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Résumé de l'article

At one time, the Jainas in India and the Greeks in abroad held that unity was not a number. This paper provides an insight for the first time into the thoughts offered by the Jainas as to why unity was not a number for them.

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Jaina Thoughts on Unity Not Being a Number

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1 INTRODUCTION

One is the first natural number. Unity is simply a synonym in mathematics for it.[1] At one time, the Jainas in India and the Greeks outside India held that unity was not a number.

That unity is not a number is found to have been expressed in the following Jaina treatises:

- *Aṇuogaddārāiṃ* (Skt. *Anuyogadvāra Sūtra*, "Aphorisms for Entrance of Disquisition") of Āryarakṣita,
- the *Dhavalā* commentary of Vīrasena (c. 816 CE) on the *Chakkhaṇḍāgama* (Skt. *Ṣaṭkhaṇḍāgama*, "Canon in Six Books") of Puṣpadanta and Bhūtabalī of some period between 87 CE and 156 CE,
- the *Tiloyasāra* (Skt. *Trilokasāra*, "An Essence of the Three ‹Regions of the› Universe") of Nemicandra (c. 981 CE),
- the commentary written in Sanskrit by Maladhārin Hemacandra (1088–1172 CE) on the *Anuyogadvāra Sūtra*, and
- the *Lokaprakāśa* ("Enlightenment of the Universe") composed in Sanskrit by Upādhyāya Vinayavijaya Gaṇi (1651/1652 CE).[2]

The *Tattvārthavārtika* ("Explanatory Commentary on the Meaning of the Fundamental Principles") of Akalaṅka (seventh century CE), and the commentary written in Sanskrit by Mādhavacandra Traividya (c. 982 CE) on the *Trilokasāra* are also relevant in connection with Jaina thoughts on unity.

1 For the sake of clarity and to avoid any possible confusion with one used as an impersonal pronoun in English I will refer to "unity" wherever possible. This also accords with usage amongst earlier scholars.

2 Saṃvat 1708 will correspond to 1651/1652 CE if it is Vikrama Saṃvat 1708. For the date of the composition of the *Lokaprakāśa* see *LoPra*$_2$, v. 37.39, p. 383.

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Āryarakṣita, Hemacandra, and Vinayavijaya Gaṇī belong to the Śvetāmbara sect of Jainism while Akalaṅka, Vīrasena, Nemicandra, and Mādhavacandra Traividya belong to its Digambara sect. All of their above treatises belong to the canonical class of the Jaina school of Indian mathematics.[3]

This paper aims at understanding why unity was not a number for the Jainas. It will provide an insight for the first time into their thoughts on this issue. Beyond this, it has three further purposes that are explored in section three (pp. 212 ff. below).

2 EXPRESSIONS ON UNITY BY THE JAINAS

The anuyogadvāra sūtra says:

> [1] *se kiṃ taṃ gaṇaṇāsaṃkhā? ekko gaṇaṇaṃ na uveti, duppabhitisaṃkhā|*[4]
>
> What is number‹-measure› as counting (*gaṇaṇāsaṃkhā*, Skt. *gaṇanāsaṅkhyā*)? Unity (*ekka*) is not for counting (*gaṇaṇa*, Skt. *gaṇana*); two, etc. (*duppabhiti*, Skt. *dviprabhṛti*) ‹i.e., from two onwards› are numbers (*saṃkhās*, Skt. *saṅkhyās*)."

This contains three statements. The first is a question. The last two are the answer to it. B. B. Datta is the first historian of mathematics to have brought the second statement to our notice. He infers from it that "the Jainas do not consider unity a number".[5] Ganitanand paid attention to three of them. His interpretation for the second statement is that "unity does not admit of numeration."[6]

Vīrasena says:

> [2] *eyādīya gaṇaṇā doādīyā vi jāṇa saṃkhe tti| tīyādīṇaṃ ṇiyamā kadi tti saṇṇā du boddhavvā||*[7]

In similar words, Nemicandra says:

3 On the basis of theorization the Jaina school of Indian mathematics is divided into the canonical class and the exclusive class. The treatises of the canonical class contain mathematics along with discussion on Jaina canons. The object of the canonical class was to demonstrate canonical thoughts including on *karma* and cosmos using mathematics. For details regarding the canonical class, see Jadhav 2017: 316–331.

4 *ADvāSū*$_3$ 497, p. 409. Also see *ADvāSū*$_4$, 497, p. 364. For "*se kiṃ taṃ gaṇaṇā saṃkhā? ekko gaṇaṇaṃ na uvei, duppabhiisaṃkhā|*" see *ADvāSū*$_3$, 146, pp. 559–560. For "*se kiṃ taṃ gaṇaṇāsaṃkhā? ekko gaṇaṇaṃ ṇa uvei, duppabhiisaṃkhā|*" see *ADvāSū*$_5$, 30.1, p. 485. For "*se kiṃ taṃ gaṇaṇāsaṃkhā? ekko gaṇaṇaṃ na uvei, duppabhii saṃkhā|*" see Kapadia 1937: xxiii. Here we are able to notice slight verbal changes.

5 Datta 1929: 140.

6 Ganitanand 1986: 44.

7 *ṢaKhaĀ* v. 121, p. 276.

[3] *eyādīya gaṇaṇā bīyādīyā havaṃti saṃkhejjā| tīyādīṇaṃ ṇiyamā kaditti saṇṇā muṇedavvā||*[8]

"Thoughts are that unity (*eya*, Skt. *eka*), etc. are for reckoning (*gaṇaṇā*, Skt. *gaṇanā*), two, etc. are numbers (*saṃkhās*, Skt. *saṅkhyās*), and three, etc. (*tīyādī*, Skt. *tryādi*) are, by rule, the names (*saṇṇās*, Skt. *sañjñās*) of growing (*kadi*, Skt. *kṛti*)".[9]

In this paper, we will focus only on unity. However, it will be interesting to know what growing (*kṛti*) is. Mādhavacandra Traividya (c. 982 CE) writes that number, say x, is growing (*kṛti*), if $x^2 > x$ and $(x^2 - x)^2 > x^2$. Since 1 does not pass the preliminary part of the test and vanishes while appearing for the main part, it is no-growing (*nokṛti*). Since 2 passes the preliminary part but does not pass the main part, it is an "inexpressible growing" (*avaktavya kṛti*). Since numbers from 3 onwards pass the complete test, each of them is a growing (*kṛti*).[10] Prior to Mādhavacandra Traividya, Vīrasena (816 CE) also referred to those three categories of growing (*kṛti*).[11]

Vinayavijaya says:

[4] *naikastu gaṇanāṃ bhajet*[12]

"Unity (*eka*) does not render service to counting (*gaṇanā*)."

Āryarakṣita is ascribed authorship of the *Anuyogadvāra Sūtra*.[13] He classified Jaina literature into four disciplines (*anuyogas*) 592 years after Lord Mahāvīra attained the bliss of liberation.[14] J. P. Jain assigns him to c. 75 CE.[15] R. S. Shah is of the opinion that material contained in the *Anuyogadvāra Sūtra* pertains to post 300 BCE.[16] Muni Punyavijaya, Dalsukh Malvania and Amritlal Mohanlal Bhojak consider it to be a work of the second century CE and emphasizes that it cannot be placed after 300 CE.[17] Alessandra Petrocchi refers to it as being of approximately fourth century CE.[18] On the basis of these dates, although divergent, regarding the *Anuyogadvāra Sūtra* and the dates of the other above six treatises it can be said for certain that the *Anuyogadvāra Sūtra* appears to be the first treatise in which a Jaina author did not consider unity a number.

8 *TriSā*, v. 16, p. 18.

9 In [3] *muṇedavvas* (Skt. *mantavyas*) has come for thoughts whereas *boddhavva* (Skt. *boddhavya*) in [2] means perceptions or teachings. *Bīyādī* (Skt. *dvayādi*) in [3] and *doādīyā* (Skt. *dvayādi*) in [2] each means two, etc.

