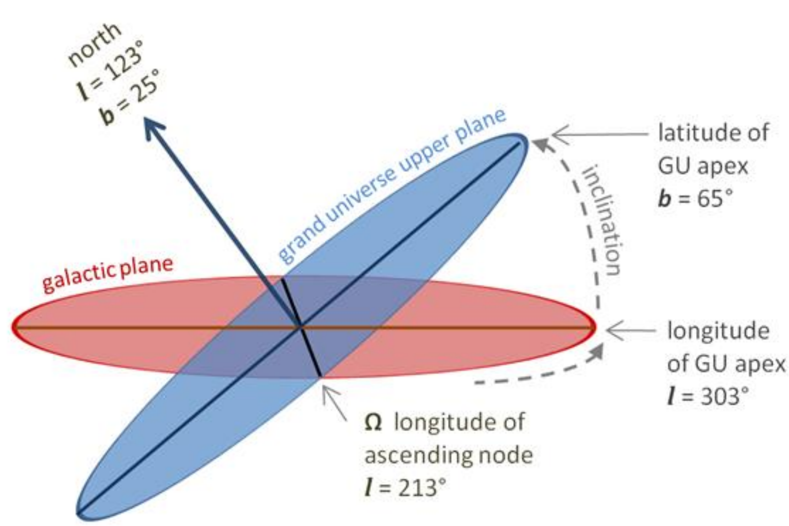
$$-1.17307\boldsymbol{x} + 1.81398\boldsymbol{y} + \boldsymbol{z} = 0$$

Every three-dimensional location on the upper plane of the Superuniverse Wall satisfies this equation. A spherical coordinate system using this plane as its equatorial plane can now be defined.

2. Upper Plane Coordinate System

Defining a coordinate system for the upper plane of the Superuniverse Wall in terms of galactic coordinates requires the galactic longitude and latitude of the North Pole of the upper plane and the galactic longitude of the ascending node.

Fig 52: **Upper Plane Coordinate System**



The equation for the upper plane can be used to find the galactic longitude of the ascending node (Ω), which is where the upper plane intersects the galactic plane and rises above it, moving in a counterclockwise direction (by convention). The equation for the upper plane is:

$$-1.17307\boldsymbol{x}+1.81398\boldsymbol{y}+\boldsymbol{z}=0$$

The x and y coordinates on the galactic plane describe a unit circle on the celestial sphere where these two coordinates are related by the equation $x^2+y^2=1$. The height above or below the galactic plane, z, equals zero at the ascending and descending nodes, since this is where the upper plane intersects the galactic plane. Since z is zero at the two nodes, the equation for the two nodes can be written as:

$$\boldsymbol{a}x+\boldsymbol{b}y=0$$

$$-1.17307\boldsymbol{x}+1.81398\boldsymbol{y}=0$$

The coefficients $\boldsymbol{a}$ and $\boldsymbol{b}$ are known, so this equation can be solved to find the ratio between x and y at the two nodes.

$$\frac{x}{y}=\frac{-\boldsymbol{b}}{\boldsymbol{a}}=\frac{-(1.81898)}{(-1.17307)}=1.54635$$

$$x=1.54635y$$

Since x is related to y by the equation for a unit circle, this equation can be solved for y: $y=\sqrt{1-x^2}$. Substituting this value for y in $x=1.54635y$, the x and y coordinates for the two nodes can be found:

$$x=1.54635y \quad \rightarrow \quad x=1.54635\sqrt{1-x^2}$$

$$x^2=2.39120(1-x^2)$$

$$x=\sqrt{\frac{2.39120}{3.39120}}=\pm\,0.83971$$

$$y=\sqrt{1-0.83971^2}=\pm\,0.54303$$

The x and y values must have the same sign, because their ratio is positive: $x/y=1.54635$. The coordinates (0.83971, 0.54303, 0.0) and (-0. 83971, -0. 54303, 0.0) define the two nodes where the galactic and upper planes intersect. Since z equals zero, the galactic longitudes of the nodes are given by the arctangent $\frac{y}{x}$ and the arctangent $\frac{-y}{-x}$.

