

Competing Cosmologies in Early Modern Indian Astronomy

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1 Introduction

In an article on ‘The Purāṇas and Jyotiḥśāstra’ [Pingree ‘Purāṇas’], David Pingree¹ sketched the history of the ways in which the cosmological account found in the Sanskrit astronomical Siddhāntas took shape in relation to the standard cosmology of the Sanskrit Purāṇas. While sharing sources of influence, and despite some attempts at accommodation, the astronomers’ model was in fundamental respects not reconcilable with the Purāṇic model of the earth or of the heavens. As Pingree showed, the contradictions were already known to the authors of the earliest Siddhāntas, but it was Lallācārya in the early ninth century who formulated the view of the problem that came to be accepted as standard, and that was repeated in the influential Siddhāntas of the twelfth century, the *Siddhāntaśekhara* of Śrīpati and the *Siddhāntaśiromaṇi* of Bhāskara.² Lalla’s solution maintained all the features of the astronomers’ model that were necessary for supporting their calculations, and rejected those parts of the Purāṇic model that contradicted them. At the same time he

¹ It seems fitting, in a volume dedicated to David Pingree (DEP), to continue something from a point where he left off. Many scholars will have the opportunity to do just that, given the nature of his work, which is in itself comprehensive at the same time that it has opened the way for further research. As will become clear in what follows, this work is greatly indebted to DEP’s help on many levels—for the invaluable published work, for giving me access to copies of manuscripts, for patiently explaining and re-explaining many points, and for general encouragement of my studies in this field of research. Over the course of two decades I have learned more from him than from anyone else, and I am honored to be able to count him my teacher and friend.

² Pingree mentions the *Siddhāntasundara* of Jñānarāja as following this standard model, but it does not do so entirely, as the following will show.

sought to accommodate his cosmology to Purāṇic doctrines where these did not interfere with the astronomy.

At the end of his article Pingree referred to two Sanskrit works of the early modern period that awaited further study, both of which sought to reconcile the Siddhāntic and Purāṇic model in a way different from the standard accommodation of Lalla/Śrīpati/Bhāskara.

He closed by posing a question about the larger intellectual context in which those attempts at creating consistency were written. This article is therefore devoted to the works of several Sanskrit authors in the early modern period on the problem of cosmological reconciliation, or what I will call here the 'virodha problem'. It is now possible to fill in more of the picture of what form the discussions took in the early modern period, and what was at stake in them.³ One finds discussion on this subject by astronomers in the Siddhāntic traditions, and also by adherents of the Purāṇic doctrines. The most interesting texts were written by authors who wished to consider themselves both.

Here I will primarily be interested in the views on the virodha problem advanced by three astronomers of Pārthapura, and in the reception of their views by two astronomers in Banaras. The two titles that Pingree mentioned in his work were the *Saurapaurāṇikamatasaamarthana* of Nīlakaṇṭha Caturdhara, and the *Bhāgavatajyotiṣayoḥ Bhūgolakhagolavirodhaparihāra* of Kevalarāma Jyotiṣarāya. An edition and study of each of these texts is now in preparation, and I will refer to their contents only briefly here. The present essay provides a context in which to understand those works, and a number of other similar independent works on the virodha problem, which I shall mention at the end.

In the course of examining the arguments of these astronomers, the following survey will, I hope, contribute to the analysis of two larger historical problems—how to place the Siddhāntic astronomers in the wider intellectual history of Sanskrit literature, and how to place their discussion of cosmology in the larger history of early modernity in India.⁴

The astronomers present special problems for the history of

³ A richer body of manuscript material has become available, much of it accumulated by DEP himself, in this genre of reconciliation literature.

⁴ The latter problem I hope to discuss elsewhere, and here will limit myself to making note of some pertinent facts in preparation.

Sanskrit literature in early modernity, as their intellectual currents seem (at least at first glance) to have run in isolation from the other śāstras. As a result the astronomers are often studied as independent of the Brahminical intellectual traditions in which they operated. And yet the Siddhāntic astronomers are of special interest because of the 'practical' nature of the knowledge they generate, and the potential points of contact they therefore present with non-Sanskritic knowledge traditions.

2 *Virodhaparihāra*

A way into the problem lies in asking a question: in what would a satisfying 'reconciliation' of Purāṇas and Jyotiṣ consist? The Sanskrit term here is virodha-parihāra, the 'removal of contradiction'. Yet removal of contradiction can conceivably be done in a variety of ways. Some of our authors simply refute one or the other of the contradictory views as untruth or illogic, hence leaving the field to the other view and in that way removing any contradiction. Others accord different levels of truth to the two positions, saying that one describes practical, the other, ultimate reality. A related removal of inconsistency is done by putting the two positions on different planes of reality by appeal to their purpose, one being for timings of mundane affairs, the other for soteriological aims. Some adopt an exegetical strategy, according one of the two views a higher truth, but reading its texts so that they only confirm what the other view already maintains. Others assume that both views have the same subject and purpose on the same plane, and actually adjust and revise doctrines so that they conform to each other. Some of our authors resort to combining several of these theoretical approaches.

A point of contact with the larger Sanskrit intellectual tradition is found in the epistemological theory that the astronomers rely on to achieve their 'removals'. One finds in the astronomers of this period evidence of a growing interest in integrating their scientific method with the fully elaborated pramāṇa system of proof developed in the principal śāstras, especially in logic. Here it is the status of textual authority (śabdapramāṇa) in particular that is a matter of urgency—the canonical status of the Purāṇas and Siddhāntas, their hierarchical relation, and the degree of autonomy accorded to the other pramāṇas, that is, logic (anumāna)

and experience (pratyakṣa).

Fixing the Limits. As for the limits of the period, it is easy to assign the beginning to the appearance of the *Siddhāntasundara* (SSJ) in 1503.⁵ This work by Jñānarāja was the first astronomical Siddhānta to appear in approximately three and a half centuries, following the impact of the hugely influential *Siddhāntaśiromaṇi* (SŚB). The return to writing a Siddhānta after such a long time marks a renewal of the past, but also a break with it, and Jñānarāja challenged the SŚB on some cosmological points, as we shall see. The close of the period does not present itself so neatly. The last of the dated works I will consider here appeared in 1763, and this seems an appropriate terminus, as a lull ensued before the Siddhāntins confronted the challenge of the new Copernican model introduced by the Europeans.

The 'Standard' Accommodation. Several studies of the cosmological debates in the nineteenth century have recently appeared, and a new essay by Plofker gives an elegant historical survey of the whole trajectory of the problem.⁶ Nevertheless, before beginning with Jñānarāja it will be useful to give a brief summary of the state of play when Jñānarāja began to write; that is, a summary of Lalla's/Bhāskara's 'standard' solution, both its accommodations and its criticisms, and the arguments for them. In some texts of the early modern period, the conclusions stay the same but are supported by different reasons.

In the 'standard' astronomical accommodation, Mt. Meru, the central axial mountain of the Purāṇas, becomes the polar axis inside the earth. The gods, who live atop Mt. Meru, are placed at the North Pole, while the Asuras, their demon counterparts, are placed at the South Pole. The seven underworlds (pātālas) are placed inside the earth. The (flat) Jambūdīvīpa and its surrounding salt ocean become the northern hemisphere and the sea surrounding it, while the six concentric continents and oceans of the Purāṇas (the 'seas of treacle and seas of butter' of Macaulay's notorious 'Minute on Education'), are made into annular continents and oceans in the southern hemisphere, where they lie beyond our local experience. The motions of the stars and

⁵ All dates in the following are given in their A.D. or Common Era form.

⁶ [Young 'Receding from Antiquity']; [Minkowski 'Nīlakaṇṭha's Comments']; [Minkowski 'The Paṇḍit']; [Plofker 'Derivation and revelation'].

planets, though predicted according to a geocentric and epicyclic model, are still caused by the Pravaha and other winds named in the Purāṇas.

On the other hand, criticisms of the Purāṇic model are unavoidable. If the earth is of the huge Puraṇic size (50 koṭi yojanas, or 100,000 times larger than the size given in the Siddhāntas of ca. 5000 yojanas circumference), then the calculation of the rising and setting of planets, of the conjunctions of planets, of eclipses, and of other celestial phenomena, which are all geared, through the size of the orbits of planets and stars, to the Siddhāntic size of the earth, and which are seen to compute well in that system, will no longer produce useful results.

If the earth is flat, then why is a tall tree at a distance not visible to an observer? (Bhāskara provided another argument which became more widely used: why does the North pole star rise in the heavens as one travels northward, while other stars at midheaven correspondingly decline, if the earth is flat?) The earth is only assumed by the unthinking to be flat, because a hundredth part of its surface appears flat to us. And (perhaps not a very good argument) why does water flow downhill if the earth is flat?

If the earth is flat, moreover, how can night be explained, for then the sun would always be visible, circling overhead? Nor can it be said that the shadow of Meru causes night, because we do not see Meru in the heavens, and the gods, atop Meru, would never know night. Furthermore, if the earth is flat, and the sun is always overhead, why would days and nights get longer and shorter in the course of a year?

The earth has no support—not on water, and not on an embodied deity such as Śeṣa or Kūrma. For if it did have a support, as the Purāṇas say, then one would have to assume a support for the supporter. In that way one would either come to the problem of an infinite regress, or one would have to assume a supporter that innately had the power to support itself. Why not let the earth be what has this power?

The moon cannot be higher than the sun, despite what the Purāṇas say, for then it would be always illuminated, and neither eclipses of the sun nor of the moon could occur. Nor can Rāhu be the cause of eclipses.

This, then, was the position of astronomers about the Purāṇas and their possible consistency with astronomical treatises. Some of these arguments were already made by earlier astronomers, and Bhāskara differs from Lalla in places, but those differences will not concern us here. It is enough to say that the received viewpoint is a substantially standardized, if not quite a stable and uniform one.⁷ For some time after Bhāskara, this was a topic that did not elicit new thinking. The stability of the ideas is made clear enough in a commentary on the SSB by Lakṣmīdāsa, the *Gaṇitatattvacintāmaṇi*, written in 1501, two years before Jñānarāja's work.⁸ Lakṣmīdāsa explicates verse by verse, but makes no attempt to expand Bhāskara's viewpoints or depart from them when it comes to the virodha problem. As we shall see, the situation had changed for the two great commentators on the SSB living a century later.

