The Chandelier Model

by

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On April 27th, 1976, Srila Prabhupada wrote a letter to Svarupa Damodara Das discussing the universe as described in the 5th Canto of the *Srimad Bhagavatam*. He asked his disciples with Ph.D's to study the 5th Canto with the aim of making a model of the universe for a Vedic Planetarium. In this essay I will outline how such a model could be designed.

This model has been called the "chandelier model" since it hangs down from a point of suspension situated on the ceiling above it. Srila Prabhupada said, "My final decision is that the universe is just like a tree, with root upwards. Just as a tree has branches and leaves so the universe is also composed of planets which are fixed up in the tree like the leaves, flowers, fruits, etc. of the tree. The pivot is the pole star, and the whole tree is rotating on this pivot. Mount Sumeru is the center, trunk, and is like a steep hill... The tree is turning and therefore, all the branches and leaves turn with the tree. The planets have their fixed orbits, but still they are turning with the turning of the great tree. There are pathways leading from one planet to another made of gold, copper, etc., and these are like the branches. Distances are also described in the 5th Canto just how far one planet is from another. We can see that at night, how the whole planetary system is turning around, the pole star being the pivot. Each planet has its orbit fixed but the sun is moving up and down, north and south."

From this we can imagine spheres representing planets connected to a central axis by pathways of gold, copper, etc. The axis is attached to the ceiling at its upper end. The entire arrangement will rotate about the central axis, and the planets will have their own orbits that also rotate as part of the upside-down tree. This is reminiscent of a mechanical solar system model known as an orrery. We can imagine this machine inverted and hung from the ceiling.

The Daily and Yearly Motions

To create a design for this model, we will proceed step by step. The first step is to consider the pole star, also known as Dhruvaloka. At night we can see that the star named Polaris, the pole star, is nearly fixed in position and that other stars rotate around it, making a complete circle in a bit less than 24 hours. In modern astronomy it is understood that the earth globe spins on its axis once in this period and that this axis extends from the north pole and nearly passes through Polaris. For a person standing on the earth, the result of this spin is that the stars appear to rotate while the person stands still.

From the standpoint of Newton's laws of motion, modern astronomers conclude that the earth actually spins, while the stars remain fixed (apart from their proper motions).

However, from the standpoint of relativity of motion, one can regard the earth globe as fixed while seeing the entire universe rotating around the polar axis. If we envision Mt. Sumeru as standing at the north pole (as it is said to be in the Surya-siddhanta) and the tree as the starry universe, this gives us a model that captures several of the points in Srila Prabhupada's statement.

Leaving aside planets for the time being, we can envision a model in which a shining sphere representing Polaris and Dhruvaloka (literally "fixed world"), is mounted on the ceiling. A vertical hollow rod (or pipe) extends down from this sphere to an earth globe oriented with polar axis pointing up. The earth globe remains fixed. Other objects in the universe will be made to rotate around the rod by a mechanical arrangement involving a rotating rod extending inside the hollow fixed rod and a motor above Dhruvaloka (in the ceiling) that rotates the rod.

This rotation takes one sidereal day per cycle. (The sidereal day is 23 hours, 56 minutes, and 4 seconds long. It is the time from star rise to star, while the solar day of 24 hours is the time from sun rise to sun rise.) It is clockwise as seen from the north looking down. In the chandelier model we will choose a much faster rate of rotation that will be visible to viewers.

From a geocentric standpoint based on relativity of motion, the sun has two motions. In its yearly motion, the sun moves around a great circle on the celestial sphere in one year of about 365.25 days. The celestial sphere can be visualized as a sphere centered on the earth globe and marked with various star constellations. It is rotating clockwise once per sidereal day, while the sun is moving counterclockwise relative to the celestial sphere. Since the sun is moving on the celestial sphere in a direction opposite to that of the sphere itself, when one revolution of the sphere is completed, the sun will have moved and more time will be required for the sun to get back to its original position. This is why the solar day is longer than the sidereal day.