The arctangent of $+0.54303/+0.83971$ equals 32.89 degrees, which makes the galactic coordinates of this node $\boldsymbol{l}$ = 32.89° and $\boldsymbol{b}$ = 0°. If these positive coordinates are the ascending node, then larger values of x and y (since $x/y=1.54635$) will cause z to become less than zero in the equation $\boldsymbol{a}x+\boldsymbol{b}y+z=0$. Since z

becomes less than zero, $\boldsymbol{l}$ = 32.89° and $\boldsymbol{b}$ = 0° are the coordinates of the descending node. The opposite node is 180 degrees from this, which places the ascending node (Ω) at $\boldsymbol{l}$ = 212.89° and $\boldsymbol{b}$ = 0°. This is the value expected, since the longitude of the ascending node should be 90 degrees less than the apex, which was found at $\boldsymbol{l}$ = 302.89°.

The longitude of the North Pole for the upper plane is found from the longitude of the apex of the upper plane. The longitude of the North Pole is 180 degrees from the galactic longitude of the apex of the upper plane or $\boldsymbol{l}$ = 122.89° (302.89° - 180°). The latitude of the North Pole of the upper plane is 90 degrees more than the galactic latitude of the apex of the upper plane or $\boldsymbol{b}$ = 24.84° $(180.00° - (90.00° + 65.16°))$.

The galactic coordinates of the North Pole and the ascending node of the upper plane define a new spherical coordinate system in terms of the galactic coordinate system. Galactic coordinates $(\boldsymbol{l}, \boldsymbol{b})$ can be transformed into upper plane coordinates $(\boldsymbol{\alpha}, \boldsymbol{\beta})$ with the following formula. [55]

$$\boldsymbol{\beta} = \sin^{-1}\{\, [\cos \boldsymbol{b} \cos \boldsymbol{b}_{NP} \cos(\boldsymbol{l} - \boldsymbol{l}_{NP})] + [\sin \boldsymbol{b} \sin \boldsymbol{b}_{NP}] \,\}$$

$$\boldsymbol{\alpha} = \tan^{-1}\left(\frac{y}{x}\right) + \boldsymbol{l}_{\Omega} \quad \text{where} \quad y = \sin \boldsymbol{b} - \sin \boldsymbol{\beta} \sin \boldsymbol{b}_{NP}$$

$$\text{and} \qquad x = \cos \boldsymbol{b} \sin(\boldsymbol{l} - \boldsymbol{l}_{NP}) \cos b_{NP}$$

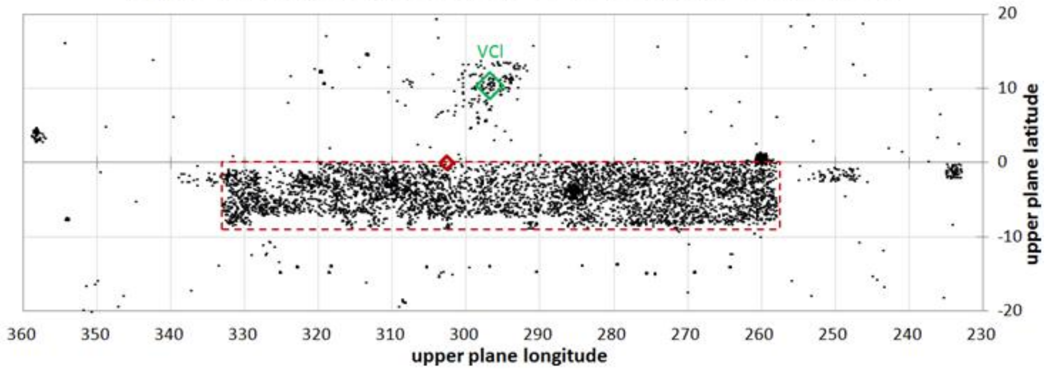
$\boldsymbol{l}_{\Omega}$ is the longitude of the ascending node in galactic coordinates.

$\boldsymbol{l}$ and $\boldsymbol{b}$ are the longitude & latitude in galactic coordinates to transform.

$\boldsymbol{l}_{NP}$ and $\boldsymbol{b}_{NP}$ are the longitude & latitude of the North Pole for the upper plane in galactic coordinates.

$\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are the longitude & latitude in upper plane coordinates.

