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# HELIOCENTRIC CONCEPT IN RETROGRADING PLANETS

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## ABSTRACT

The retrograde motion of planets is a unique feature of our Bhāratian Astronomy, Astrology and Almanacs. These texts describe that Mercury, Venus, Mars, Jupiter and the Saturn have retrograde motion, an apparent backward motion of these planets with respect to the fixed stars of the sky, on observed from the Earth. If analysed in depth, this retrograde motion of these planets, confirm that our Bhāratian Astronomy is correctly based on Heliocentric concept only.

**Key words:** Vakra gati and Vakra nivarti (Retrograde motion and its reversal), Sīghra gati, Heliocentric, Geocentric, Elliptical orbits, Ecliptic, Angular distance, Heliacal rising and setting, DrkGanitam, Saurmāna, Cāndramāna and Almanac.

#### **INTRODUCTION**

All the nine planets of the Solar system, revolves round the Sun, which is nearly at the centre, in an elliptical pathway. This is known as the Heliocentric concept of motion of the planets. On the contrary, the Greeks and the Europeans thought for a long period, that the Sun and the planets revolve round the Earth, which is thought to be at the centre, in a perfect circular pathway. Only very late after Nicholas Copernicus (1473-1543), the Europeans slowly started understanding the subject. However, in our Nation, even the Almanacs used by the common people in their day-to-day affairs, are correctly based on the Heliocentric concept itself. The statistical details revealing the motions of the NavaGraha, given in our Bhāratian Almanacs, especially the retrograde motion of the Mercury, Venus, Mars, Jupiter and the Saturn, if analysed in depth, it will show that Bhāratian Astronomy, Astrology and Almanacs correctly adopt the Heliocentric model to explain the motion of the Planets.

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#### 1. The Earth - the place of observation of the celestial movements :-

Being on the surface of the Earth only, our ancestors observed the motion of the celestial bodies. Further, it only served their purpose of analysing the effects of the celestial bodies over the Earth and the men, which depends on the position these celestial bodies, with respect to the Earth's position in the sky and not on the mere position of these celestial bodies alone. Hence, if a motion of any planet is mentioned in our Bhāratian Astronomy, then it means the change of the position of that planet in the sky, on observed from the Earth and not that planet's individual motion alone. Therefore, the motion of a planet if described, then it means the change of positions of that planet superadded with the change of the Earth's position in the sky (if any), whether positive or negative. Thus, the Earth becomes the point of reference, in computing the motion of the planets.

#### 2. Dik Deşa Kāla Vardhamāna reality :-

- Mercury and Venus are in between the Earth and the Sun, hence known as minor or inferior planets. Mars, Jupiter and Saturn are beyond the orbit of the Earth or the Sun as the case may be, as in Heliocentric or Geocentric theory respectively and hence known as major or superior planets (TārāGraha) — Deşa (space) reality.
- Mercury and Venus moves faster and Mars, Jupiter and Saturn moves slower than the Earth or the Sun as the case may be, as in Heliocentric or Geocentric theory respectively — Kāla (time – speed) reality.
- All the planets of the Solar system moves in only one direction (unidirectional motion) i.e. not one planet moving in clockwise and the other in anti-clockwise direction – Dik (direction) reality.
- 4. Planet and Graha are not synonyms. Any celestial body that attracts other is Graha. Hence, Sun, the planets of Solar System and Moon are all called as Graha, in Bhāratian Astronomy

#### **RETROGRADE MOTION OF THE MINOR PLANETS**

The following table shows the statistical data of the retrograde motion of the minor planets,

Mercury and Venus, mentioned in the D<u>r</u>k Ga<u>n</u>ita Almanacs followed in Tamilnadu Province. Here, the beginning date of the retrograde motion, that is the apparent backward motion of these planets, in the opposite direction, on observed from the Earth with respect to the fixed stars of the sky, known as Vakra gati and the reversal of this retrograde motion again to the forward direct motion, known as Vakra nivarti are given. Further, the comparatively fast forward direct motion of these planets, on compared with the apparent motion of the Sun, which is mentioned as Śīghra gati and the positive (direct) or negative (retrograde) motion of these planets in degrees of longitude on that particular day, are also given in the table.

Sl.	Туре	Sauramāna	Cāndramāna	Western	+ or – degree nirāyana
No.	of motion	month	month	calender	longitude of Mercury
1	Śīghragati	Vaiśākha 21	Jyeșțhā14	04-06-05	+ 2 ° 12 '
	beginning				
2	Vakragati	Āṣāḍha 7	Śrāva <u>n</u> a 1	23-07-05	- 0 ° 02 '
	beginning				
3	Vakranivarti	Śrāva <u>n</u> a 1	Śrāva <u>n</u> a 26	17-08-05	+ 0 ° 03 '
	-				
1	Śīghragati	Bhādrapada 3	Bhādrapada 28	19-09-05	+ 1° 50 '
	beginning				
2	Vakragati	Āśvina 28	Kārtika 23	14-11-05	- 0 ° 02'
	beginning				
3	Vakranivarti	Kārtika 19	Mārgaśirṣa 13	04-12-05	+ 0° 05 '
1	Śīghragati	Paușa 13	Māgha 6	26-01-06	+ 1° 43 '
	beginning				
2	Vakragati	Māgha 19	Phālguna 12	03-03-06	- 0 ° 06 '
	beginning				
3	Vakranivarti	Phālguna 12	Caitra 5	26-03-06	+ 0 ° 06 '

Retrograde motion of Mercury -- Pārthiva Sauramāna year  $(2005 - 06)^{1}$ 

S1.	Туре	Sauramāna	Cāndramāna	Western	+ or - degree nirayana
No.	of motion	month	month	calender	longitude of Venus
1	Śīghragati	Śrāva <u>n</u> a 1	Śrāva <u>n</u> a 27	18-08-03	+ 1 ° 14 '
	beginning	inning Subhānu Year Subhānu Year			
2	Vakragati	Vaiśākha 5	Vaiśākha 28	18-05-04	- 0 ° 01 '
	beginning	Tārana Year	Tārana Year		
3	Vakranivarti	Jyeșțhā16	Āṣāḍha 9	30-06-04	+ 0 ° 01 '
		Tārana Year	Tārana Year		
1	Śīghragati	Phālguna 18	Caitra 10	31-03-05	+ 1 ° 15 '
	beginning	Tāra <u>n</u> a Year	Pārthiva Year		
2	Vakragati	Mārgaśirṣa 10	Paușa 4	25-12-05	- 0 ° 03 '
	beginning	Pārthiva Year	Pārthiva Year		
3	Vakranivarti	Paușa 22	Māgha 15	04-02-06	+ 0 ° 02 '
		Pārthiva Year	Pārthiva Year		