The great circle of the sun's yearly motion is called the ecliptic. There are 12 important constellations situated around the ecliptic, called the signs of the zodiac. These are called rasis in Sanskrit.

The 5th Canto expresses the idea of clockwise or counterclockwise motion using the idea of a charioteer. Imagine the sun riding on a chariot driven by a charioteer. In its yearly motion around the ecliptic, the charioteer will have Sumeru (at the north pole of the earth globe) on his left hand side. The slowly moving sun is also carried around in the opposite direction by the rapid rotation of the celestial sphere. If we imagine the daily motion of the sun as due to a chariot with driver, then Sumeru will be on the right hand side of the charioteer.

Bhu-mandala

In the 5th Canto of the *Bhagavatam*, there is a description of a disk-shaped entity called Bhu-mandala. The earth globe is at the center of this disk, and the sun rides on a chariot having one wheel. The axle of the chariot extends from Sumeru in the center to the wheel, which rotates on a ring-shaped "mountain" called Manasottara (5.21.13). This mountain is like a circular race track. Since this track is parallel to the path of the sun, if we view the motion of the chariot as corresponding to the yearly motion of the sun, then Manasottara mountain and Bhu-mandala as a whole are parallel to (and very close to) the plane of the ecliptic. Simply put, the yearly path of the sun just above Bhu-mandala is the ecliptic since that is where the sun goes in its yearly orbit.

Later we will show that Bhu-mandala is associated with planetary orbits, as it should be if it corresponds to the ecliptic. For now, however, we will note some points made in the *Bhagavatam* about the sun's motion.

There it is said, "According to its movements in rising above, going beneath or passing through the equator – and correspondingly coming in touch with various signs of the zodiac, headed by Makara [Capricorn] – days and nights are short, long or equal to one another." (5.21.3) To see what this means, first consider the the situation from a heliocentric perspective. The earth spins on its axis while it orbits the sun in the plane of the ecliptic. (The ecliptic is the same, whether we see the earth as orbiting the sun or the sun as orbiting the earth. The orbital plane is the same in either case.) The earth spins on a tilt relative to the ecliptic. Due to this tilt, the sun appears to rise to the north, above the equator, in the northern summer, reaching its highest point at the summer solstice in June. The sun descends to the south, beneath the equator, in the northern winter (the summer of the southern hemisphere), reaching its lowest point at the winter solstice in December. The sun crosses the equator going north at the vernal equinox in May, and it crosses the equator going south at the autumnal equinox in October. This accounts for the seasons, which are driven by the change in the angle of incoming sunlight in the northern and southern hemispheres. In the various months, the sun is seen in various signs of the zodiac, as indicated by (5.21.3).

This account is made from a heliocentric perspective, but from a geocentric perspective everything is the same. We have placed the earth in the center with its axis pointing vertically and its equatorial plane extending horizontally through the equator. The celestial sphere, which is rotating once per day about the vertical axis, has an equator of its own lying in the same plane is the earth's equator. (It is simply the earth's equator projected out onto the celestial sphere.) The plane of the ecliptic, which is the plane of the sun's yearly geocentric orbit, is tilted with respect to the celestial equator. During the northern summer the sun is moving on the part of the ecliptic that is tilted up to the north of the equator, and during the northern winter the sun is moving on the part which is tilted down to the south of the equator. At the two equinoxes the sun crosses the equitorial plane. The ecliptic as a whole is rotating once per day around the vertical axis, and as a result the sun is slowly spiraling up and down. The ecliptic is tilted by 23.5 degrees from the plane of the equator. This angle is called the obliquity of the ecliptic, and thus it reveals its geocentric origins.