Fig 53: **The Superuniverse Wall in Upper Plane Coordinates**

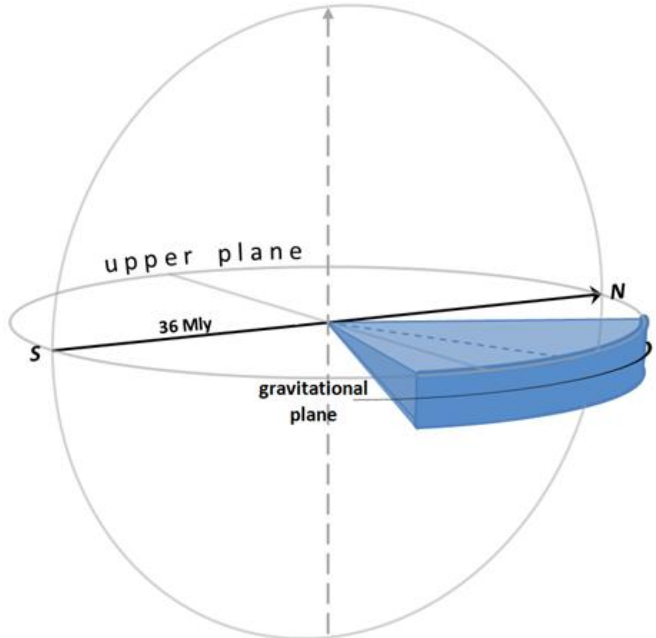


Converting the galactic coordinates for the Superuniverse Wall into upper plane coordinates transforms the arc into a straight belt of objects. This belt spans 75 degrees of upper plane longitude ($258° < \boldsymbol{\alpha} < 333°$) and 9 degrees of latitude. The Superuniverse Wall is well-formed, both in its linear alignment with the upper plane and its relatively uniform height.

3. Grand Universe Coordinate System

When plotted in upper plane coordinates, the Superuniverse Wall is a linear structure spanning 75 degrees of longitude and 9 degrees of latitude. There are 4,832 objects within the borders of this belt of objects on the opposite side of the grand universe. This amounts to 57 percent of the 8,450 objects with valid distances in the range of 5-36 Mly. Lines can be extended from our position to the four corners of the rectangle enclosing this wall defined by the upper plane coordinates: $(258°, 0.0°)$, $(258°, -9.2°)$, $(333°, 0.0°)$, $(333°, -9.2°)$. These lines form a wedge-shaped circular section, where we are located at the vertex.

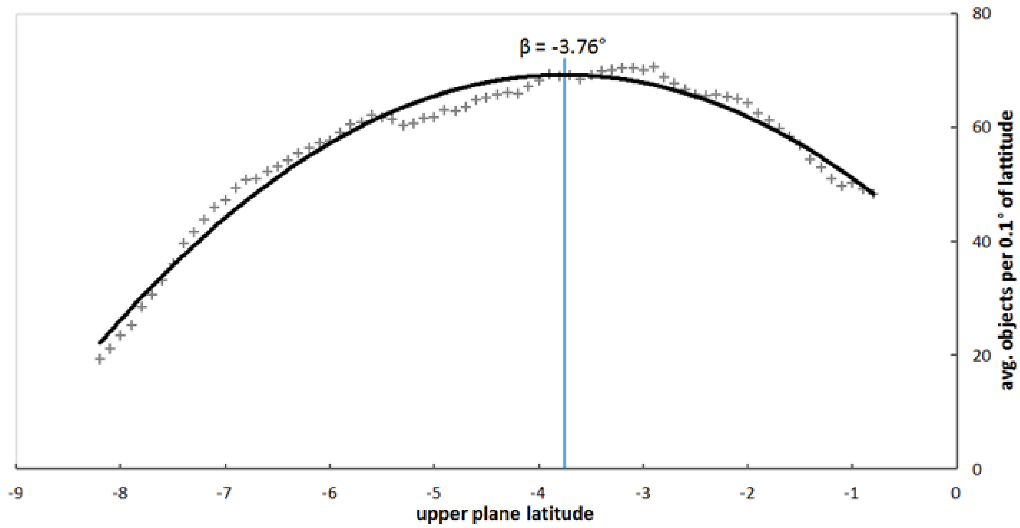
Fig 54: **Volume of the Superuniverse Wall**



The volume of this wedge is about 1.6 percent of the volume of a spherical shell with radial distances between 5 and 36 Mly. Given the thousands of objects within this distance range, the average mass for all objects can be statistically applied to each object. The density ratio of mass per unit volume in this belt is 35.6 times greater than the average density within this spherical shell: (0.57 of mass)/(0.016 of volume). The high concentration of the total mass within this thin wedge-shaped circular section conclusively identifies the gravitational plane of the grand universe.