3 Jñānarāja

It is against this background that we should read Jñānarāja's chapter on cosmology. Jñānarāja belonged to an eminent family of astronomers and śāstrīs.⁹ An ancestor had served at the court of the Devagiri Yādavas. In Jñānarāja's day the family was settled in Pārthapura, along the Godāvarī river in Vidarbha. Jñānarāja's sons Cintāmaṇi and Sūryadāsa both wrote works on astronomy (more on both of them below), as did other members of the family.¹⁰ Pārthapura was something of a center for astronomy in these centuries, Jñānarāja's being only one of the families based there. According to his son Sūryadāsa, Jñānarāja also wrote works on astrology, poetics, and music, but these texts are not extant.¹¹

Siddhāntasundara. The text of the *Siddhāntasundara* (or

⁷ See [Plofker 'Derivation and revelation'] on early differences on the treatment of eclipses, and also on the extent to which invoking Purāṇic authority might have been secondary to astronomical argument.

⁸ [Pingree CESS A5, 523–5]. He is also named Lakṣmīdhṛta. He was the son of the great Vācaspati Miśra. His commentary is to date unpublished. Thanks to DEP I had access to a MS from Bombay—AS Bombay 287.

⁹ [Pingree CESS A3, 75–6; A4, 100; A5, 122–3.]

¹⁰ For a family tree see [Pingree *Jyotiḥśāstra*, 124].

¹¹ [Dikshit *History*, 2, 143], citing Sūryadāsa's commentary on the *Bījagaṇita*.

‘Treatise Beautiful’) was widely read over the north of the subcontinent, as can be seen from the number of manuscripts extant.¹² One finds in the work a much stronger Purāṇicizing tendency, coupled with a greater concern with artistic expression. Jñānarāja regularly vies with Bhāskara’s SŚB.¹³ The closing chapter of the *Siddhāntasundara* comprises a ṛtavarṇana, that is, a poetic evocation of the seasons of the year, after the style of Kālidāsa’s *Ṛtusaṃhāra*. It was Bhāskara who was the first to devote a brief section of his *Siddhānta* to the cycle of seasons.¹⁴ Among later authors of *Siddhāntas*, it is characteristic that only Jñānarāja produced such a chapter, and that he made his chapter 34 elegant verses long, more than twice the length of Bhāskara’s mere 15.¹⁵

In the chapter on cosmology (Bhuvanakośa), Jñānarāja displays a much greater concern with textual authority, of the śruti, and, especially, of the Purāṇas.¹⁶ He breaks with Bhāskara’s understanding of several points so that he can make the Purāṇic statements about the earth’s support be true. On the other hand, he revises the interpretation of the Purāṇas, taking it out of the hands of the Paurāṇikas, as it were, so that the Purāṇas can be in agreement with the *Siddhāntic* model. Jñānarāja in attempting his new accommodations limits himself to the size, shape and support of the earth. When it comes to the planets and stars above, he resorts to what might have been an old argument, namely that the Purāṇas and *Siddhāntas* are both true, but describe the world in different creations (kalpabheda), the *Jyotiḥśāstra* being pertinent to our experience today.

¹² [Pingree CESS] lists more than 50 extant MSS. The text is as yet unpublished, but thanks to DEP I have been able to examine 3 MSS—BM 14, 365; RORI (Kotah) 981; and SB 35318, the latter including Cintāmaṇi’s commentary.

¹³ Indeed, Sudhākara Dvivedī’s brief characterization of the SSJ [Dvivedī *Gaṇakatarāgiṇī*, 57] mentions these three features: atra siddhānte bahutra purāṇamatamaṇḍanam bhāskarācāryamatakhandaṇam kṛtam asti — kutra cit kalpanā yuktīyuktā, ‘paratra ... kalpanā golayuktibahirbhūtā jalpanāpūrṇā kavītaparā ca.

¹⁴ Chapter 12 of the *Golādhyāya*.

¹⁵ Sūryadāsa, Jñānarāja’s son, has a chapter of his *Siddhānta-saṃhitāsārasamuccaya* called the *Ṛtucaryā*. This work is not exactly a full *Siddhāntic* treatise. See below.

¹⁶ The *Bhuvanakośa* appears as the first chapter in the second half (*Golādhyāya*) of the SSJ.

Jñānarāja's greater concern with textual authority is made clear in the unusually lengthy account of the origins of the world that begins the chapter. This treatment is also unusual for a Siddhānta in that it blends two accounts of the genesis of the worlds, one from the Purāṇic Sāṃkhya philosophy, the other from the *Śatapatha Brāhmaṇa*.¹⁷

The chapter concludes with a statement of the purpose of cosmological description, which is to enable appreciation of the creation in all its multiplicity as nothing other than the Supreme Being. The one who knows the world as Vyāsa describes it achieves communion with the Deity. This purpose of cosmology—which is knowledge of the Creator's Creation—effectively eradicates the distinct purpose of Jyotiṣ, since what is salvific is the *Bhāgavata*'s account and not the Siddhānta's.¹⁸ The chapter ends with astronomy no longer in sight, as the creation's purpose is said to be an extensive preparation by the creator Brahmā for staging the worship of Śiva as the Deity in his form as cosmic Śivaliṅga.¹⁹

Jñānarāja writes in response not just to the astronomers he names, but also to Paurāṇikas who criticize the astronomers' view. No texts are mentioned, and I have not come upon any texts in which such criticisms are made, so these remain for the moment offstage voices. We learn, though, that the proof that the astronomer Pṛthūdaka gave for the sphericity of the earth was not accepted by those with base minds (*khalamatayaḥ*).²⁰ Moreover there are those who cite the authority of the Purāṇas to show that the earth is flat. Mere prating, says Jñānarāja.²¹

Support of the Earth. Jñānarāja proposes that the earth is indeed supported by various incarnated divine beings as depicted

¹⁷ SSJ II.1.9–19. ŚB 6.1.1.1–6.1.2.10 is referred to in SSJ II.1.19.

¹⁸ SSJ II.1.77. Except, says the commentator Cintāmaṇi, insofar as the Siddhāntasundara's explication might more quickly facilitate an ability to understand the *Bhāgavata*'s cosmology.

¹⁹ SSJ II.1.78. The chapter also includes the account of all seven dvīpas and samudras, with geographical and ethnographical comments, which had become *de rigueur* for astronomical Siddhāntas (SSJ II.1.39–60). Jñānarāja makes a point of coordinating the four Purāṇic sub-continent of Jambūdvīpa with the four quadrant cities of the astronomers (SSJ II.1.43–9). See [Pingree 'Purāṇas and Jyotiṣśāstra', 278].

²⁰ SSJ II.1.23. This means Paurāṇikas, the commentator Cintāmaṇi tells us.

²¹ SSJ II.1.27. More on this below.

in the Purāṇas, that is, the great serpent Śeṣa, the boar incarnation Varāha, the tortoise incarnation Kūrma, and so on. This doctrine can be reconciled with a model of a spherical earth if we suppose that the supporters are stationed inside the globe, in the Pātālas, supporting the earth from its interior.²²

The implication of this proposal entails two further arguments with Bhāskara, however, since Bhāskara has proposed that the earth remains in space because it has an inherent power to hold itself there.²³ Jñānarāja must first of all criticize Bhāskara's theory that the power to remain fixed is a natural property of the earth element, just as fluidity is a natural property of the water element, or heat is a natural property of the fire element. Jñānarāja makes the telling point that if fixity is a natural property of the earth element, it should also be seen in small bits of earth, in the way that a bit of water is fluid, and a bit of fire is hot.²⁴

After all, Jñānarāja argues, if attraction power were what drew things to earth, we would see lighter things 'fall' faster to earth, and heavier things slower, since the attraction would work more powerfully on the former; yet our experience is the opposite. Why not rather suppose a supporter?²⁵ A vulture carrying a huge snake in its beak can remain soaring in air for a long time. And a vulture is a weak creature, by comparison with the high deities, who could easily stay aloft, carrying the earth, for the entire duration of a creation, that is, a kalpa of Brahmā, such is their power.²⁶

The second part of the argument has to do with the people and other creatures living on the sides and bottom of the globe. Bhāskara has argued that they are held there by an attraction power inherent in the earth (ākṛṣṭaśakti), that is, an additional power that the earth possesses to draw things to it. Jñānarāja

²² SSJ II.1.30.

²³ SSJ II.1.29. ŚŚB Bhuvanakośa vs. 2. Lalla had said this power belonged to earth but that it was god-given (ŚDVT 20.46). This occasions a discussion of earthquakes in the commentary of Cintāmaṇi, which is continued in Nṛsimha and Munīśvara. For if the earth has an inherent fixity, how can it move as it does in an earthquake?

²⁴ SSJ II.1.30. Cintāmaṇi, the commentator, points out that our common experience of clouds released in mid-air is that they fall down, after all, and do not remain fixed in the air.

²⁵ SSJ II.1.32.

²⁶ SSJ II.1.31.

denies that the earth has this attraction power. He proposes instead that there is a property of things on the sides and bottom of the globe to stay on the earth and not fall off into space. Just as we all perceive that certain substances can exhibit unusual properties in special contexts—the sunstone, for example, which becomes fiery in contact with the sun’s rays, or the moonstone which turns to liquid when exposed to moonlight—so people and other things on the sides and bottom of the earth, by virtue of being located there, exhibit the property of being able to stay on and not fall down into space.²⁷

Jñānarāja presents a second, slightly alternative argument for the same point. Just as people in different regions of our own subcontinent are seen to be different in their speech, appearance, behavior and so on, Jñānarāja reasons, how much more different must people and other things be in the other distant continents? Why not suppose that one different feature they possess is the power to stay on the earth, though they are positioned on its sides and bottom?²⁸

There is a more general principle that informs a number of these arguments, having to do with the ‘downness of down’, that is, with whether directionality is absolute or relational. Most of the authors of the Siddhāntas include in their discussion of the sphericity of the earth a statement of relational directionality, that wherever one is on the globe, ‘up’ is over one’s head, and ‘down’ is below one’s feet. People opposite each other on the globe are mutually ‘under’ each other. There is no such statement in Jñānarāja, who instead cites the Purāṇas as supporting his Siddhānta’s view that the gods’ position on the North pole of Meru is above, while the demons’ position on the South pole of Meru is below.²⁹ Cintāmaṇi, the son and commentator, does not fully agree with his father on this point.