10 *TriSā*, commentary under v. 16, p. 18.

11 *ṢaKhaĀ*, 4.1, pp. 274–275.

12 *LoPra*$_1$ v. 1.127 last quarter, p. 35.

13 *ADvāSū*$_4$, pp. 20–21; *ADvāSū*$_6$, pp. 69–70.

14 *ADvāSū*$_3$, Introduction by Upācārya Devendra Muni, p. 28. The Digambaras place the date of Lord Mahāvīra between 659 and 587 BCE, whereas the Śvetāmbaras place him between 599 and 527 BCE. See Banerji 2004: 171.

15 J. P. Jain 1979: 13.

16 R. S. Shah 2007: 82.

17 *ADvāSū*$_6$, pp. 70–72.

18 Petrocchi 2017: 235.

3 DISCUSSION

The notion of measure was central to the overall Jaina intellectual enterprise. The terms adopted by Jaina authors for "measure" are *pamāṇa* (Skt. *pramāṇa*) or *māṇa* (Skt. *māna*). Their classification of measure is broad.[19] We shall explore it to the extent required to show how and why *gaṇaṇa* which occurs in [1] and *gaṇanā* which occurs in [4] are different from *gaṇaṇā* which occurs in both [2] and [3] and to explain *gaṇaṇāsaṃkhā*, which occurs in [1]. This is the first of the three purposes of this paper. This kind of exploration will help us to justify why we have adopted two interpretations of *gaṇaṇā* (Skt. *gaṇanā*) or *gaṇaṇa* (Skt. *gaṇana*). One is "counting." See translations offered for [1] and [4]. The other is "reckoning." See the translation jointly offered for [2] and [3].

In the classification of measure according to the *Anuyogadvāra Sūtra*, reckoning-measure and number-measure as counting are of interest to us. See 1.2.4 and 4.3.7 in Table 1. Similarly, reckoning and number-measure are of our interest in the classification of measure according to the *Tattvārthavārtika* of Akalaṅka (seventh century CE). See 1.4 and 2.1.1 in the *first section* of Table 2. The term used by Nemicandra (c. 981 CE) in the *Trilokasāra* to describe reckoning is reckoning-measure. And the term used by him to describe number-measure is number (*saṃkhā*, Skt. *saṅkhyā*). See 1.4 and 2.1.1 in the *second section* of Table 2.

According to the *Anuyogadvāra Sūtra*, that which is reckoned or that which is used for reckoning is reckoning ‹-measure› (*gaṇima*). Thus, reckoning measures include 1 (*ekka*, Skt. *eka*, one), 10 (*dasa*, Skt. *daśa*, ten), 10^2 (*sata* or *saya*, Skt. *śata*, hundred), 10^3 (*sahassa*, Skt. *sahasra*, thousand), 10^4 (*dasa-sahassa*, Skt. *daśa-sahasra*, ten-thousand), 10^5 (*sata-sahassa*, Skt. *śata-sahasra*, hundred-thousand), 10^6 (*dasa-sata-sahassa*, Skt. *daśa-śata-sahasra*, ten-hundred-thousand), 10^7 (*koḍī*, Skt. *koṭi*, crore), etc.[20] The purpose of reckoning-measure (*gaṇimappamāṇa*, Skt. *gaṇimapramāṇa*) is to reckon things like coinage or currency related to professional charges, allowance for food, salary for servants or employees, income and expenditure, etc.[21] According to the *Trilokasāra*, one, etc. (*egappahudi*, Skt. *ekaprabhṛti*) are reckoning-measure (*gaṇipamāṇa*, Skt. *gaṇipramāna*).[22] The same observation is made by Mādhavacandra Traividya,[23] who instead uses the term *gaṇimāna* for reckoning-measure.[24] Why the *Tattvārthavārtika,* followed by the *Trilokasāra*, put reckoning-measure (*gaṇanāmāna*) into the category of worldly meas-

19 *ADvāSū*$_3$, 313–520, pp. 227–424. *TaVā*, v. 3.38, pp. 205–209. *TriSā*, vv. 9–52, pp. 12–49 and vv. 92–112, pp. 86–108.

20 *ADvāSū*$_3$, 326, p. 238. Also see *ADvāSū*$_5$, p. 293

21 *ADvāSū*$_3$, 327, p. 239. Also see *ADvāSū*$_5$, p. 294. Glossary is as follows. Purpose (*paoyaṇa*, Skt. *prayojana*), things (*davva*, Skt. *dravya*), professional charges (*bhiti*, Skt. *vṛtti*), allowance for food (*bhatta*), salary (*veyaṇa*, Skt. *vetana*), servants or employees (*bhitaga*), income and expenditure (*āyavvaya*, Skt. *āya-vyaya*).

22 *TriSā*, v. 10 first hemistich, p. 13.

23 *TriSā*, commentary under v. 10, p. 13.

24 *TriSā*, commentary under v. 9, p. 12.

ure (*laukika pramāṇa*)[25] is intelligible from the above details referred to from the *Anuyogadvāra Sūtra* on reckoning-measure.

According to the *Tattvārthavārtika* of Akalaṅka (seventh century CE),

> [5] *ekadvitricaturādigaṇitamānanaṃgaṇanāmānam*|[26]
>
> "calculation-measure (*gaṇitamāna*) like one, two, three, four, etc. is reckoning-measure (*gaṇanāmāna*)."

Hence, we can say that (1) reckoning (*gaṇima*)[27] and reckoning-measure (*gaṇimappamāṇa*)[28] of the *Anuyogadvāra Sūtra*, (2) reckoning (*gaṇanā*),[29] calculation-measure (*gaṇitamāna*),[30] and reckoning-measure (*gaṇanāmāna*)[31] of the *Tattvārthavārtika,* (3) reckoning (*gaṇaṇā*)[32] of the *Dhavalā*, (4) reckoning (*gaṇaṇā*)[33] and reckoning-measure (*gaṇipamāṇa*)[34] of the *Trilokasāra, and* (5) reckoning-measure (*gaṇimāna*)[35] of Mādhavacandra Traividya's commentary on the *Trilokasāra* are one and the same. They each put unity in the jurisdiction of reckoning. It is noticeable that none of them is affixed with the term "number." It is also noticeable that the term "measure" is sometimes suffixed with reckoning and sometimes not. This implies that it is always implied with "reckoning," even when it is not written as a suffix.

The following information and discussion will enable us to know what *gaṇaṇāsaṃkhā*, that occurs in [1], is and why *gaṇaṇa* (Skt. *gaṇana*), that occurs in [1], and *gaṇanā*, that occurs in [4], each mean "counting."

The canonical class of the Jaina school of Indian mathematics divides numbers into three main divisions: numerable (*saṅkhyāta*, abbreviated *S*), innumerable (*asaṅkhyāta*, *A*), and infinite (*ananta*, *I*). Innumerable (*asaṅkhyāta*) is further divided into three subclasses: preliminary (*parita*, *p*), proper (*yukta*, *y*), and innumerable (*asaṅkhyāta*, *a*). Infinite (*ananta*) too is divided into three subclasses: preliminary (*parita*, *p*), proper (*yukta*, *y*), and infinite (*ananta*, *i*). The numerable (*saṅkhyāta*), the three subclasses of innumerable (*asaṅkhyāta*) and the three subclasses of infinite (*ananta*) is each again divided into lowest (*jaghanya*, *j*), intermediate (*madhyama*, *m*), and highest (*utkṛṣṭa*, *u*). Thus, we have twenty-one folds. They are S_j, S_m, S_u, A_{pj}, A_{pm}, A_{pu}, A_{yj}, A_{ym}, A_{yu}, A_{aj}, A_{am}, A_{au}, I_{pj}, I_{pm}, I_{pu}, I_{yj}, I_{ym}, I_{yu}, I_{ij}, I_{im}, I_{iu}.[36] Those that do not contain *m* (*madhyama*, intermediate)

25 See Table 2.
26 *TaVā*, v. 3.38, p. 205.
27 See 1.2.4 in Table 1.
28 See "The purpose ... etc." in the discussion above [5] (p. 212).
29 See 1.4 in the *first section* of Table 2.
30 See [5].
31 See 1.4 in the *first section* of Table 2.
32 See [2].
33 See [3].
34 See 1.4 in the *second section* of Table 2.
35 See "The same ... reckoning-measure." in the discussion above [5] (p. 212).
36 Jadhav 2017: 325–326. Each of these twenty-one symbols is suggested to be read from the right subscript to the left full-script to know name of the fold. For example, S_j is the lowest-numerable (*jaghanya-saṅkhyāta*) and I_{iu} *is* highest-infinite-infinite (*utkṛṣṭa-ananta-ananta*).

are single numbers while those that contain m are different closed intervals.[37] For example, $S_j = 2$ and S_m is $\left[3, S_u - 1\right]$.[38] The others are similar. This kind of number system or Jaina theory of numbers was founded, developed, and applied only in the canonical class of the Jaina school of Indian mathematics, i.e., in the treatises on Jaina canons which includes Karma theory and cosmography.