How does this relate to Bhu-mandala and the sun's chariot? The answer is that Bhu-mandala must be tilted by 23.5 degrees with respect to the equitorial plane, and it must rotate once per day around the vertical axis. Where the ecliptic goes, Bhu-mandala must go also. Let us suppose, then, that Bhu-mandala is represented in our model by a disk that is centered on the earth globe and tilted at 23.5 degrees from the horizontal plane. Suppose also that this tilted disk is connected to the rotating rod (see above) that causes the daily motion around the vertical axis. (A hole must be made in the center of Bhu-mandala to accommodate the earth globe and the rods.)

On the Bhu-mandala disk there will be a circular track representing Manasottara mountain. (This could even be a model train track.) A wheeled car runs on this track, making one circuit around the track in a year (or in a much shorter time interval chosen to represent one year). The sun could be a light bulb mounted on the car or, to be more exact, on the axle extending from the car to Sumeru at the north pole of the earth globe. The combined yearly and daily motions cause the sun-bulb to spiral up and down, illuminating different parts of the earth globe and thereby modeling the passage of the seasons.

Srila Prabhupada said, "If we can explain the passing seasons, eclipses, phases of the moon, passing of day and night, etc. then it will be very powerful propaganda." Thus far we have seen that day and night and the passage of the seasons can be explained by a model based on the 5th Canto of the Bhagavatam.

Further texts in the 5th Canto give us insight into the seasons and motion of the sun. Thus, "When the sun passes through Mesa [Aries] and Tula [Libra], the durations of day and night are equal. When it passes through the five signs headed by Vrsabha [Taurus], the duration of the days increases [until Cancer], and then it gradually deceases by half an hour each month, until day and hight again become equal [in Libra]. (5.21.4) This, of course, refers to the movement of the sun through the signs of the zodiac (rasis) along the ecliptic. The half hour per month is an approximation for latitudes in northern India. Text (5.21.5) continues this account of the sun's motion.

Texts (5.21.8-9) mention that the sun moves counterclockwise with Sumeru on its left and clockwise with Sumeru on its right. In this regard, Maharaja Pariksit asked Sukadeva Goswami the following question: "How can we reasonably accept that the sun-god proceeds with Sumeru and Dhruvaloka on both his left and right simultaneously?" (5.22.2) Sukadeva Goswami answered by giving the analogy of ants walking on a spinning potter's wheel. In this analogy, Bhu-mandala corresponds to to the rapidly spinning wheel and the ants correspond to the sun and planets which are slowly moving on the wheel. The ants are walking with the axle of the wheel to their left, but they are being carried backwards by the wheel. If they turn around and walk backwards, the powerful spin of the wheel will carry them forwards with the axle on their right. Thus there are two ways of looking at their motion, one with Sumeru on the left and the other with Sumeru on the right. For our purposes the important point is that Bhu-mandala corresponds to the spinning potter's wheel and thus it is spinning (once per day). The only entity not spinning is the earth globe, which is as it should be in a geocentric system.

We also note that the signs of the zodiac, being star constellations must rotate around the polar axis once per day. Since the sun orbits through the signs month by month, it follows that the circular track of manasottara mountain must exhibit the same daily motion as the signs. It must also be tilted at 23.5 degrees like the band of the signs.

We have placed an earth globe in the center of the model. In (5.21.8-9) there are several statements that refer to an earth globe:

(1) People living diametrically opposite to the sunrise see the sun setting.

(2) People diametrically opposite midday see midnight.

(3) If people seeing the sun set could go to diametrically opposite locations "they would not see the sun in the same condition."

These points add weight to the conclusion that the spherical earth globe should be included in the model.