Jñānarāja and Purāṇic Revision. Jñānarāja makes efforts to argue against the Paurāṇikas, especially concerning their contention that the earth is flat. Jñānarāja reuses some old arguments against the earth’s flatness, and introduces new ones. A traveller going north sees the pole star’s elevation in the night

²⁷ SSJ II.1.35–6.

²⁸ SSJ II.1.37.

²⁹ SSJ II.1.51.

sky increase. A traveller east, on the other hand, sees the pole star stay at the same elevation, however far he travels.³⁰ In fact Jñānarāja introduces some figures here—a traveller will observe one degree of elevation of the pole star for every 14 yojanas that he travels north.³¹ Furthermore, a swift-moving astronomer who observes local sunrise, and then, carrying a sand-clock with him, travels east for 10 yojanas, will find that the next day's sunrise occurs there $7\frac{1}{5}$ palas earlier.³² This is a new argument, and not a very strong one, since it is only true for an observer who happens to be on the equator.

Jñānarāja introduces the old argument that the earth has been mistakenly thought to be flat because a hundredth part of its surface appears to be flat, but he uses this specifically as a strategy of accommodation. That is, Purāṇic statements of flatness must be interpreted to refer only to an apparently flat hundredth part of the world around us.³³ Those who argue that the Purāṇas propound the whole earth as flat, says Jñānarāja, do not know the true meaning of the Purāṇas, which is made clear in passages where the term 'bhūgola', the 'earth's sphere', appears. In other words, the author of the Purāṇas is showing that he knows the earth is spherical by using this term. He also shows it when he asserts that Mt. Meru is to the north of all continents and oceans, which could only be true if the earth were spherical.³⁴ In these cases Jñānarāja argues against received Purāṇic opinion, in order to adjust Purāṇic meaning to the Siddhāntic view.

Compartmentalization. I mentioned above that when it comes to the phenomena in the heavens Jñānarāja resorts to a different mode of reconciliation, the two models having different truths and purposes. The Purāṇic description confers liberating knowledge of the Deity and His universal emanation, and in this task astronomy is ancillary at best. This is a form of what I would consider an older, less literal-minded approach to reconciliation,

³⁰ SSJ II.1.24.

³¹ SSJ II.1.25. This supposes a circumference of the earth of 5040 yojanas, which is approximately the value accepted by the astronomers of the Saura pakṣa.

³² SSJ II.1.26.

³³ SSJ II.1.28.

³⁴ SSJ II.1.27. See below, where Sūryadāsa cites the passage from the *Bhāgavata* and the *Viṣṇu Purāṇas* (note 64).

one that in a variety of ways compartmentalizes truth claims.

Excursus: Vyāsasiddhānta and Untroubled Blending. A curious variant of this compartmentalizing strategy is evident in the *Vyāsasiddhānta*, a cosmological work whose date is unspecified, but which appears to have been written in the period before Jñānarāja.³⁵ This text juxtaposes the conflicting models in an impossible and yet blithely untroubled, hybridized cosmology.³⁶ The account of the earth follows the Purāṇic cosmology—huge, flat earth, ring continents and oceans, supporting Śeṣa below. On the other hand, the universe above the earth's surface is described according to the astronomer's cosmology, with the order of planets and distances just as one would find them in the Bhuvana chapter of an astronomical Siddhānta.³⁷ The orbits and distances imply a size of the earth's radius, but this is passed over in silence. Clearly even though there are mathematical and kinematic problems, they are not felt to be so, or are willed not to be so simply by the juxtaposition of the two.³⁸

4 *Cintāmaṇi*

Cintāmaṇi was Jñānarāja's son. He also lived in Pārthapura. He has no known works other than a commentary on the *Siddhāntasundara*, entitled the *Grahagaṇitacintāmaṇi*. This lengthy work was circulated widely in Northern India, though not as widely as the SSJ. It was known to the seventeenth-century astronomers in Benares, as we shall see, and survives in about

³⁵ [Pingree CESS A5, 754].

³⁶ This text is as yet unedited, but thanks to DEP I had access to a copy of a MS from Berlin—Berlin 1738 (or. fol. 981a).

³⁷ The orbit sizes are those of the modern Sūryasiddhānta. In its second half the text goes so far as to offer proofs of the sphericity of the earth that echo the arguments of the SSB. A person traveling north and south will see the pole star rise and decline in the sky respectively (vss. 213–4). The earth only appears to be flat and circular because humans are small and the earth appears flat locally. (vss. 195–6). (Compare SSB Bhuvanakośa 13, 48–9.)

³⁸ Nṛsiṃha in his *Vāsanāvērttika* on the SSB cites the *Vyāsasiddhānta* as giving the circumference of the earth as 5000 yojanas [Caturvedī *Vāsanāvērttika*, 358, l. 3]. That figure is not found in the Berlin MS. Note however that the *Vyāsasiddhānta* I examined echoes the SSB in giving the earth the power to support itself in vs. 8; on the other hand, it has Śeṣa supporting the earth in vss. 171–6.

twenty known manuscripts.³⁹

Virodha. Cintāmaṇi, as one would expect, expands and secures the position of Jñānarāja concerning the Purāṇas and Jyotiṣśāstra, with some notable additions and differences. Cintāmaṇi is the earliest author I have found who proposes to use an alternative meaning of the word for crore (koṭi) as part of the virodha discussion, i.e. as meaning not 10 million, but rather 100.⁴⁰ Cintāmaṇi appeals to this revised meaning in order to resolve the discrepancy in the earth's size. If the earth's size of 50 koṭis of yojanas in the Purāṇas actually means 50 hundreds, then one has quickly arrived at consistency with the Siddhāntic size of 5000 yojanas.

Cintāmaṇi does not always agree with Jñānarāja. He does not fully support his father's implied directional absolutism. Instead he concedes that, wherever one stands on the globe, 'up' must be over one's head, and 'down' must be beneath one's feet. Otherwise how would rain fall 'down' to earth? How would grain grow properly, and how would fire burn properly, i.e. upward? Without grain or the fire to cook it, how would someone on the side or bottom of the earth be able to eat, and therefore live?⁴¹

Cintāmaṇi and Pramāṇasāstra. The most distinctive feature of Cintāmaṇi's work is his preoccupation with integrating the arguments and demonstrations of astronomy with the pramāṇa system of the philosophical śāstras. The concern is especially with Nyāya, but Mīmāṃsā and Vyākaraṇa are also introduced.⁴²

Cintāmaṇi categorizes and reformulates Jñānarāja's arguments in the vocabulary and format of the mainstream śāstraic method—are the arguments inferences from positive evidence (anumāna), or presumptive conclusions (arthāpatti), or some other mode of argument? Do the inferences fulfill the criteria of the logical syllogism, having the five elements of proof (pakṣa, sādhya, hetu, sapakṣa and vipakṣa) in their proper re-

³⁹ [Pingree CESS A3, 49; A4, 94]. The biographers Dvivedi and Dikshit give very little information about Cintāmaṇi. The *Grahagaṇitacintāmaṇi* (GGC) is unpublished, but I was able to examine a partial copy from Banaras thanks to DEP—SB 35318. All references to the GGC are drawn from this MS.

⁴⁰ GGC on SSJ II.1.26, f. 16v. ll. 1–2.

⁴¹ GGC on SSJ II.1.37, ff. 23v, l. 12–24r, l. 3.

⁴² Thus the standard śāstraic triad (in reverse order) of pada, vākya, and pramāṇa.

relationships to each other? Or are there rather faulty arguments (hetvābhāsa), defective in their concomitance relations by departure (vyabhicāra), or misidentification of cause (upādhi), or aptness of demonstration (sādhāraṇatā)? The vocabulary is not incidental, but is basic to the commentary's agenda.

Even the mathematical results are reformulated as syllogisms: for example, in the case of the swift astronomer who goes east 10 yojanas with a sand-clock, and measures a time difference in local sunrise of $7\frac{1}{5}$ palas. The solution to the 'rule of three' problem that this presents— $7\frac{1}{5}$ is to 3600 as 10 is to what?—becomes a syllogism of this form: Earth is possessed of the property of being 5000 yojanas in overall measure (pratijñā); because there is the property of generating $7\frac{1}{5}$ palas time difference at sunrise by an interval of 10 yojanas (hetu); for wherever there is the generation of $7\frac{1}{5}$ palas time difference in an interval of 10 yojanas, there is for a time difference of 60 ghaṭikās an interval of this size (udāharaṇa).⁴³

Cintāmaṇi diplomatically signals when Jñānarāja has not made a good argument by these standards. When arguments are not very complete, or beg the question, or assume what has to be proved, he will buttress the proof by referring to arguments in later verses, or he will simply add a more śāstraic argument. Cintāmaṇi sometimes uses the dialectical style of the more argumentative philosophers.⁴⁴ He especially exerts himself to support his father's criticisms of Bhāskara, arguing out the virtues of Jñānarāja's position, and the vices of Bhāskara's, at some considerable length. Such a concern with regularizing the argumentation of the astronomers is not found in earlier astronomical commentaries, and constitutes Cintāmaṇi's main contribution. One finds the repercussions of Cintāmaṇi's innovation in the commentaries of the next century.

Sources. Jñānarāja's sources are amplified and sometimes identified in the *Grahagaṇitacintāmaṇi*. Cintāmaṇi fills in the passages from the SSB in most cases. He adds support from

⁴³ $C/10 = 3600/7\frac{1}{5}$. $C = 10 \cdot 3600/\frac{36}{5} = 5000$ yojanas. GGC on SSJ II.1.26, f. 16r ll. 8–10. Cintāmaṇi acknowledges that there is no sapakṣa for this inference.

⁴⁴ A style of critique inherited, many polemical generations earlier, from Nāgārjuna. Examples are GGC on SSJ II.1.22, f. 14v ll. 1–4; GGC on SSJ II.1.30, ff. 18v, l. 8–19r, l. 1; GGC on SSJ II.1.30, f. 19v. ll. 5–9.