According to Akalaṅka, these twenty-one folds are number-measure (*saṅkhyāpramāṇa*).[39] The same is according to Nemicandra.[40] In order to define S_u, he states, at the beginning of describing the number-measure (*saṃkhāpamāṇa*, Skt. *saṅkhyāpramāṇa*) system of twenty-one folds, that the first of the four defined pits[41] is filled with mustards starting from two.[42] In order to explain why the filling starts from two, Nemicandra refers to [3], which means that unity is not a number or number-measure. In the middle of a detailed discussion on "explanation of counting and growing" (*gaṇana-kṛti-prarūpaṇā*),[43] Vīrasena writes, in his *Dhavalā*, in order to support his discussion, that [2] has also been said. On the other hand, these twenty-one folds minus I_{iu} or the first twenty folds are number ‹-measure› as counting (*gaṇaṇāsaṃkhā*, Skt. *gaṇanāsaṅkhyā*) according to the *Anuyogadvāra Sūtra*.[44] The *Anuyogadvāra Sūtra* starts describing "number-measure as counting" of twenty folds right from [1]. By means of [1] it states that unity is not for counting. Vinayavijaya Gaṇī refers to [4] in the early part of his description on number-measure of twenty-one folds.[45] On the basis of the above facts it can be inferred that it was a founding and integral part of this system that unity was not a number.

Observing Table 1, we find that there are eight kinds of number-measure according to the *Anuyogadvāra Sūtra*. Since number as counting (*gaṇaṇāsaṃkhā*, Skt. *gaṇanāsaṅkhyā*) is the seventh of them, it is essentially number-measure as counting (*gaṇaṇāsaṃkhappamāṇa*, Skt. *gaṇanāsaṅkhyāpramāṇa*). See Table 1. That is why I interpret the term *gaṇaṇāsaṃkhā*, which also occurs in [1], as "number-measure

37 I have employed terms like "single number" and "closed interval" arbitrarily. *Number-measure system* of the Jainas is incomparable in history of world mathematics. It is not yet fully studied by modern scholars. For its initial understanding see Datta 1929: 140–142; A. N. Singh 1942: 14–20; and N. Singh 1991: 209–230.

38 Instead of $S_j = 2$ we can write $n(S_j) = 2$ where $n(S_j)$ stands for "number of elements in S_j" and

$$S_j = \{x_k : x_k \text{ is unit and } k \leq 2 \text{ where } k \text{ is natural number}\}.$$

This kind of expression of S_j may be agreed with and appreciated.

39 *TaVā*, v. 3.38, pp. 206–207.

40 *TriSā*, vv. 13–14, pp. 14–15 and 34.

41 Those four pits are variable pit (*anavasthākuṇḍa*), counting-stick pit (*śalākākuṇḍa*), counter counting-stick pit (*pratiśalākākuṇḍa*), and great counting-stick pit (*mahāśalākākuṇḍa*). In order to know the procedure, which includes the operation of filling those four pits, to define S_u see *TriSā*, vv. 13–35, pp. 14–40 and Gupta 1992: 11–23.

42 *TriSā*, v. 15, p. 17.

43 *ṢaKhaĀ*, pp. 274–321.

44 *ADvāSū*$_3$, 497–519, pp. 409–422.

45 *LoPra*$_1$, v. 1.122–212, pp. 34–40. Here we find two views on I_{iu}.

as counting," not just "counting-number" or "number as counting" or "number for counting" as Ganitanand has done. He interprets the first statement of [1] as "What are the numbers for counting?"[46]

The term "number-measure as counting" of the *Anuyogadvāra Sūtra* is more explanatory for us than "number-measure" (*saṅkhyāpramāṇa*) of the *Tattvārthavārtika* as it has three terms, namely, counting (*gaṇaṇā*, Skt. *gaṇanā*), number (*saṃkhā*, Skt. *saṅkhyā*), and measure (*pamāṇa*, Skt. *pramāṇa*). Since *gaṇa* has the sense of "group",[47] "counting (*gaṇaṇā*, Skt. *gaṇanā*)" means "the act of grouping together." What are grouped together are units. On this basis, it can be said that the Jainas expressed measure (*pramāṇa*) by means of number (*saṅkhyā*) by counting (*gaṇaṇā*) all units given.

On the basis of the above entire exploration we can say that the Jainas employed numbers for measurement under two different ideas. One was idea of reckoning and the other was idea of counting. Unity was acceptable to them as "reckoning-measure" but was not acceptable as "number-measure as counting."

WHY WAS UNITY NOT EMPLOYED TO COUNT A UNIT?

Apart from the above, it is essential to understand and explain why unity was not employed by the Jainas to count a unit when it is single and that they held that unity corresponded to unit. This is the second purpose of this paper. Since we do not find any direct material in their treatises, we will have to search for some clue or clues in their discussion on their ontology, cosmography and karma theory, that can help us answer this question.

In this regard, we find the following example followed by a comment as well, offered by Hemacandra (1088–1172 CE) on the second statement of [1].

> **[6]** ... *yata ekasmin ghaṭādau dṛṣṭe ghaṭādī vastvidaṃ tiṣṭhatītyevameva prāyaḥ pratītirutpadyate, naikasaṅkhyāviṣayatvena, athavā ādānasamarpaṇādivyavahārakāle ekaṃ vastu prāyo na kaścidgaṇayatyato'saṃvyavahāryatvādalpatvādvā naiko gaṇanasaṅkhyāmavatarati, ...*[48]
>
> "When an object like a pot is seen, what one realizes is only a pot and not its number; or it may be due to the fact that in ordinary dealings only one thing, if given or taken, is mostly not "taken into account" ‹← "counted" (*gaṇaya*, i.e, *gaṇana*)›."[49]

46 Ganitanand 1986: 44.
47 Cappeller 1891: 146.
48 *ADvāSū*$_1$, 234, p. 473.
49 Kapadia 1937: xxiii. Glossary is as follows. Object (*vastu*), pot (*ghaṭa*), number (*saṅkhyā*), dealings (*vyavahāra*), given (*samarpaṇa*), and taken (*ādāna*).

This is an English translation offered by H. R. Kapadia for [6]. I am responsible for content inserted into the angular brackets. I suggest replacing "taken into account" by "counted" so that Kapadia's translation can fully and literally accords with the subject of this paper. My suggestion is supported by the term "*gaṇaya*, i.e, *gaṇana*" occurred in [6]. However, the term "taken into account" interpreted by Kapadia has the same sense that the term "counted" has when the complete sentence containing either of them is read.