Retrograde motion of Venus – Subhānu, Tārana and Pārthiva Sauramāna year (2003, 04, 05 - 06)

These tables show clearly the exact alternate occurrence of Vagragati and Śīghragati motion of these minor planets, i.e. one Vagragati immediately followed by a Śīghragati, which in turn followed by another Vagragati and so on and thus not at a random manner. Thus, our Bhāratian Almanacs mention that Vagragati and Śīghragati of the minor planets are occurring exactly in alternate sequence only. From this, one can conclude whether these Almanacs and their basic texts, the Bhāratian Astronomical manuals are based on Heliocentric concept or Geocentric concept.

#### HELIOCENTRIC MODEL

In Heliocentric model of arrangements of Planets, retrograde motion of these minor planets, Mercury and Venus can happen, only when these planets are in between the Sun and the Earth as shown in this figure 1.



In this figure, on a particular day of a particular year, Mercury is at 180°, Venus and the Earth are at 210°, <u>on observed from the Sun</u>. But on observed from the Earth (E1), Venus (V1) and the Sun (S) are at 30° entering V<sub>I</sub>şabha rāśi from Meşa and the Mercury (ME 1) is at 60°, entering Mithuna rāśi from V<sub>I</sub>şabha. After a period of one month, Earth, due its average monthly motion of 30°, moves from 210° (E1) to 240° (E2). Hence, due to Earth's motion imposed, the Sun appears to move from 30° to 60°, entering Mithuna rāśi from V<sub>I</sub>şabha, thus Jyeşthā month begins in Sauramāna calendar, followed in Tamilnadu province. In the same way, Venus actually moves forward by its average monthly motion of 48° 04 '. But on observed from the Earth, Venus appears to move backward from its 30° (V1) position to 345° (V2), i.e. from the beginning of V<sub>I</sub>şabha, crossing the Meşa back to the Mīna rāśi itself. Even though the Venus has actually moved forward by 48° 04 ' in this one month duration, it appears to retrograde, on observed from the Earth, because in this one month duration the Earth also moved forward by about 30° and thus the position of the Earth has changed from 210° to 240°. Hence on observed from the Earth which is now at 240° (E2).

shown in the figure 1. In the same way, Mercury which is at  $60^{\circ}$  (ME 1) i.e. at the end of V<u>r</u>şabha rāśi, appears to move backward to  $0^{\circ}$  (ME 2), i.e. the beginning of Meşa rāśi, all on observed from the Earth which has moved from  $210^{\circ}$  (E1) to  $240^{\circ}$  (E2). However, Mercury has actually moved forward by  $122^{\circ}$  46', its average motion per month, during this period.

In Heliocentric model of arrangements of planets, this apparent retrograde backward motion of these minor planets can occur, only when these planets are nearer to the Earth, i.e. the planets are in between the Earth and the Sun, as shown in the figure 1.

Sīghra gati of these minor planets can occur, only when these planets are farther away from the Earth, i.e. when the Earth is on one side of the Sun and these planets are on the other side, with the Sun in between the Earth and these planets, as shown in this figure 2.

Figure 2 -- ŚĪGHRAGATI OF MINOR PLANETS - HELIOCENTRIC MODEL



Here in one-month duration, the Earth moves from  $210^{\circ}$  (E1) to  $240^{\circ}$  (E2) and due to this Earth's motion imposed on the Sun, the Sun appears to move from  $30^{\circ}$  to  $60^{\circ}$ , on observed from the Earth. Mercury from  $0^{\circ}$  (ME 1) moves by  $122^{\circ}$  46', to go to  $122^{\circ}$  46' (ME 2), and Venus which is at  $15^{\circ}$  (V1) moves by  $48^{\circ}$  04', to go to  $63^{\circ}$  04' (V2), <u>all on observed from the Sun</u>. In the beginning, the apparent Sun is at  $30^{\circ}$ , much forward than Venus and Mercury. But in one month duration, Venus

and the Mercury overtake the apparent Sun which is now at  $60^{\circ}$ , to go to  $65^{\circ}$  (V2) and  $102^{\circ}$  (ME 2) respectively, all observed from the Earth. This is the Sīghra gati, i.e. a comparatively fast forward motion of these minor planets, on compared with the apparent motion of the Sun, on observed from the Earth. Thus in Heliocentric model of arrangements of planets, Vagragati of the minor planets takes place, only when they are in between the Earth and the Sun, i.e. nearer to the Earth, on the same side of the Earth from the Sun. In Śīghra gati, these planets are on the other side of the Sun, farther away from the Earth. Since in Heliocentric model, these planets are revolving round the Sun inner to the Earth's orbit, these minor planets will be nearer to the Earth i.e. on the same side of the Earth, in the first half of their revolution round the Sun. In the next half, they will be on the other side of the Sun, farther away from the Earth. Therefore, they will be alternatively nearer and farther away from the Earth as shown in figures 1 and 2. As seen before, Vakragati of these planets will occur when they are nearer to the Earth and Śīghra gati will occur when they are farther away from the Earth. So, in heliocentric model, these minor planets alternatively come nearer and go farther from the Earth and thus, Vakragati and Sīghra gati of these planets will also occur alternatively, only in heliocentric model. Our Bhāratian Almanacs exactly mentions this alternate occurrence of the Vakragati and Śīghra gati of these minor planets and thus, these Almanacs and our Astronomical texts are based on Heliocentric model only.