śruti for the notion that the earth is supported by Śeṣa and other incarnate divine beings, citing ṚV 10.121.1c.⁴⁵ On the other hand, one is disappointed in several places with sources that he does not cite. Where in the Purāṇas is the term ‘bhūgola’ used?⁴⁶ Where does Pṛthūdaka make his proof of the earth’s sphericity?⁴⁷ Who are the critics of Pṛthūdaka in particular, and of the Siddhāntas generally? Because of Cintāmaṇi’s preoccupation with Pramāṇaśāstra, one does encounter citations from sources that are not typical for astronomical texts. There is, for example, a lengthy discussion of the logician Udayana’s *Kiraṇāvalī* on the physical properties of air (or vāyu) and the mechanics of flight.⁴⁸

Cintāmaṇi and Experiments/Realia. Cintāmaṇi is especially interesting when it comes to the examples and the realia they presuppose, especially in his section on the properties of objects under certain conditions, and in his description of people in different parts of the world. He discusses the properties of diamonds and loadstones as known to alchemical science. He knows the special excellences of Persian horses.⁴⁹ He discusses at length possible explanations for the tides, and the extent to which these can be caused by lunar activity, given their variant timings. He investigates the causes of earthquakes, the reasons for which he takes from Varāhamihira and the other Siddhāntas. There is a long discussion of how vultures manage to stay aloft.⁵⁰

⁴⁵ GGC on SSJ II.1.30, f. 18v. 1.1. sā dādhāra pṛthivīm dyām utēmām, from the ‘Ka’ hymn.

⁴⁶ Sūryadāsa (see below) does provide a citation from the Viṣṇu Purāṇa. Kevalarāma picks this argument up, and uses it in a different way, and provides citation.

⁴⁷ The argument appears in Pṛthūdaka’s commentary on Brāhmasphuṭasiddhānta 21.3. My thanks to Setsuro Ikeyama for sharing with me a draft of his forthcoming edition of this text. The argument, roughly, is that for each of the four quadrant cities on the equator, there are four other cities on the horizon; two different ones always lie relatively to the East and West, while the same two always lie to the North and South. Hence the earth is a globe.

⁴⁸ GGC on SSJ II.1.31, f. 20v, l. 12ff; f. 21r, l. 10ff.

⁴⁹ His list of other people on the subcontinent includes not just Southerners and Kārṇātakans, but also ‘Persians’, pārasika—GGC on SSJ II.1.37, f. 23v, l. 4.

⁵⁰ This is where the *Kiraṇāvalī* enters into the discussion. Note that the Indian vulture does famously soar on thermal updrafts, but does not eat serpents, while Jñānarāja’s point in invoking the vulture is his ability to carry a serpent in mid-air for a full muhūrta. The serpent eagle does both,

Most entertaining are his references to experiments, which are perhaps only thought experiments. The swift astronomer of Jñānarāja's verse, who travels east with his sand-clock, is given a fully satisfying touristic experience in Cintāmaṇi's account, even if the details of his experiment, or of its mathematical difficulties as a proof of anything, are left unexamined. 'Travelling west 10 yojanas (exactly), he comes upon a fortress stronghold atop a hill, and sees there the gateway to a royal city, decorated with masses of gems brought from all over the king's domain and from the domains of his conquered enemies. Seeing the reddish reflection of the rising sun's rays on the walls of the gateway decorated with silk banners and with stone from Kashmir, and seeing that the sun has risen, his mind is filled with wonder, and with a broad smile on his face, he reflects, "what has happened is amazing".'⁵¹

There is reference to a quasi-Galilean experiment on the behavior of objects of different weight. An iron ball and an āmalaka fruit, of equal size, each threaded onto a string, are pulled toward the observer with equal force at the same moment. The āmalaka reaches him more quickly.⁵² Hence lighter things are attracted more quickly, and yet we see that, in nature, heavy things fall to the earth faster. Thus it can't be the earth's attraction that makes them fall. Galileo's result was somewhat different.

5 *Sūryadāsa*

Sūryadāsa (born 1508), son of Jñānarāja and brother of Cintāmaṇi, also lived in Pārthapura. Sūryadāsa was a prolific writer in a variety of genres, especially in mathematics and poetry. He made some essays at mathematics as poetry, as it were.⁵³ Perhaps the most widely known of his works today is a work of ingenious

but it does not seem to receive the name of *gr̥dhra* or its reflex in modern Indian languages [Ali *Indian Birds*, 108–13].

⁵¹ GGC on SSJ II.1.26, f. 16r, ll. 2–4.

⁵² GGC on SSJ II.1.32 f. 22r, ll. 6–7; and GGC on SSJ II.1.37, f. 23v, ll. 8–10. In the first case the experiment is done with a slab of rock and an areca nut.

⁵³ For the most complete list of his works, see [Sarma 'Siddhānta-Saṃhitā-Sāra-Samuccaya']; see also [Dikshit *History*, 144–5], [Dvivedi *Gaṇakatarāṅginī*, 65–7].

poetry, the *Rāmakṛṣṇavilomakāvya*.⁵⁴

Siddhāntasamhitāsārasamuccaya. Sūryadāsa was the author of a *Siddhāntasamhitāsārasamuccaya* (SSSS), a 'compendium of essential points about the astronomical Siddhāntas and Samhitās'.⁵⁵ A reference in the last chapter appears to indicate a date of composition in 1583.⁵⁶ The SSSS concludes with a twelfth chapter entitled Jyotiḥśāstrapurāṇavirodhaparihāra, or the 'removal of contradiction(s) of the Purāṇas and Jyotiḥśāstra'. This is the earliest and perhaps only independent chapter in a Siddhāntic work devoted to the virodha problem.⁵⁷ Sūryadāsa discusses the topic in other chapters as well, however, for example in the previous chapter, where he attempts to show the Vedic authority for astronomical ideas.⁵⁸ The text was not as widely known as the work of Jñānarāja and Cintāmaṇi among astronomers.

In the virodha-parihāra chapter the textual authority of the Purāṇas is stated to be infinitely greater than that of the Siddhāntas. As a result Sūryadāsa's purpose in the chapter is to use a sort of exegetical apologetics to show where there is Purāṇic authority for the cosmology of the Siddhāntas. If a passage from the Purāṇas can be shown to express, either directly or indirectly,

⁵⁴ There is a commentary on the SSB attributed to him, which unfortunately was not available to me at the time of this writing. Sūryadāsa is a figure worthy of a great deal more study, especially for the particular nature of his polymathia, which combined the fields of kāvyā and astronomy.

⁵⁵ The text is as yet unpublished; the last two chapters were available to me (courtesy of DEP) only from a single, flawed manuscript. (Jaipur Khasmohor 5026). My synopsis in the following is provisional, pending the publication of a proper edition.

⁵⁶ Ff. 48r, l. 9–48v, l. 1. *evaṃ varttamāne śālivāhanaśaka 1505 haste saptarṣayas tiṣṭhanti ||* There are no bhūtasamkhyā numbers to secure the date. If correct this would make it a work of Sūryadāsa's 75th year, as currently reckoned. If the text was written this late, it might explain why Sūryadāsa does not mention the work in some of the lists he made of his works, which appear at the end of texts completed earlier than this.

⁵⁷ There are six sections to Sūryadāsa's virodha chapter, the first untitled, then bhūparidhipramāṇa, ākāravipratipatti, samudradvipasamsthā, grahakakṣākrama, grahakakṣākramasya abhiprāyaḥ.

⁵⁸ The eleventh chapter, on jyotiḥśāstrāmnāyamūlatva. This chapter provides a basis in śruti for some of the astronomers' cosmological and calendrical ideas. See [Sarma 'Siddhānta-Samhitā-Sāra-Samuccaya', 225], which cites a verse elsewhere in the text that is about the earth's support and attraction-power, in keeping with the views of Jñānarāja and Cintāmaṇi listed above.

an idea consistent with the Siddhāntas, then this constitutes a removal of contradiction. In this sense, although Sūryadāsa accords the Purāṇas a much higher canonical status and authority, all the 'leeway' (as it were) for removing contradiction is found in readings of the Purāṇic text, and not in any adjustments to astronomy. The chapter is not written in commentarial form, but in the form of a series of independent verses (in lengthy, difficult meters) followed by citations of Purāṇic passages that serve to demonstrate the claims.

Sūryadāsa's work very much shows the stamp of Jñānarāja's and Cintāmaṇi's ideas; the same arguments with the same examples appear, making this another work of the 'Pārthapura school', with its pronounced tilt toward the Purāṇas.⁵⁹ At the same time Sūryadāsa makes his own expansions to the argument.⁶⁰ Sūryadāsa adds a variant of the 'different creations' argument, whereby the current creation started out much larger in absolute size, and has subsequently grown smaller. The main evidence he adduces comes from the Mucukunda story of the *Bhāgavata Purāṇa*, in which Mucukunda, a sort of Hindu Rip Van Winkle, awakens from a long sleep to find that everything and everyone has gotten smaller. Thus the Purāṇas and Siddhāntas are both correct, but describe earlier and later stages in the history of creation.⁶¹

In places Sūryadāsa simply rediscovers the accommodations of

⁵⁹ The term 'koṭi' means not crore, but rather 20, or 100 (SSSS f. 46r l. 2); the flatness described in the Purāṇas refers only to a hundredth part of the globe of the earth (SSSS f. 46r, ll. 7–8). As for the problem of the 'downness of down', and why people on the sides and bottom do not fall off, Sūryadāsa follows Cintāmaṇi in adducing the example of insects that can walk on the bottom of a roof beam without falling (SSSS f. 46v, ll. 1–6). Cintāmaṇi proposes this idea in GGC on SSJ II.1.21, f. 13r, ll. 8–10.

⁶⁰ Sūryadāsa adds an argument not found in the work of J and C: that the Purāṇa's statements of uniform planetary distance only make sense if the earth is a globe (SSSS f. 46v, ll. 1–2). Note that this is treated not as an astronomical or kinematic problem, but as a problem for the authority of the Purāṇas if they are supposed not to be always true.