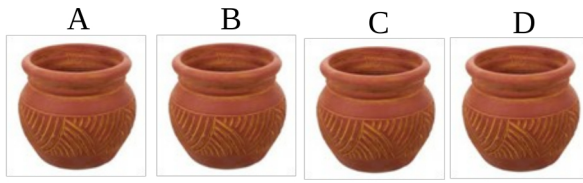

Figure 1:

Figure 2:

Now, on the basis of Hemacandra's example and that "counting" means "the act of grouping together," we can explain how and why the Jainas did not count a unit when it is single. Hemacandra's example is associated with Figure 2. Let us first see Figure 1. A, B, C, and D are pots. Since they are many, we shall have to group them together in order to know how many they are. If we first see A, we shall later see B, C, and D. Each, taken individually, is a unit. Since we have first seen A, we shall start counting from B, not from A at all, as A cannot be grouped together with itself. Counting up to B will be like this: 1 A, 1 B or 2 {A, B}. Similarly, up to C: 1 A, 1 B, 1 C or 3 {A, B, C}; and up to D: 1 A, 1 B, 1 C, 1 D or 4 {A, B, C, D}. Since total number of units in Figure 1 is 4, its "number-measure as counting" or "numeric value of its measure that has come through counting" is 4.

Let us now consider Figure 2. There is pot. It is a unit. Since it is single or there is no other unit, we cannot perform the act of grouping together. Since we have not counted any unit, no number is required to denote measure of single unit. That is why Hemacandra says that "when an object like a pot is seen, what one realizes is only a pot and not its number." Thus, [6] posits that the Jainas did not count unit when it was alone, i.e., single.

Now, we shall corroborate that unity corresponds to unit for the Jainas although they did not employ the former to measure the latter when alone. From Table 3 we can understand that the expression "knowledge of a subtle group-souled vegetable kingdom" mentioned in the *Tattvārthavārtika* and the expression "knowledge that a non-developable subtle group-souled vegetable kingdom possesses" mentioned in the *Trilokasāra* for the lowest measure of knowledge refer to are one and the same entity. The full term used by Mādhavacandra

Traividya for it is "knowledge that an absolutely non-developable subtle group-souled vegetable kingdom possesses" (*sūkṣmanigodalabdhyaparyāptakeṣujñāna*).[50] Similarly, the term coined for the highest measure of knowledge is omniscience, which the *Tattvārthavārtika* and the *Trilokasāra* refer to as "knowledge that Kevali possesses" (i.e., "perfect knowledge") and "knowledge that Jinendra possesses" *respectively*. See Table 3.

We are able to see from Table 3 that the expressions "ultimate-particle" (*paramāṇu*), "space-point" (*pradeśa*), and "infinitesimal fraction of time" (*samaya*) refer not only to the indivisible part of matter, space, and time respectively but also to their respective lowest measures. They must have been arrived at using an idea of indivisibility relating to matter, space, and time respectively. But the same is not the case with existence (*bhāva*). On the ground that unity has not been placed before the lowest measure of knowledge, i.e., before "knowledge that an absolutely non-developable subtle group-souled vegetable kingdom possesses," by either of Akalaṅka and Nemicandra while it has been prefixed with each of " ultimate-particle," "space-point," and "infinitesimal fraction of time," I conclude that the "knowledge that an absolutely non-developable subtle group-souled vegetable kingdom possesses" is not an indivisible part of knowledge. This is very important for the following discussion.

Before we proceed we would like to know what existence (*bhāva*) and knowledge are. *Bhavanaṃ bhāva* means "to be is existence (*bhāva*, state or condition)." Existence is an attribute of an entity. Entity is of two kinds. One is the living and the other is the non-living. Attributes of the latter are colour (*varṇa*), etc. while those of the former are knowledge (*jñāna*), conation (*darśana*), and "conscious attentiveness" or attention (*upayoga*).[51] J. L. Jaini writes that

> knowledge is the essence of soul. There is no soul without knowledge. There is no knowledge or knowability without soul.[52]

Knowledge was measured by the Jainas using their number-measure system. Jaini states its importance in the following words.

50 For Traividya's explanation see *TriSā*, under vv. 11–12, p. 13. For English translation of *sūkṣmanigodalabdhyaparyāptakeṣu* see *GoSāJīKā*, vv. 51–117, pp. 51–83 and vv. 299–464, pp. 175–238, especially p. 186. "All the souls occupy one body each, except some vegetable souls who share their body with other souls." See *GoSāJīKā*, p. 52. "The group-souled vegetable kingdom is called "*nogoda*." Those multitudinous souls that have their body, nourishment, and age in common are called host-souls (*sādhāraṇa*)." See *GoSāJīKā*, p. 55. "‹*Labdhyaparyāpta* (absolutely non-developable) souls› are those that shall die within an *antarmuhūrta* without becoming developable. Their age-duration is eighteenth part of the time of one pulse beat of a healthy person." See *GoSāJīKā*, p. 56.

51 *ADvāSū*$_3$, p. 358 and *ADvāSū*$_4$, 427–466, pp. 269–297. *TaVā*, v. 3.38, pp. 206 and especially 396.

52 *GoSāJīKā*, Introduction, p. 11.

> There are two ways known to us of having a very rough and remote Idea of Omniscience. One is by considering the extent of early Jaina sacred literature which is mostly lost to-day; and the other and even a better one is by considering the Jaina theory of numbers ‹(i.e., number-measure system of twenty-one folds)›.[53]

At the end of the description of the number-measure system, the *Trilokasāra* lets us know that scriptural knowledge, clairvoyance, and omniscience are numerable, innumerable, and infinite respectively.[54] Prior to this information it states that "indivisible corresponding-sections" (*avibhāga praticchedas*) of omniscience are I_{iu}.[55] J. L. Jaini writes in simple terms that the number of units (*avibhāga praticchedas*) of perfect knowledge (*kevalajñāna*) is I_{iu}.[56]

Now we are able to form the following opinions. The "indivisible corresponding-section" of knowledge is its unit. I_{iu} units of knowledge form omniscience. "Indivisible corresponding-section" seems to have been conceived by applying the idea of indivisibility to knowledge as the term "indivisible" (*avibhāga*) in the expression suggests. Since it is a unit of knowledge, Akalaṅka and Nemicandra have not prefixed one with "knowledge of a subtle group-souled vegetable kingdom" and "knowledge that a non-developable subtle group-souled vegetable kingdom possesses" respectively.[57] Since "knowledge that an absolutely non-developable subtle group-souled vegetable kingdom possesses" is the lowest measure of knowledge, the number of units in it must be S_j. In other words, "an absolutely non-developable subtle group-souled vegetable kingdom" possesses only two "indivisible corresponding-sections" of knowledge. Since no knowledge is lower in measure than the "knowledge that a non-developable subtle group-souled vegetable kingdom possesses," we can be allowed to assume that one "indivisible corresponding-section of knowledge" alone is not possessed by any soul or group-souled. That may have been the reason that one "indivisible corresponding-section of knowledge" could not be the lowest measure of knowledge. One which is prefixed with each of "ultimate-particle," "space-point," and "infinitesimal fraction of time" in Table 3 is in the capacity of reckoning-measure, not in that of number-measure at all. Now, on the basis of that concept of mathematics is applied where it fits into, we can deduce that unity corresponds to unit of any sort for the Jainas as one "indivisible corresponding-section of knowledge" corresponds to unit of knowledge.

53 *GoSāJīKā*, Introduction, p. 11.

54 *TriSā*, v. 52, p. 48. Glossary is as follows. Scriptural knowledge (*śrutajñāna*), clairvoyance (*avadhijñāna*), and omniscience (*kevalajñāna*).

55 *TriSā*, vv. 48–51, pp. 46–48.

56 *GoSāJīKā*, Introduction, p. 28. The term "indivisible corresponding-section" is very old. It is also found in the *Bhagavatī Sūtra* (some date between 362 BCE and 466 CE or earlier). See Deleu 1970: 158.