Features of Bhu-mandala

According to the 5th Canto, Bhu-mandala is marked by a series of circular features that are concentric with the center of the Bhu-mandala disk. The radii of these circles are given in the 5th Canto in units of yojanas, where a yojana is about 8 miles. These are as follows:

Radius (1000 yojanas)	Feature
50	Jambudvipa
150	Lavanoda
350	Plaksadvipa
550	Iksurasoda
950	Salmalidvipa
1350	Suroda
2150	Kusadvipa
2950	Ghrtoda
4550	Krauncadvipa
6150	Ksiroda
9350	Sakadvipa
12550	Dadhi-mandoda
15750	Manasottara mtn.
18950	Puskaradvipa
25350	Svadudaka
41100	Loka (inhabited)
125000	Lokaloka mtn.
250000	Aloka-varsa

In this table the features ending in oda (or aka) are the outer boundaries of ring-shaped oceans, such as Ghrtoda, the Ocean of Ghee. With the exception of Jambhudvipa, which is circular, the features ending with dvipa are ring-shaped islands. Manasottara mtn. is a circular "mountain" halfway across Puskaradvipa, the dvipa of lotuses. Loka is the name for an inhabited ring, and LokaLoka mtn. is a circular mountain surrounding a land of gold. Finally, Aloka-varsa is a ring-shaped region of darkness extending from Lokaloka mtn. to the shell of the universe (Brahmanda).

Jambudvipa, in the center of Bhu-mandala, is 50,000 yojanas in radius, and Bhu-mandala as a whole is 250,000,000 yojanas in radius. This creates a problem in scale. Suppose, for example, that we represented Bhu-mandala with a disk 5 meters in radius, which is quite large. Then Jambudvipa would have a radius of 1 millimeter and would be difficult to see. This problem gets worse when we bring the earth globe into the picture. First of all, the earth globe is not mentioned in the description of Bhu-mandala. Indeed, if Bhu-mandala is rotating and the earth globe is stationary, the earth globe should not be part of Bhu-mandala. (Bhu-mandala parses as earth disk, but this earth disk is different from the earth globe.) The earth globe of our experience is about 8000 miles in diameter, or about 1000 yojanas at 8 miles per yojana. This gives it a radius of 500 yojanas, or 1/100 of the radius of Jambudvipa. Alloting 1 mm to the radius of Jambudvipa, we would need a microscope to see the earth globe.

There is some controversy about how the earth globe relates to Jambudvipa. Both the earth globe and Jambudvipa must be at the center of Bhu-mandala. However, there are traditions associating the earth globe with Bharata-varsa, and some individuals propose placing the earth globe over Bharata-varsa. This shifts the earth slightly from the exact center. This, of course, gives rise to the question of why people standing on the earth globe cannot see the enormous structure of Jambudvipa, which is 100 times the size of the earth. For that matter, why can't they see Bhu-mandala at all in the night sky? Evidently, if Bhu-mandala is physical, then it must consist of some kind of subtle energy that is invisible and intangible to our senses. Or perhaps Bhu-mandala is meant purely as a geometrical model intended to aid in describing the motion of the sun and planets.

Whatever the case may be, it is clear that a physical Bhu-mandala must be part of our proposed model of 5th Canto cosmology. We suggest that Bhu-mandala should consist of a disk made of some transparent substance – probably some kind of plastic. Some of the outer rings of Bhu-mandala can be shown to scale on the Bhu-mandala disk, but some inner rings and Jambudvipa should be omitted. A circular hole should be cut in the disk to accommodate a model earth globe that is large enough to be clearly visible. Some struts will necessary to support the Bhu-mandala disk and impart rotary motion to it through the rotating rod. Electricity for the sun's chariot will be conveyed by embedded wires to the toy train tracks representing Manasottara Mtn. The purpose of making Bhu-mandala transparent is to allow people standing underneath the model to be able to see features, such as the solar chariot, that are on the upper surface of Bhu-mandala. To see these features properly, however, visitors should be able to ascend to a viewing gallery from which they can look down on the model.

Regarding Sumeru, there is a Sumeru 84,000 yojanas high in Jambudvipa and a Sumeru one yojana high at the north pole of the earth globe, according to the Surya-siddhanta. We propose to show the second Sumeru at the north pole of the model's earth globe and to expand it so that it can be clearly seen. From a modern perspective it is simply the north pole.