Siddhānta Śiromanih<sup>3</sup> a Bhāratian Astronomical manual, authored by Śrīmad Bhāskarācārya reveals the same thing that these minor planets are nearer to the Earth, during their Vakragati than at Śīghra gati. In the verse 6 of the Chapter Grahodayāstādhikārah, Siddhānta Śiromanih mentions as, शैलभुवश्च कमोण दस्रेन्दवः शका रुद्राः तिथय: खचन्द्राः निरुक्ता ज्ञ शुक्रयो र्वक्रगयो द्विहीनाः काललवा Dasrendavah Śailabhuvaśca Śakrā Rudrāh khaCandrāh tithayah kramena niruktā jña Śukrayor vakragayor dvihīnāh Candrāditah kālalavā **Meaning:** 1. Dasra – 2, Indu – 1, Dasrendu -12; 2. Śaila - 7, Bhuva – 1, Śailabhuva - 17; 3. Śakrā - 14; 4. Rudra -11; 5. Kha – 0, Candra -1, Khacandra - 10; 6. Tithi – 15; 7 Kremena – in the order of ; 8. Candra ādita – beginning from the Moon ; 9. Kālalavā - kāla amśa (degrees of angle);

10. Nirukta – expressed ; 11. Jña - Mercury ; 12. Śukra – Venus ; 13. Vakra ga – retrograde motion
14. Dvi - 2; 15. Hīnāḥ - subtraction.

This verse mentions that the Kāla amśa or the degrees of angular distance of the Moon, Mars, Mercury, Jupiter, Venus, and Saturn, from the Sun, with which these Graha rise or set heliacally, are 12, 17, 14, 11, 10 and 15 respectively. In the case of Mercury and Venus, the Kāla amśa are 2 degrees less, during their retrograde motion, i.e. 12 and 8 respectively. The angular distance from the Sun, at which these Graha rise or set heliacally depends on the luminosity of the respective planets. Thus when these Graha come nearer to the Sun's longitude, measured in kala amsa or degrees of angles, they become invisible due to Sun's brightness. However when they move farther away from the Sun, they again become visible to the men on the Earth. Besides when they are closer to the Earth, they become more visible than they are farther away. This verse mentions that the angular distance from the Sun, for Mercury and Venus are 2 degrees less in retrograde motion than in their forward direct motion. Thus, these minor planets are rising earlier and setting latter in retrograde motion than they are in direct forward motion. Therefore, they are more visible to us during their retrograde motion, which means that they are nearer to the Earth, when they are in retrograde motion and they are farther away from the Earth, when they are in fast forward motion. Since in Geocentric model, these planets are always at equidistant from the Earth, which is said to be at the centre, around which these planets are revolving in perfect circular orbits, there is no variation of the distance of these planets from the Earth, during their retrograde and forward motions. Thus, the variation of the distances of these planets observed from the Earth, during their retrograde and forward motions mentioned in this verse itself proves that the Bhāratian Astronomy is heliocentric.

Besides, this verse and the statistical data of the Almanacs shown in the table before, shows that these minor planets are revolving round the Sun only. Because on observed from the Earth, they are at one time nearer to the Earth, in between the Earth and the Sun and in the immediate next, they are farther away from the Earth and the Sun is in between them and the Earth. This is possible only when these planets are revolving round the Sun.

Besides, **Siddhānta Śiromaņiḥ** and the other Bhāratian Astronomical manuals, mention the heliacal rising and setting of the minor planets separately, during their retrograde and forward motion, where as for the major planets, only one heliacal rising and setting per one revolution is mentioned. For example, in **Vaṭeśvara Siddhāntaḥ and Gola by Vaṭeśvaraḥ**<sup>4</sup> in verses 12 and 13 of the section 4 (Jyārbhivinā Sphutīkaraṇa vidhiḥ) of the chapter 2 (Sphuṭagatyadhikāraḥ), mentions, only one heliacal rising and setting for the major planets in each revolution, in their respective orbits. However, it mentions two heliacal rising and setting for the minor planets, one during their forward, and one during their retrograde motion, in each revolution. The following tables gives these values clearly. <sup>5</sup>

DI	Śīghra kendra at heliacal <u>rising in the east</u> , in degrees $(\circ)$					
Planets	Āryabhațțīyam	Brahmagupta	MahāĀryabhaţţa	Śrīpati	Vațeśvara	
	Lalācārya	Bhāskarācārya	Siddhāntaḥ			
Mars	28	28	28	28	28	
Mercury	205	205	205	205	203	
Jupiter	14	14	14	14	13	
Venus	183	183	182.5	183	183	
Saturn	20	17	17•5	17	17	

Heliacal <u>rising</u> of the planets <u>in the east</u> (and heliacal setting in the west)

## Śīghra kendra for <u>Mercury and Venus</u> at heliacal <u>rising in the west</u> (and setting in the east)

Planets	$ ilde{S}_{\overline{I}}$ ghra kendra at heliacal <u>rising in the west</u> , in degrees ( °)						
1 milets	Āryabhațța ref.	Brahmagupta	Lalācārya	MahāĀryabhaṭṭa	Vațeśvara		
	KhaṇḍaKhādyakam	Bhāskarācārya		Siddhāntaḥ			
Mercury	51	50	51	49	49		
Venus	24	24	23	20	24		

The major planets rise in the east and set in the west heliacally, since they move slower than the apparent motion of the Sun, which is nothing but the Earth's revolution round the Sun in the ecliptic, imposed on the Sun. The minor planets rise in the west and set in the east helically, since the minor planets moves faster than the Sun's apparent motion. However, during the retrograde motion, the

minor planets rise and set in opposite direction, i.e. rising in the east and setting in the west. Unlike the minor planets, the major planets are visible to us fully, during their retrograde motion. Thus, there will not be any heliacal rising and setting for the major planets during their retrograde motion like that of minor planets. This difference between the major and minor planets in rising and setting heliacally, stated by these Bhāratian astronomical manuals can be possible only in heliocentric model, as shown in the figure 3.



