

NARADA PURANA

CHAPTER THREE

The Description Of The Sphere Of The Earth And Of Bhārata

Nārada enquired :

1. How did the Omnipresent Primordial Deity create Brahmā and others, formerly ?¹ O Sanaka, narrate this unto me, since your worship is omniscient.

Śrī Sanaka narrated :

2. Nārāyaṇa is imperishable and Infinite. He is omnipresent and unsullied. This entire universe consisting of the mobile and immobile beings is pervaded by him.

3. At the time of the first creation,² the self-luminous great Viṣṇu constituting the universe, presided over a differentiation in the *guṇas*, and created the three forms of the deities.

4-5. Formerly, the Lord created god Brahmā from the right part of his Person, for the purpose of creation (of the worlds), O sage; from the middle, he created Īśāna (the Master) called Rudra, who causes the dissolution of the universe. For the sake of protecting this universe, he created the immutable Viṣṇu from his left side. Some designate that imperishable Primordial Lord by the epithet Śiva, some by the name Viṣṇu (the Eternal Truth), while some call him Brahmā.

6. Viṣṇu's Supreme Śakti³ (Energy) stimulating the process of the universe is both positive and negative (existent and non-existent) in nature, and is described 'Vidyā-avidyā' (Spiritual Knowledge and Ignorance or Nescience).

7. When the universe appears as distinct and separate from Great Viṣṇu, that is the accomplishment (effect) of Nescience which is the cause of misery.

8. O Nārada, when the conditioning factors such as the knower, the knowable etc. fuse together, and cease to exist,

the knowledge or comprehension of the oneness of everything (in the universe) i.e. the existence of only one entity, viz., Brahman, is called Vidyā (spiritual lore).

9. Thus the Māyā of the great Viṣṇu, if seen as distinct and separate from him, bestows (i.e. involves one in) the worldly existence, but if realized with the consciousness of non-difference from him, it brings about the destruction of the Saṁsāra (or metempsychosis).

10. The entire universe of the mobile and immobile beings, has been originated from Viṣṇu's (illusive) potency. All these things whether they move or not are different from it.

11. Just as, by means of the conditioning factors (such as a pot, a room) the ether differs (as the ether conditioned by the pot, etc.), so also the entire universe appears different through the conditioning factor of *avidyā* (Nescience).

12. O Sage, even as Lord Hari pervades the entire universe so also does his (potency), just as the burning capacity of a (heated, fiery) coal manifests itself by pervading its substratum.

13. Some call this potency (*Śakti*), Umā,⁴ others call it Lakṣmī, still others call it Bhārati, Giriḅā and Ambikā.

14-15. The great sages designate her as Durgā, Bhadrakālī, Caṇḁī, Māheśvarī, Kaumārī, Vaiṣṇavī, Vārāhī, Aindrī, Śāmbhavī, Brāhmī, Vidyā (spiritual knowledge), Avidyā (Nescience), Māyā (The illusive potency of the Lord) and *Parā Prakṛti* (The Supreme Primordial Nature).

16. *Śeṣaśakti* is Viṣṇu's transcendental power, the cause of creation, etc. of the universe. It pervades the universe in its 'manifest-cum-unmanifest form', and abides therein.

17. One of these is the cause of creation, maintenance and dissolution, viz., *Prakṛti* (The Primordial Nature), *Puruṣa*, *Kāla* (Time), *Vidhi* (abidance of the opportune time or fate) and *sthiti* (steadiness or continuance in one state).

18. All this (universe) has been created by the deity assuming the form of Brahmā, but it is (authoritatively) stated that the Supreme Deity transcends him and is eternal.

19-22. The God who protects is called the Eternal Deity. The Lord who protects is the *Puruṣa*, greater than and beyond the worlds. What is greater than and beyond him is the highest

imperishable region. (He is called) *akṣara* (the imperishable), *Nirguṇa* (devoid of attributes), *Śuddha* (pure), *Paripūrṇa* (perfect, complete) and *Sanātana* (eternal). The greatest being is called *Kālarūpa*. He is greater than the greatest, worthy of being meditated upon by *yogins*. He is the greatest *ātman*, the greatest bliss, devoid of all conditioning factors. He can be realised only through perfect knowledge. The greatest Being has Existence, Knowledge and Bliss for his physical bodies.

23. Although he is the greatest and the purest, He is accompanied by the Ego, and is then called *dehin* (the embodied soul) by persons of confused mind. Alas, the deception of Ignorance !

24. That greatest and purest Lord, on being differentiated through Sattva etc., assumes the forms of three Deities, and causes Creation, Sustenance and Dissolution.

25. The deity who is the creator of the universe is Brahmā. The deity from whose umbilical lotus Brahmā came out is the *ātman*, in the form of Bliss. O sage, none except him is so.

26. He is the immanent Soul. He pervades the universe. He is the Cosmic witness. He is unsullied, The great *Īśvara* abides both as different and non-different.

27. His *śakti* is the great *māyā*, the trustworthy upholder of the universe. In view of its being the material cause of the universe, it is called *prakṛti* by scholars.

28. Of Viṣṇu who was exerting for creation of the the worlds, at the time of the primordial creation, there evolved three-fold forms, viz. *Prakṛti* (primordial matter), *Puruṣa* and *Kāla* (Time-spirit).⁵

29. What men of purified souls perceive as the pure highest, resplendent asylum called Brahman, is the supreme region of Viṣṇu.

30. The pure, imperishable, infinite Maheśvara in this way assumed the form of Kāla (Time spirit), and with a form constituted of and affording support to *guṇas* (modifications of Prakṛti e.g. *sattva* etc.) the omnipresent Lord became the primary creator of the world.

31. When *prakṛti* became agitated⁶ through the Lord of the world called Puruṣa, the principle of *Mahat* became manifested. Therefrom evolved the *Buddhi* (Intellect) from which originated the *Ahaṁkāra* (Cosmic Ego).

32. From the Cosmic Ego were evolved the subtle primary elements called the *tanmātras* and the subtle sense organs. All the gross elements were evolved out of the *tanmātras* for the creation of the universe.

33. Of the elements, viz., the ether, air, fire, water and the earth the former becomes the cause of the latter one, in the due order, O Nārada, the son of the lotus-born god Brahmā.

34. Thereafter, Lord Brahmā, the creator of the universe, (at first) created the *tāmasa* beings⁷, viz., the sub-human beings such as creatures, beasts, birds, deer, etc.

35. Considering that the *Deva-sarga* (the creation of celestials) was non-productive and fruitless, god Brahmā the eternal lotus-born deity, conceived of and created the *Mānuṣa-sarga* (the creation of human beings).

36. Thereafter, he created Dakṣa and other sons who were exclusively devoted to the task of creation. All this entire universe including gods, demons and human beings, is occupied through these sons.

37. The following seven regions⁸ are stationed above : (above the earth) *Bhūḥ*, *Bhuvaḥ*, *Svaḥ*, *Mahaḥ*, *Jana*, *Tapas* and *Satya* (each one is above the other).

38-39. There are seven nether worlds,⁹ each below the other, viz., *Atala*, *Vitala*, *Sutala*, *Talātala*, *Mahātala*, *Rasātala* and *Pātāla*. He created the guardians of the worlds also, for all these regions.

40. He duly created the principal (seven) mountains and rivers in each of these worlds, and assigned specific means of livelihood befitting the residence of the respective worlds.

41. The mountain Meru, the resort of all gods, is located at the centre of the surface of the earth. The Lokāloka mountains¹⁰ form the farthest end (limit) of the earth. In between them are the seven seas.

42. O, prominent Brāhmaṇas ! There are seven continents¹¹ and each continent has its own (chain of) principal mountains, and well-known rivers flowing therein, and the people thereof resemble the immortals i.e. gods.

43. The names of the continents are : *Jambū*, *Plakṣa*, *Śālmala*, *Kuśa*, *Krauñca*, *Śāka*, and *Puṣkara*. All of them are regions (traversed by) gods.

44. These seven continents are surrounded by seven

oceans,¹² each having (for its liquid content) salt water, sugar-cane juice, wine, ghee, curds, milk and sweet water.

45. These continents and oceans should be understood (to have dimensions) in this manner : the latter one is double the former one in extent, and the same with the Lokāloka mountains.

46. The continent which is to the north of the salt sea, and to the south of the mountain Himālaya should be known as *Bhārata Varṣa* — the Indian continent. This continent confers the fruit of all actions.

47. O Nārada ! People perform three types of holy acts here, the fruit thereof is enjoyed in the following order : enjoyment of desired pleasures, land and affluence.

48. If any act whether auspicious or inauspicious is performed in *Bhārata*, the fruit thereof, being of a perishable nature, is enjoyed by the creatures elsewhere (in the other worlds).

49-51. Even today the celestials desire to secure birth in the *Bhārata-varṣa*. They think, “Great, auspicious, pure and everlasting merit has been accumulated by us. When shall we get the opportunity of being born in the *Bhārata varṣa*, where we shall attain to the supreme region (i.e. liberation) thanks to the great merits. Through charitable gifts or performance of different kinds of sacrifices or various types of penances, we shall attain to Lord Hari, the Ruler of the Universe, of eternal bliss and free from ailments.”

52. O Nārada ! There is no one else in all the three worlds comparable in merits to that person who, after being born in *Bhārata*, is devoted to the worship of Viṣṇu.

53. A person habitually glorifying Lord Hari or a person beloved of his devotees or one who is eager to render service to the great persons, is worthy of being bowed down by the heaven-born gods.

54. A person delighting in the worship of Lord Hari or his devotees or a person regularly partaking of the leavings of the food of the devotees of Hari, attains to the highest region of Viṣṇu.

55. He who constantly utters the names of Viṣṇu, such as Nārāyaṇa, Kṛṣṇa, and Vāsudeva, and who is quiescent and devoted to non-violence, etc., is also worthy of being saluted by the foremost ones of gods.

56. It is traditionally remembered (i.e. laid down in *Smytis*) that he who constantly remembers (and mutters the divine names) Śīva, Nīlakaṇṭha and Śaṅkara¹³ and is always engaged in doing good to all living beings, deserves to be worshipped by the celestials.

57. One devoted to his preceptors, a person meditating on Śīva, a man engaged in performing the duties prescribed for his own stage of life, one devoid of jealousy and one who is pure, is worthy of being adored by leaders of gods.

58. One who is a benefactor of Brāhmaṇas, one who cherishes faith (in the duties prescribed for) *varṇas* (classes in society and their duties), one who is ever devotedly engaged in propounding the Vedas, should be regarded as one who sanctifies all persons who sit in the same row to dine with him.¹⁴

59. A person who looks upon the pair of the Lords of gods consisting of Nārāyaṇa and Śīva equally without any discrimination, should always be saluted by god Brahmā. What need be said of persons like us? (We must definitely worship him).

60. A person who has established perfect control over his senses and organs, is celibate, refrains from slandering others and invariably abstains from having any possession (or acceptance of monetary gifts), is, O Nārada, worthy of being worshipped even by gods.

61. One who is averse to such censurable acts as stealing, is full of gratefulness, is a man of purity and truthful speech and takes delight in rendering help to others, deserves to be worshipped by gods and demons.

62. He whose mind and intellect are inclined to listen to the exposition of the *Vedas* and the *Purāṇas*, and is keen in associating with the righteous persons, deserves respect and salutations from excellent ones amongst the gods.

63. Association with such persons be established by us — with persons who perform such and other sacred rites with perfect faith, in this continent of Bhārata.

64. If anyone, despite being a Brāhmaṇa, does not begin any one of these sacred or holy activities, he is a man of wicked actions, dullard in mind, and none else is more insensible than he.

65. Even after being born in Bhārata, a person who is

totally averse to the performance of righteous acts, is like a person who prefers a pot of poison spurning aside the jar of nectar.

66. O sage, a person who does not sanctify himself by performing religious rites prescribed in the *Vedas* and the *Smṛtis* is the leader of sinners, confounder of his own self.

67. O prominent sage ! After attaining birth in the land of holy rites (i.e. Bhārata), if one does not abide by the path of righteousness (*dharma*), he is decried as the meanest of all, by knowers of the *Vedas*.

68. He who eschews auspicious rites and acts and performs evil deeds is (like a person who) abandons (the milk of) the wish-yielding cow (*Kāmadhenu*) and seeks the milk-like exudation from the sun plant (*arka*).

69. O leader of Brāhmaṇas ! In this way even the inhabitants of heaven like god Brahmā and others who are afraid of the termination of their period of enjoyment of pleasures, praise the land of Bhārata.

70. Hence, the excellent subcontinent of Bhārata should be regarded as exceedingly meritorious. It is accessible with great difficulty even to gods. It bestows the fruits of all holy rites and actions.

71. In the three worlds, there is no one comparable to that person who diligently attempts to perform good and righteous acts in this holy land.¹⁵

72. A man who is born in this land and who attempts to destroy and exhaust the balance of his actions in previous birth, is Lord Hari himself in the guise of a man. There is no doubt about this.