For the purpose of showing the motion of the sun and the passage of the seasons, it is not necessary to display the full Bhu-mandala. Manasottara Mtn. is in Puskaradvipa, and so one could model Bhu-mandala out to Puskaradvipa. In this case, if the Bhu-mandala disk has a radius of 1 meter representing the outer radius of Puskaradvipa, then Manasottara could have a radius of 83.1 cm (32.22 inches). Also, if the earth globe is assigned a radius of 2 cm, this corresponds to 379 thousand yojanas. We could round up to the radius of Iksurasoda (at 550 thousand yojanas) for the hole.

The Planets

The next topic is the orbits of the planets. In the 5th Canto the sun and moon and the five visible planets are given heights above Bhu-mandala as follows.

Entity	Height above Bhu-mandala (thousands of yojanas)
Rahu	90
Sun	100
Moon	200
28 naksatras	400
Venus	600
Mercury	800
Mars	1000
Jupiter	1200
Saturn	1400
Sapta-rsi	2500
Dhruvaloka	3800

This is the sum total of what the *Bhagavatam* says about the positions of the planets. Unfortunately, this table of heights tells us nothing about the orbits of the planets.

Criteria for Orbital Models

It would certainly be disappointing to present a Vedic planetarium without planetary orbits, and Srila Prabhupada's statements clearly refer to such orbits. In the absence of explicit information in the Bhgavatam, how can we determine how to present planetary orbits in the chandelier model? I propose that three criteria must be satisfied in such a presentation:

(1) The orbital model should by supported by Vaisnava tradition or texts.

(2) The model should harmonize with the structural details presented in the 5th Canto.

(3) The model should agree as much as possible with known astronomy.

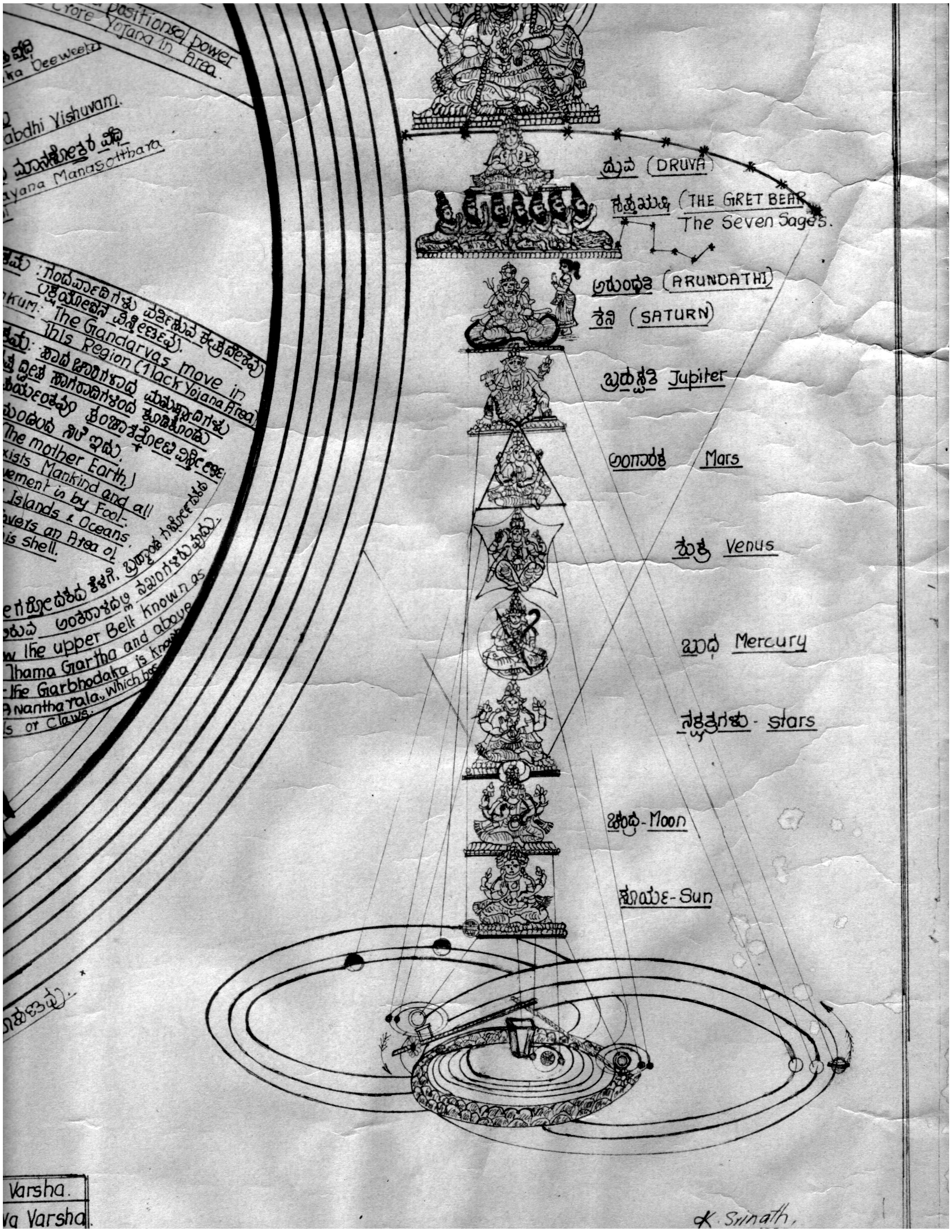
From the standpoint of these criteria, we can survey some known planetary models. According to historians of astronomy, kinematic models of planetary motion based on movement in circles or combinations of circles were first developed by the Greeks. These culminated in the Ptolemaic system, in which planets orbit the earth in on epicycles mounted on cycles. However, if we compare the Ptolemaic orbits with 5th Canto cosmology, we find no relationship. Thus Ptolemy's model fails to satisfy criterion (2) as well as (1).