#### Figure 3 -- HELIACAL RISING AND SETTING OF MAJOR AND MINOR PLANETS

Thus, during their direct forward motion, both the minor and the major planets are obscured by the Sun on observed from the Earth, since the Sun is in between these planets and the Earth, as shown in the figure 3. So, both the minor and the major planets rise and set heliacally during their direct forward motion. The minor planets are revolving round the Sun, inner to the Earth's orbit in heliocentric model and so during their retrograde motion, the minor planets are in between the Earth and the Sun. Hence, on observed from the Earth they enter into the rays of the Sun, thus become invisible due to the brightness of the Sun. Hence, the minor planets rise and set heliacally during their retrograde motion also. However, the major planets revolve round the Sun, exterior to the Earth's orbit, and hence they will not come in between the Earth and the Sun, during their retrograde motion. Thus, major planets will not enter into the rays of the Sun, as shown in figure 3. Hence, during their retrograde motion, the major planets are always visible to the men at the Earth. Thus, there is no heliacal rising and setting for the major planets, during their retrograde motion. But, in Geocentric model as shown in figure 4, the minor planets will not be obscured by the Sun and can only enter into the rays of the Sun, because they are always in between the Earth and the Sun and the Sun will never be in between the Earth and these minor planets. Therefore, in Geocentric model, there will not be two heliacal rising and setting for the minor planets as in heliocentric model. Since our Bhāratian astronomical texts mention two heliacal rising and setting for the minor planets, they are based on heliocentric model only.

#### GEOCENTRIC MODEL - MINOR PLANETS

In the Geocentric model, the Earth is said to be exactly at the centre and stationary - not moving. The other planets with the Sun, are said to be revolving round the Earth in a perfect circular pathways. Therefore, the minor planets are always at equidistant from the Earth. Retrograde motion will be apparent and possible, only when the motion of a particular planet is observed, from another moving celestial body. So when observed from a stationary, not moving celestial body, no retrograde motion of any planet will be apparent. This is shown in the figure 4, where the Sun is at  $30^{\circ}$ , Mercury is at  $0^{\circ}$  and the Venus is at  $15^{\circ}$  all on observed from the Earth. After a period of one month, the Sun moves by  $30^{\circ}$ , from  $30^{\circ}$  (Ss1), to go to  $60^{\circ}$  (Ss2), Mercury moves by  $122^{\circ}$  46', from  $0^{\circ}$  (ME 1) to go to  $122^{\circ}$  46' (ME 2) and the Venus moves by  $48^{\circ}$  04', from  $15^{\circ}$  (V1) to go to  $63^{\circ}$  04' (V2), all on observed from the Earth, there is only direct forward motion for the Mercury and the Venus and there is no retrograde motion.

No vakragati on observed from the Earth, but only on observed from the Sun.



Thus in Geocentric model, when observed from the supposed to be stationary Earth, no retrograde motion of any planet is possible. Since our ancestors observed the motion of the celestial bodies from the Earth only and described their motion, only with the Earth as the point of reference, they would not have mentioned the retrograde motion of any planet, if they would have adopted the Geocentric model. Thus, by mere mentioning of retrograde motion of the planets itself shows that they have adopted Heliocentric model only.

Nevertheless, if observed from the Sun, retrograde motion of the minor planets is possible, only when they are in between the Earth and the Sun as shown in the figure 4. Here, in one-month duration, Mercury which is at 283° (ME 1), moves retrograde by 118°, to go to 165° (ME 2) and the Venus which is at 235° (V1), moves retrograde by 16° to go to 219° (V2) all on observed from the Sun. In the same way, Śīghra gati of these minor planets will also occur, on observed from the Earth, when these planets are in between the Earth and the Sun, as shown in figure 5.



Here, in one month duration, the Sun which is at  $30^{\circ}$  (Ss1), moves by  $30^{\circ}$  to go to  $60^{\circ}$  (Ss2), Venus which is at  $15^{\circ}$  (V1), moves by  $48^{\circ}$  04', to go to  $63^{\circ}$  04' (V2) and the Mercury which is at  $0^{\circ}$ (ME 1), moves by  $122^{\circ}$  46', to go to  $122^{\circ}$  46' (ME 2). Thus, the figure 5 shows that in the beginning the Sun is at  $30^{\circ}$ , much forward in position than Venus and Mercury. But after a period of one month, Venus and Mercury overtake the Sun, which is at  $60^{\circ}$ , to go to  $63^{\circ}$  04' (V2) and  $122^{\circ}$  46' (ME2) respectively, all on observed from the Earth. This is Śīghra gati, a comparetively fast forward motion of these planets on compared with the motion of the Sun, on observed from the Earth.

Because of this, Vakragati and Šīghragati can not occur alternatively, but simultaneously, in Geocentric model, that too Vakragati on observed from the Sun (not from the Earth) and Śīghragati when observed from the Earth. Since our Almanacs mention the alternative occurrences of Vakragati and Śīghra gati of these minor planets, on observed from the Earth, they are not based on Geocentric concept.

Thus, the analysis of the stastical data given in the Bhāratian almanacs and the Astronomical manuals detailing the retrograde motion and the heliacal risings of the minor planets, shows that these

texts clearly knew that the minor planets are revolving round the Sun and the Bhāratian astronomy is

Heliocentric. Heliocentric concept in retrograding major planets is to be analysed next. 2

## RETROGRADE MOTION OF THE MAJOR PLANETS

Mars, Jupiter and the Saturn are the major or the superior planets (TārāGraha) of the Solar system. The following table shows the statistical data, given in the Drk Ganita almanacs followed in Tamilnadu province, detailing the Vakra gati, the apparent backward motion of these major planets with respect to the fixed stars of the sky, on observed from the Earth. Vakra nivarti is the reversal of this retrograde motion, to the usual direct forward motion. These data are of the six years, commencing from Vikrama (2000 – 01), to Pārthiva (2005 – 06), in Souramāna year calculations.