73. One who is desirous of attaining the highest worldly benefits or fruits, should vigilantly perform righteous and holy acts. If an act is performed, after dedicating with devotion the fruit thereof unto Lord Hari, that fruit is said to be ever lasting.¹⁶

74. If one is devoid of any desire for the fruits of actions, one shall not cause any such acts to be done. He should dedicate a pious and religious act (to Lord Hari) by saying, "May Lord Hari be hereby pleased with me".

75. All the worlds upto and including the region of god Brahmā are the bestowers of rebirth. But a person who has

no desire for the fruit even of meritorious acts, attains to the highest region namely *Mokṣa* — Liberation from *samsāra*.

76. It is just for the propitiation of the Lord of the Universe, that one should perform sacred rites and actions prescribed in the Vedas as per his stage in life (*āśrama*). One who is desirous of renouncing all *karmas* altogether including even those prescribed for his *āśrama* (stage of life), attains to the Eternal Region.

77. Irrespective of one's desire for obtaining the fruit thereof, one should perform the holy rites in accordance with the injunctions laid down in the *śāstras* (for performance of sacred acts). One who is fallen from the conduct of life (performance of duties) befitting the stage of his life, is called "a fallen fellow" by wise persons.

78. A Brāhmaṇa devoted to righteous conduct shines forth with Brahmanical splendour. O Nārada ! Lord Viṣṇu also is propitious to him who is endowed with devotion.

79. If, after being born in the continent of Bhārata a person does not redeem himself, he is tortured in the terrible hell as long as the moon, the sun and the stars shine.

80. Real *Dharma* has Vāsudeva as the highest object. Penance is to be solely devoted to Vāsudeva. Perfect knowledge refers to Lord Vāsudeva and Lord Vāsudeva is the ultimate goal.

81. The entire Universe including the mobile and the immobile beings, from god Brahmā down to a clump of grass, is identical with Lord Vāsudeva. There is nothing else other than he.

82. He alone is god Brahmā, the Creator of the Universe as well as god Rudra, the destroyer of *Triṇipuras* (Three Cities). He alone has assumed the forms of gods, demons, and sacrifice. He alone constitutes this *Brahmāṇḍa* (Cosmic Egg). There is nothing else that is separate and distinct from him.

83. There is nothing else greater than he. There is nothing more minute or more immense than he.¹⁷ All this wonderful Universe is pervaded by him. One should bow down to that Lord of gods, worthy of being praised.

CHAPTER THREE

The Descriptions of the sphere of the earth and of Bhārata

1. The description of the creation of the universe is the 1st characteristic of all Purāṇas. The famous verse enumerating 5 characteristics of Purāṇas :

Sargaśca prati-sargaśca varṣo manvantarāṇi ca |

Varṣānucaritaṁ ceti purāṇam pañca-lakṣaṇam ||

is found with slight modifications in *V.P.*3.6.25, *A.P.*1.14, *BS.P.* (*Bhaviṣya Purāṇa*) 2.5, *M.P.*64, *Bd.P.-Prakriyā* 1.38 etc. Naturally after eulogizing god Viṣṇu, (*NP.* is a Vaiṣṇava Purāṇa), the *NP.* opens with the 1st topic, viz. creation of the universe, although the chapter is designated by the author as 'The description of the earth and that of Bhārata'.

2. Though *NP.* as a Vaiṣṇava Purāṇa, treats Viṣṇu, as the Supreme Brahman, the theory of the evolution of the universe is strongly influenced by the Sāṅkhya theory of evolution. It is, of course, the Theistic Sāṅkhya and not the Agnostic. In the Primary Creation, the credit of the differentiations of three *guṇas*, the modes of *Prakṛti*, into *sattva*, *rajas* and *tamas*, is given to the All-Pervading Viṣṇu who created the functionaries or Agents of the Creation, sustenance and destruction of the Universe, viz. Brahmā, Viṣṇu and Rudra from himself. Vide vv.4 & 5 below.

3. The *Vaiṣṇavī Śakti* (the Supreme potency of Lord Viṣṇu) is the real force that stimulates the process (creation, etc.) of the universe. It is noteworthy that the Purāṇa author regards *Vidyā* (Spiritual Knowledge) and *Avidyā* (Nescience) as both sides of the same coin as it were. This potency of the Lord is called by various names such as Umā, Lakṣmī, etc. vide vv. 13-15 below. And also of *BVP-Kṛṣṇa-Janma-Khaṇḍa* 118.35 where Śakti (Pārvatī) tells the Śaiva pantheon : 'I am Mahālakṣmī in Vaikuṅṭha, Rādhā in Goloka, Śivā in the region of Śiva, and Sarasvatī in the abode of god Brahmā.'

4. Although the *purāṇa*-writer appears to give synonyms of *Vaiṣṇavī śakti*, he is actually describing or summarizing the various aspects of this potency. Thus Māyā emphasizes the illusive power, *Vidyā*, the Spiritual Knowledge, *Avidyā*, Nescience, *Parā Prakṛti*, the Supreme Primordial nature, and the *Śaktis* of various gods like Brāhmī, Aindri, etc. are given to emphasize that whatever feats these gods achieve are due to the motive force of Viṣṇu.

5. *Kālah svabhāvo niyatir yadṛcchā. etc.—SV.Up.*1.2

N.P. broadly follows the concept of Time, as delineated in the *Bh.P.* e.g. 3.10.11 ff, 3.26.18ff. etc. According to the *Bh.P.*, Time is the Supra-phenomenal Reality. It pre-exists creation. Its primary function is to disturb the equilibrium of the *guṇas* of *Prakṛti* and thus set in motion the process of creation. It is a complex concept and appears to be a mixture of three aspects—God, the Power of God and the Time sequence. Time as a power of motivation does not simply stop with disturbing the equilibrium of the tri-partite matter (*guṇa-mayī ātma-māyā*), but pursues the creative process at every stage. If God is the agent-cause of creation, Time is the efficient cause. Creation takes place through

the force or operation of Time. It is classified as : (i) *Prākṛta* (material) (ii) *Vaikṛta* (elemental) and (iii) *Prākṛta-Vaikṛta* (mixed, material-cum-elemental). The Bh.P. states that the following 10 types of creations are brought about by the motive-force of *Kāla* :

I. *Prākṛta* : (i) *mahat*, (ii) *ahaṅkāra* (ego), (iii) *tanmātras* (subtle sense-organs), (iv) External sense-organs, (v) presiding deities of senses and the mind, (vi) *aviḍyā* (with its five 'knots').

II. *Vaikṛta* : (i) vegetations (ii) animals (iii) human beings.

III. *Prākṛta-Vaikṛta* : (i) Divinely human souls, e.g. Sanatkumāra, etc. It is called *Kaumāra sarga*.

V.P. 5.1-25, MK P. 47 and other *Purāṇas* enumerate 9 (nine) types of creations as follows :

I. *Prākṛta*: (i) *Brāhma* vide *mahat* of the Bh.P. (ii) *bhūta* vide *tanmātras* of the Bh.P. (iii) *Vaikārika* corresponds to (iv) & (v) of *Prākṛta* creation of the Bh.P.

II. *Vaikṛta* : (i) *mukhya* or *Tāmasa* creation of immobiles and immovables :
mukhyā vai sthāvarāḥ smṛtāḥ |—V.P.1.5.21

(ii) *tiryak*—(birds and beasts) (iii) *deva* (celestial beings) (iv) *mānuṣa* (human beings) (v) *anugraha*—(both *Sāttvika* and *Tāmasa*) vide VP. 1.5.24.

About this II-v MK.P. 47.28 and *Vāyu P.* 6.57 state :

Pañcamo'nugrahasargaś caturdhā sa vyavasthitāḥ |
vīparayaṇa śaktyā ca tuṣṭyā siddhyā tathaita ca ||

Bh.P. & other *purāṇas* agree about the 3rd type of creation.

6. This is the *Prākṛta* creation.

7. This is the *Vaikṛta* creation, vide 65 above.

8. These seven *lokas* represent the different parts of the upper half of the Cosmic Man's (*Virāja-Puruṣa's*) body. Vedic cosmogony as found in the *Puruṣa* (RV.X.90), *Nāsadiya* (RV X. 129) and *Hiranyagarbha* (RV.X.121) *sūktas* presuppose cosmic water, Viṣṇu, the primordial creator and three worlds : *Prthvī*, *Antarikṣa* and *Dyau*—the earth, intermediate space and the sky. *Bh.P.* adopted these three worlds as *bhū*, *bhuva* and *Svar* respectively. But the still upper regions *mahar*, *jana*, *tapas* and *satya* is a later—*purāṇic*—contribution. Even *Bh.P.* has vague idea about these four upper regions. They are separated from the lower three worlds by a boundary mountain *Lokālokācala* which shuts out the light of the sun and other luminaries to these higher four worlds.

These seven *lokas* are also regarded as the 'planes' of existence, the lowest being our terrestrial globe (*bhū*) and the highest, *satya*—the region of god Brahmā.—*Bh.P.*5.22 V.P. 2.7, *Vāyu* 50.

9. These represent the lower part of the body of the Cosmic Man. These regions are below our earth and do not receive the light of the Sun (*Bh.P.* 5.24.11). In *Atala* lives Bala, the son of Maya. *Vitala* is the region of god Śiva with His divine Consort *Bhavāni*. In *Sutala* reigns Bali with Lord Viṣṇu as his door-keeper. *Mahātala* is the region of serpents and *Rasātala*, that of *Daityas*, *Dānavas* and *Paṇis*. *Talātala* is the residence of Maya, under the protection of god Śiva. The last of the nether-world is *Pātāla*, the kingdom of *Vāsuki*, the serpent king. All these regions are held together by *Saṅkarṣaṇa* (The principle of gravitation (*Bh.P.*5.ch.24 & 5.25.1). To regard Mexico as *Pātāla* and identify the *Mayas* thereof with demon Maya of *Purāṇas* is only a

clever theory of Chamanlal in *Hindu America* though it must be conceded that he made out a good case for it. *Bh.P.5.24, VP. 2.7, Vāyu 50.1-48.*

10. *Lokāloka mountain :*

This mountain is the dividing range between *Loka* i.e. regions illuminated by the Sun and other heavenly bodies and *Aloka*—those regions like *mahar, jana, tapas* and *satya* which do not receive such light. It is beyond the 'sea of sweet water' and encircles it. All the seven great continents and seven oceans etc. lie between Mount Meru and Lokāloka mountain—the distance between them being twelve and half crores of *yojanas*. The tract beyond the ocean of 'fresh water' upto Lokāloka mountain is 'a land of gold shining like a sheet of mirror. Nothing that goes or is dropped there ever returns'. God Brahmā has posted four big elephants, viz. *R̥ṣabha, Puṣkara, Vāmana* and *Aparājita* in four cardinal points beyond that mountain, for retaining the stability of the world—*Bh.P.5.20.34-39.*

11. *Seven Continents :*

The dominant cosmographical conception of the *Purāṇas* is that of the earth consisting of seven concentric island-continents (*saptadvīpā Vasundharā*). Each continent has its own chain of principal mountains, river-systems. The names of these continents, as enumerated in the next (43rd) verse, are : *Jambū, Plakṣa, Śālmala, Kuśa, Krauñca, Śāka* and *Puṣkara*. This order of *dvīpas* is found also in *VP.2.4, Bh.P.5.20* but *M.P. 121, 122, AP. 108.1-3* differs, though all begin with *Jambūdvīpa*. The following is briefly the Purāṇic conception of these *dvīpas* :

(1) *Jambū dvīpa* with mount Meru or Sumeru at the centre and surrounded by the ocean of *Lavaṇa* (salt water). It is identified with India and the land around it as *Bhārata varṣa*—a prominent part thereof is 'to the north of the salt sea and south of the Himālayas' (*NP. 1.3.46* below) and the glorification of this holy land from vv.47-72 below leaves no doubt that India is the land so praised.

(2) *Plakṣa*—Surrounding the *Lavaṇa* ocean and surrounded by the ocean of *Ikṣu* (sugarcane juice).

(3) *Śālmali*—Surrounding the *Ikṣu* ocean and surrounded by the ocean of *Surā* (wine); probably *Chaldea*—*chal-dia* < *śālmali dvīpa* : Ancient region SW Asia on the Euphrates and Persian Gulf (*Webster—College Dict. P. 1106*), if the derivation recorded by N.L. De in *GDAM I*, p.175 be correct. But the rivers *Nirvṛtti* and *Vitṛṣṇā* mentioned by him in *Brahmāṇḍa P. Ch.53* are not traced in Jagdish Shastri's new edition (Motilal Banarsidass, Delhi) either at ch.19 describing *Plakṣadvīpa* or ch. 53 as mentioned by De at the corresponding ch. therein.)

(4) *Kuśa*—Surrounding the *Surā* ocean and surrounded by *Sarpis* (Ghee) ocean. *Purāṇas* state that the source of the Nile is in a lake in the *Kuśa dvīpa*. It is, of course, a region in Africa. Ancient Persian inscriptions mention a country called 'Kusha' and its people 'Kushiya' "There is no doubt that Kusha was situated in North East Africa beyond Egypt" D. C. Sircar—*GAMI P. 25*. Probably it is Ethiopia.