The jyotisa sastras of India have explicit models of planetary orbits. For example, the Surya-siddhanta has cycles and epicycles similar to those found in Ptolemy. However, the rotating point on an epicycle is project along a radial line onto the cycle, thus creating a circular orbit orbit with forward and retrograde motion. This is rather unrealistic and does not satisfy (3). It also fails to satisfy (2). Thus the circular orbits of the Surya-siddhanta have no relationship with the circular features of Bhu-mandala. Similar observations can be made about the other jyotisa sastras.

Since Bhu-mandala corresponds to the plane of the ecliptic and the planets orbit near the ecliptic plane, it stands to reason that the planets should orbit close to Bhu-mandala. This is supported by the small heights of the planets above Bhu-mandala given in the 5th Canto. The planets are close to Bhu-mandala, and the question is, how do they orbit relative to Bhu-mandala?

Tiruvenkata's Model

An interesting model of planets orbiting over Bhu-mandala was presented by the South Indian sannyasi Tiruvenkata Ramanuja Jiyar Swami in the 19th century. He expressed his ideas in a diagram from which we extract the following figure:



At the bottom of this figure we see a picture of Jambudvipa with a square Mount Sumeru in the center. This is surrounded by a series of rings culminating in a rocky-looking Manassotara Mountain. We see the chariot of the sun in two positions, corresponding to two different times. The chariot consist of an axle running from a point above Sumeru to a wheel riding on Manassotara. The sun is riding on a box-shaped car on the axle, close to the wheel. There are two arrows indicating counterclockwise motion (with Sumeru on the left-hand side).

The earth globe is shown next to Sumeru, and the moon is shown orbiting the earth at close range. Each image of the sun (representing a particular time) is surrounded by orbits of Mercury and Venus. At a greater distance each sun is surrounded by the orbits of Mars, Jupiter, and Saturn, and Saturn is even shown with a ring. Icons representing the planets are shown above Sumeru in nearly the order given in the *Bhagavatam* (with Mercury and Venus switched). The swami has drawn lines linking each orbiting planet with its icon.

