History of Science in South Asia

Jaina Thoughts on Unity Not Being a Number

Dipak Jadhav

Volume 9, 2021

URI: https://id.erudit.org/iderudit/1083367ar
DOI: https://doi.org/10.18732/hssa67

Article abstract
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.

See table of contents

Publisher(s)
University of Alberta Library

ISSN
2369-775X (digital)

Cite this article
Jadhav, D. (2021). Jaina Thoughts on Unity Not Being a Number. History of Science in South Asia, 9, 209–231. https://doi.org/10.18732/hssa67
Jaina Thoughts on Unity Not Being a Number

Dipak Jadhav

Government Boys Higher Secondary School, Anjad, India

MLA style citation form: Dipak Jadhav. “Jaina Thoughts on Unity Not Being a Number.” History of Science in South Asia, 9 (2021): 209–231. DOI: 10.18732/hssa67.

Online version available at: http://hssa-journal.org
HISTORY OF SCIENCE IN SOUTH ASIA
A journal for the history of all forms of scientific thought and action, ancient and modern, in all regions of South Asia, published online at http://hssa-journal.org

ISSN 2369-775X

Editorial Board:

- Dominik Wujastyk, University of Alberta, Edmonton, Canada
- Kim Plofker, Union College, Schenectady, United States
- Clemency Montelle, University of Canterbury, Christchurch, New Zealand
- Fabrizio Speziale, School of Advanced Studies in the Social Sciences (EHSS), Paris, France
- Michio Yano, Kyoto Sangyo University, Kyoto, Japan
- Gudrun Bühnemann, University of Wisconsin-Madison, USA
- Anuj Misra, University of Copenhagen, Denmark
- Aditya Kolachana, Indian Institute of Technology, Madras, India
- Dagmar Wujastyk, University of Alberta, Edmonton, Canada

Publisher:
History of Science in South Asia

Principal Contact:
Dominik Wujastyk, Editor, University of Alberta
Email: ⟨wujastyk@ualberta.ca⟩

Mailing Address:
History of Science in South Asia,
Department of History, Classics and Religion,
2–81 HM Tory Building,
University of Alberta,
Edmonton, AB, T6G 2H4
Canada

This journal provides immediate open access to its content on the principle that making research freely available to the public supports a greater global exchange of knowledge.

Copyrights of all the articles rest with the respective authors and published under the provisions of Creative Commons Attribution-ShareAlike 4.0 License.

The electronic versions were generated from sources marked up in \LaTeX in a computer running GNU/Linux operating system. PDF was typeset using XeLaTeX from TeXLive. The base font used for Latin script and oldstyle numerals was \TeX Gyre Pagella developed by cusc, the Polish \TeX Users Group.
Jaina Thoughts on Unity Not Being a Number

Dipak Jadhav

Government Boys Higher Secondary School, Anjad, India

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 Virasena (c.816 CE) on the Chakkaṇḍāgama (Skt. Saṭkhaṇḍāgama, “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, v. 37.39, p. 383.
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 Jai-nas. 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 gaṇanāsaṃkhā? ekko gaṇanaṃ na uveti, duppabhītisaṃkhā||
What is number-«measure» as counting (gaṇanāsaṃkhā, Skt. gaṇanāsaṅkhyā)? Unity (ekka) is not for counting (gaṇaṇa, Skt. gaṇana); two, etc. (duppabhīti, Skt. dviprabhīti) <i.e., from two onwards> are numbers (saṅkhās, Skt. sankhyās).”

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] eyādiya gaṇanā doādiyā vi jāṇa saṃkhe tti| tīyādiṇaṃ niyamā kadi tti saṃkhe du bodhavvā||

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, 497, p. 409. Also see ADvāSū, 497, p. 364. For “se kiṃ taṃ gaṇanā saṃkhe?” ekko gaṇanaṃ na uveti, duppabhītisaṃkhā” see ADvāSū, 146, pp. 559–560. For “se kiṃ taṃ gaṇanāsaṃkhā? ekko gaṇanaṃ na uveti, duppabhītisaṃkhā” see ADvāSū, 30.1, p. 485. For “se kiṃ taṃ gaṇanāsaṃkhā? ekko gaṇanaṃ na uveti, duppabhītisaṃkhā” see Kapadia 1937: xxiii. Here we are able to notice slight verbal changes.

5 Datta 1929: 140.

6 Ganitanand 1986: 44.

7 ṢaKhāA v. 121, p. 276.
“Thoughts are that unity (eya, Skt. eka), etc. are for reckoning (gaṇaṇā, Skt. gaṇanā), two, etc. are numbers (saṃkhās, Skt. saṅkhyās), and three, etc. (tiyādī, Skt. tryādi) are, by rule, the names (saṇṇās, Skt. sañjñās) of growing (kadi, Skt. kṛti)”.

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).

Prior to Mādhavacandra Traividya, Vīrasena (816 CE) also referred to those three categories of growing (kṛti).

Vinayavijaya says:

“Unity (eka) does not render service to counting (gaṇanā).”