⁶¹ On the annular oceans and continents Sūryadāsa discovers a problem in the old Siddhāntic accommodation: Although the oceans and continents are placed in the same order in both models, their sizes must be different, as the oceans farther down in the southern hemisphere must be smaller, given the smaller circumference of the earth closer to the poles (SSSS f. 46v, l. 10–f. 47r, l. 1). Sūryadāsa makes no attempt to work out this irregularity, having been the first to notice it.

earlier Siddhāntins, showing how Purāṇas and Siddhāntas have the same model in their direct meaning.⁶² In other places he resorts to the secondary or implied meanings of Purāṇic passages where these support the proposals already made by Jñānarāja and Cintāmaṇi, or support new ones of his own. For example, on the differences in the order and distance of the planets and stars, Sūryadāsa wishes to show that all the planets and stars are described in the Purāṇas as having two motions, both the diurnal rotation to the west, and an independent motion to the east. This he accomplishes by referring to passages that have the seven ṛsis, or Ursa Major, rotating with respect to the nakṣatras.⁶³ Since the stars move (very slowly) east, so by implication do all the other planets. Other Purāṇic passages are invoked that show the sun and moon moving eastward, at different speeds. Even though the Purāṇic model appears to place the moon above the sun, Sūryadāsa argues, the Purāṇas also know that moon moves faster than any of the planets. The implication Sūryadāsa finds here is that the Purāṇic sages know the moon must be below the sun.⁶⁴

6 *Nṛsiṃha*

So far we have considered the Purāṇicizing tendencies of three members of one family of astronomers. To trace the impact of their ideas we must move from Pārthapura to Banaras, and consider the work of two astronomers belonging to two rival families. Both of their families had made such a move, from the Deccan to Banaras.

⁶² The first of the chapter's six sections is devoted to pointing out that there are transparent uniformities between the Purāṇas and Jyotiṣ when it comes to the duration of the yugas. The sixth shows that units of time and the names for powers of ten are consistently described.

⁶³ On this see H. H. Wilson's notes to his tr. of VP 4.24.33 [Wilson VP, 2, 666] and *Bṛhatsaṃhitā* 13.1–11.

⁶⁴ This is clearer in the eleventh chapter's exposition (SSSS f. 44v, ll. 4–6). The eleventh chapter also fills out the understanding of Sūryadāsa's position on the Purāṇas. On the question of the earth's shape, Sūryadāsa adduces a passage from the *Bhāgavata Purāṇa* where the term 'bhūgola', the 'earth's globe', is used (BhP 10.8.37). He cites the passage from the *Viṣṇu Purāṇa* that places Meru to the north of all continents—sarveṣāṃ dvīpavarṣāṇāṃ merur uttarataḥ sthitāḥ (VP 2.8.20c). Jñānarāja and Cintāmaṇi had alluded to these passages, but had not cited them.

The family of Nṛsiṃha Daivajña (born 1586) had been based in Golagrāma, a village on the Godāvarī only a few miles from Pārthapura.⁶⁵ They were a family of vaidikas, śāstrīs, and astronomers. Nṛsiṃha's grandfather, Divākara—and later his uncle, Viśvanātha—were pupils of the highly innovative and widely read astronomer of the era, Gaṇeśa Daivajña. Divākara eventually moved the family from Golagrāma to Banaras. Four of his sons became astronomers and/or astrologers, most notably Nṛsiṃha's uncle Viśvanātha, with whom Nṛsiṃha studied. Nṛsiṃha in turn had three sons, all literary astronomers: Divākara, Kamalākara and Raṅganātha.⁶⁶ This family appears to have been the main force disseminating Gaṇeśa's work around the subcontinent from Banaras.

The move of this family is indicative of a shift in the institutional structures of Sanskrit intellectuals in north India in this period. After a period of dormancy, the 16th and 17th centuries in Banaras are marked by an influx of śāstrīs, especially from the Deccan. In Banaras, the structure of patronage appears to have operated rather differently from the sort of land-grant patronage that Jñānarāja's family probably enjoyed in the Deccan.⁶⁷ Support was provided in Banaras for the śāstrīs from many and far-flung princes; support, however, that appears to have been more piecemeal than what local patrons had provided their local pundits. In this period, then, Banaras re-emerged as an 'international' or 'cosmopolitan' center, and Sanskrit works that achieved success there were circulated quickly and widely on the subcontinent.

Nṛsiṃha wrote a huge commentary on the *Sūryasiddhānta* (*Saurabhāṣya*), as yet unpublished.⁶⁸ The work I will consider here is his commentary on the SŚB, the *Vāsanāvērttika*, completed in 1621. Copies circulated widely in north and south India,

⁶⁵ [Pingree CESS A3, 204; A4, 162–3; A5, 202–3] with further bibliography noted. See also [Pingree *Jyotiḥśāstra*, 125]. The village's name translates approximately as 'Globeville' or 'Sphereton'.

⁶⁶ [Pingree *Jyotiḥśāstra*, 125], and the [Pingree CESS] entries for these three authors. The family produced many other śāstrīs as well.

⁶⁷ See [Minkowski 'Nīlakaṇṭha Caturdhara', n. 99].

⁶⁸ This work was completed in 1611. He also wrote a commentary on the *Tithicintāmaṇi* of Gaṇeśa Daivajña, and a 'vast nibandha on astrology' called the *Jātakasārādīpa* (ca. 1625) [Pingree *Jyotiḥśāstra*, 95].

as did copies of his *Saurabhāṣya*.⁶⁹ Unlike earlier commentaries on the SSB such as Bhāskara's own, or Lakṣmīdāsa's, Nṛsiṃha's does not proceed verse by verse, but presents, rather, an essay on each section, in which he arranges the verses in the order most convenient to his own discussion.

Nṛsiṃha and the 'Pārthapura School'. Though Nṛsiṃha defends Bhāskara in general, he does in places accept the revisions of Jñānarāja and Cintāmaṇi. He knows their work in detail and is influenced by them. He does not appear to know Sūryadāsa's SSSS. He reuses the arguments of Cintāmaṇi, sometimes with attribution, and sometimes without.

Nṛsiṃha accepts Jñānarāja's theory about the Purāṇic supporters of the earth; he agrees that we should assume that Śeṣa and the others perform this role, but that they must be located inside the earth. For the two entailed arguments, however, he remains with the SSB. He argues that the earth does have an inherent power to support itself, and that 'down' is relative to where one stands. Nṛsiṃha rejects Jñānarāja's refutation of Bhāskara on the first point saying that attraction can be a special property of earth as a whole, and not of earth the simple element.⁷⁰ And supposing that the supporters have an unlimited number of powers is a needless proliferation of suppositions, since giving the earth the one power of fixity solves all problems.⁷¹ On the second point he takes up Cintāmaṇi's argument for the relative 'downness of down'—how could fire burn or rain fall or crops grow—nearly verbatim.⁷²

Nṛsiṃha ridicules Cintāmaṇi's (and also Sūryadāsa's) argument about the meaning of the term 'koṭi', pointing out that, after all, if a Purāṇic crore of yojanas is equal to one hundred 'actual' yojanas, then the Purāṇic Jambūdvīpa of 100,000 yojanas, our entire continent, that is, must be understood to be only one yojana across!⁷³

⁶⁹ Aside from Bhāskara's own, the *Vāsanāvērttika* is one of only two pre-modern commentaries on the SSB to have been published. The other is by Munīśvara (see below). Citations from Nṛsiṃha in the following are drawn from the edition of the *Vāsanāvērttika* by Muralīdhara Caturvedī.

⁷⁰ [Caturvedī, 340, ll. 27–9]. In fact Cintāmaṇi anticipates this explanation in a *pūrvapakṣa*.

⁷¹ [Caturvedī, 341, l. 8].

⁷² [Caturvedī, 338, ll. 11–14. See above, note 41.

⁷³ [Caturvedī, 358, ll. 5–9]. Nṛsiṃha further rejected the argument that

Nṛsiṃha rejects a series of Jñānarāja's and Cintāmaṇi's proposals without argument. Jñānarāja's claim (SSJ vs. 29) that Bhāskara is not logical is to be ignored (*upekṣaṇīyam*). His argument (SSJ vs. 30) by way of the the variety of customs and appearances of people in our own continent is not logical (*tad ayuktam*). Cintāmaṇi's argument that many passages of śruti refer to Śeṣa et al. as the supporters of the earth is also to be doubted (*sāpi cintyā*).⁷⁴

Elsewhere Nṛsiṃha accepts Cintāmaṇi's arguments and examples cheerfully (not always acknowledging his source). He likes Cintāmaṇi's proof of the earth's sphericity by appeal to the example of the insect circling a lamp, which, he finds, is 'well-said'.⁷⁵ He borrows the two specified arguments about the size of the earth that Sūryadāsa and Cintāmaṇi have made, about the astronomer travelling north 14 yojanas, and travelling east 10 yojanas.⁷⁶ He refers to 'self-styled' Paurāṇikas, using the phrasing of Cintāmaṇi.⁷⁷ He makes use of a dialectical argument found in Cintāmaṇi phrased in the same structure and wording.⁷⁸

Attitude to Pramāṇa. Although he has accepted at least one of Jñānarāja's Purāṇicizing proposals, Nṛsiṃha does not value the authority of the Purāṇas as highly as do the members of the 'Pārthapura school'. He considers them to be of an authoritative weight equal to the Siddhāntas, but not greater.⁷⁹ For Nṛsiṃha,

the Purāṇic measurement is of an earth of a different era for two different reasons.

⁷⁴ All of these statements are found on [Caturvedī, 341, ll. 5–12].

⁷⁵ *iti cintāmaṇinā kandukākarakatve 'numānaṃ saṃyag upanyastam* [Caturvedī, 353, l. 15]. Cintāmaṇi uses this analogy in the commentary on vs. 23—f. 14r, l. 10.

⁷⁶ [Caturvedī, 357, ll. 22–30]. Note that Nṛsiṃha reuses the same argument for the first, but notices the problem that the second example only holds true for the equator, and adjusts it to make it more general. Cintāmaṇi is however not mentioned by Nṛsiṃha here, but see above, notes 31, 32, and 43.

⁷⁷ *ye tu purāṇārtham ajānantaḥ paurāṇikaṃ manyā ...* [Caturvedī, 355, l. 27]. See SSJ vs. 27 with GGC.

⁷⁸ [Caturvedī, 340, ll. 10–16], echoing a pūrvapakṣa in GGC on SSJ 2.1.30—f. 18v, l. 8ff.

⁷⁹ This is probably because of the argument made by astronomers in later periods that the Siddhāntas derive their authority from the status of their authors, who are, after all, various gods. For example, the author of the *Sūryasiddhānta* is the deity Sūrya. Even works attributed to human authors are, in this logic, revealed to them by deities; and this includes the works of some foreign astronomers. See [Pingree 'Indian Reception', 476–80].

therefore, the contradiction of the text of the Purāṇas by the text of the Siddhāntas results in an impasse, which is to be resolved by experience and reasoning, in which astronomy principally consists. A greater scope is thus allowed for astronomical argument.