Year	Type of	Date	Nirāvana Lor	ngitude of	Difference	Around
	Motion	(Souramāna)	(in degrees )	ninutes)	between Sun &	180°
			Sun	Jupiter	Jupiter	or 360°
Vikrama (2000-01)	Vakragati beginning	Bhādrapada16	165° 22'	47 ° 30 '	117 ° 52 ' to	180 °
	Vakranivarti	Paușa 13	282 ° 22 '	37° 27'	244 ° 55 '	
V <u>r</u> șa (2001-02)	Vakragati beginning	Āśvina 19	198° 53'	81° 56'	116 ° 57 ' to	180 °
(2001 02)	Vakranivarti	Māgha 18	317 ° 28 '	71° 52'	245° 36'	
Citrabhānu (2002-03)	Vakragati beginning	Kārtika 21	230 ° 56 '	114 ° 20 '	116° 36' to	180 °
(2002 03)	Vakranivarti	Phālguna 24	353 ° 00 '	104 ° 18 '	248° 42'	
Subhānu (2003-04)	Vakragati beginning	Mārgaśirṣa 24	263 ° 14 '	145 ° 08 '	118 ° 06 ' to	180 °
Tārana	Vakranivarti	Caitra 25	22° 52'	135 ° 01 '	247° 51'	
(2004-05)	Vakragati beginning	Paușa 21	290 ° 20 '	174 ° 57 '	115° 23' to	180 °
Pārthiva (2005-06)	Vakranivarti	Vaiśākha 24	52 ° 26 '	165 ° 01 '	247° 25'	

Nirāyana Longitude of the Sun and Jupiter, during Vakragati of Jupiter, as observed from the Earth<sup>1</sup>

Year.	Type of	Date	Nirāyana Lor	ngitude of	Difference	Around
	Motion	(Souramāna)	(in degrees, minutes)		between Sun &	180°
			Sun	Saturn	Saturn	or $360^\circ$
Vikrama (2000-01)	Vakragati beginning	Śrāva <u>n</u> a 29	147° 45'	37° 15'	110 ° 30 ' to	180 °
	Vakranivarti	Paușa 16	285° 25'	30°20'	255 ° 05 '	
V <u>r</u> șa (2001-02)	Vakragati beginning	Bhādrapada14	163 ° 09 '	51° 13'	111 ° 56 ' to	180 °
(2001 02)	Vakranivarti	Paușa 29	298 ° 19 '	44° 17'	254 ° 02 '	
Citrabhānu (2002-03)	Vakragati beginning	Bhādrapada28	176° 42'	65° 19'	111 ° 23 ' to	180 °
(2002 00)	Vakranivarti	Māgha 12	311 ° 11 '	58° 22'	252 ° 49 '	
Subhānu (2003-04)	Vakragati beginning	Āśvina 12	191 ° 22 '	72 ° 32 '	118 ° 50 ' to	180 °
(	Vakranivarti	Māgha 28	326 ° 58 '	65° 37'	261 ° 21 '	
Tārana (2004-05)	Vakragati beginning	Āśvina 24	203 ° 01 '	93° 26'	109 ° 35 ' to	180 °
()	Vakranivarti	Phālgu <u>n</u> a 13	341 ° 31 '	86° 29'	255 ° 02 '	
Pārthiva (2005-06)	Vakragati beginning	Kārtika 9	217 ° 53 '	107 ° 24 '	110 ° 29 ' to	180 °
<pre></pre>	Vakranivarti	Phālguna 26	355 ° 05 '	100 ° 28 '	254 ° 37 '	

Nirāyana Longitude of the Sun and Saturn, during Vakragati of Saturn, as observed from the Earth<sup>1</sup>

Here, it is seen that the major planets have retrograde motion, whenever they are around 180° away from the Sun, on observed from the Earth. This means, that these major planets and the Sun are exactly at opposite angles of 360° circle, on observed from the Earth, i.e. if the Sun is at 360° (0°), then these major planets will be at 180° or vice versa, during their retrograde motion. Thus, on observed from the Earth, the Sun is on one side, and these planets are on the other side of the sky. Therefore, during the retrograde motion of these planets, the Earth will be in between these major planets and the Sun. Jupiter and the Saturn have retrograde motion every year, because of their slow motion, requiring 11.86 and 29.46 years on an average, to complete one full revolution. Due to this, these two planets will be 180° away from the Sun, every year. Since Mars completes one revolution, in an average of 687 days, in some of the years it will not be at 180° from the Sun. Therefore, during these years, there will be no retrograde motion for Mars as shown in the following table. For example, in Vikrama, Citrabhānu and Tārana years, Mars is only at 140°, 124° and 116° at the maximum, from the Sun and thus, there is no retrograde motion for Mars in these years.

<u>Nir</u> ā	yana Long	gitude of the Su	n and Mars, <b>du</b>	uring V	Vakragati of Mars	, as observed from the Earth

Year.	Type of	Date	Date Nirāyana Longitude of		Difference	Around
	Motion	Motion (Souramāna) (in degrees, minutes)		between Sun	180°	
			Sun	Mars	& Mars	or $360^\circ$
Vikrama (2000-01)		No Vakragati	for Mars		- 21 ° 51 ' to +118 ° 32 '	Only 140° 23'
V <u>r</u> ṣa	Vakragati	Caitra 29	27° 36'	245 ° 19 '	142 ° 17 '	100.0
(2001-02)	beginning				to	180 °
	Vakranivarti	Āṣāḍha 4	93° 36'	231 ° 21 '	222° 15	
Citrabhānu		I			<b>-</b> 36 ° 19 ' to	Only
(2002-03)		No Vakragati	for Mars		+ 88 ° 08 '	124° 27'
Subhānu	Vakragati	Āṣāḍha 14	102 ° 39 '	316° 21'	146° 18'	100 0
(2003-04)	Vakranivarti	DI-1 111	160 ° 40 '	306 ° 20 '	$10^{-10}$	180
	v aki allival ti	Bhadrapada11	100 40	300 20	214 20	
Tārana				<b>-</b> 51 ° 26 ' to	Only	
(2004-05)		No Vakragati	+ 65 ° 19 '	116° 45'		
D= (1:	Volzrogoti	DI-1 117	165 ° 58 '	20 ° 27 '	126 ° 21 '	
Parthiva	beginning	Bhadrapada17	105 58	29 ZI	to 51	180 °
(2003-00)	Vakranivarti	Kārtika 11	235 ° 07 '	14° 19'	220 ° 48 '	100
	I		1	1		

Thus, these tables show that the major planets will move in retrograde motion, on observed from the Earth, only when they are 180° away from the Sun i.e. when the Earth is in between the major planets and the Sun.

The ancient astronomical manuscripts of our Nation also mention clearly that the major planets have retrograde motion, only when they are 180° away from the Sun. For example, **Vațeśvara** Siddhāntaḥ and Gola by Vațeśvaraḥ, in the 9<sup>th</sup> verse of the 4<sup>th</sup> section (Jyārbhivinā Sphutīkaraṇa vidhiḥ), of the 2nd chapter (Sphuṭagatyadhikāraḥ),<sup>6</sup> mentions the Śīghrakendra, at

which these planets move in retrograde motion.

