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On The Value Implied In The Data Referred To In The *Mahābhārata* for π

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Abstract

E. Washburn Hopkins interpreted, in 1902, the values for π from the data referred to in some verses contained in the *Bhīṣma Parva* of the *Mahābhārata* where π is a non-terminating and non-recurring fixed ratio of the circumference, C , of a circle to its diameter, d . The values interpreted for it by him from the data referred to for the dimensions, including C , d , and *vipulātva t*, of the Rāhu, the Moon, and the Sun are 3.5, 3.5+, and 3.58 respectively. R. C. Gupta found, in 1990, these values to be the yielding of the gross misinterpretations. He pointed out that the value implied in the data of each of the three cases is only 3. The present paper is mainly aimed at probing when and why 3 was used in the *Mahābhārata* as the value for π . The date when those above verses were incorporated in the *Mahābhārata* is the one when 3 as the value for π was used in the same if consistency is preferred to as a sound criterion in determining so. It tends to 500 BCE in its range extending from 500 BCE to 500 CE. It may go even beyond 500 BCE. 3 as the value for π seems to have been borrowed from some older forms of the *Purāṇas* into the *Mahābhārata*. If simplicity, prevalence, and traditionalism are preferred to as a sound criterion to calculate C for a given d , no other option for π is better than 3. The support for this option was available not only in the interior of India right from the *R̥gveda* but also in the exterior of India at least right from the old Babylonian text.

Keywords: *Mahābhārata*, π , *Purāṇa*.

I. Introduction

The *Mahābhārata* is one of the two major epics of ancient India, the other being the *Rāmāyaṇa*. It is a poem, in Sanskrit, woven around the story of a conflict between two dynasties, the *Pāṇḍavas* and the *Kauravas*, of the same clan. The *Pāṇḍavas* includes the epic hero Arjuna and his four brothers while the *Kauravas* include the epic villain Duryodhana and his ninety nine brothers. The *Mahābhārata* has influenced the thoughts, actions, and culture of the people of Indian subcontinent and its surroundings including Indonesia (Suastika et al, 2017) since its composition. It is divided into eighteen *parvas* (divisions), which we may call books. Each of the books is again divided into a number of *parvas*, which we may call sections. Each section is again divided into a number of *adhyāyas*, which we may call chapters. The *Bhīṣma Parva* is the sixth of the eighteen books after the name of Bhīṣma, a dedicated grand hero of the epic.

E. Washburn Hopkins (1857-1932), a great American indologist, is remembered for his work *The Great Epic of India: Its Character and Origin* (Hopkins 1901). He interpreted, in 1902, the values for π from the data referred to in some verses, which we shall study in the next section of this paper, of the *Bhīṣma Parva* where π is a non-terminating and non-recurring fixed ratio of the circumference, C , of a circle to its diameter, d , and is 3.14159 when approximated to 5 decimal places. The values interpreted for it by him from the data referred to for the dimensions, including C , d , and *vipulatva* t , of the Rāhu, the Moon, and the Sun are 3.5, 3.5+, and 3.58 respectively (Hopkins 1902: 154-155). R. C.

Gupta found, in 1990, these values to be the yielding of the gross misinterpretations. He pointed out that the value implied in the data of each of the three cases is only 3 (Gupta 1990: 45-47). The same value was interpreted in 1975 by him from the data referred to for the Sun (Gupta 1975: 1-2).

Kisari Mohan Ganguli is remembered for the first complete English translation of the *Mahābhārata*. It was the Victorian prose version of the *Mahābhārata*, published during the period from 1883 to 1896. We shall also take notice of that his translation of the above verses for each case does not yield, when interpreted, 3 as the value for π as well (Ganguli 2003: *Bhūmiparva*, pp. 28-29). The present paper is aimed at probing when and why 3 was used in the *Mahābhārata* as the value for π .

Ganguli translates the *Bhīṣma Parva* referring to its 124 chapters divided into three sections, namely *Jambūkhaṇḍa-vinirmāṇa-parva* (“Section on the construction of the *Jambū* Island”), *Bhūmiparva* (“<Concise> section on the lands <and seas except the *Jambūdvīpa*>”), and *Śrīmadbhagadgītā-parva* (“Section on the *Śrīmadbhagadgītā*”) (Ganguli 2003: *Bhīṣma Parva*, pp. 1-314) while Paṇḍita Ramanārāyaṇadatta Śāstrī Pāṇḍeya translates 6100 verses of the *Bhīṣma Parva* described into 122 chapters under four sections, namely the above three, and the *Bhīṣmavadha-parva* (“Section on the martyr of *Bhīṣma*”) (Pāṇḍeya: 2543-3100).

The *Bhūmiparva* containing the chapters 11 and 12 provides information regarding seven islands (*saptadvīpas*); each of them is surrounded by sea. In the end, a representation of the dimensions of the *Svarbhānu*, the Moon, and the Sun is made

pass to the blind king Dhṛtarāṣṭra, father of Duryodhana, by his charioteer Sañjaya using data as stated below.

1⁰ *svarbhānoḥ kauravaśreṣṭha*
yāvadeva pramāṇataḥ
parimaṇḍalo mahārāja svarbhānuḥ
śrūyate grahaḥ
yojanānām sahastrāṇi viṣkambho
dvādaśāsya vai
pariṇāhena ṣaṭtriṃśad vipulatvena
cānagha
ṣaṣṭimāhuḥ śatānyasya budhāḥ
paurāṇikāstathā
 (Pāṇḍeya: vv. 6.12.40-42 first hemistich, p. 2572)

“O *Kauravaśreṣṭha* (the superior among the *Kauravas* i. e., Dhṛtarāṣṭra)! <I (i. e., Sañjaya) let you know> as many as the dimensions (*pramāṇas*) of the *Svarbhānu* are. O *Mahārāja* (Great King)! It is heard that the *graha* (planet) *Svarbhānu* is round on <its> periphery (*parimaṇḍala*) <in shape>. Its diameter (*viṣkambha*, *d*) is twelve thousand *yojanas*, and it is thirty six <thousand *yojanas*> in circumference (*pariṇāha*, *C*). And O *Anagha* (Sinless)! Its *vipulatva* (extent, *t*) is said to be sixty hundred <yojanas> by the *paurāṇika* learned scholars (*budhā*).”