57 See Table 3.

ANCIENT GREEK APPROACHES

The third and last purpose of this paper is to take stock of some thoughts offered by the ancient Greeks. Following the Egyptian view, Thales (c. 600 BCE) defined number as "a collection of units." The Pythagoreans made number out of one. Some of them defined it as "a progression of multitude beginning from a unit and a regression ending in it".[58] From their doctrine, Aristotle observed that the one was reasonably regarded as not being a number, "because a measure is not the things measured, but the measure or the one is the beginning (or principle) of number".[59] He defined number as a "multitude of units" or a "multitude of indivisibles" or "several ones" or a "multitude of measures".[60] He asserted that "number is the principle both as matter for things and as constituting their attributes and permanent states".[61] In this way, he justified his teacher Plato (c. 380 BCE), who had already regarded unity as different from number.[62] Heath writes that,

> by arithmetic Plato meant, not arithmetic in our sense, but the science which considers numbers in themselves, in other words, what we mean by the Theory of Numbers. He does not, however, ignore the art of calculation (arithmetic in our sense); he speaks of number and calculation and observes that "the art of calculation (*λογιστική*) and arithmetic (*ἀριθμητική*) are both concerned with number;" ... But the art of calculation (*λογιστική*) is only preparatory to the true science; those who are to govern the city are to get a grasp of *λογιστική*, not in the popular sense with a view to use in trade, but only for the purpose of knowledge, until they are able to contemplate the nature of number in itself by thought alone. This distinction between *ἀριθμητική* (the theory of numbers) and *λογιστική* (the art of calculation) was a fundamental one in Greek mathematics.[63]

Euclid (c. 300 BCE) also believed in a similar doctrine when he defined the unit as "that by virtue of which each existing thing is said to be one" and number as "the multitude made up of units".[64] Another notion the ancient Greeks held was that unity, like a point, is incapable of division.[65] Nicomachus (c. 100 CE) defined number as "a flow of quantity made up of units".[66]

Until modern times the view that unity was not a number prevailed in Europe. Boethius (sixth century CE) propagated this view among medieval

58 Heath 1921: 69–70.
59 Heath 1921: 69.
60 Heath 1921: 70.
61 Heath 1921: 67.
62 Smith 1958: 27.
63 Heath 1921: 13–14.
64 Heath 1921: 69.
65 Smith 1958: 29. In this paper, we shall confine our discussion on unity to notion of measure and not bring that of point into it.
66 Heath 1921: 70.

writers such as al-Khwārizmī (c. 825 CE), Psellus (c. 1075 CE), Savasorda (c. 1100 CE), Johannes Hispalensis (c. 1140 CE), and Rollandus (c. 1425 CE).[67] Not only these writers, but most of the authors, such as Pacioli (c. 1494 CE), J. Köbel (c. 1514 CE), Tzwivel (1505 CE), Humphrey Baker (c. 1568 CE), and many others also, of the early printed books excluded unity from the number field.[68] The first printed book on arithmetic by an unknown author in the Venetian dialect and published on December 10, 1478 CE at Treviso, clearly states that,

> number is a multitude brought together or assembled from several units, and always from two at least, as in the case of 2, which is the first and the smallest number. One is not called a number but the source of number.[69]

Baker writes in his book *The Well-spring of Sciences* that,

> an vnitie is no number but the beginning and original of number.[70]

But Smith writes,

> it is not probable that Nicomachus (c. 100) intended to exclude unity from the number field in general, but only from the domain of polygonal numbers. It may have been a misinterpretation of the passage from Nicomachus that led Boethius to add the great authority of his name to the view that one is not a number. Even before his time the belief seems to have prevailed, as in the case of Victorius (475) and Capella (c. 460), although neither of these writers makes the direct assertion.[71]

Even in more recent times some writers have not considered unity to be a number. For example, George Baron (1769–1818 CE), the founder and editor-in-chief of the *Mathematical Correspondent*, categorically stated that,

> numbers are composed of units, but a unit is not a number; if a book be said to consist of leaves, it is plain that a leaf is not a book.[72]

In the sixteenth century, thinkers in Europe started to oppose the view that unity is not a number. Hylles (1592), speaking of "an vnit or an integer…," was rather afraid to take a definite stand in the matter, but said that,

67 Smith 1958: 27.
68 Smith 1958: 28.
69 Smith 1929: 1–3.
70 Jackson 1906: 30.
71 Smith 1958: 27.
72 Baron 1804: footnote, p. 85. Also see Hogan 1976: 412.

> the latter writers, as namely Peter Ramus, and such as have written since his time, affirme not only that an vnite or one, is a number, but also that euery fraction or parte of an vnite, is a number. ...[73]

Simon Stevin (1585) found it necessary to correct this popular view that unity is not a number. After reviewing the various arguments which history had handed down, he argued that,

> (i) a part is of the same nature as the whole, and hence that unity, which is part of a collection of units, is a number,

and

> (ii) if from a number there is subtracted no number, the given number remains; but if from 3 we take 1, 3 does not remain; hence 1 is not no number.[74]

By the end of the century it was recognized due to those thinkers that the ancient view on unity was too narrow. Among them Stevin was the first prominent writer to clearly assert that unity is a number.[75]

Now we can say that the logistic[76] (*λογιστική* or the art of calculation) of the Greeks seems to be somewhat like the reckoning-measure of the Jainas. The arithmetic (*ἀριθμητική* or the theory of numbers) of the Greeks is said to have been more abstract than geometry.[77] It appears to be somewhat similar and somewhat dissimilar to the number-measure of the Jainas. Similarities between them are that

1. unity is unit, or unity corresponds to unit,
2. number is a collection of units or a group of units together, and
3. unity is not a number.

That number constitutes attributes is also a similarity between them. The number-measure of the Jainas, unlike the arithmetic of the Greeks, was of multifolds i.e., both from S_j to I_{im} and from S_j to I_{iu}, although the idea that unity was not a number was a founding and integral part of both the Greek arithmetic and the Jaina number system. This was a major dissimilarity between them. It is interesting that the Jainas found areas where they could apply their number-measure, including the idea that unity is not a number, as we have seen in the case of

73 Smith 1958: 28.
74 Smith 1958: 28–29; Jackson 1906: 30.
75 Smith 1924: 315. The following must be noted here. "In his *Sefer ha-Echad* ("*Book on Unity*") there are several passages in which Rabbi ben Ezra (c. 1140) argues that one should be looked upon as a number." See Smith 1958: 27–28.
76 Smith 1958: 7.
77 Smith 1958: 7.

knowledge. From Hylles' quote it is that "euery fraction or parte of an vnite is a number" but the unit was indivisible for both of the Greeks[78] and the Jainas.[79]

4 CONCLUDING REMARKS

The concept of number-measure developed by the Jainas was essentially "number-measure as counting." Keeping this in view, they developed system of "number-measure as counting," both from S_j to $I_{\text{im}}$and from S_j to I_{iu}, to measure the magnitude of total units that they grouped together. The idea of indivisibility enabled them to allow unity to correspond to a unit while the idea of counting, i.e., "grouping together" did not allow them to count a unit when it was alone. For them, counting was prior to measuring. That is why they could not employ unity to measure a unit when it was alone. Similarly, certainly prior to the Jainas, the Greeks did not measure a unit when it was alone, using unity, as for them number meant "multitude" or it was "a collection of units." Since, for them, unity was not a collection, it was not considered a number.