What the Swami has shown is a geocentric model of the planetary orbits in which the sun orbits the earth, and the planets, Mercury, Venus, Mars, Jupiter, and Saturn, orbit the sun. Such a model was presented by the famous Danish naked-eye astronomer Tycho Brahe in the 17th century. It corresponds to the heliocentric model with the center of motion shifted from the sun to the earth. This can be done on the basis of the principle of relativity of motion.

The Swami's diagram certainly satisfies criterion (1), since he is presenting 5th Canto cosmology. It is consistent which what the 5th Canto says about the orbit of the sun and it does not contradict what the 5th Canto says about the planets. Thus it satisfies criterion (2). Although the Swami has only presented a rough sketch, his model is the same as the geocentric model of Tycho Brahe – which conforms to Brahe's accurate observations. Thus it agrees with criterion (3).

This amounts to a reasonable case for adopting Tiruvekata Swami's orbital model for the chandelier exhibit. To do so, however, we need an exact definition of the geocentric orbits of the planets. One way to do this is simply to use a modern ephemeris to calculate planetary orbits with the center of motion fixed on the earth. When this is done, an interesting observation emerges. As is well known, these geocentric orbits look like spirograph patterns centered on the earth. The remarkable observation is that these spirograph patterns run tangent to circular features of Bhu-mandala. I argue in detail in Mysteries of the Sacred Universe that these agreements between geocentric orbits and Bhu-mandala features are highly unlikely to happen by chance. They amount to an independent confirmation of Tiruvenkata's model. They greatly enhance his model's satisfaction of criterion (2), agreement with the 5th Canto, and criterion (3), agreement with modern astronomy. I would therefore advocate using Tiruvenkata's model in the chandelier exhibit.

Engineering the Chandelier Model

Now we must confront some engineering issues involved with the chandelier model. To represent the motion of a planet we must make it orbit the sun, which is orbiting around Manasottara Mtn., which in turn is rotating around the cosmic axis. This must be done for each of the five planets, Mercury through Saturn. My impression is that it will be difficult to produce these complicated motions with an apparatus that is easy to maintain and that works reliably in India. I also note that in such a model it is imperative that viewers will have to look down on the model from above, since from below one must see the model through the Bhu-mandala disk. I also note that while a model limited to the sun has to go out only as far as Puskaradvipa, a model including Saturn has to go out to the Lokaloka Mtn.

I therefore suggest that the chandelier model should have two levels. On the first level the chandelier is suspended from the ceiling above the Deities. This model has the sun's chariot but no planetary orbits. Its aim is to show day, night, and the seasons. It has a tilted Bhu-mandala disk that rotates, thereby causing the sun to spiral up and down. By going up ramps or staircases, viewers will be able to see the moving sun from the side or somewhat above.

The ramps or staircases will take people up to a second level where they will look down on Bhu-mandala, the sun's chariot, and the planetary orbits. On the second level, Bhu-mandala lies flat on the floor, the sun's chariot travels around its circular track, and the planets orbit the sun. Above this there will be further levels with exhibits representing the higher lokas, etc.

A planetary orbit could consist of an ellipse of clear plastic with embedded photodiodes that flash on and off successively like lights in a theatre marquee. Radial plastic struts could connect each orbital ellipse with the sun-chariot in the center. Necessary wiring will pass through these struts.

Since this has to be done for Venus, Mercury, Mars, Jupiter, and Saturn, a considerable amount to electronics has to ride on the chariot. I would recommend a simpler arrangement. Let there be a clear plastic disk of radius equal to the maximum radius of the orbit of Saturn scaled to the size of the model. On this disk the heliocentric orbits of of the five planets are ellipses marked out by fluorescent tubes of different colors, The clear disk is mounted on the chariot at its center. Due to its size it probably cannot be supported fully above the horizontal Bhu-mandala disk. It will have to be supported at various points by some kind of roller bearings. Thus it will move smoothly as the sun-chariot moves.