2⁰ *candramāstu sahastrāṇi*
rājannekādaśa smṛtaḥ
viṣkambheṇa kuruśreṣṭha trayastriṃśat
tu maṇḍalam
ekonaṣaṣṭiviṣkambhaṃ
śītaraśmermahātmanaḥ
 (Pāṇḍeya: vv. 6.12.42 second hemistich-43, p. 2572)

“O *Rājan* (Ruler)! The Moon (*candramā*) is handed down by memory to be eleven thousand <yojanas> in diameter (*viṣkambha*, *d*). O *Kauravaśreṣṭha* (the superior among the *Kauravas*)! Its <peripheral> circle (*maṇḍala*, *C*) happens to be thirty three <thousand *yojanas* when calculated>. O *Mahātman* (High-souled i. e., lofty-mined)! The *viṣkambha* (extent, *t*) of the cold-rayed (*śītaraśmi*) <i. e., of the Moon> is fifty nine <hundred *yojanas*>.”

3⁰ *sūryastvaṣṭau sahastrāṇi dve cānye*
kurunandana
viṣkambheṇa tato rājan maṇḍalam
triṃśatā samam
aṣṭapañcāśataṃ rājan vipulatvena
cānagha
śrūyate paramodāraḥ patago'sau
vibhāvasuḥ
 (Pāṇḍeya: vv. 6.12.44-45, p. 2572)

“O *Kurunandana* (descendant of the Kuru <clan>)! The Sun is eight thousand <yojanas> and another two <thousand *yojanas*> in diameter (*viṣkambha*, *d*). O *Rājan* (Ruler)! From that its <peripheral> circle (*maṇḍala*, *C*) comes to be equal to thirty <thousand *yojanas*>. O *Rājan* (Ruler)! It is fifty eight hundred <yojanas> in *vipulatva* (extent, *t*). And O *Anagha* (Sinless)! This is what to be heard about the benevolent (*paramodāra*), fast-going (*patago'sau*) and resplendent (*vibhāvasu*) <Sun>.”

The set of the above verses, each of which is accompanied with the translation offered by the present author, is a reply given by Sañjaya to the question raised by

Dhṛtarāṣṭra before the former when the latter asks to tell the particulars about the Rāhu, the Moon (*soma*), and the Sun (*arka*) (Pāṇḍeya: v. 6.11.3 second hemistich, p. 2568).

The name of the *Svarbhānu* is also used as an attribute of the Rāhu (Kramrisch and Burnier 1976: pp. 325–6). We have noticed in 1⁰ that the *Svarbhānu* i. e., the Rāhu is a *graha* (planet). It is one of the nine planets (*navagraha*) that include the Sun and the Moon as well. The definition, ‘*graha* is that which seizes’ (Ganguli 2003: 13.17, footnote no. 76.5), seems to put them in the category of *graha* (planet). “The Rāhu ... is the ascending node of the moon”, remarks Ganguli (Ganguli 2003: 12.203, footnote no. 74.1).

If the Rāhu is not a celestial body, how we can think of its C , d , and t ? But we must be agreeing with the following note of Hopkins. “Of the three heavenly bodies, Svarbhānu or Rāhu (the devouring planet) is circular, *parimaṇḍala*, no less than the moon and the sun, so that π can be established in this case as well as in the others (Hopkins 1902: 154).”

The data referred to for the variables C , d , and t in each of 1⁰, 2⁰, and 3⁰ are assembled in Table I. In order to calculate the value for π from each of 1⁰, 2⁰, and 3⁰ Hopkins, in his description, refers to the values of C and t separately but what he has followed is that $(C+t) \rightarrow C$ as shown in Table I. “This is mathematically unsound,” remarks Gupta (Gupta 1990: p. 46). The English equivalent term used by Hopkins, in case of both of the Rāhu and the Sun, for t is ‘extent’ (Hopkins 1902: 154). He interprets *pariṇāhena vipulatvena ca*, from 1⁰, to be “in its circumference and extent” and writes that

it is “thirty-six thousand sixty hundred” or 42000 (Hopkins 1902: 154). He seems to have taken t to be the part of C . This becomes, in case of the Moon, very clear when he interprets the following. “The moon's diameter, *viskambha*, is eleven thousand and its circle, *maṇḍala*, is thirty-three (thousand) and “sixty-less-one” (hundreds, given in the text as the *viṣkambha*, but this must be *pariṇāha*, as in the preceding case), making the sum in thousands (33) and in hundreds (59) equal in all to 38,900 (Hopkins 1902: 154).”

On the other hand, prior to Hopkins, Ganguli, in his translation offered for each of 1⁰, 2⁰, and 3⁰, refers to the value of C only, without any mention of t at all, as shown in Table I. Here it is, in absence of direct evidence, very difficult to corroborate whether Hopkins, for the interpretations of 1⁰, 2⁰, and 3⁰, followed Ganguli or not but it is certain that the former went through the latter's translation of the *Mahābhārata* (Hopkins 1901: 95).

For both of them,

$$\pi_{\text{Sun}} > \pi_{\text{Moon}} > \pi_{\text{Rāhu}}.$$

In his translation of each of 1⁰, 2⁰, and 3⁰, Gupta refers to the values of C and t separately. “For the calculation of π , the thickness t is not needed whatever be its interpretation (Gupta 1990: 46).” This is Gupta's argument. The present author endorses it for the following reasons.

- (1) It allows us to hold that one should concentrate on the values of only C and d when to determine the value for π_1 . We shall see soon what π_1 is.
- (2) It allows the datum offered, in each case, for C to remain intact.
- (3) It deduces that

$\pi_{\text{Sun}} = \pi_{\text{Moon}} = \pi_{\text{Rāhu}}$,
which is highly expected.

Here nothing is clear about t . It
needs to be explained. The present author

proposes to write a separate paper to ignite
the process of thinking over it.