Nṛsiṃha's Sources. Sūryadāsa and Cintāmaṇi are not Nṛsiṃha's only sources. His work takes note of a variety of views, some of which are not extant,⁸⁰ and provides something of a doxography of the virodha problem.⁸¹ Most noteworthy is Nṛsiṃha's account of the view of the 'Yavanas', namely that the majority of the earth is underwater, and that the earth floats in the water like a tumba gourd.⁸² This constitutes a reference (even if an incorrect one) to the presence in India in this period of models that belong to Arabic and Persian cosmology and geography, models that attracted some attention among Sanskrit astronomers in the 17th and 18th centuries.⁸³ Nṛsiṃha rejects this 'floating earth' model, since it is our common experience that the earth supports water and is not supported by it; and that water thrown into air falls until it rests on earth. Hence it cannot be the fixed support of earth.⁸⁴

Kalpabheda and Virodha Again. Nṛsiṃha rejects the proposals of Jñānarāja and Cintāmaṇi (and Sūryadāsa) to reconcile the cosmological models of the Siddhāntas and Purāṇas by making them representations of different creations. Nṛsiṃha points out,

⁸⁰ Or not quite. He has the *Vyāsasiddhānta* give an earth's circumference of 5000 yojanas, but I do not find this reference in the Berlin MS (see above notes 36, 37, and 38). He also cites a passage of the *Śākalyasaṃhitā* other than what is available in the extant *Brahmasiddhānta* [Caturvedī, 338, ll. 23–5].

⁸¹ Some of the views are old—the views of Bauddhas and Jinas, for example, which Bhāskara rejects. The Paurāṇikas again make an appearance, and there are some more arguments attributed to them, but still they are offstage voices. No other post-Bhāskara astronomers are mentioned by name other than Jñānarāja and Cintāmaṇi.

⁸² I.e., it floats approximately in the way that an iceberg does [Caturvedī, 354, ll. 14–18]. The tumba is identified in the lexicons as *Lagenaria Vulgaris*, the common gourd. Apparently this is a garbled reference to the Aristotelian theory that most of the earth is under the seas, presumably brought into India through an Arabic source.

⁸³ For a discussion of some aspects of the phenomenon see [Pingree 'Indian Reception'] and [Pingree 'Islamic Astronomy'].

⁸⁴ There is also the problem that we commonly see clods of earth dissolve in water, so why would the Earth, if floating in the ocean, not similarly dissolve? [Caturvedī, 354, l. 22].

first of all, that the *Mahābhārata*'s cosmology, which is about the same as the Purāṇic one, is clearly presented as a description relevant to our own age. He also notes that the Siddhāntas acknowledge a change in the size of the earth of only one yojana during the creation.⁸⁵ The implication is that this sort of accommodation puts the Siddhāntas and Purāṇas too much on the same plane. Nṛsiṃha proposes instead that we settle for a compartmentalizing solution, something like the conclusion of Jñānarāja, that the two models constitute different visions, having different uses and purposes.⁸⁶

7 *Munīśvara*

Nṛsiṃha's sons encountered a formidable rival in Munīśvara Viśvarūpa (born 1603). He was the son of Raṅganātha, who wrote a widely disseminated commentary on the *Sūryasiddhānta*, the *Gūḍhārthaprakāśa*, in 1603.⁸⁷ Raṅganātha's father had moved the family to Banaras from the village of Dadhigrāma, a village on the Payoṣṇī river in Berar.⁸⁸ In Banaras, Raṅganātha's brother Kṛṣṇa had received patronage from Jahangir, and some evidence suggests that Munīśvara was at one time patronized by Shah Jahan or figures in his court.⁸⁹ Munīśvara (born 1603) was the most prolific writer in the family. He produced a lengthy commentary on the SSB, entitled the *Marīci*, sometime before 1638, and completed a Siddhānta of his own, the *Siddhāntasārvabhauma* (SSB), in 1646.⁹⁰

⁸⁵ The growth is the result of the accumulated detritus of previously existing creatures. SSB Bhuvanakośa 62–3.

⁸⁶ [Caturvedī, 358–9]. Jñānarāja's proposal was found in SSJ 2.1.77. For Nṛsiṃha, the Purāṇic accounts are concerned with a different earth, the earth which forms part of the gross body of the cosmic Virāt, which is knowable only through the revelation experienced by sages who behold the Viśvarūpa of the Deity, such as Mārkaṇḍeya.

⁸⁷ [Pingree CESS A4, 436–41; A5, 314]; [Dikshit *History*, 161–2]; [Dvivedi *Gaṇakatarāṅginī*, 61–4]. For a diagram of the family tree with list of works, see [Pingree *Jyotiḥśāstra*, 126].

⁸⁸ Thus this was another family of Deccani Brahmins, from a village North and West of Pārthapura and Golagrāma. The village's name translates approximately as 'Curdston'.

⁸⁹ [Pingree CESS A4, 440].

⁹⁰ Munīśvara completed his own commentary on the SSB, the *Āśaya-prakāśinī*, in 1650. The SSB is, to date, not fully in print. The chapters

Muniśvara knows the work of both Jñānarāja and Cintāmaṇi, and cites both of them at length in the Bhuvana section of the *Marīci*.⁹¹ On cosmological questions, Muniśvara rejects the innovations of the Pārthapura school to a greater extent than Nṛsiṃha does. He cites Cintāmaṇi and in a few cases re-uses his arguments and examples (though to a much lesser extent than Nṛsiṃha does). Of most interest are the places where Muniśvara uses Cintāmaṇi's own doubts about the *Siddhāntasundara* to argue against Jñānarāja.

Support of the Earth. When it comes to the support of the earth, Muniśvara relies on another part of Bhāskara's exposition to render most of this discussion peripheral. This is Bhāskara's statement that the earth is at the center of the Brahmanḍa.⁹² Muniśvara takes this to mean that there is no 'down', except in the direction of the center of the earth. Where, then, would the earth fall? Where would other things fall except toward the center of the earth? Hence there is no real need for arguing about support of the earth, or its attraction powers, except as these are occasioned by arguments with others whose theories are more elaborate or faulty.

Unlike Nṛsiṃha, Muniśvara does not accept Jñānarāja's Purāṇicizing adjustment concerning the incarnated supporters of the earth, i.e. that Seṣa et al. can do their supporting from inside the spherical earth. He cites Cintāmaṇi's discussion of this topic at length and argues against it, saying that Cintāmaṇi only shows his own ignorance in making such statements.⁹³

on gola are not published, and in any case are not very extensive. Muniśvara does refer to the SSJ in his SSB commentary, in a section on the size of the earth and its sphericity; he welcomes the 'swift astronomer' argument, and the vss. are cited from the SSJ. In the following I will use primarily the commentary on the Bhuvana sections of the SSB. All citations are drawn from the edition of the *Marīci* on SSB's Golādhyāya by Kedāradatta Joṣī.

⁹¹ Like Nṛsiṃha, he does not appear to know Sūryadāsa's work. He does not usually cite J and C or their work by name, but the passages are those of the *Siddhāntasundara* and *Grahagaṇitacintāmaṇi*. For a place where he cites the *Siddhāntasundara* by name see [Joṣī, 80, l. 18].

⁹² SSB Bhuvanakośa vs. 1.

⁹³ Cintāmaṇi is cited from [Joṣī, 33, l. 22] to [Joṣī, 35, l. 17]. He is not named but identified as an astronomer who follows the Paurāṇikas—paurāṇikānuyāyino jyotirvidaḥ. The relevant sections of Cintāmaṇi are found in his commentary on SSJ vss. 30 and 31. Muniśvara's closing comment is worth citing for a flavor of his polemical style: ...granthadūṣaṇajalpanaṃ

The earth's inherent attraction power, proposed by Bhāskara, was rejected by Jñānarāja and Cintāmaṇi, arguing that the earth cannot have a power to attract, since we don't see such a power in small clumps of earth. Munīśvara turns this argument on its head. In fact, even small bits of earth do have the power to attract, argues Munīśvara; it is just that the spherical Earth's power is much greater, and overpowers the attraction power of smaller things.

As for the Pārthapurian argument that creatures on the sides and bottom of the earth have special properties that enable them to stay on, Munīśvara asserts that this amounts to an overly complex theory of three-fold attraction powers (one power each for things on the side, bottom, and top) which nevertheless suffers from the same fault it set out to solve, i.e. that heavy things are seen to fall faster than light things.⁹⁴

Furthermore, Munīśvara invokes Cintāmaṇi's misgivings about Jñānarāja's 'downness' theory (though without attributing them to Cintāmaṇi)—how will rain fall down, and grain grow up, and fire burn upward?⁹⁵ Elsewhere, he invokes Cintāmaṇi explicitly. Arguing with Jñānarāja in the second person, he closes an argument about the earth's attraction power by appeal to the standpoint of 'your own son'.⁹⁶

Elsewhere the reconciling arguments of the Pārthapura school are rejected without identification. The relevant passage of the Purāṇas about Meru, says Munīśvara, cannot serve to show the Purāṇas in conformity with the Siddhāntic model of the spherical earth.⁹⁷ The term 'koṭi' cannot mean 100, since one ends up with overly small continents and oceans.⁹⁸

svājñānasūcakamatimad anādarayogyam siddhāntakartṛṇām bhavādṛśām
anucitam eva.

⁹⁴ [Joṣī, 37, ll. 11ff.]

⁹⁵ [Joṣī, 37, ll. 14-17]. See above, notes 41 and 72.

⁹⁶ [Joṣī, 37, ll. 21-24]. Cintāmaṇi's argument that the power of the earth to attract is adventitious (āgantuka) can be used against Jñānarāja. Your own son, he says, 'accepts that the earth's attraction power is not independently argued but only argued for the purpose of proving the primary power of the earth, to stay fixed in space'. Cintāmaṇi's comments appear on SSJ 2.1.38. In fact the passage in Cintāmaṇi is not about the simple claim, but its hierarchical positioning within a larger structure of arguments.

⁹⁷ [Joṣī, 46, ll. 1-4]. See above, note 64.

⁹⁸ [Joṣī, 54, l. 9]. M adds here that one would be able to cross an ocean

Muniśvara does briefly notice the Yavana view that the earth floats in the ocean like a gourd (tumba), but rejects it because of the basic arguments of the SŚB against any support.⁹⁹

Muniśvara assumes, with Nṛsiṃha, that the Siddhāntas and Purāṇas are of equal weight as textual authorities, but that the Siddhāntas have the additional advantage that they are supported by experience, and by reason. In general Muniśvara is not very concerned about adjusting astronomical views to the Purāṇic model, simply preferring the older Siddhāntic standpoint. He saves his polemical strength for refutations of other astronomers, especially in their non-cosmological sections.