Within the Superuniverse Wall the density of objects should be greatest at the latitude of the gravitational plane. The 9° height of the Superuniverse Wall can be examined in 0.1° increments of latitude, where each increment is 75° of longitude in length. The number of objects in each of these 0.1° strips can then be counted. To smooth out over- and under-densities, these object counts can then be averaged over 2° of latitude; ten 0.1° strips of latitude above and ten below a central strip are averaged together.

Fig 55: **Latitude of the Gravitational Plane is – $3.76°$ below the Upper Plane**

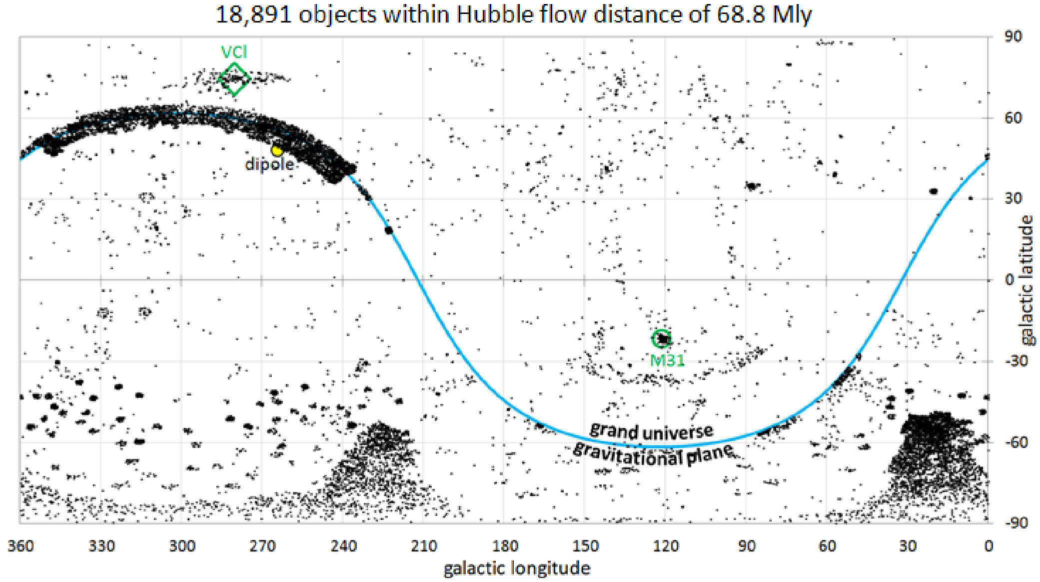


The plotted points follow a trend line described by a quadratic equation. The vertex of this equation occurs at **β** = – 3.76°. At this latitude there is an average of 70 objects in a strip 0.1° of latitude high and 75° of longitude long. This gives a reasonably good value for the latitude of the center of mass in upper plane coordinates.

The grand universe coordinate system is defined using this center of latitudinal mass as the equator. The gravitational plane has the same ascending node as the upper plane (***l*** = 212.89°, ***b*** = 0°), but the angle of inclination is 61.40° instead of 65.16° (65.16 – 3.76). The apex of the grand universe plane is then ***l*** = 302.89°, ***b*** = 61.40°, which makes the North Pole coordinates ***l*** = 122.89° and ***b*** = 28.60° (24.84 + 3.76). This North Pole and ascending node define the grand universe coordinate system, which uses the gravitational plane identified in the Superuniverse Wall as its equator.

The grand universe coordinate system retains the direction to the center of the Milky Way as the longitude of due north. Normally, a point on the gravitational plane, such as the Isle of Paradise or the ascending node, would define zero degrees of longitude. This is not done here for two reasons. The location of Paradise is not known with the level of precision with which the center of the Milky Way is known. It is also the case that the galactic coordinate system is typically used for extragalactic objects. By not adjusting grand universe longitudes to a different zero point, its longitudes are comparable in direction to those of the galactic longitude, which makes them easier to visualize. For instance, the galactic and grand universe longitudes are the same for the ascending and descending nodes as well as the apex.