Table I

Graha (planet)	In <i>yojanas</i>			$\pi =$			
	$C =$	$d =$	$t =$	Hopkins (1902: 154- 155) $\left(\frac{C+t}{d} =\right)$	Gupta (1990: 45-46) $\left(\frac{C}{d} =\right)$	Ganguli (2003: 6.12, pp. 28-29 and footnote no. 29.1)	
						$\left(\frac{C}{d} =\right)$	when, as interpreted by him, $C =$
Rāhu	36000	12000	6000	3.5	3	3.5	42000
Moon	33000	11000	5900	3.5+	3	3.5363	38900
Sun	30000	10000	5800	3.58	3	3.58	35800

II. Discussion

2.1 The *Mahābhārata*, at the end of the
Bhūmiparva, makes Sañjaya say the
following to Dhṛtarāṣṭra.

4⁰ yathoddiṣṭaṃ mayā proktaṃ
sanirmāṇamidam jagatḥ
tasmādāśvasa kauravya putram
duryodhanam pratiḥ
(Pāṇḍeya: vv. 6.12.48 first hemistich-
49
second hemistich, p. 2573)

“In the above, I have told <you> about
the <measurements of the> construction
(*nirmāṇa*) of this universe (*idam jagat*) as
indicated (*yathoddiṣṭa*) <in the *śāstras*>. O
Kauravya (descendant of the *Kuru*)!
Therefore (*tasmād*), be encouraged
(*āśvasa*) in favour of <your> son
Duryodhana.”

The term ‘*śāstras*’ inserted in the
paraphrase of the above translation is

substantiated by the verse, in the
Mahābhārata, previous to 4⁰ (Pāṇḍeya: v.
6.12.47, p. 2573).

The translation offered by Ganguli
for the last hemistich of 4⁰ is slightly differed
from the above tendered by the present
author. It is as follows. “Therefore, O
Kauravya, pacify thy son Duryodhana
(Ganguli 2003: 6.12, pp. 28-29).”

This variation is not so much
important as Ganguli’s following
interrogative comment on the hemistich is.
“How Dhṛtarāṣṭra is to pacify his son having
listened to the geographical digression is not
easy to see (Ganguli 2003: 6.12, footnote no.
29.2).” In other words, it can be questioned
how the cosmographical information
including the dimensions of the Rāhu, the
Moon, and the Sun could help Dhṛtarāṣṭra to
remain encouraged in favour of his son when
the war was being fought in the battle field.
This establishes, although its purpose may
have been to show where our location in the
cosmos is, the irrelevancy of the entire

Bhūmiparva. It can be testified in the light of the opinions of the indologists.

“The *Mahābhārata* began its existence as a simple epic narrative. It,” writes German Indologist Hermann Oldenberg (1854–1920), “became, in course of centuries, the monstrous chaos (Sukthankar 1957: 1).” “Besides the main story,” writes he, in it, “there were veritable forests of small stories and besides, numberless and endless instructions about theology, philosophy, natural science, law, politics, practical and theoretical knowledge of life (Sukthankar 1957: 1 and 125).” S. S. N. Murthy finds that it is a dramatized version of the battle of the 10 kings mentioned in the *Rgveda* and there is no historicity involved in it (Murthy 2003: 1 and 9). “The epic became,” writes, long before Murthy, Romesh Chandra Dutt (1848–1909) “so popular that it went on growing with the growth of centuries. Every generation of poets had something to add; every distant nation in Northern India was anxious to interpolate some account of its deeds in the old record of the international war; every preacher of a new creed desired to have in the old Epic some sanction for the new truths he inculcated. Passages from legal and moral codes were incorporated in the work which appealed to the nation much more effectively than dry codes; ... All the floating mass of tales, traditions, legends, and myths ... found a shelter under the expanding wings of this wonderful Epic; and ... It is thus that the work went on growing for a thousand years after it was first compiled and put together in the form of an Epic (Sukthankar 1957: 2-3).” Prior to Dutt as early as in 1829 Franz Bopp (1791-1867) had expressed his opinion that

all parts of the epic were not of the same age (Sukthankar 1957: 5).

At least three redactions of the text of the *Mahābhārata* are commonly recognized. The authorship of the original epic or first redaction is traditionally attributed to Kṛṣṇa Daivapāyana Vyāsa. It was an *itihāsa* (history) by nature and not a didactic work. The title which he gave it was *Jaya* (“Triumph”). It is said to have been a composition of 8800 verses (Vaidya 1905: 2-3). In order to destroy the snakes Janamejaya performed *sarpasatra* (session of snake <sacrifice>) when his father Parīkṣit, Arjuna’s grandson, had died bitten by a snake. At that sacrifice, Vaiśampāyana, a disciple of Vyāsa, recited the poem of his ancestors to him. This was the second redaction in which Vyāsa’s *Jaya* was expanded into Vaiśampāyana’s *Bhārata* up to 24000 verses (Vaidya 1905: 3-4 and 10). Many a year later, the third redaction was done when Ugrasravā Sauti, son of Lomaharṣaṇa, recited it with over 100,000 verses to an assemblage of sages performing the twelve year long sacrifice under Kulapati Śaunaka in the Naimiṣa forest. Owing to its greatness and weight, it was named, Sauti says, the *Mahābhārata* (“Great *Bhārata*”) (Pāṇḍeya: vv. 1.1.1-2, p. 1 and Vaidya 1905: 4-6 and 11).

“Let me state here,” says V. S. Sukthankar, “more fully, for the sake of clarity, the view-point of the modern analytical criticism of the *Mahābhārata*. Modern criticism begins with the assumption that the epic is definitely not the work of any one poet, like most works of antiquity. No one can write unaided a poem of 100000 stanzas. We cannot possibly conceive any *one* man being equal to the task attributed to

the supposed author of the epic, Kṛṣṇa Daivapāyana Vyāsa. The poem is, therefore, unquestionably a compilation, embodying the work of many writers of varying abilities – some of them even real poets – who have added to the original corpus from time to time as it pleased them. The result is naturally a confused assemblage of heterogeneous matter originating from different hands and belonging to different strata. ... It is a great pity that a fine heroic poem, which may even be found to contain precious germs of ancient Indian history, should have been thus ruined ... But it is not quite beyond redemption. A skilful surgical operation – ... – could still disentangle the submerged ‘epic core’ from the adventitious matter – known to textual critics as “interpolation” – in which it lies embedded. ... This is ... the origin and the character of the *Mahābhārata*, which was espoused by the majority of the Western critics of the Great Epic of India, chief among them being <Christian> Lassen <(1800-1876)>, <Albrecht> Weber <(1852)>, <Alfred> Ludwig <(1878)>, <Sören> Sörensen <(1883)>, Hopkins, and <M.> Winternitz <(1863-1937)> (Sukthankar 1957: 9-11).”

In the above paragraph, we come across the term ‘real poets’, which needs to be explained. According to Bruce M. Sullivan (1994), “Vyāsa is the symbolic representation of all the anonymous poets who contributed to the composition of the epic *Mahābhārata*. The epic poets attributed authorship of the text to Vyasa (Sullivan 1994: 398).”