8 *Aftermath among the Paurāṇikas*

By way of closing this study I will turn to several Paurāṇika works that reflect the aftermath of the cosmological controversies awakened by Jñānarāja and Cintāmaṇi. This is not intended as a full study or description of these works, which will have to come elsewhere. The works discussed below were not governed by the same constraints by which the astronomers' accommodations were limited. It is only certain that one of them was written by an astronomer, and his abandonment of astronomical necessities is all the more striking. The survey will also serve as a conclusion, by showing the variety, not just in cosmological doctrines, but in what virodhaparihara, the removal of contradiction, comprises.

Saurapaurāṇikamatasaamarthana. Nīlakaṇṭha Caturdhara flourished in Banaras in the mid-seventeenth century. A contemporary of Muniśvara and Kamalākara, he was also a Marāṭhī-speaking Brahmin who had moved from the upper Godāvarī to Banaras. He is best known for his commentary on the *Mahābhārata*, the *Bhāratabhāvadīpa*, but he was also the author of about a dozen other works. The work of interest to us here is the independent treatise on the virodha problem entitled *Saurapaurāṇikamatasaamarthana* (SPMS), 'allaying the disputes in the

only one yojana broad, and hence visit the fabulous outer continents no mortal from Bhārata has seen. Elsewhere [Joṣī, 80, l. 18ff.] Muniśvara rejects the SSJ's championing of Prthūdaka (2.1.23), since it assumes things not in evidence to make its proof.

⁹⁹ [Joṣī, 32 ll. 15ff.] He also cites the reasons that Nṛsiṃha gives.

doctrines of the Purāṇas and the *Sūryasiddhānta*'.¹⁰⁰ The earliest manuscript is dated 1679, and the text was probably not written much before then.¹⁰¹ Nīlakaṇṭha had already made some forays into this topic in his *Bhāratabhāvadīpa* (BhBhD).¹⁰²

For Nīlakaṇṭha the 'allaying of disputes' consists in arguing wholeheartedly for the Purāṇic model, in a number of ways. For the model of the earth (bhūgola), he attempts a numerical reconciliation, proposing to adjust the conflicting sizes of the earth found in the Purāṇas and Siddhāntas by making the yojana variable, and by an ingenious rereading of certain crucial passages in the *Mahābhārata*.¹⁰³ For the model of the heavens (khagola), Nīlakaṇṭha rejects outright the spherical model, and argues that Jyotiṣ cannot account for a variety of astronomical phenomena.¹⁰⁴ He attempts his own explanation of how several problematic phenomena work in the Purāṇic model—the changing length of days in the course of the year, and the waxing and waning of the moon.

It is clear that in making these arguments Nīlakaṇṭha does not have much comprehension of the Siddhāntic cosmology or what motivates it; in fact he has the least understanding of any of the authors surveyed here.¹⁰⁵ Instead he attempts his own novel diagrammatic explanations of the earth's shape and what causes the sun to be visible longer when north of the ecliptic, even though in the Purāṇic model this should imply that the sun is overhead a shorter time.¹⁰⁶ Nīlakaṇṭha is not very interested in preserving

¹⁰⁰ The work has the alternative title *Paurāṇikajyotiṣam*. See [Minkowski 'Nīlakaṇṭha's Comments', 35–7] and bibliography cited there. An edition based on two manuscripts in the SB was produced by Indunātha Śarma. A fresh edition based on more manuscripts is forthcoming.

¹⁰¹ SB 37122, ff. 1–16. [Minkowski 'Nīlakaṇṭha's Comments', 37, n. 44].

¹⁰² See [Minkowski 'Nīlakaṇṭha's Comments', 28–35].

¹⁰³ These are the proposals already found in the BhBhD. The yojana changes size in different ages.

¹⁰⁴ The 'downness of down', the reason rivers flow only in one direction between two points, the length of days, the waxing and waning moon.

¹⁰⁵ Indeed, there is no evidence in his œuvre or in his educational biography that he had studied any branch of Jyotiḥśāstra. For bibliography, see [Minkowski 'Nīlakaṇṭha's Comments', 27–8]. Indunātha Śarma, the editor of the published SPMS, and a Lecturer in Jyotiṣ at the Sanskrit University in Banaras, spends several pages of his introduction [Śarma, ga-cha] deploring NC's lack of astronomical knowledge.

¹⁰⁶ Since the circle on which it revolves overhead is smaller, it ought to travel over us more quickly. Nīlakaṇṭha argues that it becomes visible sooner,

the integrity of the Siddhāntic model. He compares its status in relation to that of the Purāṇas to the status of vyāvahārika, or mundane, knowledge by comparison to ultimate Vedāntic knowledge.

Nilakaṇṭha has picked up some of these ideas from his predecessors in the discussion. We have seen the variable yojana and kalpabheda ideas before, though Nīlakaṇṭha blends them. Ascribing the two models to different layers of philosophical truth is also an old idea, though Nīlakaṇṭha gives it a more explicitly Vedāntist rendering.

‘*Bhūgolavicāra*’. Though the date, author, and actual title of this text are not known, I will discuss it here since it devotes a prominent section to rejecting Nīlakaṇṭha’s ideas. This text is, nevertheless, also in favor of the Purāṇic model.¹⁰⁷ The *Bhūgolavicāra* is composed in the form of a dialogue, with a Siddhāntic point of view, Bhāskara’s specifically, holding sway for the opening pages; then there is an argumentative turn, and the Purāṇic point of view is presented, apparently as the final opinion.¹⁰⁸ The author’s mode of ‘reconciliation’ is really to support the Purāṇas as more authoritative, reasonable, and in keeping with our common experience. The Siddhāntas are not wicked, and have some provisional value, but depend on a contingent, unreliable sort of epistemology. The author dislikes attempts at reconciliation that assume the two models describe the same reality. For example, he rejects the ‘different creations’ (kalpabheda) argument out of hand.

By way of transition to the Purāṇic view, the author argues that the Purāṇic sages know the Siddhāntic model and have accounted for it. He adduces a verse from the *Mahābhārata* which he understands to mean that the earth, though actually flat, is reflected in the watery surface of the spherical moon, and that this

however.

¹⁰⁷ It is preserved in only one manuscript, which lacks its first page, and an indeterminable number of final pages (Jaipur (Khasmohor) 5032, ff. 2–11). There is no colophon, no title, no author, no date. The text must be later than Nīlakaṇṭha, however. The cataloguer gives it a descriptive title, ‘*Bhūgolavicāra*’, ‘consideration of the earth’s model’.

¹⁰⁸ As the MS ends, however, the Purāṇic point of view is beginning to be interrogated. It is possible that the dialogue takes another turn in its later pages.

reflection makes the earth look spherical.¹⁰⁹ It is for this reason that the astronomers think the earth is a sphere.¹¹⁰ After all, the astronomers cannot measure the earth, and must depend for their understanding on an informal sort of practical reasoning based on their observations of the heavens. Thus the astronomers' knowledge is only a sort of customary lore (*vyavahāra*) supported by none of the philosophical *Pramāṇas*—not textual authority, not direct observation (since what they rely on is a scattering of indirect observations), and not logic (calculation not being reliably provable).

Since the verse that makes this argument possible is taken from the cosmological passage in the *Bhīṣmaparvan* of the *Mahābhārata*, the author takes up the commentary of *Nīlakaṇṭha*, in which an attempt at reconciling *Siddhāntas* and *Purāṇas* is discussed.¹¹¹ All of *Nīlakaṇṭha*'s ideas are rejected as contradictory to scripture, to logic, and to common practical experience. To accept them would amount to saying that the sages are crazy (*unmatta*), and therein would the Vedic teachings perish.¹¹²

This text is also interesting for the sources it cites. The author knows the work of *Bhāskara* well, both the *SŚB* and the *Karaṇakutūhala*. He challenges *Bhāskara* on the support of the earth and on the earth's attraction power with strong arguments, though he does not refer to the ideas of *Jñānarāja* and *Cintāmaṇi*. He knows a commentary on the *SŚB* that seems to take in some of *Muniśvara*'s arguments on these topics, but that has other ones as well. The author's father (*tātacaraṇāḥ*) has also apparently written on the *virodha* problem. It is hoped that a complete copy of the text will come to light.

Bhāgavatajyotiṣayor Bhūgolakhagolavirodhaparihāra. The astronomer *Kevalarāma*, who served as *Jyotiṣarāya* at the court of *Sawāi Jaisingh* in *Jaipur*, was commissioned to compose 'a work that removes the contradiction between the models of the earth

¹⁰⁹ MBh 6.6.15 Crit. Ed. (= 6.5.12 Bombay Ed.).

¹¹⁰ This argument explains the astronomers' error as resulting from their basing their model of the earth on observing its reflection in the moon. This etiology is a sort of mirror image of the astronomers' explanation for the *Purāṇic* flat earth model, i.e. that it is predicated on a partial observation of the earth, i.e. of only one hundredth part of its surface. See above, note 33.

¹¹¹ The author is aware only of the *BhBhD* commentary, and shows no awareness of the *SPMS* of *Nīlakaṇṭha*.

¹¹² F. 8r, ll. 8–11.

and heavens found in the *Bhāgavata* (*Purāṇa*) and *Jyotiḥśāstra*'. Kevalarāma had written works on astronomy before, but had to ignore much of what he knew as an astronomer in order to compose this work.¹¹³

Kevalarāma proposes to reconcile the two models in a very unusual way. He argues that there are in reality two different earths, both the large, flat Purāṇic earth and also a small, spherical earth floating above the large Purāṇic one. The spherical earth is surrounded by the planets, whose orbits are the large ones posited in the *Siddhāntas*. The planets, therefore, must pass through the surface of the flat Purāṇic earth as they revolve.

In this (two) earth model, the Purāṇic doctrine holds the upper hand, with the *Bhāgavata* serving as the main source for establishing it. In the model of the heavens, it is the orbit distances established by Bhāskara that serve as the starting point for explaining the Purāṇic distances. Kevalarāma rejects the 'different creations' (*kalpabheda*) argument, but points to evidence in the *Bhāgavata* itself to show that the *yojana* is indeed of variable size.