(5) *Krauñca*—Surrounding *sarpis* ocean and surrounded by the ocean of *Dadhi* (curds).

(6) *Śāka*—Surrounding the *Dadhi* ocean and surrounded by the ocean

of Milk. It is obviously the land of Śakas or Scythians of the Greeks. Dr. Ray Choudhary identifies it with Seistan (<Śākasthāna) in Eastern Iran, the land of the Māgi and of the Mihira cult and its inhabitants. The *Maga-dviṣas* worshipped *Sūrya-rūpadhara Hariḥ*. There had been three settlements of Śakas—modern Mesopotemia, Helmund in Eastern part of Iran and Seistan. D.C. Sircar weighs the evidence and states, “Śaka-dvipa in the original Purāṇic conception, is the Śaka settlement in the Oxus and Jaxartes valleys in Central Asia” (*GAMI*. P. 25).

(7) *Puṣkara*—Surrounded by *Surā sāgara* ‘A portion of Central Asia commencing from the north of the Oxus including Western Tartary. Perhaps it has preserved its name in Bhushkara or Bokhara’—N.L. De *GADMI*, p. 163.

It will be seen that though the idea of concentric islands is poetic, there is some geographical reality about some lands in these Purāṇas. This conception of *sapta-dvīpā vasumatī* is as old as Patañjali (187-151 B.C.) and has strongly influenced Jain works like *Tiloya pannatti* : *GAMI*, pp. 22-24.

12. Seven Seas surrounding these island continents are traditionally mentioned as in v.44-B.

lavaneḥḥṣu-surā-sarpīr-dadhi-kṣīra-jalaih samam |

i.e. seas consisting of (1) Salt water, (2) Sugar-cane juice (3) wine, (4) ghee, (5) curds, (6) milk and (7) sweet water. N.L. De locates them as follows :

(1) *Lavaṇa* (salt water) : The Indian Ocean surrounding *Jambū dvīpa* or India.

(2) *Ikṣu*—(Sugar cane juice). *Ikṣu* is another name for the Oxus (*V.P.* 2.4.66 mentions this as a river). De explains, “Here the river is taken as a sea.”

(3) *Surā* (wine)—Corruption of the sea of Sarain, another name for the Caspian sea and it formed the Southern or south-eastern boundary of *Kuśa dvīpa*.

(4) *Sarpis* or *Ghṛta* (Clarified butter)—It is a corruption of the Erythraean sea or the Persian Gulf and formed the boundary of Śālmali-dvipa or *Chaldia* i.e. Assyria.

(5) *Dadhi*—(curds) : The sea of Aral, *Dadhi* is Sanskritisation of *Dahi* (*Dahae*) the name of a Scythic tribe which lived in the upper Jaxartes and evidently on the shores of this lake, it formed the boundary of *Krauñca dvīpa*.

(6) *Kṣīra* (Milk) : It is a corruption of Shirwan sea, as the Caspian sea was called, and it formed the northern boundary of *Śāka dvīpa*.

(7) *Jala* i.e. *Svādūjala* (sweet water)—Perhaps a corruption of *Tchadun*, a river in Mongolia forming a boundary of or flowing through *Plakṣa dvīpa*—*GADMI*, p. 179.

Rivers and seas were formerly designated by the same word. Hence some rivers came to be understood as ‘seas’ in Purāṇas. The extent of some seas like the Caspian and the Aral were different (much larger than at present) in ancient times. But the unanimous tradition in Purāṇas shows a race-memory and not a geographer’s report of an expedition. The above is enough to show that geography in Purāṇas is not all imagination, but had some basis in reality.

13. Though NP. is a *purāṇa* of the Viṣṇu group, it does not show the bitterness of later Vaiṣṇavas against Śiva. On the contrary, it advocates the oneness of Śiva and Viṣṇu both being the forms of *Para-Brahman*. vv.4-5 above state

that the trinity—Brahmā, Viṣṇu and Rudra are the forms of Nārāyaṇa or Mahāviṣṇu. This is the breadth of outlook consistently shown by the *N.P.* 14. *Pañkti-pāvanaḥ* : *Pañkti* is a row of diners. The *Dharmaśāstra* prohibits sitting in the same *pañkti* with undeserving persons. But some highly religious persons sanctify the row of diners by sitting with them in the same row for dining. The 'sanctifiers of rows of diners' are persons who know the 6 *aṅgas* of the *Veda*, who have studied the *Jyēṣṭha-sāman*, who have enkindled the *Nāciketa fire*, who know the three *madhu* verses, who have studied the text called *trisuparṇa*, who maintain 5 fires, have taken ceremonial bath after finishing Vedic studies (*snātaka*), know the *mantras* and *Brāhmaṇas* of their respective *Veda*, who have studied *Dharma-śāstra* and who are born of a woman married in the *Brāhma* form. *pañkti-pāvanaḥ ṣaḍaṅga-vij jyēṣṭha — sāmikas tri-nāciketās tri-madhūs tri-suparṇaḥ, pañcāgñiḥ snātako mantra-brāhmaṇa-vid dharmajño brahma-deyānusantānaḥ* //

—Gautama dh.Sū XV. 29.

In this *jyēṣṭha-sāmaka* is the reciter of *udu tyam* (RV.I.50.1) and 'citram' (R. I.115.1) which constitute the *sāman* of the *Talavakāras*. (Haradatta on *Gaut.* above).

The *nāciketa fire* is described in *Tait.Br.III.11.7 & 8* and *Kaṭha Up.* I. 1.17-18.

Tri-madhu is the reciter of RV.I.91-6-8 each of which begins with the word *madhu*. It can, however, be claimed that this term refers to the knower of *madhu-vidyā* mentioned in *Śatapatha BR.IV.1.5.18* and *Br.Up.* II.5.16. But this *vidyā* does not explain the word *tri* in *tri-madhu*. *trisuparṇa* are the *anuvākas* of *Tait.Ar.Q.48-50 brahmaetu mām, madhu etu mām* etc. in this side of the country, but Haradatta alternately suggests the 3 verses in RV. X.114. 4-6 (*ekas Suparṇaḥ, etc.*)

The topic is discussed in *Baudhāyana Dh. Sū.* II.8.2, *Āpastamba Dh.Sū.* II.7.17 21-22, *Manu* III. 184-86, versified *Śaṅkha. Smṛti* 14.1-8 *MBh. Anuśā-sana* 90.34, *Vāyu P.* chs. 79 & 83, and other *Purāṇas* which give long lists of such 'sanctifier *Brāhmaṇas*'. The list in *NP.I.3.57-58* above is already covered in the above-mentioned works.

15. The glorification of *Bhārata* in the above verses is common to a number of *Purāṇas* e.g. *Bm.P.* 27.2, 70.21-24, 143.8-11, *VP.* 2.3.2, 22-26. The common verses in these *Purāṇas* suggest that they belong to some ancient common source
16. Verses 73-76 advocate *Niṣkāmakarma-yoga*, *NP.* insists that a person should perform all the religious rites etc. prescribed for his particular social class (*varṇa*) and stage of life (*āśrama*) in *śāstras*, without coveting for its fruit but should dedicate it to the Lord. As *BG* 9.27 says whatever one does should be dedicated to Me (the Lord).

yat karoṣi yad aśnāsi yaj juhoṣi dadāsi yat |

yat tapasyasi Kunteya tat kuruṣva madarṇaṇam //

As *Śaṅkara*, the great *advaitin* happily put it in his famous hymn *parā pujā* (the supreme worship)

yad yat karma karomi tat tad akhilaṁ Śambho tavārādhanaṁ |

'Whatever act I do, Lord Śiva, each and everything of it is thy worship.'

17. An echo of *upaniṣadic mantra*

aparāṇīyān mahato mahīyān etc. — *Kaṭha* 2.2—, 2.20, *Śvet. Up.* 3.20 *mahānārāyaṇa* 8.3, *Kaivalya* 20.

91. In order to find out the horse taken away by Indra with his physical body invisible, the sons of Sagara were extremely surprised and they wandered over the earth and other worlds in search of it.

92. When they could not trace the horse, they attempted to make their way to the *Pātāla*, the nether-world. And each one of them severally dug up the earth's surface to a depth of a *Yojana* (eight miles).

93. The earth dug out by them, they scattered on the shores of the ocean. All the sons of Sagara reached *Pātāla* through that passage.

94-96. The sons of Sagara who were perplexed and mad with arrogance searched for the horse. There they beheld the noble-souled Kapila dazzling with the lustre of ten million suns together, absorbed in meditation. And they espied the sacrificial horse near him. On seeing the sage they became very furious. With great speed they rushed at him and attacked him with the intention of killing him.

97-98. They shouted to one another : "Let him be struck down. Let him be struck. Let him be slain. Let him be killed. Let him be taken captive. Let him be quickly taken prisoner. It is he only by whom the horse is taken away and like a stork he pretends to be absorbed in meditation, showing off to be a saint. Alas ! There are wicked persons in this world who put up a great show (of saintliness)".

99-100. Shouting thus, they laughed and jeered at Kapila, the leader of sages who had exercised perfect control over his sense organs and stabilized his mind in the *Ātman*. As he was absorbed in meditation, Kapila did not notice their activities.

101. Those sons of Sagara whose death was imminent, lost their sense and kicked the sage, while others caught hold of his arms.

102. When the sage left off his trance, he was surprised (to see all this). In a deep majestic voice, he spoke to them who caused harassment to the world.

103. "The following persons lose their power of discrimination viz. those who are intoxicated with the arrogance of affluence; those who are oppressed with hunger; the passionate ones and those who are puffed with self-conceit.

CHAPTER FIFTYFOUR

Mathematics and Astronomy

Sanandana said :

1. I shall now set out the auxiliary (of the Veda) called *Jyotiṣa* which had been enunciated by Brahmā in days of yore and through the mere knowledge of which men can attain the fulfilment of their ordained duties.

2. O Brāhmaṇa ! the science of *Jyotiṣa*, which has been expounded in four lakhs of verses, falls into three sections, devoted, respectively, to mathematics and astronomy (*Gaṇita*), horoscopy (*Jātaka*) and natural astrology (*Samhitā*).

3-4a. *Topics of Mathematics and astronomy.* In the *Gaṇita* section have been set out the arithmetical operations (vv.12b-59); computation of the mean and true positions of Planets (vv. 60-127); 'the questions' (on time, place and direction)¹ (vv. 128-53a); lunar and solar eclipses, (vv. 153b-65a); the diagrammatic representation thereof,² (gnomonic) shadow, (vv. 165b-67a); elevation of the lunar horns (vv. 167b-69), (planetary) conjunction (vv.170-73) and the (*vyati-*)*pātas*³ (vv.174-87).

4b. *Topics of Horoscopy.* In the *Jātaka* section are treated — the signs (*rāśi*) (of the zodiac), their divisions (and properties); Nature of the planets (and their properties; (Manifold inferior) births;

5. Conception; Birth; Early death; Longevity; Order of divisions (and subdivisions in one's life): Vocations; Eight emplacements, (being those of the 7 planets and the *lagna*, in the horoscopic chart); 'Royal' planetary combinations; 'Atmospheric' planetary combinations;

6. 'Lunar' planetary combinations; 'Ascetic' planetary combinations; Effect of the planets occupying the different signs; Effect of planets aspecting one another; Effect of the planets being in the several 'houses'; Effect of mutual associa-

tion (of planets); Miscellaneous matters (relating to the association of planets) :

7. Malefic combination (of planets; Female horoscopy; Death; Reconstruction of lost horoscopes; and Effects of decanates.

8. *Topics of Natural astrology.* The contents of the *Samhītā* section are: Effects of the motion of the planets (across the different signs) (vv. 1-108); *Abdalakṣaṇa* (Characteristics of the year) (vv. 109-33a); *Tithi* (Lunar day) (vv.133b-56a); *Vāra* (Weekday) (vv. 156b-67a); *Nakṣatra* (Asterism) (vv. 167b-211a); *Yoga*⁴ (vv. 211b-19a); *Tithyārtha* or *Kāraṇa*⁵ (vv. 219b-23).

9. (*Auspicious moment Muhūrta*) (vv.224-2a); *Upagraha* (Secondary atmospheric phenomena) (vv. 230-50a); (*Saṅkrānti* (Sun's transit into a sign) (vv. 250b-70); *Gocara* (Current motion of the planets) (vv. 271-82); *Candra-Tārābala* (Astrological strength of the Moon and of the Asterisms) (vv. 283-89); *Sarvalagna* (Rising of the signs) (vv. 290-312a); *Ārtava* (First menstruation) (vv. 312b-17).

10. *Ādhāna* (Conception) (vv.318-19); *Puṁsavana* (Rite for the birth of a male child) (vv. 320-25); *Jāta-Nāma-karma* (Birth rites and Naming Ceremony) (vv. 326- 30a); *Annabhukti* (*Annaprāśana*, First feeding) (vv. 330b-34); *Caula* (Tonsure) (vv. 335-43a); *Ankurārpaṇa* (Auspicious sowing) (vv. 343b- 47); *Mauñjibandhana* (and *Upanayana*, Tying the girdle and commencing studies) (vv.348-79), *Kṣurikābandhana*, (Girding the sword) (vv. 380-91a).