The reasons enumerated, in depth, by C. V. Vaidya to discuss how the *Mahābhārata* attained to its present bulk concisely are (1) the ambition of Sauti to

make it an all-embracing repository of legendary lore, (2) to make it a depository of knowledge of which instance is afforded by the *Jambūkhaṇḍa* and the *Bhūkhaṇḍa* sections in the *Bhīṣmaparva*, and (3) to make it a vehicle of moral and religious instruction. (4) It was extended due to repetition of stories without any acknowledgement. (5) Lapse of thousands of years between the events and its last recasting necessitated that certain actions should be explained away and Sauti appears to have added chapters here and there for this purpose (Vaidya 1905: 22-35 and 193-210).

For the sake of the present paper our interest lies in the book *Bhīṣmaparva*, that too in its section *Bhūmiparva*. “The description given of the universe,” says Vaidya, “is the usual orthodox one, perhaps prevalent in India from many centuries. But that it is an interpolation here may easily be gathered from the break in the context. At the end of Chapter 12 of the *Bhīṣmaparva* where the *Bhūmikhaṇḍa* ends, we have Dhṛtarāṣṭra and Sañjaya talking to each other. The next chapter begins as follows – “Thereafter Sañjaya, having returned from the battlefield after seeing everything with his own eyes, told Dhṛtarāṣṭra that Bhīṣma was dead.” This chapter should properly have been the beginning of the *Bhīṣmaparva* and if not the first, it should at least have been the second. For it is nowhere stated when Sañjaya went to the battlefield and when this dialogue between Sañjaya and Dhṛtarāṣṭra about the extent of the world took place (Vaidya 1905: 25-26 and 200).”

From the above it gets now confirmed that the *Bhūmiparva*, which contains 1⁰, 2⁰, and 3⁰, is a later addition. Hence our interest is now in knowing when

the final recasting of the *Mahābhārata* text was done, not in probing when it was originally composed.

There have been many attempts to determine the date of its final recasting. “The present form of the epic,” writes Virendra N. Sharma, “is supposed to have taken shape by 400 A. D. and very little or nothing has been added to it since then (Sharma 2004: 83).” In very clear terms, Shankar Balkrishna Dikshit writes, in 1896, that an inscription, belonging to *saṃvat* 197, of king Sarvanātha of Uccakalpa states that the *Mahābhārata* consists of 100000 verses. The *saṃvat* quoted in it is *cedi* (Kalacurī). Now $197 \text{ cedi} = (197+170) = 367 \text{ Śaka} = 445 \text{ A. D.}$ This shows that nothing new was interpolated in the *Mahābhārata* after 4th century (*Śaka*) (Dikshit 1969: 107-108). Albrecht Weber (1825–1901), a German Indologist, placed its origin between 300 BCE and 50 CE (Vaidya 1905: 13). It was compiled, according to M. Winternitz, over a long period of time extending from 400 BCE to 400 CE (Bose et al. 1971: 35). Here it may be noted that the *Mahābhārata* with its 100000 verses was well known even in the south of India in 50 CE (Vaidya 1905: 14). That the complete *Mahābhārata*, for the most part as we have it today, cannot be later than the fourth or fifth century of our era, follows from the fact brought out first by R. G. Bhandarkar (1837-1925) and then by Johann George Bühler (1837–1898) (Hopkins 1901: 387). According to Hopkins, it was composed or compiled after the Greek invasion and was practically completed by 200 CE, and there is no date of the epic which will cover all its parts (Hopkins 1901: 398). “The time of the whole *Mahābhārata*,” also he writes, “generally speaking may then be from 200-

400 A. D. This, however, takes into account neither subsequent additions, such as we know to have been made in later times, nor the various recastings in verbal form, which may safely be assumed to have occurred at the hands of successive copyists (Hopkins 1901: 389).” According to C. V. Vaidya, the *Mahābhārata* in its present shape cannot be placed earlier than 300 BCE (Vaidya 1905: 14) and it took its present form between 300 BCE and 100 BCE (Vaidya 1905: 21).

On the other hand, as per Dahlmann, the date of the composition of the epic is certainly not later than the fifth century BCE (Sukthankar 1957: 21). Jogesh Chandra Ray finds that the greater portion of the present *Mahābhārata* was composed about the 13th century BCE and that the latest edition of which we have any astronomical evidence was made so late as the 4th or 5th century BCE (Ray 1913: 208).

Since we are going to draw a serious conclusion regarding when 3 as the value for π was used in the *Mahābhārata*, which is not a text on mathematics, and the dates suggested for its final recasting are diversified, it will be better and critical if we suggest the safer range of date for the purpose. On the basis of the above diversified dates, a conclusion can be drawn, if Dahlmann is excluded, that

$$500 \text{ BCE} \leq x \leq 500 \text{ CE}$$

where x is the date of incorporating 1^0 , 2^0 , and 3^0 in the *Mahābhārata*.

2.2 We come across the term *paurāṇika* when we go through the last hemistich of 1^0 . The term *paurāṇika* may have two connotations.

One is ‘belonging to or derived from the olden times’ when it is put before a noun

and ‘well versed in or having the knowledge of the olden times or one who knows the past’ when used as an adjective predicatively for a scholar (Cappeller 1891: 320 and 329).

The other is ‘well versed in the *Purāṇas*’. Here it may be noted that the *Purāṇas* form part of the Hindu sacred texts that are categorized as “smṛti” (“what is remembered”). There are 18 *Mahā-Purāṇas* (‘Principal *Purāṇas*’), viz. (1) *Vāyu*, (2) *Brahmāṇḍa*, (3) *Matsya*, (4) *Mārkaṇḍeya*, (5) *Viṣṇu*, (6) *Bhāgavata*, (7) *Kūrma*, (8) *Vāmana*, (9) *Liṅga*, (10) *Varāha*, (11) *Padma*, (12) *Nārādīya*, (13) *Agni*, (14) *Garuḍa*, (15) *Brahma*, (16) *Skanda*, (17) *Brahma Vaivarta*, and (18) *Bhaviṣya*. Besides these eighteen, there are a large number of *Upapurāṇas* (‘Secondary *Purāṇas*’) (Hazra 1963a: 240). The *Purāṇas* are distinguished, according to the Sanskrit lexicon *Amarkośa* (c. sixth century CE), by five characteristics, viz. (1) *sarga* (creation of the universe from its natural cause), (2) *pratisarga* (recreation of the universe from its constituents), (3) *vaṃśa* (genealogy), (4) *manvantara* (cosmic cycles), and (5) *vaṃśānucarita* (accounts of royal dynasties) (Hazra 1963a: 241-242).