INSIDE INDIA

Outside India, the ancient Greek thoughts regarding unity, first due to the Greeks themselves and later due to the thinkers in Europe and elsewhere, lasted for almost 2000 years. Mathematicians and philosophers continued to argue over whether unity was a number. On the other hand, Jaina thoughts on unity, like those on figurate numbers,[80] logarithms,[81] raising a number to its own power,[82] number-measure and so forth, remained confined to the canonical class of the Jaina school of Indian mathematics. To make the importance of the thoughts offered by the canonical class on unity very clear to the non-Jaina thinkers in India was only a remote possibility; even its exclusive class[83] that includes Śrīdhara (c. 799 CE), Mahāvīra (850 CE), Rājāditya (twelfth century CE), Ṭhakkara Pherū (c. 1265–c. 1330 CE), never referred to the idea that unity was not a number. A plausible reason for this seems to have been that the exclusive class did not find any area of application of those thoughts for public interest. Moreover, the canonical class placed its thoughts about unity in the category of post-worldly measure (*lokottaramāna*, measure which is not common in ordinary

78 See "Another notion ... incapable of division." in the section "Ancient Greek Approaches" above (p. 219).

79 See Table 3 and the discussion in the section "Why was Unity not Employed..." above (pp. 215–218).

80 Jadhav 2009: 35–55.

81 Jadhav 2002: 261–267; 2003: 53–73.

82 Jadhav 2008: 139–149.

83 The treatises of the exclusive class of the Jaina school of Indian mathematics are composed exclusively on mathematics. The object of the exclusive class was to provide mathematics education to the contemporary civil life. For details regarding the exclusive class, see Jadhav 2017: 316–331.

life) and it not only drew a clear line of demarcation between reckoning-measure and number-measure but also had been getting that line brought through its treatises into the notice of its followers and learners to come.

GREEK AND JAINA APPROACHES

Ancient Greek thoughts on unity go back, as we have seen, to at least 600 BCE. It cannot be said with certainty how old the Jaina thoughts on unity are. But it can be said for certain that they developed prior to the division of the Jaina organization since they had developed before the composition of *Anuyogadvāra Sūtra* and both the Digambaras and the Śvetambaras had held that unity was not a number. The Jaina organization is said to have officially split into Digambara and Śvetambara sects by the first century CE.[84] If the chronological order of the development of the Greek and Jaina thoughts on unity and the similarities between the arithmetic of the Greeks and the number-measure system of the Jainas are kept in view, it may be said that the thoughts on unity might have been transmitted from the Greeks to the Jainas. On the other hand, if the dissimilarities between the arithmetic of the Greeks and the number-measure system of the Jainas are kept in view, any possibility of transmission of the thoughts on unity does not arise. But this opinion may be rejected on the ground that indirect transmission can account for bits and pieces of thoughts while other aspects might have substantially changed. The lack of concrete evidence of transmission, such as Greek loanwords in Prakrit and Sanskrit texts or vice versa, must surely lead us to conclude, at least prima facie, that such transmission did not occur and that these ideas arose independently in the Greek and Jaina cultures.

FUTURE DIRECTIONS

Many more clues, apart from those that helped in this paper to explore Jaina thoughts on unity, can be found, if searched for, in the treatises of the Jainas on their canonical thoughts including those on ontology, cosmography and Karma theory, which can enlighten us further and can inform us about other aspects of their thoughts on unity. For example, those clues may be no-growing (*nokṛti*), space-point (*pradeśa*), their number-measure system itself, etc.

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84 Specifically by the year 79 CE or some date between 80 CE and 82 CE. See Banerji 2004: 170; Basham 1986: 291; Kumar 1997: 47; Schubring 2000: 50.

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TABLES

Measure (*pamāṇa*, Skt. *pramāṇa*)			
1 Matter-measure (*davvappamāṇa*, Skt. *dravyapramāṇ*)			4 Existence-measure (*bhāvappamāṇa*, Skt. *bhāvapramāṇa*)
1.1 ‹Measure› based on space-point (*padesanipphaṇṇa*, Skt. *pradeśaniṣpanna*) 1.2 ‹Measure› based on division (*vibhāganipphaṇṇa*, Skt. *vibhāganiṣpanna*) 1.2.1 ‹Volume or capacity-› measure (*māṇa*, Skt. *māna*) 1.2.2 Raising-measure, i.e., weighing-measure ‹using balance› (*ummāṇa*, Skt. *unmāna*) 1.2.3 Linear-measure (*omāṇa*, Skt. *avamāna*) 1.2.4 Reckoning ‹-measure› (*gaṇima*) 1.2.5 Measure for precious metals (*paḍimāṇa*, Skt. *pratimāna*)	2 Space-measure (*khettappamāṇa*, Skt. *kṣetrapramāṇa*)	3 Time-measure (*kālappamāṇa*, Skt. *kālapramāṇa*)	4.1 Attribute-measure (*guṇappamāṇa*, Skt. *guṇapramāṇa*) 4.2 Viewpoint-measure (*ṇayappamāṇa*, Skt. *nayapramāṇa*) 4.3 Number-measure (*saṃkhappamāṇa*, Skt. *saṅkhyāpramāṇa*) 4.3.1 Number ‹-measure› as name (*nāmasaṃkhā*, Skt. *nāmasaṅkhyā*) 4.3.2 Number ‹-measure› as notional installation (*ṭhavaṇasaṃkhā*, Skt. *sthāpanāsaṅkhyā*) 4.3.3 Number ‹-measure› as physical aspect (*davvasaṃkhā*, Skt. *dravyasaṅkhyā*) 4.3.4 Number ‹-measure› as simile (*ovammasaṃkhā*, Skt. *aupamyasaṅkhyā*) 4.3.5 number ‹-measure› as magnitude ‹of the scriptures› (*parimāṇasaṃkhā*, Skt. *parimāṇasaṅkhyā*) 4.3.6 Number ‹-measure› as knowledge (*jāṇaṇāsaṃkhā*, Skt. *jñānasaṅkhyā*) 4.3.7 Number ‹-measure› as counting (*gaṇaṇāsaṃkhā*, Skt. *gaṇanāsaṅkhyā*) 4.3.8 ‹Measure of› shell as essence (*bhāvasaṃkhā*, Skt. *bhāvaśaṅkha*)

Table 1: The classification of measure according to the *Anuyogadvāra Sūtra*.[85]

85 *ADvāSū*$_3$, 313–314, pp. 227–229; 316, p. 231; 427, p. 357; 477, pp. 397 and 423. Also see *ADvāSū*$_4$, pp. 54–55, 269, 316, 341–342 and 384.

Tattvārthavārtika Measure (*pramāṇa*)		*Trilokasāra* Measure (*māṇa*, *Skt. māna*)	
1 Worldly (*laukika*) ‹measure›	2 Post-worldly (*lokottara*) ‹measure›	1 Worldly (*logiga*, Skt. *laukika*) ‹measure›	2 Post-worldly (*loguttara*, Skt. *lokottara*) ‹measure›
1.1 ‹Volume or capacity-› measure (*māna*, example: *ṣoḍaśikā*, *kuḍava*, etc.) 1.2 Raising-measure, i.e., weighing-measure (*unmāna*) 1.3 Linear-measure (*avamāna*, example: *daṇḍa*, etc.) 1.4 Reckoning (*gaṇanā*) or reckoning-measure (*gaṇanāmāna*) [86] 1.5 Measure for precious metals (*pratimāna*) 1.6 Suggestion-measure (*tatpramāṇa*)	2.1 Matter-measure (*dravyapramāṇa*) 2.1.1 Number-measure (*saṅkhyāpramāṇa*) 2.1.2 Simile-measure (*upamāpramāṇa*) 2.2 Space-measure (*kṣetrapramāṇa*) 2.3 Time-measure (*kālapramāṇa*) 2.4 Existence-measure (*bhāvapramāṇa*)	1.1‹Volume or capacity-› measure (*māṇa*, Skt. *māna*, example: *pattha* (Skt. *prastha*)) 1.2 Raising-measure (*ummāṇa*, Skt. *unmāna*, example: *tula* (Skt. *tulā*, balance)) 1.3 Capacity-measure (*omāṇa*, Skt. *avamāna*, example: *culuya* (Skt. *culuka*, hollowed palm)) 1.4 Reckoning-measure (*gaṇipamāṇa*, Skt. *gaṇipramāna*) 1.5 Measure for precious metals (*paḍipamāṇa*, Skt. *pratipramāna* or *pratimāna*, example: *guṃjā* (Skt. *guñjā*, rosary pea or '*guñjā* berry used as a weight')) 1.6 Suggestion-measure (*tappaḍipamāṇa*, Skt. *tatpratipramāṇa*) ‹to determine the amount required› to pay for horse ‹offered for sale by examining its body parts›	2.1 Matter (*davva*, Skt. *dravya*) ‹-measure› 2.1.1 Number (*saṃkhā*, Skt. *saṅkhyā*) ‹-measure› 2.1.2 Simile-measure (*uvamapamā*, Skt. *upamā pramāṇa*) 2.2 Space (*khitta*, Skt. *kṣetra*) ‹-measure› 2.3 time (*kāla*) ‹-measure› 2.4 existence (*bhāva*) ‹-measure›

Table 2: The classification[87] of measure according to the *Tattvārthavārtika* and the *Trilokasāra*

86 The interpretation of the term *gaṇanāmāna* as "counting-measure" is not appropriate. See Jadhav 2017: 325. It should have been "reckoning-measure."