Kevalarāma's model of 'removing contradiction' is thus an odd blend of keeping the two models distinct, of refuting one or the other model, and of actually proposing to adjust both models so that they conform to one another. In the end Kevalarāma argues (as Nṛsiṃha did and others before him) that the two models really represent two distinct visions of two distinct realities, with different purposes.¹¹⁴

Vyāsamatoddhāra. In 1753, Śaṅkara Mallimaya wrote a work which attempts a 'retrieval of the viewpoint of Vyāsa'.¹¹⁵ Since the *Purāṇas* can satisfactorily explain all necessary astronomical

¹¹³ Several MSS of the work are extant. See [Pingree CESS A2, 63; A5, 54]. An edition, translation and study of this work are forthcoming. See also a brief mention in [Pingree 'Paurāṇic versus Siddhāntic Astronomy'].

¹¹⁴ Kevalarāma's work was expanded and revised by Nandarāma Miśra in a text entitled *Goladarpaṇa*, completed in 1763. [Pingree CESS A3, 128–9; A5, 156]. The arguments are similar enough that I will omit reference to this work here. Nandarāma's date does serve as the terminus for the period I am investigating.

¹¹⁵ This work is unpublished. To date I have had available only a partial MS, Nagpur 977 (I had this MS again thanks to DEP), and only some folios—ff. 6–14, 30–46, but the general implications of the work are clear from the sections at hand.

phenomena, argues Śaṅkara, a sense of duty and obligation commands us to prefer Vyāsa's, that is the Purāṇas', view. As the title would suggest, the bulk of the argumentation is defensive. It is designed to reply to Siddhāntic criticisms of the Purāṇic model. The arguments for the flatness of the earth incorporate some older Paurāṇika arguments (i.e. that water can't be made to flow properly on a sphere, and more generally, downness cannot be relative), as well as a new one to do with arcs and chords of arcs.¹¹⁶ There is an ingenious argument to show that Bhāskara's theory of the earth's stability and of its gravitational power are mutually dependent and hence unprovable. Śaṅkara reuses one of Kevalarāma's arguments for the Paurāṇika planetary model,¹¹⁷ and even uses one of Nṛsiṃha's reasons to argue against Bhāskara.¹¹⁸ The idea that the sun's distance from the observer is what causes the appearance of sunrise and sunset resurfaces in this text.¹¹⁹

In general the authority of the Purāṇas is emphasized. Correspondingly the authority of the Siddhāntas is belittled. To those who assert that the Siddhāntas are authored by gods,¹²⁰ Śaṅkara raises the question of whether these works are really the compositions of the deities to whom they are attributed, or are rather impostures created by wicked men.¹²¹ In any case, the method of

¹¹⁶ If an ant starts from the top and travels 18 inches down the circumference of a ball 12 inches in diameter, he reaches (approximately) the bottom. By that logic of 3/2, if we travel south 60 yojanas, we should be 40 yojanas farther 'down', and yet we experience ourselves no more 'down' than before. (In fact Śaṅkara has the relationship of circumference and diameter a little unclear in this; the evidence he invokes seems to me a better proof of sphericity.)

¹¹⁷ I.e., that the relative coolness of the sun at dawn and its heat at mid-day is much better explained by the Paurāṇika model, in which the sun gets proportionately much closer to us at noon than at dawn, while in the Siddhāntic spherical model the difference in proximity of the sun is negligible. Kevalarāma makes this argument as well.

¹¹⁸ I.e., that the fixed earth cannot support the revolving planetary spheres, as the earth's fixity would prevent the planets and stars from revolving [Caturvedī, 338, ll. 2–8].

¹¹⁹ F. 46r. It is a matter of curiosity to note that Śaṅkara denies any Paurāṇika has ever asserted that it is the sun's disappearance behind Meru that causes sunset, though this is seen repeatedly as an argument; as for example in the next author, Harideva.

¹²⁰ As the Siddhāntic authors were increasingly tempted to argue in this period; see [Pingree 'Indian Reception', 476–80].

¹²¹ Ff. 41r–42v. Of course Śaṅkara does not pursue the implications of this line of questioning for the provenance of the Purāṇas.

the Siddhāntas cannot be said to be based on any *pramāṇa*, even direct perception, as the '*Bhūgolavicāra*' also declares. Meanwhile we are better off to be obedient to Vyāsa's view.

Mataikyacandra. Harideva Bhaṭṭa composed a text on the *virodha* problem called the *Mataikyacandra*, 'moon of the oneness of views' together with a commentary.¹²² The date of this work is unknown, but I include it here because of its reference to the astronomers of Pārthapura, and because its general approach to reconciliation brings us, I think, full circle. For the *Mataikyacandra* resorts to a strategy of perspectivism—both models are true depending on the standpoint from which the world is viewed (*yathāyogyāt*). Thus descriptions of the earth as spherical and flat are both true—the former refers to the uneven appearance of the earth in the days before the legendary figure Pṛthu leveled it out with the tip of his bow; the latter refers to the earth's even, smooth appearance afterwards.

Similarly the various sizes for the earth and the heavens that one encounters in the different Siddhāntas and then again in the Purāṇas can be explained by *kalpabheda*, that is, as true for different creations. Furthermore, the Purāṇic account of the earth's layout is true from the gods' perspective at the top of Mt. Meru; the Siddhāntic account is true from the human's perspective from the city of Lāṅkā. And even if the order and sizes of the oceans and continents are not the same exactly, both accounts agree that the regions are circular. Varying accounts of the 'downness of down' are also acceptable and assimilable, because all of them have an explanation of 'down'.

Harideva knows all of the authors of the Pārthapura school. He agrees with Jñānarāja in rejecting Bhāskara's theory of the earth's lack of support. On the other hand he accepts the idea that the earth has 'gravity', against Jñānarāja. Nor does he like the idea of putting Śeṣa and the other supporters inside the earth. In general he does not like the critiques of the Purāṇic view that are found in the Siddhāntas and argues against them, but he is much more favorable toward the Siddhāntas than the authors de-

¹²² Also known as the *Purāṇajyotiḥśāstramataikyavākyaṭā*. The commentary is called the *Mataikyārthaprakāśa*. This work is known from only one manuscript, RORI (Kota) 639, which I was able to examine through the courtesy of Richard F. Young via DEP. It is as yet unpublished, and I know of no extant studies of its contents.

scribed in the immediately preceding sections. Harideva is not keen on the strategy of directly adjusting or revising the models to make them conform to a single picture, and is more in favor of finding similarity within existing models, by selective interpretation of passages, and by making the terms of agreement loose enough that they can incorporate both views.

Of the types of removal of contradiction with which I began, I have suggested that the strategy of compartmentalization was an old one, that probably preceded the time when Jñānarāja stirred up the cosmological controversy again. Harideva has given it a new, much looser, grounding in perspectivism that does not attempt to establish an explicit hierarchy of views.

9 Conclusion

The *Mataikyacandra* throws up a question with which I might conclude. Suppose Harideva's solution is a new version of compartmentalization, this perspectivism which is not mere relativism but which enables several irreconcilable viewpoints to co-inhabit the same intellectual 'living space'. Why could not an even less forgiving scientific viewpoint also be so incorporated? If any viewpoint can be held together with the viewpoint of the śruti and smṛti through a perspectivist or compartmentalist strategy, why do the authors of the Siddhāntas need to seek intellectual accommodation with the Purāṇas at all? If the science was practically useful (which it was, in enabling a confident timing of ritual practices and casting of horoscopes), would that not be enough to guarantee the creation of a niche within the 'ecosystem' of canonical literature?

Apparently not. There can be little doubt that the astronomers in every period felt a pressure, in varying degrees, to make their science acceptable to doctrines found in the Purāṇas and in other religious literature. In the early modern period, this pressure appears to have significantly increased. The history of the avirodha problem in this period does not lend itself to a single-stranded or developmental explanation, but historical change there nevertheless was. For some of these works, the number of manuscripts is very small, but their existence serves to show the recurrent concern with 'reconciliation'. One can also see that there were differentials in institutional support, as it were,

the astronomers knowing and citing each other's work in detail, the Paurāṇikas working much more on their own, in apparent ignorance of other individual efforts.

Thus it will not do to appeal simply to an inveterate complacency about intellectual inconsistency among the Sanskrit intellectuals, for in this period at least, there is an awareness that the cosmology is problematic, and there are attempts, however accidental, to sort the problem out.

Nevertheless, the appeal to a 'layers of truth' mode of accounting for intellectual difference turns up in many of our authors, in more or less limited roles. It is a strategy that is almost perfectly ambiguous in its historical interpretation. It could be explained as a failure of Indian knowledge systems to adapt, by hampering the ability to attend much to new scientific models that might have become available in this period.

On the other hand the 'levels of truth' appeal could be interpreted as the basis for a modernizing intellectual adjustment, one that separates the scope of different sources of knowledge. An accommodation between science and religion of this kind is sometimes claimed to be the trademark of the arrival of modernity in the contemporary cosmological debates in Florence and Rome.

Abbreviations

AS	Bombay Asiatic Society of Bombay
BhBhD	<i>Bhāratabhāvadīpa</i> of Nīlakaṇṭha Caturdhara
BhP	<i>Bhāgavata Purāṇa</i>
BM	British Museum
C	Cintāmaṇi
CESS	<i>Census of the Exact Sciences in Sanskrit</i>
DEP	David E. Pingree
GGC	<i>Grahagaṇitacintāmaṇi</i>
J	Jñānarāja
M	Munīśvara
MBh	<i>Mahābhārata</i>
NC	Nīlakaṇṭha Caturdhara
RORI	Rajasthan Oriental Research Institute
ṚV	<i>Ṛg Veda</i>
SB	Sarasvati Bhavan

ŚB	<i>Śatapatha Brāhmaṇa</i>
ŚDVT	<i>Śiṣyadhīvrddhidatantra</i> of Lalla
SPMS	<i>Saurapaurāṇikamatasaṁarthana</i> of NC
SSB	<i>Siddhāntasarvaśhauma</i> of Munīśvara
ŚSB	<i>Siddhāntaśiromaṇi</i> of Bhāskara
SSJ	<i>Siddhāntasundara</i> of Jñānarāja
SSSS	<i>Siddhāntasaṁhitāsārasamuccaya</i> of Sūryadāsa
VP	<i>Viṣṇu Purāṇa</i>

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