11. *Samāvartana* (Return from studies) (vv. 391b-94a); *Vivāha* (Marriage) (vv. 394b-523); *Pratiṣṭhā* (Installation of deities in temples) (vv. 524-39a); *Sadma* (Building of human residences) (vv.539b-619); *Yātrā* (Travel for pilgrimage, war etc.) (vv.620-712); *Praveśana* (Return home) (vv. 713-20); *Sadyovṛṣṭi* (Immediate rain) (vv. 721-39a); *Kūrma-vibhāga* (Division of the globe) (vv.739b-45); and *Utpāta* (Portentuous phenomena) (vv. 646-56a). I shall be setting out all these briefly.

MATHEMATICS

12b-14a. *Notational places.* *Eka* (one), *daśa* (ten), *śata*

(hundred), *sahasra* (thousand), *ayuta* (ten thousand), *lakṣa* (lakh), *prayuta* (ten lakhs/million), *koṭi* (crore), *arbuda*, *abja*, *kharva*, *nikharva*, *mahāpadma*, *śaṅku*, *jaladhi*, *antya*, *madhya*, *parārdha*—these are the names (of the notational places), each succeeding one being ten times (the preceding).

14b. *Addition and subtraction.* Addition and subtraction (of numbers) can be done either in a forward or in a backward manner.⁶

15a. *Multiplication.* In multiplication, the multiplicand (*gunya*) is multiplied up to its last digit (by the multiplier) (and the products added together).⁷

15b. *Division.* O sage ! In division that is the quotient (*phala*) which when multiplied by the divisor is completely subtractable (from the dividend).

16a. *Square.* The product of a number multiplied by itself is called *varga* (square); the learned call it also (by the term) *kṛti*.

16b-18a. *Square root.* (Mark off the odd digits of the number whose square root is required.) Having subtracted the (greatest possible) square from the last odd place, keep that 'root' apart. Double that 'root' and divide the remainder and place the quotient alongside the previously obtained 'root'. Subtract, O Brāhmaṇa, the square of that and again divide as before by the (newly formed) 'root'. O great sage, by repeating as above (till all the digits are completed) the square root is obtained.

18b-21a. *Cube and cube root.* The product of the multiplication thrice of the same number is called its *ghana* (cube). The method to derive the cube root (*pada*) is as follows : The first place (unit's digit of the number whose cube root is required) is termed 'odd'; the next two digits (*i.e.*, the tens and hundreds) are termed 'even.' (Mark off the digits of the number into groups of three digits each in this manner, each group having one 'odd' and two 'even-s'). Subtract from the last (group having an) odd place the (greatest possible) cube; that is the cube root (*mūla*) (of that group). Divide (the next) even place with thrice the square of the (previous) cube root and place the quotient alongside the previous cube root. Square the new quotient and multiply it by three and by the

last cube root and subtract it (from the next even place). Subtract, the cube (of the new cube root-digit) from the next odd place. Repeat the process and the cube root of the number is obtained.

21b. *Fractions*. Two fractions are reduced to a common denominator when their numerators and denominators are multiplied by the denominator of one by that of the other.

22. *Fractions of fractions*. O sage ! Enquirers into science should understand that in fractions of fractions (*bhāga-prabhāga*), the products of their numerators and of their denominators give the correct figures (of the numerator and denominator of the resultant fraction).

23-24a. *Associated and dissociated fractions*. Associated fractions (*bhāgānubandha*) and dissociated fractions (*bhāgā-pavāha*) are those in which a number is increased or decreased (by a fraction of its own). Here, multiply the whole number by the denominator (*talasthahāra*), ascertain whether the fraction is positive or negative and accordingly add to or subtract from it the numerator.

24b. *Addition and subtraction of fractions*. O sage ! (Addition and subtraction of fractions are effected by) adding together or subtracting one from the other their numerators (after reducing the fractions) to a common denominator.

25a. *Denominator of an integer*. When a denominator is not attached to a number, take 1 as its denominator.

25b-26. *Multiplication and division of fractions*. The product of the multiplication of two fractions is obtained by dividing the product of the numerators by the product of the denominators. In the division of two fractions, the numerator and denominator of the divisor are inverted and the process of multiplication applied.

27. *Square etc. of fractions*. For the square, cube, square root and cube root of fractions, calculate the respective squares etc. of the numerator and of the denominator. These for zero are always zero.

28-29. *Inverse operations*. When the result (of certain operations) is 'given' (*dr̥śya*) and the original number is to be found (*rāsiprasiddhaye*), calculate taking the denominator as the numerator and the numerator as the denominator, the

square as the square root and the square root as the square, minus as plus and plus as minus. However, in such cases of inverse operation where a part (of an item) has been added to or subtracted from it, the denominator to which the numerator has been added to or subtracted from should be taken as the denominator, and the denominator as such should be taken as the numerator; the rest (of the calculations are to be done) as before.

30. *Operations with assumed numbers (Iṣṭakarma)*. When an intended number (*uddiṣṭa-rāśi*) has been multiplied, divided, has a part of its taken away from it or added to it (and the result is *dṛṣṭa* 'known'), the intended number can be found by multiplying that result by an assumed number and dividing by the resultant (obtained by subjecting the assumed number to all the said operations).

31. *Operations with sums and differences*. The difference (of two numbers) when added to or subtracted from the sum (of those two numbers) and (the result) divided by two, will give the two numbers.⁸ (This operation is called) *Saṅkrama*. The difference of the squares (of two numbers) will give their sum.⁹ (And from the said sum and difference), the individual numbers (can be found as stated above).

32-34. *Methods to get perfect squares based on any assumed number (vargakarma)*. Multiply the square of an assumed number by 8 (*gaja*), subtract 1, halve it and divide by the assumed number. This would be one (number). Square this number and add 1. This would be another such number.¹⁰

Or, 1 divided by twice the assumed number and the assumed number added is one (number). The other number is 1. The sum or difference of these two numbers reduced by one would be the squares of the two (desired) numbers.

Or, multiply the square of the square and the cube of the assumed number and add 1 to the first. The two desired numbers are obtained. These are according to the methods to be adopted in arithmetic (*vyakta-gaṇita*) and algebra (*avyakta-gaṇita*).

35-36. *Operation involving the addition of a quantity to squares*. When a resultant (*dṛṣṭa*) is obtained by adding to or subtracting from a square its root multiplied by a multiplicand,

that resultant should be added to the square of half the multiplicand and the root of the result calculated. To this result half the multiplicand is added (when *guṇaghanamūla* had been subtracted) and subtracted (when the *guṇaghanamūla* had been added) and the result squared. (This would give the required number). (This is called) *Guṇa-(Karma)*.

When, however, the resultant (*dr̥śya*) is less or more by a part of the (required) number, the resultant and the root are to be appropriately reduced or increased and using them the required number is calculated as before.

37. *Rule of three* (In a *Trairāśika*) the *Pramāṇa* (argument) and *Ichhā* (requisition) are to be of the same denomination and (are to be placed) at the beginning and at the end. *Phala* (fruit) (which would be of a different denomination) would be placed in the middle. *Phala* multiplied by *Ichhā* and divided by *Pramāṇa* (*ādya*) will yield the *Ichhā-phala*. In the Inverse (rule of three), (the method is) reversed.

38. *Rule of five etc.* In *Pañcarāśika* etc. the *pramāṇa* side and the *phala* side are properly set down. By dividing the product of the larger number (of quantities) by the product of the smaller number (of quantities) the result is obtained.

39a. *Capital and interest.* Capital is obtained through calculation with an assumed number (*iṣṭakarma-vidhi*, see verse 30, above). That subtracted from the composite amount (of capital and interest) will give the interest (*kalāntara*).

39b-40a. Rate multiplied by time, and the interest multiplied by the invested time are to be calculated and kept independently. Each divided by their sum and multiplied by the composite amount, would yield results which are respectively the capital and the interest.

40b-41a. (In the matter of the loan of different amounts for different periods, the individual income is identical), while arranging the sides (as in *Pañcarāśika* etc., see above, verse 38), if the product of the smaller number of quantities and the months be greater than the product of the larger number of quantities, the interest divided by the total number of months, would give the rate.

41b. (In the case of investments by different people making up the capital), the investment by each (*kṣeṇa*) multi-

plied by the total income (*miśra*) and divided by the total investment (*kṣepayoga*), would give the (proportionate) income (*phala*).

42a. *Time for filling a tank.* (When different pipes individually take different times to fill a tank, in order to find the time required to fill the tank if all the pipes are opened together), divide the denominators by the numerators of the individual fractions of time taken by each to fill the tank), find the sum (of the new fractions obtained) and (with that sum) divide 1. The time to fill (the tank) is obtained.

42b-43. *Geometrical progression (Guṇottaraśreḍhi).* The sum of the series in geometrical progression (*mānam guṇottare*) (is found thus): when the number of terms (*gaccha*) is odd, reduce it by 1 and multiply; when it is even, halve it and square. (Continue the process) till the number ends. Then, beginning from the last term (*gacchānta*) perform backwards (*vyasta*) the operations of multiplication (*guṇa*) and squaring (*varga*) (in continuation). From the result subtract 1, divide the remainder by 'guṇaka-1' and multiply by the first member of the series (*prāg-gḥna*).¹¹

44-45a. *Triangles and quadrilaterals.* In the case of plane figures (*kṣetra*), like triangles and quadrilaterals (*tri-caturaśraka*), the following apply; The hypotenuse (*karṇa*) is the square root of the sum of the squares of the base (*bhujā*) and altitude (*koṭi*). The base would be the square root of the difference between the squares of the hypotenuse and the altitude. And, the altitude would be the square root of the difference between the squares of the hypotenuse and the base.¹²

45b-46a. (The rational sides of a right angled triangle, as calculated from any two numbers would be : (1) The square of the difference of two (natural) numbers added to twice the product of the numbers, which is equal to the sums of their squares; (ii) the product of the sums and differences of the two numbers, which is equal to the difference of their squares, and (iii) twice the product of the numbers.¹³

46b. *Circumference of a circle.* O sage, the diameter of a circle multiplied by 22 (*ākṛti*) and divided by 7 (*adri*) will give the circumference of a circle.¹⁴

47-48. *Relation of Sine, Reversed sine and Diameter.* Experts in trigonometry say: Reversed sine (*śara*) is given by multiplying together the sum and difference of the sine (*jyā*) and the diameter (*vyāsa*), finding the square root thereof and halving the result. The sine (*jyā*) is given by (diameter-minus-reversed sine) multiplied by the reversed sine, finding its root and doubling it. And, the diameter is obtained by squaring half sine, dividing it by the reversed sine and adding to the result the reversed sine.¹⁵

49-50a. *Sine of an arc.* Let the (circumference minus arc) multiplied by the circumference be called 'First' (*prāg*). One fourth the square of the circumference is multiplied by 5 and the 'First' subtracted therefrom. With the result divide (Diameter 'First'). O brāhmaṇa ! the result obtained would be the sine (*jyā*) (of the relevant arc).¹⁶

50b-51a. *Arc from sine.* One fourth the sine is multiplied by the square of the circumference and divided by four times the diameter to which the sine is added. The result is subtracted from one fourth the square of the circumference and the square root (of the same is calculated). Thus, when subtracted from half the circumference, gives the arc.¹⁷

51b-52a. *Measure of corn heaped up in a cone.*

When coarse, medium and fine grain are heaped, the heights (*vedha*) (of the cones so formed) would, respectively, be one-ninth (*aṅka*) one-tenth (*āśā*) and one-eleventh (*iśa*) of the respective circumferences. The measure of the grain in cubic cubits (*ghana-kara*) would be given by the square of one-sixth (*aṅga*) multiplied by the height.¹⁸

52b-53a. *Measure of water in a tank.* The length of the (stretch of) water multiplied by its breadth and height in inches and divided by 3100 (*khakhendurāma*) will give the volume of water in *drona* measures.¹⁹

54b-55a. *Measure of rubble.* The height, breadth and length, in inches, O brāhmaṇa, of a heap of rubble, multiplied together and divided by 1150 (*kha-akṣa-iśa*) would give its volume in *drona* measures.

55b-56a. *Measure of metal.* In the case of metal pieces, the length, breadth and height, in inches, multiplied together

and divided by 585 (*bāṇa-ibha-mārgaṇa*) should be declared to be the volume of the heap in *droṇa* measures.

56b-57. *Gnomon and the lighted lamp*. O sage ! the gnomon²⁰ multiplied by the distance between the lamp and the gnomon and divided by the height of the lamp less the gnomon, gives the gnomonic shadow.²¹

Again, the gnomon multiplied by the distance between the gnomon and the lamp and divided by the gnomonic shadow, gives the height of the lamp.²²

58. The height of the lamp-minus-gnomon multiplied by the gnomonic shadow and divided by the gnomon will give the distance between the lamp and the gnomon.²³

58b-59a. *Two gnomons and the lighted lamp*. The distance between the shadow tips multiplied by the shadow and divided by the difference between the shadows gives the base (*bhūmi* of the relevant shadow).²⁴

59. The base multiplied by the gnomon, and divided by the shadow gives the height of the lamp by the rule of three.²⁵

ASTRONOMY

Mean Planets (Madhya-graha)

60. (Operational) mathematics has been set out concisely, as above. Now, shall be set out in brief, (the computation of) the mean planets etc. according to (astronomical) mathematics.