Any of the above two connotations excluding the former part of the former connotation can be applied while interpreting 1⁰. The latter connotation can be applied only in the presence of evidence that the *Mahābhārata* was familiar with the *Purāṇas*. In the *Mahābhārata* are found a lot of evidences in this regard. A few of them are as follows:

5⁰ *mayā śrutamidaṃ purvaṃ
purāṇe bhr̥gunandana |
prajāpateḥ kathayato*

yathānyāyaṃ tu tasya vai||
(Pāṇḍeya: v. 13.84.59, p. 5728)

6⁰ *aṣṭādaśapurāṇāni dharmasāstrāṇi
sarvaśaḥ |
vedāḥ sāṅgāstathaikatra bhārataṃ
caikataḥ sthitam||*
(Pāṇḍeya: v. 18.5.46, p. 6507)

7⁰ *śrūyatāṃ siṃhanādo ’yamṛṣestasya
mahātmanaḥ|
aṣṭādaśapurāṇānām
karturvedamahodadheḥ||*
(Pāṇḍeya: v. 18.5.47, p. 6507)

8⁰ *aṣṭādaśapurāṇānām śravaṇād yat
phalaṃ bhavet|
tat phalaṃ samavāpnoti vaiṣṇavo nātra
saṃśayaṃ||*
(Pāṇḍeya: v. 18.6.97, p. 6515)

9⁰ *etat te
sarvamākhyātamatītānāgataṃ tathā|
vāyuproktamanusmṛtya
purāṇamṛṣisaṃstutam||*
(Pāṇḍeya: v. 3.191.16, p. 1500)

These verses make us to assume that they were inserted into the *Mahābhārata* when the eighteen *Purāṇas* were known. Ugrasravā Sauti seems to have done so as he himself was *paurāṇika* (Pāṇḍeya: v. 1.1.1, p. 1).

“Whether the *Purāṇas* precede or follow epic literature,” writes Hopkins, “is not a question that can be answered categorically. Nothing is commoner than the statement made by some epic character that a story <told by Prajāpati> was heard by him long ago in a *Purāṇa*. <See 5⁰.> But most of the extant *Purāṇas* are in their present shape

certainly later than the epic. Nevertheless, before the great epic was completed the eighteen Purāṇas were known, since they are mentioned as a group <in 6⁰ and 8⁰> (Hopkins 1901: 47-48).” “There is no earlier,” he also refers to, “allusion to an extant Purāṇa (Hopkins 1901: foot no. 2 on p. 47).” The name of the *Vāyu Purāṇa* is referred to in 9⁰. This mention in the *Mahābhārata* has led scholars to propose that the *Vāyu Purāṇa* is among the oldest ones (Winternitz 1981: 13). “This statement <i. e., 9⁰>, however, implying that the Purāṇa treats of future events, though illustrated in this instance by the epic’s account of later ages, scarcely tallies with the early epic use of the word, which regularly connote atīta, the past, but not anāgata, (account of) things to be; yet it corresponds exactly to the ordinary contents

of the later Purāṇas (Hopkins 1901: 48).” “Even the Garuḍa and Vārāha Purāṇas may precede the final revision of the whole epic, though the evidence for references is far from conclusive; but on the other hand our present Purāṇas may have been so changed as not to agree in any detail with Purāṇas that once bore these names. The arguments are,” he refers to, “given by <Adolf> Holtzmann <(1810-1870)> (Hopkins 1901: foot no. 2 on p. 48).”

Here we may infer that there were two sorts of the *Purāṇas*. One was the older forms of the *Purāṇas* and the other is the present forms of the *Purāṇas*.

According to R. C. Hazra,

$$200 \text{ CE} \leq y \leq 900 \text{ CE}$$

where y denotes the dates for the present forms of the *Purāṇas* (Bose et al. 1971: 37).

Table II

S. No.	Treatise	Dimension of the Sun (in <i>yojanas</i>)	Rule (stated or not)	$\pi =$ (used)	Any other information if provided
1	<i>Vāyu Purāṇa</i> (Mitra 1879: v. 50.63, pp. 395-396)	$d_{\text{Sun}} = 9000$	$C = 3d$ (stated)	3	$d_{\text{Moon}} = 2d_{\text{Sun}}$
2	<i>Brahmāṇḍa Purāṇa</i> (Tagare 1983: vv. 21.7-8, pp. 198-199 and vv. 24.99b-103, p. 242)	$d = 9000$	$C = 3d$ (stated)	3	$d_{\text{Moon}} = 2d_{\text{Sun}}$, $d_{\text{Rahu}} = d_{\text{Sun}} + d_{\text{Moon}}$
3	<i>Matsya Purāṇa</i> (Kalicharan and Vastiram 1892: vv. 123.7-8 second hemistich, p. 377)	$d = 9000$	$C = 3d$	3	$d_{\text{Moon}} = 2d_{\text{Sun}}$
4	<i>Kūrma Purāṇa</i> (Mukhopādhyāya 1890: vv. 41.13-14, p. 369)	$d = 9000$	$C = 3d$ (stated)	3	$d_{\text{Moon}} = 2d_{\text{Sun}}$, $d_{\text{Rahu}} = d_{\text{Sun}} + d_{\text{Moon}}$

Alberuni spent time in India around 1030 CE. He also testified $C = 3d$ in the

Matsya Purāṇa, the *Āditya Purāṇa*, and the *Vāyu Purāṇa* (Sachau 1910: 167-168).

Among them the *Āditya Purāṇa* is an *Upapurāṇa* (Hazra 1963b: 272). It may here be noted that the date of the formation of the *Upapurāṇas* is placed between 650 CE and 800 CE (Hazra 1963b: 272). “Whatever the period of origin of the earliest *Upapurāṇa*,” writes R. C. Hazra, “may have been, it must be admitted that the *Upapurāṇas* came into existence after the eighteen principal *Purāṇas* had been formed for the first time (Hazra 1963b: 273).” “The fact that this extensive *Upapurāṇas* literature,” writes he, “includes works of comparatively late dates, does not prove that the whole literature has a late beginning (Hazra 1963b: 272).” The same case seems to be with the *Āditya Purāṇa* in which $\pi = 3$ may have been followed from some principal *Purāṇa*.