रामाष्टिभिः क्षितिसुतः चलकेन्द्रभागैः वक्रीन्दुजोऽक्षमनुभिः गुरु रड्गसूर्यैः । शुक्रः शरर्तुशशिभिः शनिरग्निरु द्रैः चक्र च्युतैः कुटिलगाः कथितास्त्वमीभिः ।। Rāmāstibhih ksitisutah calakendrabhāgaih vakrīndujo5ksamanubhih

gururańgasūryaiķ

Sukraḥ śarartuśaśibhiḥ Saniragnirudraiḥ cakracyutaiḥ kuṭilagāḥ kathitāstvamībhih ||

Meaning:- 1. Rāma – 3, aşţi – 16, . Rāmāşţi – 163 ; 2. Kşiti – The Earth, Suta – son, Kşitisuta –
Mars; 3.Calakendra - Śīghrakendra; 5. Vakra – retrograde; 6. Indu – Moon, ja – born from, Induja – Mercury; 7. Akşam – 5, Manu – 14, Akşamanu – 145 ; 8. Guru – Jupiter; 9. Ańga – 6, Sūrya – 12, Ańga Sūrya – 126 ; 10. Śukra – Venus; 11. Śarartu – 56, Śaśi – 1, ŚarartuŚaśi – 165 ; 12. Śani –
Saturn; 13. Agni – 3, Rudra -11, AgniRudra – 113 ; 14. Cakra – full circle (360°); 15. Ca – aggregation (along with); 15. Yuta – joined; 16. Kuţilaga – retrograde motion; 17. Kathita – described; 18. asta – Thrown off.

This verse mentions that the Sīghrakendra of Mars is  $163^{\circ}$ , of Mercury  $145^{\circ}$ , of Jupiter  $126^{\circ}$ , of Venus  $165^{\circ}$ , and of Saturn is  $113^{\circ}$ , when these planets start to move in retrograde (backward) motion. They end their retrograde motion and start moving again in forward direct motion at an angle, which if added with their respective Śīghrakendra given above, will make  $360^{\circ}$  (full circle). That means Mars will start to move in direct forward motion at  $360^{\circ}$  subtracted with its Śīghra kendra of retrograde motion ( $163^{\circ}$ ), i.e. (360 - 163) which is equal to  $197^{\circ}$ . In the same way, Mercury starts to move in direct forward motion, at an angle  $360 - 145 = 215^{\circ}$ , Jupiter at  $360 - 126 = 234^{\circ}$ , Venus at  $360 - 165 = 195^{\circ}$  and Saturn at  $360 - 113 = 247^{\circ}$  respectively.

Thus, this verse clearly shows that these planets are moving in retrograde motion when their Śīghrakendra are around 180° only. For example, Mars starts retrograde motion at 163°, 17 less of 180° and ends its retrograde motion 197°, 17 more of 180°. In the same way for Mercury, it is 145°,

35 less of 180° and 215°, 35 more of 180°, for Jupiter it is 126° and 234°, 54 less and more of 180°, for Venus it is 165° and 195°, 15 less and more of 180° and for the Saturn it is 113° and 247°, 67 less and more of 180°. Thus, this verse concludes that the retrograde motion of these planets occur when their Śīghra kendra are around 180°.

				7
The following table shows the	data given ir	various ancient	t astronomical text	s of our Nation $'$
The following table shows the	uata given n	i various ancient	astronomical text	s of our radion.

Planets	Śīghra kendra in degrees ( $^\circ$ ) at the beginning of Vagra gati / at Vakra nivarti						
	Āryabhațța	Brahmagupta,	Sūrya	Mahā	Vațeśvara		
	(Kha <u>n</u> ḍa	Lallācārya	Siddhāntaḥ	Āryabhațța			
	Khādyakam)	Bhāskarācārya		Siddhāntaḥ			
Mars	164 / 196	163 / 197	164 / 196	163 / 197	163 / 197		
Mercury	146 / 214	145 / 215	144 / 216	145 / 215	145 / 215		
Jupiter	130 / 230	125 / 235	130 / 230	125 / 235	126 / 234		
Venus	165 / 195	165 / 195	163 / 197	166 / 194	165 / 195		
Saturn	116 / 244	113 / 247	115 / 245	113 / 247	113 / 247		

Thus the ancient astronomical manuscripts of our Nation concludes that the retrograde motion of these planets occur when their Śīghrakendra are around 180° only. The 16<sup>th</sup> verse of the 2<sup>nd</sup> section (Svoccanīca Graha Sphutīkarana Vidhih),<sup>8</sup> and 54<sup>th</sup> verse of the 1<sup>st</sup> section (Sūryācandramasoh Sphutīkarana Vidhih),<sup>9</sup> of the same 2<sup>nd</sup> chapter in this manuscript, mention that the mean longitude of the planet's Śīghrocca, diminished by the longitude of that planet is defined as the **Śīghrakendra** of that planet. The **Śīghrocca** of a planet, is the Sun (the Earth) or the planet itself, whichever moves faster, as mentioned in the page no.165 of the book **Vaṭeśvara Siddhāntaḥ and Gola by Vaṭeśvaraḥ** 2<sup>nd</sup> part,<sup>10</sup> edited with English translation and commentary by K.S.Shukla. So, the Sun (Earth) is the Şīghrocca for these major planets, since the Sun (the Earth) moves faster than these major planets.

The  $\hat{S}_{\bar{I}}$  ghrakendra of the planets = the  $\hat{S}_{\bar{I}}$  ghrocca of a planet - the same planet's longitude.

For the major planets, the  $\hat{S}_{\bar{I}}$  ghrakendra = Sun's longitude - major planet's longitude,

#### (both on observed from the Earth).

So,  $\hat{S}_{\bar{I}}$ ghrakendra of Major planets, on retrograde motion = Sun's longitude - major planet's longitude = around 180°, as shown in the ancient astronomical texts and almanacs of our Nation.

Thus our Bhāratian almanacs and the ancient astronomical manuscripts concludes that these major planets move in retrograde motion, only when they are 180° away from the Sun, on observed from the Earth. From this one can conclude whether our Bhāratian almanacs and their basic texts, the Bhāratian Astronomical manuals are based on Heliocentric or on Geocentric concept.