61-62a. *The aeon (yuga)*. O brāhmaṇa ! The measure of the (great) aeon (*mahā-yuga, catuṛyuga*) is said to be 43,20,000 (*khacatuṣka-rada-aṇava*) (*divine*) years.²⁶ Four tenths of it is said to be the *kṛta-yuga*; three tenths form the *Tretā-yuga*; two tenths the *Dvāpara-yuga*; and one tenth the *Kāli-yuga*.

62b. Seventyone *yugas* plus one *kṛta-yuga* period form (the time duration of) one Manu.²⁷

63. O foremost among brāhmaṇas ! fourteen Manus occur during the day-time of God Brahmā. That much period, again, O foremost among brāhmaṇas ! is said to be His night.

64. O Nārada ! the years that have gone by from the beginning of creation by God Brahmā might be consolidated and the computation of planets could be commenced

from that beginning. Alternatively, the computation could be done from the beginning of any desired *yuga*.

65. *Revolutions of the planets.* The number of eastward revolutions (*bhagaṇa*) in a *yuga* (i.e., *mahā-yuga*) or (*caturyuga*), of the Sun, Mercury (Budha) and Venus (Śukra) and of the *śighrocca*²⁸ of Mars, Saturn and Jupiter is 43,20,000.

66. The number of revolutions of the Moon is 5,77,53,336; that of Mars is 22,96,832.

67. The number of revolutions of the *śighrocca* of Mercury (*Budha*) is 1,79,37,060. The revolutions of Jupiter are 3,64,220.

68. The number of revolutions of the *śighrocca* of Venus is 70,22,376. The revolutions of Saturn are 1,46,568.

69. The number of revolutions of the Moon's *mandocca* (apogee) is 4,88,203 and the retrograde revolutions of the Moon's ascending node (*pāta*) are 2,32,238.

70. *Terrestrial and Lunar days.*²⁹ The time from sunrise to sunrise is a terrestrial civil day (*bhūmi-sāvana-vāsara*). The number of terrestrial days in a (*mahā-yuga*) is 1,57,79,17,828. The number of lunar days (*tithi-s*) in the *yuga* is 1,60,30,00,080.

71. *Additive months*³⁰ and *Subtractive days.*³¹ (In a *mahā-yuga*) there are 15,93,336 additive months (*adhimāsa*) and 2,50,82,252 subtractive days (*tithi-kṣaya*).

72. *Solar months*³² and *lunar months.*³³ There are (in a *mahā-yuga*) 5,18,40,000 solar months (*ravi-māsa*), and the number of lunar months is 5,34,33,336.

73-74. *Mandoccas or Apogees of the planets.*³⁴ The number of eastward revolutions of the Sun's apogee (*Śūrya-mandocca*) in a *Kalpa* period is 387; that of Mars 204; that of Mercury 368, that of Jupiter 900; that of Venus 535; and that of Saturn 39.

74b-76a. *Pātas or Nodes of the planets.*³⁵ Now, to the retrograde (*vāma*) revolutions of the nodes (of the planets) in a *Kalpa*: Of Mars it is 214, of Mercury 488, of Jupiter 174, of Venus 903 and of Saturn 662.

76b-79. *Ahagaṇa or number of days from the epoch.*³⁶ The (solar) years, called *bhagaṇa* that have elapsed in the current *yuga* are converted into (solar) months (by multiplying them by 12) and added to the (lunar) months *Madhu*, (*Caitra*)—*Śukla* (bright fortnight). etc. which have elapsed (in the

current year), and the result is written down separately (in two places). It is then multiplied by the number of additive months (in a *yuga*) and divided by the number of solar months (in a *yuga*). The quotient got (which will be the elapsed additive months) is added to the result (in months) got before and converted into days (by multiplying by 30). The number of days elapsed (in the current month) is added to it and the result written down in two places. (In one place) it is multiplied by the subtractive days (*tithikṣaya*) (in the *Yuga*) and divided by the number of lunar days (in the *Yuga*). The quotient obtained would be the elapsed subtractive days. These (elapsed subtractive days) are subtracted from the result (kept as above, in the second place). The result would be the number of elapsed terrestrial days (from the commencement of the *yuga*) to the previous midnight at Laṅkā.³⁷

79b-80a. *Lords of the day etc.* The Lords of the current day, month and year are reckoned, as counted from the Sun. Thus, (the *ahargaṇa*) divided by 7 and (the remainder) counted from Sunday will give the name of the Lord of the day. (Again, the *ahargaṇa*) is divided by the number of days in a month and that in a year (*viz.*, 30 and 360); the quotients are then multiplied, respectively, by 2 and 3, and the products increased by 1. The results are divided by 7 and the remainders counted from the Sun will give the Lords of the present month and year, respectively.

81b-82a. *Mean planets.* The number of revolutions of a planet (in a *Mahāyuga*) multiplied by the (currently) elapsed terrestrial days and divided by the number of terrestrial days (in the *yuga*) will give the elapsed revolutions of the planet (in signs, degrees etc.).

82b-83a. *Mean apogees and nodes.* In the same manner, can be computed the mean positions of the apogees with direct motion, mentioned before. The nodes, too, (should be computed) similarly, but the results have to be subtracted from the circle (*cakra*, 180° or 12 signs) because of their retrograde motion).

83b-84a. *Measurements of the Earth.* The diameter of the Earth is 1600 *yojanas*.³⁸ The square there is to be multiplied

by 10, and the square root of the product will give the circumference of the Earth.

84b. The Earth's circumference multiplied by the sine colatitude (*lambajyā*) (of a given place) and divided by the radius (*trijivā*)³⁹ is the exact circumference of the Earth at that place.

85-86a. *Deśāntara correction to due terrestrial longitude.* The *Deśāntara* (i.e., the distance of the place, in *yojanas*, along the said local circumference, from Zero or Laṅkā-Ujjain meridian) is multiplied by the daily motion of the planet (in minutes) and divided by the local circumference of the Earth. The quotient, which would be in minutes (*kalā*), should be subtracted from the mean planet (at Laṅkā, *vide* verse 81b-82a, above) if the place is east of the meridian, and added if it is to the west of the meridian. The result would be the mean position of the planet at the given place.

86b-87a. *The central meridian.* On the central meridian, which extends from the capital of the demons (Laṅkā) to the divine mountain (Meru), are (the cities of) Avantikā (Ujjain), Rohitaka and the one near the 'Tank' (Kurukṣetra).

87b-88a. *Beginning of the weekday (Vārapravṛtti).* A weekday (at a place) commences (at midnight at that place, which would be) midnight (at Laṅkā meridian, *vide* verse 79) to which the *deśāntara-nāḍis* (time-difference due to terrestrial longitude) are added (if the place is) to the east and subtracted from (if the place is) to the west (of the meridian).

88b-89a. *Mean-position of a planet at any time.* The desired time in *nāḍi-s* (after the local midnight as calculated above) multiplied by the mean daily motion of the planet and divided by 60 gives a result in terms of minutes. This, when added (to the mean position at midnight) if the time taken after midnight and subtracted from it before midnight, will give the position (of the planet) at the desired time.

89b-91a. *Vikṣepa or Celestial latitude of the Moon and the planets.*⁴⁰ The Moon is deflected by its node towards north and south from the limit of its declination, the maximum deviation being 1/80 of a circle (i.e. 4°30'). Jupiter (is similarly deflected) by twice one-ninth (i.e., 2/9) thereof (i.e., of the deflection of the Moon (i. e., 2/9 of 4°30' = 1°), Mars thrice (i.e.,

3/9 of $4^{\circ}30' = 1^{\circ} 30'$) and Mercury, Venus and Saturn are deflected four times (*i.e.*, 4/9 of $4^{\circ}30' = 2^{\circ}$).

TRUE PLANETS (SPHUṬA-GRAHA)

91b-93a. *Primary Sines*. The eighth part of the minutes contained in a sign (*rāśi*) is the first sine (*jjārdha*).⁴¹ That divided by itself, the quotient subtracted from the sine and the remainder added to the sine will give the second sine. In the same manner, divide, successively, the sines found by the first sine, subtract (the sum of) the quotients from the divisor and add the remainder to the previous sine. The result will be the next sine. Thus the 24 sines are to be calculated successively.⁴²

93b-94a. *Krānti or declination*. The sine of Maximum declination (*Parama-apakramajyā*) is 1397.⁴³ When any sine is multiplied by this and divided by *trijivā* (sine 90° , *i.e.*, 3438), the arc of the result would be the declination (of the planet required).

94b-95a. *Sines re. planetary positions*. When (the longitude of) the planet is subtracted from that of its *mandocca* (higher apsis of the equation of the centre) or from its *śighrocca* (higher apsis of the equation of conjunction), the remainder is its *kendra* anomaly); the *pada* (quadrant) (of the *kendra* is noted, and from that) its base-sine (*bhuja-jyā*) and perpendicular-sine (*koṭi-jyā*) are found.⁴⁴

95b-96a. In an odd (*viśama*) quadrant the base-sine is reckoned from the part gone by (*gata*) and the perpendicular-sine from the part yet to be covered (*gamya*). In an even quadrant (*sama*), the base-sine is reckoned from the part yet to be covered and the perpendicular-sine from the part gone by.

96b-98a. *Derivation of sines of arcs*. (To derive the sine of any arc, *e.g.*, the *kendra-minus-planet*, convert the arc) to minutes and divide by 225 (*tattva-locana*); the result would be the number of the preceding tabular sine (*jjā-piṇḍaka*). Multiply the remainder (in minutes) by the difference of the preceding and following tabular sines and divide by 225 (*tattva-locana*). The quotient obtained is added to the preceding tabular sine; the result would give the sine (of the arc taken).

The same procedure is to be adopted also for versed sines (*utkramajyā*).

100b-101a.⁴⁵ *Derivation of arcs from sines.* Subtract from the given sine the next less tabular sine; multiply the remainder by 225 (*tattvāśvi*) and divide by the difference between the next lower and next higher tabular sines. Add the quotient to the product of the serial number of the next less sine and 225. The result would be the arc (of the sine taken).

101b-103a. *Manda-paridhi (Epicycle of the apsis or the equation of the centre).* The number of degrees of the Sun's *mandaparidhi* is 14, and that of the Moon 32, at the end of the even quadrants; at the end of the odd quadrants, they are 20 minutes less (in each case).

(In the case of the other planets, they are), at the end of even quadrants, 75 for Mars, 30 (for Mercury), 33 (for Jupiter), 12 (for Venus) and 49 (for Saturn). At the end of the odd quadrants, (they are) 72 for Mars, 28 (for Mercury), 32 for Jupiter, 11 (for Venus) and 48 (for Saturn).

103b-105a. *Śighraparidhi or Epicycles of the equation of conjunction.* The *Śighraparidhis* at the end of the even quadrants are 235 for Mars, 133 (for Mercury), 70 (for Jupiter), 202 (for Venus) and 39 (for Saturn). At the end of the odd quadrants they are 232 for Mars, 132 (for Mercury), 72 (for Jupiter) 260 (for Venus) and 40 (for Saturn).

105b-106a. *Sphuṭaparidhi or corrected epicycle.* The base-sine (*bhujajyā*) should be multiplied by the difference of the epicycles at the odd and even quadrants and divided by the Radius (*trijyā*) and the result, (which would be in minutes), should be applied to the even epicycle (*Yugma-vṛtta*): (these minutes are) additive if the even epicycle is less than the odd epicycle and subtractive otherwise. The corrected (*sphuṭa*) epicycle (is thus obtained).

106b-107a. *Mandaphala or Equation of the centre.* The base-sine (*bhujajyā*) and perpendicular sine (*koṭijyā*) should be multiplied by the corrected epicycle and divided by the number of degrees in a circle (360). (The result would be the corresponding *bhujāphala* and *koṭiphala*, respectively, in minutes). The arc corresponding to the base-sine (*bhujajyā*) would be the equation of the centre (*mandaphala*) in minutes etc.

107b-108. *Śighraphala or Equation of conjunction.* When the *kendra* is in the half-orbit beginning with capricorn (*makarādi*), the result from the perpendicular-sine (*koṭi-phala*) of the distance from the conjunction (*kendra*) is to be added to Radius (*trijivā*) and subtracted when in that beginning with Cancer (*karkyādi*). The square of this sum or difference is added to the result from the base-sine (*bhujāphala*). The square root of their sum is called *calakarṇa* (variable hypotenuse).

110b-111.⁴⁶ The result from the base-sine (*bhujāphala*) is multiplied by radius and divided by the variable hypotenuse (*calakarṇa*). The arc corresponding to the quotient is in minutes and will be the equation of conjunction (*śaighrya-phala*). This (the *Śaighryaphala*) is to be employed in the first and fourth process of correction for Mars and other planets.

112. *Computation of True planets.* For the Sun and the Moon, *mandakarṇa* alone is required. That for Mars etc. is now stated: (First) that for conjunction, then that for the apsis, again that for apsis and for conjunction—the four in succession (half the corrections being applied of the first two and the entire correction of the last two).