In the period extending from the time of the *Rgveda* (‘Praise-knowledge’), the oldest of the entire Indian literature, to 850 CE the status of the use of the values for π in India is shown in Table III. The range of the period covers the proposed range of x and the range of y as well. Table III contains the entries for π_1 and π_2 where π_1 is a ratio of C to d while π_2 is a ratio of the area of a circle to $(d/2)^2$. We now know for certain that $\pi_1 = \pi_2 = \pi$ (say). A. J. E. M. Smeur points out that this fact was not always recognized in ancient times (Smeur 1970: 249-270).

Going by Table II and Table III together, we are able to notice that 3 is found to have been used in the *Mahābhārata* and in the *Purāṇas* even when the better values for π were available in India in the unified range of x and y .

Going by Table III, we find that 3 was in use as the value for π in very early

period i. e., in the period of the *Rgveda* i. e., long before the range of x . It was also used in later period i. e., in the unified range of x and y , however as a practical value. It seems to have been only one choice for π for those treatises that are non-mathematical in nature as the *Purāṇas* from Table II and the *Abhidharmakośa* of Vasubandhu (4th century CE), which records $C = 7500$ *yojanas* for the Godānīya Island described long before the Christian era in the Buddhist cosmography when $d = 2500$ *yojanas* (Pruden 1988-1990: 455), from Table III substantiate. These facts establish that 3 has been the older and more traditional value for π . This is one of the reasons for which it is in the *Mahābhārata*. The *Purāṇas*, and so the *Mahābhārata*, should have followed some other value than 3 from the *Śulba Sūtras*, which often come in the jurisdiction of the *Śrauta Sūtras* and are virtually manuals for the construction of various types of altars for fire sacrifices, but it did not happen so perhaps for the reasons that the other values for π in them were not so simple as 3 was and were aimed at acquiring accuracy in construction of altars while the *Purāṇas* were the works meant for common folk.

Here the intersection of the ranges of x and y , if calculated, comes to be from 200 CE to 500 CE. Since we have noticed above that 3 as the value for π followed in the *Mahābhārata* from the *Purāṇas*, the inequality

$$500 \text{ BCE} \leq x \leq 500 \text{ CE}$$

may be narrowed to

$$200 \text{ CE} \leq x \leq 500 \text{ CE}.$$

This narrowed range for x is not acceptable to us for the following reasons.

1^0 , 4^0 , 5^0 , 6^0 , 7^0 , 8^0 , and 9^0 claim that most of the knowledge contained in the *Mahābhārata* was inserted into it from the *Purāṇas*; especially the first two i. e., 1^0 and 4^0 categorically assert, when interpreted, that 3 as the value for π moved from the *Purāṇas* into the *Mahābhārata*. On comparing Table I with Table II, we attest the use of 3 in the present forms of the *Purāṇas* but we do not find t to have been mentioned in them. For this reason, one cannot be allowed to infer that 3 was brought into the *Mahābhārata* from the present forms of the *Purāṇas* and t got its entry from somewhere into the great epic. It would not be unreasonable if we infer that 3 was received into the *Mahābhārata* from the older forms of the *Purāṇas* wherein t may have been in use. This gets support when we notice that (1) $d_{\text{Sun}} \langle =10000 \rangle$ in the *Mahābhārata* is not equal to $d_{\text{Sun}} \langle =9000 \rangle$ in the present forms of the *Purāṇas*, and (2) the *Mahābhārata* follows neither $d_{\text{Moon}} = 2d_{\text{Sun}}$ nor $d_{\text{Rāhu}} = d_{\text{Sun}} + d_{\text{Moon}}$.

From 3^0 it is noticeable that d_{Sun} is expressed in the *Mahābhārata* to be equal to 8000 plus 2000. Here are two possibilities of writing so. One is that some older datum 8000 would have been improved to 10000 by adding 2000. The other is that 8000 was some inner diameter of the Sun and it became its outer one when 2000 was added. This leads us to infer that the data referred to in the *Mahābhārata* are older than those in the present forms of the *Purāṇas*. The data seem to have belonged to such some older school as there were the three schools from which the *Sūryaprajñapti* ('Suggestion on the Sun'), a celebrated Jaina treatise of around 500 BCE, refers to three sets of

dimensions for the Sun namely (1) $C = 3399$ when $d = 1133$, (2) $C = 3402$ when $d = 1134$, (3) $C = 3405$ when $d = 1135$ for the two reasons. One is that the *Sūryaprajñapti* itself refuted the use of 3 in order to accommodate $\sqrt{10}$ as the value for π (Madhukara 1995: sūtra 20, p. 25; and Datta 1929: 131 and its foot note no. 1). The other is that each of those three sets of dimensions works out to be $\pi = 3$. It may here be noted that $\sqrt{10}$ is known as the Jaina value for π . $\sqrt{10}$ was a breakthrough in India on the improvement of the value for π , which lasted in the real sense up to the time of Āryabhaṭa (born 476) who himself made another breakthrough when he investigated $\pi = 62832/20000$ (Jadhav 2013: 516-517).

On the basis of the chronology revealed in the following facts and opinions, the data referred to in the *Mahābhārata* seem to be of the older forms of the *Purāṇas*. "Although the *Purāṇas* have suffered," Subhash Kak writes, "extensive revisions, the core *Purāṇa* can be dated to Vedic times. Atharvaveda 11.7.24 mentions *Purāṇa* along with the three other Vedas. Śatapatha Brāhmaṇa 11.5.6.8 refers specifically to the *itihāsa-purāṇa* and 13.4.3.13 refers to the recitation of the *Purāṇa*. There is a similar reference in the Chāndogya Upaniṣad 3.4.1. According to the Viṣṇu *Purāṇa*, the original *Purāṇa* was transmitted to Romaharṣaṇa (i. e., Lomaharṣaṇa) by Vyāsa. Romaharṣaṇa taught it to his six disciples, including his son Ugraśravā. At that time the *Purāṇa* consisted of 4,000 verses. The oldest three *Purāṇas*-the Vāyu, the Matsya, and the Brahmāṇḍa-are supposed to have been narrated in the reign of Adhiṣṭamakṛṣṇa, the great-great grandson of Parīkṣit. The Vāyu

Purāṇa was first narrated to a gathering of ṛṣis, performing their twelve-year sacrifice in the Naimiṣa forest (Kak 2001: 8-9; for that the word *Purāṇa* is contained in the *Atharva Veda* also see Hazra 1963a: 241).” On the

basis of Kauṭilya’s reference to the *Purāṇa*, V. A. Smith (1924) thought that this type of literature had already become authoritative in the fourth century BCE (Bose et al. 1971: 36-37 and 658).