## HELIOCENTRIC MODEL

As shown in the figure 6, in Heliocentric model of arrangements of planets, the retrograde motions of the major planets occur, only when they are 180° away from the Sun.



Figure 6 – Heliocentric model – Major planets 180° away from the Sun

The Earth travels on an average of 30° per month, whereas Mars travels on an average of 15.7208°, Jupiter 2.4925° and Saturn 1.0042° per month. This figure shows that the Earth, which is at 150° (E1) from the Sun, travels in two-month duration to 210° (E2). Mars which is at 164° (MA 1) from the Sun, travels to 195.44° (MA 2), Jupiter at 178° (J1) moves to 183° (J2) and the Saturn at 179° (S1) moves to 181° (S2) in two-month duration, in direct forward motion, <u>all on observed from the Sun</u>. But on observed from the Earth, due to the Earth's movement from 150° (E1) to 210° (E2), these major planets which are at Tulā rāśi, appears to retrograde to Kanyā rāśi i.e. Mars from 185° (MA 1) to 172° (MA 2), Jupiter from 185° (J1) to 176° (J2) and the Saturn from 185° (S1) to 179° (S2). The Sun appears to move from 330 to 30, i.e. from the beginning of Mīna rāśi to the end of Meşa rāśi, due to the Earth's revolution round the Sun in the ecliptic, imposed on the Sun. Thus, the major planets appear to retrograde in the opposite direction, when these planets are 180° away from the Sun, on observed from the Earth, in Heliocentric model. R r Ā ā Ī ī Ū ū Ḥ ḥ Ń ń Ñ ñ Ț t D d N n Ś ś Ş ş

On the contrary, as shown in the figure 7, the major planets will not appear to move retrograde when they are in conjunction with the Sun, i.e. in the same longitude as that of the Sun, on observed from the Earth, in Heliocentric model of arrangements of planets.



Figure 7 - Heliocentric model - Major planets in conjunction with the Sun

This figure shows that the Earth, which is at  $150^{\circ}$  (E1) from the Sun, travels in two-month duration to  $210^{\circ}$  (E2). In the same way, Mars which is at  $358^{\circ}$  (MA 1) travels to  $29.44^{\circ}$  (MA 2),

Jupiter from  $356^{\circ}$  (J1) to  $1^{\circ}$  (J2) and the Saturn from  $352^{\circ}$  (S1) to  $354^{\circ}$  (S2) in two-month duration, <u>all</u> on observed from the Sun. But, on observed from the Earth which is at  $150^{\circ}$  (E1), these major planets are at  $350^{\circ}$  initially. In two months duration, Mars moves to  $29.44^{\circ}$ , Jupiter to  $5^{\circ}$  and the Saturn to  $358^{\circ}$ , on observed from the Earth, which is now at  $210^{\circ}$  (E2). Thus, these major planets move in direct forward motion, from Mīna rāśi towards Meşa rāśi, on observed from the Earth (no retrograde motion). The Sun appears to move from  $330^{\circ}$  to  $30^{\circ}$ , i.e. from the beginning of Mīna rāśi to end of Meşa rāśi, on observed from the Earth, due to the Earth's revolution round the Sun in the ecliptic, imposed on the Sun. Thus, these major planets will not appear to move retrograde on observed from the Earth, when they are in the same longitude as that of the Sun, in Heliocentric model.

Therefore, in Heliocentric model, the retrograde motion of the major planets occur, when these major planets are 180° away from the Sun, on observed from the Earth and not when they are in conjunction with the Sun, i.e. in the same longitude as that of the Sun.

#### GEOCENTRIC MODEL

In Geocentric model of arrangements of the planets, the retrograde motion of the major planets occur, when they are in conjunction with the Sun, that too, only on observed from the Sun, which is said to be revolving and not stationary, and no retrograde motion occur when these major planets are 180° away from the Sun. Besides, no retrograde motion of these major planets is possible, on observed from the Earth, which is said to be stationary at the centre. Since our ancestors observed the motion of the celestial bodies, with Earth as the point of observation, i.e. they observed and computed the motion of the celestial bodies from the Earth only, they would have not mentioned anything like retrograde motion of the planets, if they would have adopted the Geocentric model at all. This is because in the true sense, the planets will not at all move in retrograde motion, which is nothing but an apparent backward motion, with respect to the fixed stars of the sky, always observed from a moving object. If observed from a stationary place, there will not be any retrograde motion of any of the planets at all.

Further, the retrograde motion of one moving object occur, on observed from another moving object, only when both the objects are revolving round the same centre, but at a varied distance from the centre. More than that, the retrograding planet's position and speed are important in computing its retrograde motion. For example, if the observed planet moves faster than the observing planet, then this observed planet will move in retrograde motion, when it is in between the centre and the observing planet, which is actually happening with the minor planets, as shown already. Where as, if the observed planet moves slower than the observing planet, then this observed planet moves slower than the observing planet, then this observed planet will move in retrograde motion, when the centre and the observed planet moves slower than the observing planet, then this observed planet will move in retrograde motion, when the observing planet is in between the centre and this observed planet, which is actually happening with major planets, as shown before. Besides, if the observing point is stationary, no retrograde motion of any of the planets is possible. Thus, the mere mention of retrograde motion of these planets itself shows, that our ancestors adopted Heliocentric model only, because our ancestors observed the motion of the celestial bodies with the Earth as the point of observation.





In this figure, the major planets are 180° away from the Sun, on observed from the Earth, with the

Earth in between the Sun and these major planets. In two-month duration, the Sun is said to have moved from  $330^{\circ}$  (Ss1) to  $30^{\circ}$  (Ss2), where as the Mars moves from  $178^{\circ}$  (MA 1) to  $209.44^{\circ}$  (MA 2), Jupiter from  $176^{\circ}$  (J1) to  $181^{\circ}$  (J2) and the Saturn from  $172^{\circ}$  (S1) to  $174^{\circ}$  (S2), all observed from the Earth which is said to be at the centre and stationary. Further, on observed from the Sun, which is at  $330^{\circ}$  (Ss1), the major planets are at  $170^{\circ}$ , initially. After a period of two months, Mars moves to  $209.44^{\circ}$  (MA 2), Jupiter to  $184^{\circ}$  (J2) and the Saturn to  $178^{\circ}$  (S2), in direct forward motion, on observed from the Sun, which is now at  $30^{\circ}$  (Ss2). Thus, if observed either from the Earth or even from the Sun, there is no retrograde motion of any of these three planets, when the major planets are  $180^{\circ}$  away from the Sun in Geocentric model, as shown in the figure 8.