113. When the *kendra* is in the half or bit beginning with Aries (*Ajādi*) the equation is additive (*dhana*) for all planets, both in the correction for conjunction and for the apsis; they are all subtractive in the half orbit beginning with Libra (*Tulādi*).

114. *Bhujāntara correction for the equation of time.* The daily motion (*bhukti*) of a planet multiplied by the sun's result from the base-sine and divided by the number of minutes in a circle (*bhacakra*). The result, which would be in minutes, is applied to the True planet got (verses 112-13 above) in the same direction as (the equation applied to) the Sun.

115-16. *Mean daily motion.* The equation of a planet's daily motion is to be calculated like that for the Mean planet in the process for the apsis. The daily motion is multiplied by the difference of the tabular sines corresponding to the base-sine (*doriyāntara*) of anamoly and then divided by 225 (*tattvanetra*). The result is multiplied by the corresponding epicycle of the apsis (*mandaparidhi*) and divided by the number of degrees in a circle (*bhagaṇa*); (the result) is additive when

in the half-orbit beginning with cancer, and subtractive when in the half-orbit beginning with Capricorn.

117-18. Subtract the daily motion of the planet corrected for the apsis from the daily motion of its conjunction (*śighra*). Multiply the remainder by the difference between the last hypotenuse (*antya-karṇa*) and the radius and divide by the variable hypotenuse (*calakarṇa*), verses 107b-108). The result is to be added to the daily motion when the hypotenuse is greater than the radius and subtractive when it is less; (in the latter case, if the result) is greater (than the daily motion) subtract the latter from it; the remainder will be the retrograde (*vakra*) daily motion (of the planet).

119-120a. *Retrogression of planets.* Mars and other planets would (commence to be in retrograde motion (*vakri*) when the degrees of their *kendra* in the fourth process (verse 112) are, respectively, (Mars) 164, (Mercury) 144, (Jupiter) 130, (Venus) 163 and (Saturn) 115. They cease to be retrograde from when the degrees (of their *kendras*) are equal to the above-said numbers subtracted from (the degrees in) a circle.

120b-121a. *Length of day and night.* Sine declination (*krāntijyā*) multiplied by the equinoctial shadow (*viśuvadbhā*)⁴⁷ and divided by 12 is the Earth-sine (*k,sitijyā*).⁴⁸ This multiplied by Radius (*trijyā*) and divided by the 'day-radius' (*dina-vyāsa*)⁴⁹ (gives the sine of the ascensional difference, *cara*). The corresponding arc (in minutes) would be the ascensional difference in *prāṇas*⁵⁰ (*cārāsavaḥ*).

121b-122. The said arc added to and subtracted from the fourth part of the day and night, separately, will give the duration of half day and half night respectively, when the declination is north (*udak-krānti*). The reverse would be the case when the declination is south (*yāmya-krānti*). Double these (half days and nights) would give (the lengths of) the day and night, respectively.

123. *Position of a planet in an asterism*,⁵¹ (Since 27 *nakṣatra-s* or *bham-s* or asterisms make up the full ecliptic of 360°), the extent in it of one asterism (*bha-bhoga*) is 800 minutes (or 13° 20'). (And, since the Moon gains in longitude over the Sun one circle or 360° in 30 lunar days or *tithis*), the extent of a *tithi* (*tithi-bhoga*) is 720 minutes. The asterisms crossed by a

planet is got by dividing the longitude of the True planet by 800. (The remainder divided) by the daily motion of the planet will give the days etc. (traversed by the planet in the next asterism).

124. *Yoga at a given time.*⁵² The sum of the true longitudes of the Sun and the Moon at the required time, reduced to minutes, if divided by 800, will give the number of *Yogas* which have elapsed. The portion gone (*gata*) and to go (*gamyā*) in the current *Yoga* multiplied by 60 and divided by the sum of the daily motion of the Sun and the Moon will give the corresponding *nāḍikās* thereof.

125. *Tithi at a desired time.* Subtract the longitude of the Sun in minutes from the longitude of the Moon in minutes and divide by the extent of a *tithi* (*tithibhoga*, 720'); the result will be the *tithis* elapsed. The *nāḍis* gone or to go in the current *tithi* at the desired time are derived by multiplying the remainder by 60 and dividing by the difference between the daily motion of the Sun and Moon at the desired time.

126-127. *The Karaṇa at the desired time.*⁵³ The *tithis* elapsed after the first half of the first *tithi* of the bright fortnight are multiplied by two and divided by seven (*nāga*). The remainder, counted as Bava, Bālava, Kaulaka, Taitila, Gara, Vaṇij and Viṣṭi, would give the elapsed *karaṇas*. The *karaṇas* from the latter half of the fourteenth *tithi* of the dark fortnight (to the first half of the first *tithi*, of the bright fortnight) are *Śakuni*, *Nāga*, *Catuṣpāt* and *Kimstughna*.

ON DIRECTION, PLACE AND TIME

128. *Setting the gnomon.* On a stone slab, levelled with water, or on hard level plaster, describe a circle with any radius measured in gnomonic digits.

129-131. At its centre fix the gnomon, of twelve digits of the measure of the gnomonic digits used above. Mark the two points where the (gnomonic) shadow meets the circumference of the circle, before and after noon; these two points are to be called the west and east points, (respectively). Midway between them, draw, (using a pair of compasses), by means of a fish-figure (*timi*), a north-south line. Also, Midway bet-

ween the north and south directions, draw, by means of a fish-figure, an east-west line. In the same manner, by means of fish-figures (*matsya*), draw the intermediate directions between the four cardinal directions.

132. Draw a square circumscribing (the circle), along with the (eight) lines emanating from the centre. Any given shadow is reckoned by the digits of its base-sine (*bhujā-sūtra*) projected on the square.

133. *Prime vertical etc.* The east-west line is called the prime vertical (*sama-maṇḍala*); it is termed also the equatorial horizon (six o'clock circle, *unmaṇḍala*) and equinoctial circle (celestial equator, *viśwanmaṇḍala*).

134. *Agrā (Amplitude)*. (In the circle) draw another east-west line through the extremity of the equinoctial shadow (*viśwadbhā*); the interval between any given shadow and the line of the equinoctial shadow is termed the amplitude (*agrā*).

135. The square root of the sum of the squares of the gnomon and of the shadow is the hypotenuse (*karṇa*). If, from the square of the latter, the square of the gnomon be subtracted, the square root of the remainder is the shadow; the gnomon is found by the converse process.

136. *Precession of the equinoxes (Ayanacalana)*, at any desired time. In a *Yuga*, the circle of asterisms librates eastward thirty score (*i.e.*, 600) times. This (number) multiplied by the terrestrial days elapsed (at the desired time) and divided by the number of days in a *Yuga* gives the elapsed liberations, (signs, degrees) etc.

137. Derive the sine (of the *ayana-sphuṭa* thus got), multiply it by three and divide by ten. The result will be the amount of the precession of the equinoxes (at the desired time). The longitude of the planets should be corrected (by adding to or subtracting from the longitudes) the said precession. It is from this (corrected longitude of the planets) that their declination (*krānti*), gnomonic shadow (*chāyā*), ascensional difference (*cara*) etc. are to be calculated.

138. *Latitude and co-latitude from shadow*. The radius multiplied separately by the gnomon (12) and the equinoctial shadow (*chāyā*) and divided by the equinoctial hypotenuse

(*viṣwatkarna*)⁵⁴ will give the cosine and sine, respectively, of the latitude. The arcs of these sines will be the co-latitude and latitude. These two will always be inclined to the south.

139. *Zenith distance of the Sun.* The Zenith distance of the Sun (at any time) would be the sum of the latitude of the place and the Sun's declination, when both are in the same direction; and, their difference when in opposite directions. From the Zenith distance, its sine and cosine are to be found.

140. *The shadow and its hypotenuse from Zenith distance.* The sine (of the Zenith distance, found as above) and the Radius⁵⁵ multiplied by the length of the gnomon in digits (*i.e.*, 12) and divided by the cosine (of the Zenith distance), give, respectively, the shadow of the gnomon and its hypotenuse at midday (*ahardala*).

141. *Sun's declination and longitude from latitude of a place and zenith distance.* Find the difference between the degrees of the latitude (of the place) and those of the Sun's zenith distance at noon when both are in the same direction and their sum, otherwise. The sun's declination (*apakrama*) would be detained.

141b-143a. Multiply sine declination by the Radius and divide by the maximum declination of the Sun (*i.e.*, 1397 minutes). (Taking the quotient as the sine) find its arc. This arc will be the longitude of the Sun (in the first quarter of the ecliptic) beginning with Aries. When the Sun is (in the second quarter) beginning with Cancer, subtract (the arc) from 6 signs (*cakrārdha*). When (in the third quarter beginning with Libra), add (the arc) to 6 signs (*bhārdha*). When (in the fourth quarter) beginning with Capricorn subtract (the arc) from 12 signs (*cakra*); in each case, the result will be) the true longitude (*sphuṭa*) of the Sun at midday.

143b. *Mean Sun.* Apply to this the equation of the apsis (*mandaphala*) repeatedly in the opposite sign and the Sun's mean longitude will be got.

144. *Ahorātrāsu of a planet.* The diurnal motion (in minutes) of any planet (on any day) is to be multiplied by the number of *prāṇas* (*asus* or respirations, of time) contained in the rising periods of the sign (*rāśi*) occupied by the planet and

divided by 1800. The quotient added to the number of *prāṇas* in a circle is termed the day-night duration in *prāṇas* of the planet (on that day).

145-146. *Right ascensions of the Signs at Laṅkā.* (Towards finding the right ascensions of the ends of the first three signs, Aries, Taurus and Gemini, find the declinations of the said ends), multiply the day-radius of three signs (*tribhadyukarṇārdha*) and divide by their own respective day-radii (*svāhorātrārḍha*), in order, the sines of one, of two and of three signs. The quotients when converted into arc and subtracted, each from the one following, give, beginning with Aries, the times of rising (in *prāṇas*) (of the three signs) at Laṅkā. They are, respectively, 1670, 1795 and 1935.

147a. *Right ascensions at any place.* The above, diminished each by its portion of ascensional difference (*carakhaṇḍa*), as calculated for a place, give the times of rising at that place.

147b-148a. For the three signs beginning with Cancer, invert the times of rising at Laṅkā and add the portions of ascensional difference of the respective signs inverted. The above six, in inverse order, will be the times for the other six commencing with Libra.

148b-149a. *Udaya-Lagna (rising point of the ecliptic) at any time.* The ascensional equivalents of the parts of the sign (occupied by the planet) which are gone (*bhukta*) and to come (*bhogyā*) are to be calculated from the longitude of the Sun at the given time. They will be given by the number of degrees traversed and to be traversed, multiplied by the ascensional equivalent (*udayāsavaḥ*) of the sign and divided by 30.

149b-150a. From the desired time in *nāḍikās* (as reckoned from sunrise) reduced to *prāṇas*, subtract the equivalent in *prāṇas* of the part of the sign to come, and also the ascensional equivalents of the further signs, in succession. In the same manner, subtract the equivalents of the part which has gone by and of the signs which have to go, in inverse order.

150b-151a. If there be a remainder, multiply by 30 and divide by the equivalent of the unsubtracted sign; subtract or add the quotient, appropriately, to the whole signs. The

result would be the point of the ecliptic at the horizon at that time.

151b-152a. *Madhyalagna* (Point of the ecliptic at the meridian). From the east or west hour-angle of the Sun in *nāḍis* (*nata-nāḍi*), calculate as above using the equivalents in right ascension (*laṅkodayāsavaḥ*) and apply the result as an additive or subtractive equation to the Sun's longitude. The point of the ecliptic upon the meridian (*Madhya-lagna*) at that moment would result.

152b-153-a. *Time from Lagna*. (In order to find the instant when a given point of the ecliptic would be upon the horizon), add together the ascensional equivalents, in *prāṇas*, of : (1) the part of the sign to be traversed by the given point (on the ecliptic) if it is less (than the longitude of the Sun), (2) of the part traversed if it is greater (than the longitude of the Sun), and (3) of the intervening signs. The sum (in *prāṇas*) will give the instant (for the given *lagna*).

SOLAR AND LUNAR ECLIPSES

153b-154a. *Possibility of a lunar eclipse*. (Compute the True Sun, Moon and Node at the syzygies). If sine (Sun-minus-Node) is less than 14 (Indra), there is a possibility of an eclipse. The said sine in minutes is to be multiplied by 11 (Śiva) and divided by 7 (śaila). The result is called *Śara* in digits (*aṅgulas*), and would be directed towards the hemisphere in which (Sun-minus-Node) lies.

154b. *Eclipses and the eclipsed*. (In the solar eclipse, which occurs only at new moon), the Moon obscures the Sun; and in the lunar eclipse, (which occurs only at full moon), the shadow of the Earth obscures the Moon.

154b-155a. Half the (angular) diameters of the eclipsed and the eclipser minus the *śara* is called *channa* (*ka*), (the eclipsed portion, reckoned in digits).⁵⁶ Subtract, (if possible), the eclipsed body from the *channa*; the result would be *kha-cchanna* (empty space eclipse).