Table III

S. No.	Treatise	$\pi_1 =$ (status if given)	$\pi_2 =$ (status if given)
1	<i>R̥gveda</i> (Sinha 2000: 7-8)	3	-
2	<i>Atharvaveda</i> (Sinha 2000: 7-8)	3	-
3	<i>Śatapatha Brāhmaṇa</i> (Kak 1997: 308-309; also see Gupta 1997: 93-94)	-	25/8
4	<i>Baudhāyana Śulba Sūtra</i> (c. 800 BCE) (For first row see Satyaprakash and Sharma 1980: v. 1.58, p. 8. For second row see Satyaprakash and Sharma 1980: v. 1.59, p. 8. For third row see Satyaprakash and Sharma 1980: v. 1.60, p. 8. For fourth row see Satyaprakash and Sharma 1980: vv. 1.112-113, p. 11. For fifth and sixth rows see Kak 1997: 310-312)	-	$4/[1 + ((\sqrt{2}-1)/3)]^2$ $\langle = 3.0883 \rangle$
		-	3.0885
		-	$4(1 - (2/15))^2$ $\langle = 3.004 \rangle$ (gross)
		3	-
		-	900/289
		-	1156/361
5	<i>Mānava Śulba Sūtra</i> (between 800 BCE and 500 BCE) (For first row see Sen and Bag 1983: v. 11.13, pp. 66, 136 and 278. Also see Sen and Bag 1983: v. 13.6, pp. 68 and 138, and Gupta 1988: 116-118. For second row see Sen and Bag 1983: v. 11.15, pp. 66 and 136, and Gupta 1988: 120-122. For third and fourth rows see Sen and Bag 1983: vv. 11.14-15, pp. 66 and 136, and Gupta 1988: 122.)	16/5	-
		-	25/8
		-	49/16
			625/196

6	<i>Āpastamba Śulba Sūtra</i> (between 800 BCE and 500 BCE) (For first row see Sen and Bag 1983: v. 3.2, pp. 40 and 103. For second row see Sen and Bag 1983: v. 3.3, pp. 41 and 103)	-	$4/[1+((\sqrt{2}-1)/3)]^2$
		-	$4(1-(2/15))^2$ (gross)
7	<i>Kātyāyana Śulba Sūtra</i> (between 800 BCE and 350 BCE) (Sen and Bag 1983: vv. 3.11-12, pp. 56 and 123)	-	$4/[1+((\sqrt{2}-1)/3)]^2$
		-	$4(1-(2/15))^2$
8	<i>Sūrya Prajñapti</i> (c. 500 BCE) (Jaina treatise) (Datta 1929: 131 and its foot note no. 1)	3 (for disapproval)	-
		$\sqrt{10}$	-
9	<i>Jambūdvīpa Prajñapti Sūtra</i> (c. 500 BCE) (Jaina treatise) (For π_1 see Sastri 1994: <i>vakṣaskāra</i> 1, sūtra 3, p. 5; <i>vakṣaskāra</i> 4, sūtra 92, p. 190; and sūtra 106, vv. 1-2, p. 219. For π_2 see Sastri 1994: <i>vakṣaskāra</i> 6, sūtra 158, v. 2, p. 312)	$\sqrt{10}$	$\sqrt{10}$
10	<i>Jīvājīvābhigama Sūtra</i> (c. 500 BCE) (Jaina treatise) (Madhukara 1989: sūtra 124, p. 344; sūtra 150, p. 433)	$\sqrt{10}$	-
11	<i>Uttarādhyayana Sūtra</i> (c. 300 BCE) (Jaina treatise) (Madhukara 1991: v. 36.58, p. 644)	$\sqrt{10}$	-
12	<i>Bhagavatī Sūtra</i> (c. 300 BCE) (Jaina treatise) (Mahāprajña 2005: <i>saya</i> 9, <i>uddeso</i> 1, sūtra 1, p. 197 and <i>saya</i> 9, <i>uddeso</i> 3, sūtra 7, p. 200)	$\sqrt{10}$	-
13	<i>Anuyogadvāra Sūtra</i> (3 rd century CE) (Jaina treatise) (Madhukara 1987: 508, p. 412)	$\sqrt{10}$	-
14	<i>Tattvārtha-adhigama-sūtra Bhāṣya</i> of Umāśvāti (between 150 BCE and 219 CE) (Jaina treatise) (Sūrīśvara 1994: below sūtra 3.11, p. 62)	$\sqrt{10}$	$\sqrt{10}$

15	<i>Jyotiṣakaraṇḍaka</i> of Anonymous Vallabhīcārya (c. 300 CE) (Jaina treatise) (Anonymous 1928: v. 185, p. 107)	$\sqrt{10}$	$\sqrt{10}$
16	<i>Abhidharmakośa</i> of Vasubandhu (4 th century CE) (Sastri 1981: Part I, 3.48, p. 507 and 3.55, p. 512)	3	-
17	<i>Paitāmahasiddhānta</i> (425 CE) (Hayashi 1997: p. 194)	$\sqrt{10}$	-
18	<i>Loyavibhāga</i> of Sarvanandi (c. 458 CE) (Jaina treatise) (Mishra 1949: 106)	19/6	-
19	Āryabhaṭīya (499 CE) of Āryabhaṭa (Shukla 1976: v. 2.10, p. 71)	62832/20000	-
20	<i>Pañcasiddhāntikā</i> (505 CE) of Varāhamihira (c. 485-587 CE) (Thibaut and Dvivedi 1889: v. 4.1)	$\sqrt{10}$	-
21	<i>Tiloyapaṇṇatti</i> of Yativṛṣabha (between 176 CE and 609 CE) (Jaina treatise) (For π_1 see Patni 1997: v. 4.9, p. 3. For π_2 see Patni 1997: v. 4.9, p. 3 and v. 4.2805, p. 753)	$\sqrt{10}$	$\sqrt{10}$
22	<i>Bṛhatkṣetrasamāsa</i> of Jinabhadra Gaṇī (609 CE) (Jaina treatise) (Vijayaṇi 1988: v. 1.7)	$\sqrt{10}$	$\sqrt{10}$
23	<i>Brāhmasphuṭasiddhānta</i> (c. 628 CE) of Brahmagupta (598-665 CE) (For first and second rows see Sharma et al. 1966: v. 12.40, p. 857. For third row see Sharma et al. 1966: v. 11.15. Also see Gupta 2003: 4)	3 (practical)	3 (practical)
		$\sqrt{10}$ (subtle)	$\sqrt{10}$ (subtle)
		377/120	-
24	Bhāskara's citation (c. 629 CE) (For first row see Shukla 1976: Rule cited by Bhāskara I below v. 2.7 first hemistich, p. 60. For second row see Shukla 1976: Rule cited by Bhāskara I below v. 2.10, p. 72)	-	3
		$\sqrt{10}$	-
25	<i>Pauliśasiddhānta</i> (modern, c. 750 CE) (Hayashi et al. 1989: 11-12)	3927/1250	-