As the disk with orbits is driven in a circle by the sun-chariot, it must keep a constant orientation—i,e, an arrow drawn on the disk must keep pointing in the same direction as the disk moves. This causes the orbit-ellipses to continue to point in their respective initial directions as orbital dynamics requires. To achieve this, the disk must rotate clockwise at the same rate that the sun-chariot rotates counterclockwise. This can be done by introducing a chain of three gear-wheels: a gear mounted on the fixed earth globe. A gear mounted on the rotating sun-chariot, and an idle gear that meshes these two. Here the wheel-carriage of the chariot is not free to rotate, but the chariot can have an upper story that can rotate.

In this model we need to represent Bhu-mandala out to the Lokaloka Mtn. Beyond this there lies Aloka-varsa, which is in darkness and can be omitted. It turns out that Saturn comes very close to Lokaloka Mtn. Saturn is the outermost planet, and the 5th Canto says that Lokaloka Mtn. is the outer limit of the luminaries. In general, this model shows that Bhu-mandala is very similar to the solar system. It is important to make this point because medieval writers of scriptures should not have known the size or layout of the solar system. Yet it would appear that they did.

To show this it is important to retain the proportions of the features of Bhu-mandala in the model. This brings us to questions of scale.

Problems of Scale

It is noteworthy that Tiruvenkata made the moon very small and very close to the earth. In fact, the moon is about 30 earth diameters away from the earth. We pointed out before that if Bhu-mandala is given a radius of 5 m, then the earth will have a radius of .02 millimeters. In that case, the earth-moon distance comes to .6 mm. If the earth globe is made large enough to clearly see—which is important for the chandelier model – then the moon, Jambudvipa, and some additional dvipas will wind up inside it. I propose that we omit the moon from the chandelier model. It can be dealt with in other exhibits.

It is also noteworthy that Tiruvenkata placed the earth globe over Bharata-varsa in Jambudvipa. This is in accordance with one tradition, and another tradition (followed by the jyotisa sastras, for example) placed Mount Sumeru at the north pole of the earth globe. We propose to place a fixed earth globe that is large enough to see at the center, and place Sumeru at its north pole. After all, the north pole is the cosmic spin axis in a geocentric model.

We cannot make the earth so large that the planet Venus, which approaches closest to the earth, rams into it. This would be at a distance from the center of about 6 cm (2.36 inches), using the 5 m Bhu-mandala disk. So we need an earth globe of about 1 to 2 inches in radius.

We will have to enlarge the vertical distance from Bhu-mandala to Dhruvaloka in order to make room for the features extending above Bhu-mandala. Using 5 meters for the radius of the Bhu-mandala disk, the height of Bhu-mandala comes to 7.6 cm (3 inches), which is much too small.

A radius of 5 m (16.4 feet) for Bhu-mandala is probably too much. Perhaps it should be reduced by a factor of 2. We can also omit all of Bhu-mandala outside Lokaloka Mtn., since this is simply the region of darkness. This gives us another factor of 2. Thus the rotating disk in the chandelier model can be about 4.1 feet in radius with an earth globe about 1 inch in diameter. Due to its tilt this Bhu-mandala disk extends up and down by about 1.6 feet. This seems reasonable.

Finally, using the 4.1 foot radius for Lokaloka Mtn,. the radius of Manasottara Mtn. comes to about 6 inches. The sun orbits at an orbital radius a bit smaller than this. This puts some constraints on the Manosottara track and the car that runs on it. Everything on the sun's chariot will have to be miniaturized as much as possible. Nonetheless, the orbit of Saturn extends all the way to Lokaloka Mtn., and this has to be balanced by a car moving on a 1 foot diameter track. We probably need the car to move on sliders that will not come loose and to be propelled by a gear arrangement similar to that of a cogged railroad. I do not think we should sacrifice the scale of the planetary orbits or that of the Bhu-mandala rings, since these are the strongest indicators of the realistic nature of the 5th Canto model.