87 To ensure clarity of the terminology we have assembled the classification of measure in this table from both the *Tattvārthavārtika* and the *Trilokasāra* although the classifications of measure according to them are nearly the same. For the *Tattvārthavārtika* see *TaVā*, v. 3.38, pp. 205–209. For the *Trilokasāra* see *TriSā*, vv. 9–10 and v. 12 second hemistich, pp. 12–14.

According to the	Measure	Matter-measure (*dravyapramāṇa*)	Space-measure (*kṣetrapramāṇa*)	Time-measure (*kālapramāṇa*)	Existence-measure (*bhāvapramāṇa*)
Tattvārthavārtika	lowest (*jaghanya*)	one ultimate-particle (*eka paramāṇu*)	one space-point (*ekaākāśa*, i.e., *eka pradeśa*)	one infinitesimal fraction of time (*eka samaya*)	‹knowledge› of a subtle group-souled vegetable kingdom (*sūkṣmanigotasya*)
Trilokasāra	lowest (*avara*)	‹one› ultimate-particle (*paramāṇu*)	one space-point (*egapadesa*, Skt. *ekapradeśa*)	one infinitesimal fraction of time (*igisamaya*, Skt. *ekasamaya*)	knowledge that a non-developable subtle group-souled vegetable kingdom possesses (*suhumaṇigodesu puṇṇesu ṇāṇa*, Skt. *sūkṣmanigodeṣu apūrṇeṣu jñāna*)
Tattvārthavārtika	intermediate (*madhyama*)	two, three, four, etc. space-points based (*dvitricaturādi-pradeśātmaka*)	two, three, four, etc. space-points (*dvitricaturādi-pradeśās*)	two, three, four, etc. *samayas* (*dvitricaturādi-samayas*)	‹knowledge that› other souls possess (*anyajīvānām*)
Trilokasāra	intermediate (*majjhima*, Skt. *madhyama*)	various kinds (*aṇeyavihaṃ*, Skt. *anekavidham*)	various kinds (*aṇeyavihaṃ*, Skt. *anekavidham*)	various kinds (*aṇeyavihaṃ*, Skt. *anekavidham*)	various kinds (*aṇeyavihaṃ*, Skt. *anekavidham*)
Tattvārthavārtika	highest (*utkṛṣṭa*)	great-aggregate (*mahāskandha*)	entire space (*sarvaloka*)	*anantakāla* (infinite time)	knowledge that Kevali possesses (*kevala jñāna*)
Trilokasāra	highest (*vara*)	all matter (*sayaladavva*, Skt. *sakaladravya*)	entire space (*savvamāgāsa*, Skt. *sarvamākāśa*)	entire ‹present, past and future› time (*savvakāla*, Skt. *sarvakāla*)	knowledge that Jinendra possesses (*ṇāṇa jiṇesu*, Skt. *jñāna jineṣu*)

Table 3: The lowest, intermediate, and highest post-worldly measures [88]

88 To ensure clarity of the terminology we have assembled the lowest, intermediate, and highest post-worldly measures in this table from both the *Tattvārthavārtika* and the *Trilokasāra* although they are one and the same. For the *Tattvārthavārtika* see *TaVā*, v. 3.38, pp. 206 and 396. For the *Trilokasāra* see *TriSā*, vv. 11–12 first hemistich, p. 13.

ABBREVIATION AND NOTATION

Skt. Sanskrit. The terms that I put just after Skt. will help the reader to understand Prakrit through Sanskrit.

‹...› Angle brackets contains a paraphrase supplied by me to achieve comprehensiveness and clarity. It does not mean that the original expressions are incomplete or corrupted.

PRIMARY SOURCES

ADvāSū$_1$ **मलधारगच्छीयाचार्यश्रीमद्धेमचन्द्राचार्यविरचितवृत्तियुक्तं श्रीमदनुयोगद्वारासूत्रम्** [*Anuyogadvāra Sūtram* (*Uttarārdham*) *with Hemacandra's Sanskrit Commentary*] (1916) (Bombay: Śreṣṭhi Devacandra Lālabhāī Jain-apustakoddhāra Fund), https://jainelibrary.org/book-detail/?srno=600060, (on 30 Mar. 2021); page references are to the PDF.

ADvāSū$_2$ Miśra, M. K. (1953) (ed.), **मूलसुत्तानि: श्री दशवैकालिकसूत्र, श्री उत्तराध्ययनसूत्र, श्री नंदीसूत्र तथा श्री अनुयोगद्वारसूत्र का शुद्ध मूलपाठ** = *Mūla Suttāṇi* (Beawar: Śāntilāla Vī. Śetha).

ADvāSū$_3$ Miśrīmalajī Mahārāja 'Madhukara' et al. (1987) (eds.), **श्री आर्यरक्षितस्थविरविरचित अनुयोगद्वारसूत्र (मूल पाठ, हिन्दी अनुवाद, विवेचन परिशिष्ट युक्त)** = *Anuyogadvārāsūtra* (*Original Text, Hindi Version, Notes, and Annotations and Appendices etc.*) (Jināgama-Granthamālā, 28; Beawar: Śrī Āgama Prakāśana Samiti), https://jainelibrary.org/book-detail/?srno=003468, (on 11 Apr. 2021).

ADvāSū$_4$ Amara Muni, Tarun Muni, and Surana 'Saras' (2001) (eds.), **सचित्र अनुयोगद्वार सूत्र. मूल पाठ - हिन्दी - अंग्रेजी अनुवाद, विवेचन तथा रंगीन चित्रों सहित** = *Illustrated Anuyogadvar Sutra*, trans. S. Bothara, 2 vols. (Delhi: Padma Prakāśana), https://jainelibrary.org/book-detail/?srno=007656, (on 11 Apr. 2021); vol. 2.

ADvāSū$_5$ Līlamabāī Mahāsatī et al. (2009) (eds.), **श्री अनुयोगद्वार सूत्र (मूलपाठ, शब्दार्थ, भावार्थ, विवेचन, परिषिष्ट** [*Anuyogadvāra Sūtra with Original Text, Meaning, Annotations, Appendices, etc.*] Trans. Subodhikābāī (Mumbai: Śrī Guru Prāṇa Prakāśana), https://jainelibrary.org/book-detail/?srno=008782, (on 11 Apr. 2021); In Gujarati.

ADvāSū$_6$ Puṇyavijaya, M., Mālvaṇiā, D., and Bhojak, A. M. (1968) (eds.), **सिरिदेववायगविरैयं नंदिसुत्तं सिरिअज्जरक्खियथेरविरइयाइं अणुओगद्दाराइं** = *Nandi-suttam and Aṇuogaddārāiṃ* (The Jaina Āgama Series, 1; Bombay: Shri Mahavira Jaina Vidyalaya), https://jainelibrary.org/book-detail/?srno=001062, (on 11 Apr. 2021).

GoSāJīKā Jaini, J. L. (1927) (ed. and trans.), *Gommatasara Jiva-kanda* (*The Soul*) *by Nemichandra Siddhanta Chakravarti. Edited with Introduction, Translation and Commentary* (The Sacred Books of the Jainas, 5; Lucknow: Ajit Prasada at the The Central Jaina Publishing House), ARK: ark:/13960/t5t811r7d, (on 11 Apr. 2021).