155b-156b. *Computation of the lunar eclipse*. Half the angular diameters is to be added to the *śara*, the sum multiplied by ten and divided by *channa*. The square root (of the product) is found and a sixth of it is subtracted from it and

divided by the angular diameter of the Moon (*glau-vaṣuḥ*). The result will give the half-duration of the eclipse (*sthityardha*) in *ghaṭikā* etc.

156b-158a. The *sthityardha* (is placed at two places). Sine Sun-minus-Node in degrees is doubled and the number taken as *palas*. They are subtracted from or added to the *sthityardha* if Sun-minus-Node is less than 6 signs or 12 signs, respectively, and vice versa if otherwise. The results got would be the true *sthityardha* (as reckoned) from the commencement and completion of the eclipse. The eclipsed portion (in digits) multiplied by 20 (*nakha*) and divided by the angular diameter of the eclipsed body will give the results called *Vī(m)śopaka-s*.

158b-159. *Computation of the solar eclipse*. (In the solar eclipse), the mid-eclipse occurs at the moment of conjunction. Calculate the *tribhona-lagna* (rising point of the ecliptic-minus-three signs) of the Sun for the moment of conjunction (*parvānta*) and keep it apart. (For the *tribhona-lagna*) calculate the parallax in latitude in degrees (*natāmsa*) by combining, appropriately, the declination (*krānti*) and latitude (*akṣa*). Divide it by 22 and square the result. If the square is less than 2, halve it and add to the square; if the square is more than 2, subtract 2 from it, halve the result and add to the square. The result thus got is added to 12 and the sum is called 'divisor' (*hara*).

160. Find the difference between *tribhona-lagna* and the Sun, reduce it by a tenth thereof, multiply by 14 (*purandara*) and divide by the 'divisor' (found in verse 159). The result would be the *lambana* (parallax in longitude, in *nāḍikās*). If *tribhona-lagna* is more than 12 (*arka*), the *lambana* is positive and, if otherwise, negative.

161. The *lambana-nāḍikās* are multiplied by 13 (*viśva*); the result is to be reckoned in terms of minutes and added to or subtracted from Sun-minus-Node appropriately and (from its sine) its *sara* is determined (*vide* verse 154a). The *lambana* therefrom is multiplied by six. After appropriate addition and subtraction thereof, re. *tribhona-lagna*, the *natāmsas* are again calculated.

162-163a. A tenth part of these *natāmsas* are subtracted

from 18 and the result multiplied by the said tenth part. The product is subtracted from 18 minutes and divided by 6. The result will give parallax in longitude (*nati*) in the same direction of the (previous) *natāṃśas*. Appropriate application of this subtractively or additively in accordance with opposite directions or the same direction of the two, will render the *śara* accurate.

163b-165a. Using the said *śara*, the (exact) eclipsed portion (*channa*) and half duration of the eclipse are to be found (as before). The half-duration is multiplied by 6; the result, which would be in degrees, is kept at two places and the *tribhona-lagna* subtracted from or added to it, respectively, and the *lambana* calculated from the two, as before. The results being appropriately applied, the exact (first and second) half durations are obtained. These subtracted from and added to, as the case may be to the mid-eclipse (*madhya-kāla*), will give the exact times of the commencement and the conclusion of the eclipse.

MISCELLANEOUS MATTERS

165b-166a. *Heliacal visibility of the planets*⁵⁷. The *kālāṃśa*- (degrees of time) of the planets beginning with the Moon are : 12 (Moon), 17 (Mars), 13 (Mercury), 11 (Jupiter), 9 (Venus) and 15 (Saturn). The heliacal setting and rising of these planets occur, respectively, at times got by subtracting (the *kālāṃśas*) from sunrise and by adding them to sunset.

166b-167a. *Shadow of a planet*. Consider the reflection of a planet (in water or in a mirror) and ascertain the ocular altitude (*dr̥gaucyaṃ lambam*). The distance between the foot of the gnomon and the spot of the reflection, multiplied by 12 (*ravi*) and divided by the ocular altitude, will give the measure of the shadow of the planet (in digits).

167b-168. *Elongation of the Moon's horns*. At sunset (on the desired day) the *tithi* and its divisions (*nāḍikā*, *vināḍikā* etc.) gone and to go are accurately determined. The *tithis* are multiplied by 16 and the square of the *tithis* subtracted therefrom. The result is multiplied by the equinoctial shadow (*akṣabhā*) and divided by 15. The direction of the result is taken as north and corrected appropriately with the declination (in minutes) of the Sun and also by *śara* of the Moon in minutes applied

reversely. The result is divided by twice the *tithis*. The *valana* (deflection) in digits towards the direction of the correction (i.e., the direction in which the Sun is with reference to the Moon) is got.

169. Subtract from the *tithi* one-fifth of itself; (the measure of) the illuminated part of the Moon (phase, *sita*) is obtained. The horn of the Moon will be elongated in the direction of *valana*. The measure in digits of the elongation shall be ascertained by means of a diagram.

170-171a. *Conjunction of the planets*. The numbers 5, 6, 7, 9 and 5 (corresponding to the five planets Mars etc.) are multiplied by *Trijyā*-minus-the respective *śiḡhrakarṇa* and (placed at two places. One set is divided, respectively by 21, 12, 6, 24 and 3 and the result is applied to other set, i.e., subtracted if the hypotenuse is larger than *trijyā* and added otherwise. The results divided by 3 will be the angular diameters of the discs of the several planets beginning from Mars.

171b-172a. *Time of conjunction*. (When it is necessary to determine when two planets will meet): If the two planets are both regular or retrograde, the difference in their longitudes is divided by the difference of their rates of motion; if one is regular and the other retrograde, (the difference of their longitudes) is divided by the sum of their rates of motion. The result in days etc. would give the time to pass for their conjunction.

172b-173. *Mutual non-obscuration of planets in conjunction*. (The two planets in conjunction) should be corrected by their respective parallaxes in latitude (*nati*) according to their *śaras*, it being addition if in the same direction and subtraction otherwise. When the north-south difference of the two planets is less than half the sum of their diameters, there will be (visual) distinction between the two, (there being no obscuration). True (*sphuṭa*) results can, of course, be arrived by working with the parallax in longitude (*lambana*) etc. as in the case of the solar eclipse.

YATIPĀTA AND VAIDHṚTA : MALIGNANT SITUATIONS OF SUN AND MOON

174. *Vaidhṛta*.⁵⁸ When the Sun and the Moon are in

the same *ayana*, *i.e.*, on the same side of either solstice, if the sum (of their longitudes) is one circle (360), and both have equal declinations, that situation is called *Vaidhṛta*.

175. *Vyatīpāta*. When the Sun and the Moon are on the opposite sides of either solstice and have equal minutes of declination, that situation is called *Vyatīpāta*, the sum (of their longitudes) being a half-circle.

176. *Time when declinations are equal*. When the longitudes of the Sun and the Moon corrected by the degrees of precession of the equinoxes as found by observation, is equal to 12 signs or 6 signs, respectively, compute their declinations.

177. Then, if the declination of the Moon, which is in an odd quadrant, and had been corrected for its latitude (*Vikṣepa*), is greater than the declination of the Sun, the situation of *pāta* is already past.

178. If less, it is still to come. In an even quadrant, the reverse is the case. If the Moon's declination is subtractible from its latitude, the rules as to the quadrant are to be reversed.

179. Multiply the sines of the two declinations separately by Radius (*trijyā*) and divide by the sine of the maximum declination (*parakrāntijyā*, *viz.*, 1397) and find the arcs (of the two results). The difference (of the arcs) or half that difference is to be added to the Moon's longitude when the *pāta* is yet to occur.

180. It is to be subtracted from the Moon's longitude when the *pāta* is past. The said (difference) when multiplied by the Sun's daily motion and divided by the Moon's daily motion, gives a correction, in minutes, to be duly applied to the longitude of the Sun, (being subtracted from the Sun if the *pāta* is past and added to it if the *pāta* is yet to occur).

181. A similar correction is to be applied, in the reverse order, to the Moon's mode. This operation is repeated until the declinations (of the Sun and the Moon) are equal.

182. *Mean time of the Pāta*. The *pāta* occurs at the moment when the declinations are equal. (To find out whether a *pāta* is past or yet to come): If the Moon's longitude at the *pāta* found by applying the correction to the Moon (*vide* verse 180) is less or greater than (the Moon's longitude) at

midnight (of that day), the *pāta* is past or is yet to occur, respectively.

183. *True time of Pāta.* The minutes of the interval between the Moon's longitude (at the Mean *pāta*), as ascertained, and that at midnight, when multiplied by 60 and divided by the Moon's daily motion, will give the time of the *pāta* in *nāḍikās*.

184. *Half-duration of the Pāta.* Multiply half the sum of the diameters of the Sun and the Moon by 60 and divide by the difference of their daily motions. The result will be the half-duration, (*sthityardha* (of the *pāta*), in *nāḍikā* etc.

185. *Beginning, Middle and End of the Pāta.* The true time (of the *pāta* (vide verse 183) is the middle (moment of the *pāta*). That diminished by the half-duration (vide verse 184) is the moment of its commencement and that increased by the half-duration is the moment of its end.

186. *Consequence of the Pāta.* Compared to the beginning and the end, the middle moment of the *pāta* is extremely harmful. It is like burning fire and is to be avoided in all (auspicious) rites.

187. O brāhmaṇa ! Thus has been stated, in brief, matters relating to mathematics and astronomy (*gaṇita*). I shall, now, set out horoscopy (*jātaka*) commencing with (the statement of) the nomenclature of the *rāśi-s* (signs).

CHAPTER FIFTYFOUR

NOTES

1. Hindu texts on astronomy call this section as *Tripraśna-adhyāya*, since it deals with 'problems' concerning the 'three' topics, *viz.*, time, place and direction.

2. Actually, however, this topic is not treated in the *Purāṇa*.

3. The two *vyatīpatas*, being malignant aspects of Sun and Moon, called *Lāṭa* and *Vaidhṛta*, occur at the moments when the sum of the longitudes of the Sun and the Moon is equal to 180° and 360° , respectively. These moments are considered to be highly inauspicious (*vi-ati-pāta*).

4. For the constitution and list of *Yogas*, see below, note under verse 211b. See also ch. 54, Verse 124 and footnote.

5. For the nature of *karāṇa* and the list thereof, see below, note under verse 219b. See also ch. 54, verses 126-27 and footnote.

6. The idea is that the operation could start from the unit digits *i.e.*, from the right end of the numbers, as is the general practice, or from the highest digits of the numbers at the left end.

7. For the detailed working, see *Līlāvati* of Bhāskaračārya, (edn. Hoshiarpur, 1975). So also, for the arithmetical operations set out below.

8. Written in modern convention, this would be

$$\frac{(a+b) + (a-b)}{2} = a; \quad \frac{(a+b) - (a-b)}{2} = b$$

9.
$$\frac{a^2 - b^2}{a - b} = a + b$$

10. 1. Verses 32-34 give three methods to derive, on the basis of any assumed number, sets of two numbers which when squared and added together or one subtracted from the other, and reduced by 1, give perfect squares.

Method I. The numbers are : $\frac{8x^2-1}{2x}$ and $1/2 \frac{(8x^2-1)^2}{2x} + 1$.

Sum of their squares *minus* 1 = $64x^4 - 2 + \frac{1}{64x} 4 = (8x^2 - \frac{1}{8y})^2$

Diff. of their squares *minus* 1 = $64x^4 + 6 + \frac{1}{64x} 4 - 32x^2 - \frac{1}{2x^2} = (8x^2 - 2 + \frac{1}{8x^2})^2$

Method II. The numbers are : $(x + \frac{1}{2x})$ and 1.

Sum of their squares *minus* 1 = $(x + \frac{1}{2x})^2 + 1^2 - 1 = (x + \frac{1}{2x})^2$

Diff. of their squares *minus* 1 = $(x + \frac{1}{2x})^2 - 1^2 - 1 = (x + \frac{1}{2x})^2$

Method III. The numbers are : $(8x^4 + 1)$ and $8x^3$

Sum of their Squares *minus* 1 = $(8x^4 + 1)^2 + (8x^3)^2 - 1 = (8x^4 + 4x^2)^2$

Diff. of their Squares *minus* 1 = $(8x^4 + 1)^2 - (8x^3)^2 - 1 = (8x^4 - 4x^2)^2$

Thus, all the results obtained are perfect squares.

11. Here, the first two lines give the method to calculate the last term of the series and the third line, the sum of the series. Thus, in a geometrical series, if m is the first member (*mukha, prāg*), g is the common ratio (*gunaka*), r is the number of terms (*gaccha*) and s the sum of the series (*dhana, sarvadhana*) :

$$\begin{aligned} \text{The last term} &= m \times gr \\ \text{Sum of the series} &= \frac{m(g^r - 1)}{(g-1)} \end{aligned}$$

For detailed working, see *Līlāvati, op. cit.*, 125 (pp. 256-64).