Fig 56: **Gravitational Plane of Grand Universe in Galactic Coordinates**
18,891 objects within Hubble flow distance of 68.8 Mly

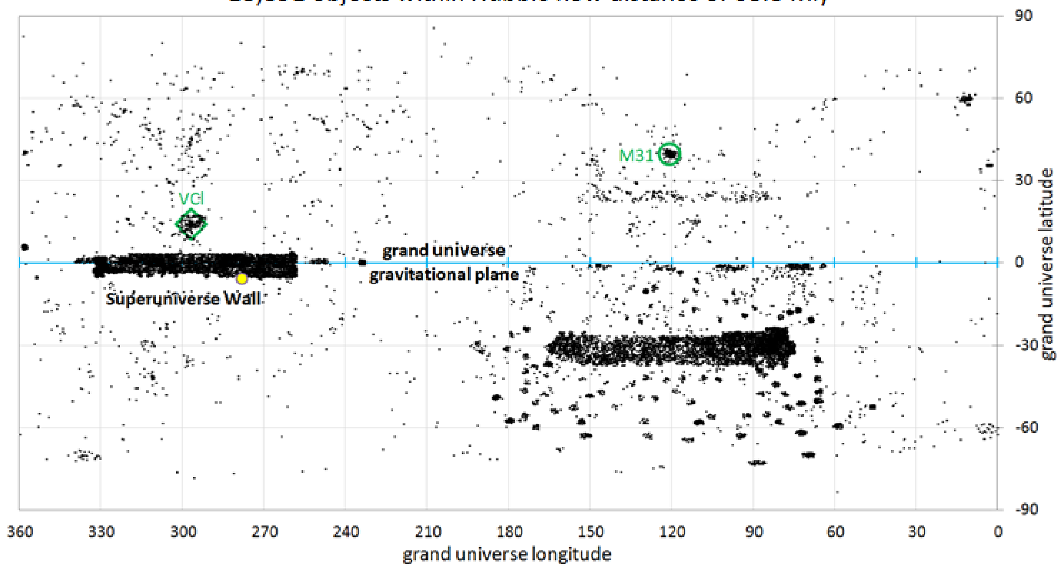


There are valid distance calculations for only 8,450 out of a total of 18,891 objects with a redshift of $z \leq 0.0039$. Over 55 percent of all objects in this redshift range are excluded from the above analysis because they are outside the distance range of 5-36 Mly, they have invalid CMB distances, or they are members of the Local Group. Plotting all of these objects in galactic coordinates (figure 56) shows the plane of the grand universe bisecting the arc of the Superuniverse Wall. The great circle of the gravitational plane of the grand universe also passes close to a few much smaller and thinner belts in the lower right, below Andromeda. There is a lot of scatter in the lower latitudes with a couple of "hills." Otherwise no overall pattern is readily apparent in these lower latitudes. However, charting all 18,891 objects in grand universe coordinates instead of galactic coordinates reveals a striking overall pattern across the whole of the celestial sphere.

The overwhelming majority of the 18,891 objects are concentrated in large elongated groupings which are aligned parallel to the gravitational plane. The Superuniverse Wall on the left is centered on the gravitational plane. It is approximately delineated by α = 258° to 333°, β = -5.1° to +3.6°. There are three distinct parallel belts on the right, or Andromeda side, of the celestial sphere; one around +25 degrees of latitude, another running along the equator, and a third in the lower latitudes. The large southern belt beneath Andromeda and below the equator (α = 75° to 165°, β = -37° to -25°) contains a number of objects that is comparable to the number in the Superuniverse Wall.

Fig 57: **Gravitational Plane in Grand Universe Coordinates**

18,891 objects within Hubble flow distance of 68.8 Mly



Without valid distance measurements for most of these objects, it is not immediately apparent which of the objects in these three belts on the Andromeda side of the celestial sphere are parts of the superuniverse space level. However, the fact that all of these elongated, linear groupings are aligned parallel to the gravitational plane of the grand universe can only mean that all of these structures have a common cause. Removing any unintentional bias in the data by considering every object for which there is an actual redshift observation, the overwhelming majority of all objects are systematically organized in linear groupings aligned parallel with the gravitational plane defined by the Superuniverse Wall.

Gravity and gravitational rotation about a single point is the only possible cause for the appearance of this overall pattern across the entire celestial sphere. This conclusion is firm, since it is based upon accurate position data and does not depend upon accurate distance measurements. Distance determinations based solely upon redshifts can be problematic, but future improvements in this technique will not change the basic data already available. The existence of the grand universe as a gravitationally bound revolving structure is confirmed by the available data.