26	<i>Śiṣyadhīvrddhidatantra</i> of Lalla (8 th century CE) (For first row see Chatterjee 1981: v. 2.8. Also see Hayashi et al 1989: 3, and 11-12. For second row see Chatterjee 1981: v. 1.43. Also see Gupta 1975: 2; and Hayashi 1997: 198-199. For third row see Chatterjee 1981: v. 5.3. Also see Hayashi 1997: 198)	600/191	-
		3300/1050	-
		3927/1250	-
27	<i>Triśatikā</i> of Śrīdhara (c. 799 CE) (Jaina treatise) (Dvivedi 1899: Rule 45, p. 234)	$\sqrt{10}$	$\sqrt{10}$
28	<i>Bṛhatpāṇī</i> of Śrīdhara (c. 799 CE) (Jaina treatise) (Hayashi et al 1989: 8. Also see Jadhav 2013: 523-525)	22/7	22/7
29	«Modern» <i>Sūryasiddhānta</i> (c. 800 CE) (Shukla 1957: v. 1.58, p. 19)	$\sqrt{10}$	-
30	<i>Dhavalā</i> Commentary of Vīrasena (c. 816 CE) on the <i>Ṣaṭkhaṇḍāgama</i> of Puṣpadanta and Bhūtabalī (87-156 CE) (Jaina treatise) (For first row see Jain 1996: below v. 8, p. 168. For second row see Jain 1996: v. 8 cited below v. 28, p. 209. For third row see Jain 1996: v. 14 cited below v. 3 p. 42; and v. 9 below v. 38, p. 221)	-	3 (practical)
		$\sqrt{10}$ (subtle)	$\sqrt{10}$ (subtle)
		$(355 + (16/d))/113$ (subtler) where d is the diameter of a circle	-
31	<i>Gaṇitasārasaṅgraha</i> of Mahāvīra (c. 850 CE) (Jaina treatise) (For first row see Padmavathamma 2000: v. 7.19, p. 435. For second row see Padmavathamma 2000, v. 7.60, p. 460)	3 (practical)	3 (practical)
		$\sqrt{10}$ (subtle)	$\sqrt{10}$ (subtle)

2.3. In Babylonia, 3 was used for π_1 around 2000 BCE as the old Babylonian text *British Museum 85194* shows (Smeur 1970: 262-263). In China, the *Chou Pei Suan Ching* ('Arithmetical Classic of the Gnomon and the Circular Paths of Heavens', written in the period of the Han dynasty (206 BCE-221 CE) but gives a very good record of the mathematics of about 1100 BCE), the *Chiu Chang Suan Shu* ('Nine Chapters on Mathematical Art', placed between 100 BCE and 100 CE), and the other treatises employ it for π_1 (Needham 1959: 99, and Mikami 1913: 8). In Egypt, it was used for both π_1 and π_2 in the Cairo Papyrus (about third century BCE) (Gupta 1990/91: 129). It is found to have been used in the *Old Testament* (I Kings 7.23), which is the Hebrew Bible of around 950 BCE although the Book of Kings was edited by the ancient Jews about 550 BCE, for π_1 (Beckmann 1974: 15; Gupta 1990/91: 127-135; and Deakin and Lausch 1998: 162). The Jewish *Talmud* (about 500 CE), a commentary on the *Old Testament*, also holds 3 for π_1 (Beckmann 1974: 15). Vitruvius, a Roman engineer of 1st century BCE/CE, applied $\pi_1=3$ in his *De Architectura* in giving periphery for a wheel of given diameter (Pottage 1968: 190-197). On the basis of these facts it can be asserted that the use of 3 as the value for π in the *Mahābhārata* was not out of what was accepted and approved in various other ancient cultures and culture-areas prior to and in the proposed range of x .

III. Concluding Remarks

The greatest reality regarding the *Mahābhārata* is that its text is available to us. It is of composite nature. And the

Bhūmiparva is a later addition to it. If consistency is preferred to as a sound criterion in determining when 3 as the value for π in the *Mahābhārata* was used, we can say that x is not only the date of incorporating 1^0 , 2^0 , and 3^0 in it but also the date of the use of 3 as the value for π in it.

Both of the *Mahābhārata* and the *Purāṇas* underwent changes. The *Purāṇas* continued to be revised even after the *Mahābhārata* was finally recast until they were shaped into the present form of the *Purāṇas* from their older form. Concept of t is not found in the present forms of the *Purāṇas*. It was borrowed from some older forms of the *Purāṇas* into the *Mahābhārata*. The dimensions referred to for the Rāhu, the Moon, and the Sun also seem to be from those forms of the *Purāṇas*. Keeping all these in view the above study supports that x tends to 500 BCE in its range extending from 500 BCE to 500 CE. With the support of the inference that the data referred to for the dimensions of the Rāhu, the Moon, and the Sun are older than those in the present forms of the *Purāṇas*, Dahlmann's date that the epic was composed not later than the fifth century BCE, and the other facts mentioned above x may go even beyond 500 BCE.

It would not be reasonable if we say that one who has incorporated 1^0 , 2^0 , and 3^0 in the *Mahābhārata* was unaware of the better values available during or prior to x in India for π other than 3. In regard to the use of 3 as the value for π , his source of information was the *Purāṇas*, certainly their older forms, which were the works for common public instruction. If simplicity, prevalence, and traditionalism are preferred to as a sound criterion to calculate C for a

given d , no other option for π is better than 3. This is what was followed in the *Purāṇas*, whether they belong to the older forms or to the present forms, and because of them in the *Mahābhārata*. The support for this option was available not only in the interior of India right from the *R̥gveda* but also in the exterior of India at least right from the old Babylonian text.

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