12. Thus, in a right angled triangle, if a is the altitude, b the base, and h the hypotenuse, $a^2 + b^2 = h^2$.

13. The three sides would thus be i. $(a-b)^2 + 2ab = a^2 + b^2$;
ii. $(a+b)(a-b) = a^2 - b^2$; iii. $2ab$, for $(a^2 - b^2)^2 + (2ab)^2 = (a^2 + b^2)^2$.

14. Thus the circumference of a circle is $22/7d$.

$$\begin{aligned} \text{Thus: } \textit{sara} &= 1/2 (\textit{vyāsa} - \sqrt{(\textit{vyāsa} + \textit{jyā})(\textit{vyāsa} - \textit{jyā})}) \\ \textit{jyā} &= 2 \sqrt{(\textit{Vyāsa} - \textit{sara}) \times \textit{sara}} \\ \textit{Vyāsa} &= \frac{(1/2 \textit{jyā})^2 + \textit{sara}}{\textit{sara}} \end{aligned}$$

16. If a is the arc, c circumference, d diameter and s sine;

$$\begin{aligned} \text{'First'} &= \frac{(c-a) a}{c} \\ \text{Sine} &= 4 d \times \frac{a (c-a)}{5/4c^2 - a(c-a)} \end{aligned}$$

$$17. \text{Arc} = \frac{c}{2} - \sqrt{\frac{c^2}{4} - \frac{5 s.c^4 \div 4}{4d+s}}$$

18. Different heights for different grains are suggested for the reason that when made into a conical heap, coarse grain would pile up higher while fine grain would slip down and so pile up only to a lesser height.

19. *Droṇa* is one of the bigger measures of volume used in ancient and mediaeval India.

20. The gnomon in general use in ancient India was a strong, straight, cylindrical rod, made of metal or of wood, 12 inches in height, and pointed at the tip. In use, it was fixed firmly on a hard, level surface at the centre of a graduated circle.

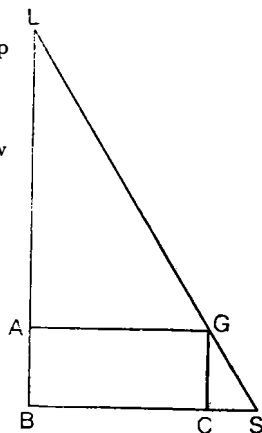
21. In the figure, LA=Height of the lamp

GB=Gonomon

CS=Gnomonic shadow

By the application of the rules of similar triangles, shadow,

$$CS = \frac{GC \times BC}{LA}$$



22. Height of the lamp,

$$BL = \frac{GC \times BC}{CS}$$

23. Lamp to gnomon,

$$BC = \frac{LA \times CS}{GC}$$

24. If LB, the lamp,
GC and G' C', the two
gnomons,

CS and C' S', the two
shadows

BS and BS', the two
bases,

$$\text{Base } BS = \frac{SS' \times CS}{(C'S' - CS)}$$

$$BS' = \frac{SS' \times C'S'}{(C'S' - CS)}$$

$$25. \text{ Lamp } LB = \frac{BS \times GC}{CS} = \frac{BS' \times G'C'}{C'S'}$$

26. A 'divine' year (*divya-varṣa*) is equal to 360 'mortal' years or sidereal years of current astronomical parlance.

27. Manu is one of the mythical progenitors of man and the time mentioned here is called a *manvantara*. 14 *manvantaras* constitute a longer Puranic duration of time mentioned in the next verse, which is termed *Kalpa*.

28. By *Śighrocca* is meant the farthest point from the centre of the earth in the orbit of the planet, or the higher apsis of the epicycle related to the equation of conjunction.

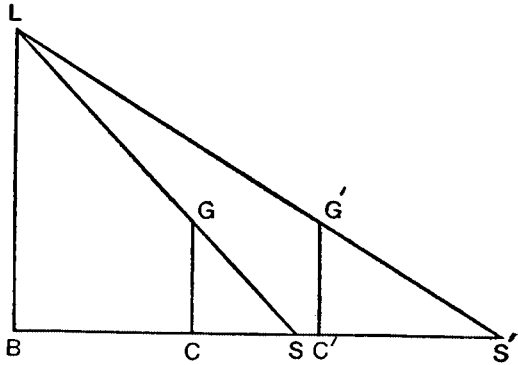
29. A lunar day (*tithi*) is equal to one-thirtieth of a lunar month (*cāndra-māsa*) which is the interval between two conjunctions (or oppositions) of the Moon, being the period of the moon's synodical revolution, and is reckoned either from new moon to new moon or from full moon to full moon.

30. A lunar month, extending over 29.5306, days, being shorter than a solar month of 30.4380 days, the number of lunar months in about three solar years would be one more than that of the solar months. This extra lunar month is called *adhimāsa* (additive or intercalary month).

31. A lunar day (*tithi*) being smaller than a terrestrial day (*bhūdaya*), if the two begin simultaneously at a sunrise, the lunar day will end earlier. This difference will increase day by day and when it is equal to one day (24 hrs.), it constitutes one *tithikṣaya* or subtractive day.

32. The solar month (*saura-māsa*), being one-twelfth of a solar year (*saura-varṣa*) or sidereal year (*nakṣatra-varṣa*), is the time required by the Sun to pass through one *rāśi* (sign or 30°) of the Zodiac and is equal to 30.4380 terrestrial days.

33. A lunar month (*cāndra-māsa*) is equal to 30 lunar days (*tithis*) and is equal to 29.5306 terrestrial days.



34. *Mandocca* is equivalent to the higher Apsis. The *mandoccas* of the Sun and the Moon are the same as their Apogees (points on the orbit farthest from the planet), while the *mandoccas* of the other planets are equivalent to their Aphelions (points on the orbit farthest from the Sun).

35. *Pāta* (node) is the point at which the orbit of a planet intersects the ecliptic.

36. The *ahargaṇa* (lit. 'total of days') or *bhūdina* at any time is the number of (terrestrial) days that have elapsed upto the previous midnight from the time of the commencement of the epoch, which latter is generally taken as the current *Yuga*.

37. *Laṅkā* is one of the cardinal hypothetical cities on the Earth's equator where the meridian of the Indian city of Ujjain cuts it. In Indian astronomy, days are reckoned from midnight (or sunrise, according to different systems) at the meridian of *Laṅka*. For a discussion on the position of *Laṅkā*, see *Āryabhaṭīya*, Ed. with Tr., (Delhi 1976), pp. 123-25. See also below, verses 86b-87a.

38. 1. A *Yojana*, according to this, will be about 4.95 miles or 7.56 km. Thus, if r is the radius of the Earth, Circumference = $2r \times \sqrt{10} = 2rx \sqrt{10}$. Here $\sqrt{10}$ is taken as π as per the formula, *cir.* = $2 \pi r$. This works out of 5059.556 *yojanas*.

39. *Trijivā*, called also *trijyā*, *tribhajyā*, *triguṇa*, *trirāśijyā*, is sine 3 *rāśis* (or 90) and is equal to the radius of the circle.

40. *Vikṣepa* (celestial latitude) is the deviation of the planets from the plane of the ecliptic.

41. Thus : The cycle = 360° , *rāśi* or sign = $1/12 \times 360^\circ = 30^\circ$ 1/8 sign = $3^\circ 45'$ or $225'$. This is the first of the 24 signs contained in a quarter (90° or 3 signs).

42. The second sine, being the sine for the second section (*khaṇḍa*) $225' + 225' = 450'$, would be : $225/225 = 1$; $450 - 1 = 449'$.

The third sine, being the sine for the third section (*Khaṇḍa*), $225' + 225' + 225' = 675'$, would be : Present quotient $449/225 = 2$; the sum of the quotients = $2 + 1 = 3$; the sum reduced from the first sine $225 = 225 - 3 = 222$. The result added/to the second sine = $449 + 222 = 671$, the third sine.

The process is repeated. The several sines calculated thus are given below :—

No.	<i>Khaṇḍa</i> in minutes	Sine	No.	<i>Khaṇḍa</i> in Minutes	Sine
0	0	000			
1	225	225	13	2925	2585
2	450	449	14	3150	2728
3	675	671	15	3375	2859
4	900	890	16	3600	2978
5	1125	1105	17	3825	3084
6	1350	1315	18	4050	3177
7	1575	1520	19	4275	3256
8	1800	1719	20	4500	3321
9	2025	1910	21	4725	3372
10	2250	2093	22	4950	3409
11	2475	2267	23	5175	3431
12	2700	2431	24	5400	3438

43. In Hindu astronomy, the maximum declination (obliquity of the ecliptic) is taken as $24'$; and 1397 represents sine 24° .

44. While the *mandoccas* of the Sun and the Moon are the same as as their apogees, that of the other planets are equal to their aphelions. For details on the concept of and computations with *mandoccas* and *śighroccas* in Hindu astronomy, see E. Burgess, *Translation of the Sūryasiddhānta*, ed. by P. Gangooly, Calcutta, 1935, pp. 53-56.

45. The Venkatesvara Press edn. of *Nārada Purāṇa* used for this translation, repeats, here, haplographically, two verses, thus erratically increasing serial number of the verses by two. While the repeated verses are dropped in the translation the increased serial number is retained so that there might not be any discrepancy in the number of the verses in the text edition and the present translation.

46. The Venkatesvara Press edition of *Nārada Purāṇa* used for this translation repeats here haplographically three earlier lines, increasing the serial numbering of the verses correspondingly. Here, the changed verse number is adopted according to the edition; the repeated lines are not translated.

47. *Viṣvavād-bhā* or Equinoctial shadow at a place is the shadow of the Sun cast by a gnomon of 12 digits at Midday on the day of the Vernal equinox (March 21) or Autumnal equinox (Sept.23) at that place.

48. *Kṣīṭijyā* (Earth-sine) is the sine of the arc of the diurnal circle intercepted between the horizon and the six o'clock line.

49. *Dina-vyāsa-dala* (day-radius), called also *dyu-jyā* ('day-sine') is the radius of the diurnal circle, in contrast to *trijyā* which is the radius of the 'great circle' or the 'tabular radius'.

50. *Prāṇa* or *Asu* ('respiration') is the period of time required for one respiration and is equal to 4 seconds.

51. The ecliptic is divided into 27 asterisms or lunar mansions of equal extent of $13^\circ 20'$ or $800'$ each, called *Aśvini*, *Bharaṇi* etc. The *nakṣatra* forms one of the members of the five-member, almanac (*Pañcāṅga*) of the Hindus, the other four members being, *Vāra* (weekday), *tithi* (lunar day), *Yoga* and *Karaṇa*, for which see below.

52. *Yoga*, one of the members of the five-membered Hindu almanac, is used only for astrological purposes. It is a period of time of variable length during which the joint motion of the longitudes of the Sun and the Moon amounts to $13^\circ 20'$ or $800'$, being the extent of a lunar mansion. They are 27 in number, and are mentioned in Hindu almanacs for each day. They have individual names, as follows :—

1. Viṣkambha, 2. Pṛiti; 3. Āyusmān; 4. Saubhāgya; 5. Śobhana,
6. Atigaṇḍa, 7. Sukarma, 8. Dhṛti; 9. Śūla; 10. Gaṇḍa; 11. Vṛddhi;
12. Dhruva; 13. Vyāghāta; 14. Harṣaṇa; 15. Vājra, 16. Siddhi,
17. Vyatipāta, 18. Variyas; 19. Parigha, 20. Śiva, 21. Siddha; 22. Sādhyā; 23. Śubha; 24. Śukla, 25. Brahman, 26. Indra, and 27. Vaidhṛti.

53. The *karāṇa* is also an entity made use of only in astrology and forms a member of the five-membered (*pañcāṅga*), Hindu almanac. Each *Karāṇa* extends over half a *tithi*. The four *dhrūva* ('fixed') *karāṇas* viz., *Śakuni*, *Nāga*, *Catuṣpāt* and *Kīṁstugna* occupy the four half-*tithis* as stated above, and the other seven *karāṇas* repeat eight times through the next 56 half-*tithis*, when the cycle of 60 *karāṇas* in a lunar month is completed. The cycle is then repeated.

54. *Viṣuvatkarāṇa*, or equinoctial hypotenuse, is the hypotenuse of the equinoctial shadow found by calculating the square root of the sum of the squares of the equinoctial-shadow and the gnomon.

55. By 'Radius' (with capital 'R') is meant the radius of the great circle or the tabular radius. In Sanskrit it is called *trijyā*, *trijīvā*, *tribhajyā* etc., meaning the sine of three sines or 90° .

56. It might be noted that if the *śara* is larger and cannot be subtracted from half the (angular) diameters of the eclipsed and the eclipser, there will be no *channa* (eclipsed portion) and so no eclipse.

57. For a little time before sunrise and after sunset, the planets, near the Sun, would be invisible on account of the sun's brilliance. The times after sunset and before sunrise they would be visible are indicated here.

58. This section, called *Pātādhikāra* (Section on *pātas*) in treatises, treats of two astronomical situations called *Vyatiṣṭā* and *Vaidhṛta* which are highly malignant in character. They are computed and used for astrological purposes, viz., to avoid auspicious acts being held at these situations.