LoPra$_1$ Shah, M. O. (1926) (ed. and trans.), **श्रीमहोपाध्यायकीर्तिविजयशिष्य-महोपाध्याय-श्रीविनयविजयगण्युपज्ञः श्रीलोकप्रकाशः** [= *Lokaprakāśa of Vinayavijaya Gaṇi. Part I, Cantos 1–11*] (Bombay: Jīvanacanda Sākaracanda Jhaverī for Shri Agamodaya Samiti), ARK: ark:/13960/t8vb3cz6b; Page references are to the PDF.

LoPra$_2$ Vajrasenavijaya Gaṇivara (1996) (ed.), **श्री विनयविजय गणि विरचित श्री लोकप्रकाश...प्रथम भाग...सर्ग ३२ थी ३७ सुधी भाग ५** [*Lokaprakāśa of Vinayavijaya Gaṇi, Part 5, Cantos 32–37*], trans. K. A. Shah (Mumbai: Namaskar Aradhak Trust), https://jainelibrary.org/book-detail/?srno=005158, (on 11 Apr. 2021); In Gujarati.

ṢaKhaĀ Jain, H., Phūlacandra, Bālacandra, Devakīnandana, and Nemināthatanaya-ādināth a (1949) (eds.), **श्री-भगवत्-पुष्पदन्त-भूतबलि-प्रणीतः षट्खंडागमः श्रीवीरसेनाचार्य-विरचित-धवला-टीका-समन्वितः तस्य चतुर्थखंडे वेदनानमधेये ... कृतिअनुयोगद्वारम्** = *Ṣaṭkhaṇḍāgama of Puṣpadanta and Bhūtabalī with Dhavalā commentary of Vīrasena, Book 9*, trans. H. L. Jain et al. (Amarāvatī: Śrimanta Seṭha Śitābarāya Lakṣmīcandra), https://jainelibrary.org/book-detail/?srno=001403, (on 15 Apr. 2021); Reprinted Solapur 2005.

TaVā Jain, M. K. (1953) (ed.), *Tattvarthavartik of Shri Akalank Deva with Hindi Translation ... with Introduction, Appendices, Variant Readings, Comparative Notes etc.* (Jnāna-Pītha Murtidevi Jaina Granthamala, Samskrit Grantha 10; Kāshi: Bhāratīya Jñānapīṭha), ARK: ark:/13960/t7xm3qm63; Reprinted, Bharatiya Jnanpith, New Delhi, 1999.

TriSā Mukhtāra, R. J. and Pāṭanī, C. (1975) (eds.), **श्रीमन्नेमिचन्द्र सिद्धान्तचक्रवर्ति विरचित त्रिलोकसार (श्रीमन्माधवचन्द्रत्रैविद्यदेवकृत व्याख्या सहित). हिन्दी टीकाकर्त्री आर्यिका विशुद्धमति माताजी** [*Trilokasāra of Nemicandra. With Mādhavacandra Traividya's Sanskrit commentary and Āryikā Viśuddhamati's Hindi commentary*] (Śrī Śivasāgara granthamālā; Śrī Mahāvīrajī (Rājasthāna): Lāḍamala Jaina), https://jainelibrary.org/book-detail/?srno=090512, (on 16 Apr. 2021).

SECONDARY LITERATURE

Banerji, S. R. (2004), 'Understanding Jain Religion in a Historical Perspective', *Jain Journal*, 28/3: 161–79.

Baron, G. (1804), 'An Enquiry Respecting the True Definition of Proportional Numbers', *The Mathematical Correspondent*, 1: 83–9.

Basham, A. L. (1986), *The Wonder That Was India* (New Delhi: Rupa & Co); First published in 1954.

Cappeller, C. (1891), *Sanskrit-English Dictionary* (Strassburg), ARK: ark:/13960/t50g3tc1g.

Datta, B. B. (1929), 'The Jaina School of Mathematics', *Bulletin of the Calcutta Mathematical Society*, 21: 115–45.

Deleu, J. (1970), *Viyāhapannatti (Bhagavaī); The Fifth Anga of the Jaina Canon. Introduction, Critical Analysis, Commentary & Indexes* (Brugge: De Tempel).

Ganitanand (1986), 'When There Was No Unity in the Number-land', *Gaṇita Bhāratī*, 8/1-4: 44–5.

Gupta, R. C. (1992), 'The First Unenumerable Number in Jaina Mathematics', *Gaṇita Bhāratī*, 14/1-4: 11–24.

Heath, T. (1921), *A History of Greek Mathematics* (Oxford: The Clarendon Press), https://tinyurl.com/1x3k5vql, (on 4 Feb. 2021).

Hogan, E. R. (1976), 'George Baron and the Mathematical Correspondent', *Historia Mathematica*, 3: 403–15. DOI: 10.1016/0315-0860(76)90068-9.

Jackson, L. L. (1906), *The Educational Significance of Sixteenth Century Arithmetic from the Point of View of the Present Time* (New York: Teachers College, Columbia University), ARK: ark:/13960/t4th9hh39.

Jadhav, D. (2002), 'The Laws of Logarithms in India', *Historia Scientiarum*, 11/3: 261–7.

—— (2003), 'Theories of Indices and Logarithms in India from Jaina Sources', *Arhat Vacana*, 15/4: 53–73.

—— (2008), 'On Raising a Number to Its Own Power in Ancient India', *Gaṇita Bhāratī*, 30/2: 139–49.

—— (2009), 'On the Figurate Numbers from the Bhagavatī Sūtra', *Gaṇita Bhāratī*, 31/1–2: 35–55.

—— (2017), 'The Jaina School of Indian Mathematics', *Indian Journal of History of Science*, 52/3: 316–34.

Jain, J. P. (1979), 'Jaina Authors and Their Works', *The Jaina Antiquary*, 32/2: 8–18.

Kapadia, H. R. (1937), 'Introduction', in *Gaṇitatilaka by Śrīpati with the Commentary of Siṃhatilaka Sūri*, ed. H. R. Kapadia (Baroda: Oriental Institute), v–lxix, ARK: ark:/13960/t6b33cp07.

Kumar, B. (1997), 'Jainas and Their Religion in America: A Social Survey', *Arhat Vacana*, 9/1: 43–53.

Petrocchi, A. (2017), 'Early Jaina Cosmology, Soteriology, and Theory of Numbers in the Aṇuogaddārāiṃ an Interpretation', *Journal of Indian Philosophy*, 45/2: 235–55. DOI: 10.1007/s10781-016-9305-z.

Schubring, W. (2000), *The Doctrine of the Jainas* (*translated from German by Wolfgang Beurlen into English*) (Lala Sundarlal Jain Research Series, 15; Delhi: Motilal Banarsidass); First published in 1962.

Shah, R. S. (2007), 'Mathematics of Anuyogadwara-sutra', *Gaṇita Bhāratī*, 29/1–2: 81–100.

Singh, A. N. (1942), 'Mathematics of Dhavalā', *ṢaKhaĀ*, 4: 1–21.

Singh, N. (1991), 'Jain Theory of Measurement and Theory of Transfinite Numbers', in A. Jain (ed.), *Proceedings of International Seminar on Jaina Mathematics and Cosmology* (Hastinapur: Digambara Jaina Institute of Cosmographic Research), 209–38.

Smith, D. E. (1924), 'The First Printed Arithmetic (Treviso, 1478)', *Isis*, 6/3: 311–31. DOI: 10.1086/358240.

—— (1929), *A Source Book in Mathematics* (New York: McGraw-Hill), ARK: ark:/13960/t7mp5hk4v.

—— (1958), *History of Mathematics. Volume II: Special Topics of Elementary Mathematics* (2nd edn., New York: Dover Publications), ARK: ark:/13960/t22b8w241.

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