In this figure, major planets are in conjunction with the Sun i.e. in the same longitude as that of the Sun, with the Sun in between the Earth and these planets, on observed from the Earth. In twomonth duration, the Sun is said to have moved from  $330^{\circ}$  (Ss1) to  $30^{\circ}$  (Ss2), where as Mars moves from  $345^{\circ}$  (MA 1) to 16.44° (MA 2), Jupiter from  $357^{\circ}$  (J1) to  $2^{\circ}$  (J2) and the Saturn from  $359^{\circ}$  (S1) to  $1^{\circ}$  (S2) all observed from the Earth, which is said to be at the centre and stationary. Thus on observed from the Earth, as done by our ancestors, there is no retrograde motion of these major planets, when these planets are in the same longitude as that of the Sun i.e. in conjunction with the Sun. However, if observed from the Sun, which is practically not at all possible for human beings, there will be retrograde motion of these major planets, when these planets are in conjunction with the Sun i.e. in the same longitude as that of the Sun, as shown in this figure 9. Here, on observed from the Sun, which is at  $330^{\circ}$  (Ss1), these major planets are at 5° initially. After a period of two months, even though Mars, Jupiter and the Saturn actually move forward by  $31.44^{\circ}$ , 5° and 2° respectively, they appear to retrograde to  $352^{\circ}$  (MA 2),  $355^{\circ}$  (J2) and  $359^{\circ}$  (S2) on observed from the Sun (said to be moving in Geocentric model) which is now at  $30^{\circ}$  (Ss2). Thus, in Geocentric model of arrangements of the planets, the retrograde motion of the major planets occur, only when they are in conjunction with the Sun, that too, only on observed from the Sun and there will not be any retrograde motion of these major planets when they are  $180^{\circ}$  away from the Sun. Besides, no retrograde motion of these major planets is possible, if observed from the Earth.

Thus, the retrograde motion of the major planets occur, in Heliocentric model, when they are 180° away from the Sun and in the Geocentric model, when these major planets are in conjunction with the Sun, (in the same longitude with the Sun), that too, only if observed from the Sun, and not from the Earth. Our Bhāratian almanacs and astronomical manuals, whose statistical data analysed so far, clearly mention that these major planets move in the retrograde motion, only when these planets are 180° away from the Sun, on observed from the Earth and hence our Bhāratian astronomy is correctly based on Heliocentric model of arrangements of planets.

#### CONCLUSION

Our Bhāratian astronomical manuals and almanacs clearly mention the following:-

- 1. The retrograde motions of the major planets occur, only when they are 180° away from the Sun,
- 2. The alternate occurrences of Vakragati and Śīghra gati of the minor planets, on observed from the

Earth and

3. Two heliacal risings and two heliacal settings for the minor planets and the earlier heliacal rising and latter heliacal setting, of the minor planets in their retrograde motion than in their direct forward motion,

which are possible only in Heliocentric model and not in Geocentric model and

- The alternate occurrences of Vakragati and Sīghra gati of the minor planets, on being observed from the Earth, and
- 5. The only one heliacal rising and heliacal setting for the major planets in each revolution, especially none during their retrograde motion, which will occur definitely in Geocentric model, shows clearly that these minor and the major planets revolve round the Sun and not the Earth.

Thus, our Bhāratian astronomy is correctly based on Heliocentric theory only.

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- 2. *Ibid.* the same tables of the same almanacs.
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- 5. *Ibid.* pages 221 and 222 of English translation (part 2), Tables 17 & 18.

- 6. *Ibid.* 9<sup>th</sup> verse of the 4<sup>th</sup> section, of the 2nd chapter, pages 119 of part 1 & 219 of part 2.
- 7. *Ibid.* page 220 of part 2, Table 15.
- *Ibid.* 16<sup>th</sup> verse in the 2<sup>nd</sup> section Svoccanīca Graha Sphutīkarana Vidhih, of the 2<sup>nd</sup> chapter, page 108 of part 1 and 200 of part 2.
- 9. *Ibid.* 54<sup>th</sup> verse of the 1<sup>st</sup> section Sūryācandramasoḥ Sphutīkaraṉa Vidhiḥ, of the 2<sup>nd</sup> chapter, page

93 of part 1 and 165 of part 2.

10. Ibid. page 165 of part 2 (English translation and commentary).

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# DIACRITICAL MARKS FOR ROMAN TRANSLITERATION OF

# DEVANAGARI SCRIPT

- 1. Short Vowels
  - अ.- A, a इ.- I, i उ.- U, u ऋ.- <u>R</u>, <u>r</u> ऌ.- ļ
- 2. Long Vowels
  - आ Ā, ā ई Ī, ī ऊ Ū, ū ए E, e ओ O, o
  - ऐ Ai, ai औ Au, au
- 4. Non-aspirant S
- 5. Consonents

•

क्- K, k	ख्- Kh, kh	ग् - G, g	घ्-Gh, gh	ङ् - Ń, ń
च् - С, о	c छ् - Ch, ch	ज् - J, j	झ् - Jh, jh	স্ - Ñ, ñ
ट् - Ț,ț	ठ् - T़h, țh	ड् - Þ, d	ढ् - Dh, dh	ण् - <u>N</u> , <u>n</u>
त् - T, t	थ् - Th, th	द् - D, d	ध् - Dh, dh	न् - N, n
प् - P, p	फ्Ph, ph	ब् - B, b	भ् - Bh, bh	म् - M, m
य् - Y, y	र् - R, r	ल् - L, I	व् - V, v	
श् - Ś,ś	ष् - Ṣ, ṣ	स् - S, s	ह् - H, h	
6. Compound	l letters - क्ष् - Kş, kş	र्ज् - Jñ, jñ	त्र् - Tr, tr	

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