Āryarakṣita is ascribed authorship of the Anuyogadvāra Sūtra. He classified Jaina literature into four disciplines (anuyogas) 592 years after Lord Mahāvīra attained the bliss of liberation. J. P. Jain assigns him to c.75 CE. R. S. Shah is of the opinion that material contained in the Anuyogadvāra Sūtra pertains to post 300 BCE. 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. Alessandra Petrocchi refers to it as being of approximately fourth century CE. 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.
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. māṇa). Their classification of measure is broad. 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 gaṇanā which occurs in both [2] and [3] and to explain gaṇanāsāmkhā, 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 gaṇana (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 Akalanka (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 (gaṇimappamāṇa, Skt. gaṇimapramāṇa). Thus, reckoning measures include 1 (ekka, Skt. eka, one), 10 (dasa, Skt. daśa, ten), 10² (sata or sāya, Skt. śata, hundred), 10³ (sahassa, Skt. sahasra, thousand), 10⁴ (dasa-sahasra, Skt. daśa-sahasra, ten-thousand), 10⁵ (sata-sahasra, Skt. śata-sahasra, hundred-thousand), 10⁶ (dasa-sata-sahasra, Skt. daśa-sata-sahasra, ten-hundred-thousand), 10⁷ (koḍī, Skt. koṭi, crore), etc.¹⁹ The purpose of reckoning-measure (gaṇimāna, Skt. gaṇimāna) is to reckon things like coinage or currency related to professional charges, allowance for food, salary for servants or employees, income and expenditure, etc.²⁰ According to the Trilokasāra, one, etc. (egappahudi, Skt. ekaprahūti) are reckoning-measure (ganipamāṇa, Skt. ganipamāṇa).²¹ The same observation is made by Mādhavacandra Traividya,²² who instead uses the term ganimāna for reckoning-measure.²³ Why the Tattvārthavārtika, followed by the Trilokasāra, put reckoning-measure (gaṇanāmāna) into the category of worldly meas-

---

¹⁹ ADvāSū, v.3.38, pp.205–209. TriSā, vv.9–52, pp.12–49 and vv.92–112, pp.86–108.
²⁰ ADvāSū, p.293
²¹ ADvāSū, p.238. Also see ADvāSū, p.294. Glossary is as follows. Purpose (pauṇa, Skt. prayojana), things (davea, Skt. drveya), professional charges (bhiti, Skt. vr̥tti), allowance for food (bhutta), servants or employees (bhitaga), income and expenditure (āya-vyaya, 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) 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] ekadvitricaturādiganitamānaṃgaṇanāmānam

“calculation-measure (gaṇitamāna) like one, two, three, four, etc. is reckoning-measure (gaṇanāmāna).”

Hence, we can say that (1) reckoning (gaṇima) and reckoning-measure (gaṇimapamāṇa) of the Anuyogadvāra Sūtra, (2) reckoning (gaṇanā), calculation-measure (gaṇitamāna), and reckoning-measure (gaṇanāmāna) of the Tattvārthavārtika, (3) reckoning (gaṇanā) of the Dhvaalā, (4) reckoning (gaṇanā) of the Trilokasāra, and (5) reckoning-measure (gaṇimāna) 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 gaṇāsaṃkhā, that occurs in [1], is and why gaṇana (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 Sj, Sm, Sμ, Ap, Apμ, Apv, Ay, Ayμ, Ayv, A, Aμ, Aν, A, Ij, Im, Ivμ, Ivv, Iμ, Iν, I, Ij, Im, Iv. Those that do not contain m (madhyama, intermediate)
are single numbers while those that contain \( m \) are different closed intervals.\(^{37}\) For example, \( S_j = 2 \) and \( S_m = [3, S_u - 1] \).\(^{38}\) 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 \(( \text{saṅkhya-pramāṇa} )\).\(^{39}\) The same is according to Nemicandra.\(^{40}\) In order to define \( S_u \), he states, at the beginning of describing the number-measure \(( \text{saṅkhya-pramāṇa} )\) 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” \(( \text{gaṇana-krti-prarūpaṇā} )\), Virasena writes, in his Dhavala, 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 \(( \text{gaṇanāsaṅkhyā} )\) 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 Gaṇi 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 \(( \text{gaṇanāsaṅkhyā} )\) is the seventh of them, it is essentially number-measure as counting \(( \text{gaṇanāsaṅkhappamāṇa} )\) 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 Gaṇi 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.

\[^{37}\] 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 \(( \text{anavasthākuṇḍa} )\), counting-stick pit \(( \text{śalākākuṇḍa} )\), counter counting-stick pit \(( \text{pratiśalākākuṇḍa} )\), and great counting-stick pit \(( \text{mahāśalākākuṇḍa} )\). 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.

\[^{43}\] ŠākhaA, pp. 274–321.

\[^{44}\] ADraŚū, 497–519, pp. 409–422.

\[^{45}\] LoPra, 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?”

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 (gaṇanā, Skt. gaṇanā), number (saṃkhā, Skt. saṅkhyā), and measure (pamāṇa, Skt. pramāṇa). Since gaṇa has the sense of “group”, counting (gaṇanā, 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 (pamāṇa) by means of number (saṅkhyā) by counting (gaṇanā) 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 ghatādau dṛṣṭe ghatādī vastvīdam
tiṣṭhatityevameva prāyāḥ pratīṭirūtpadyate, naikasaṅkhyāviṣay- atvena, athavā ādānasamarpaṇādivyavahārakāle ekam vastu prāyo na kaścidgaṇayatyo’samvyavahāryatvādalyadpatvādō naiko ganaṇas-aṅkhyāvataraṇi, ...

“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).”

46 Ganitanand 1986: 44.
47 Cappeller 1891: 146.
48 ADvāŚū., 234, p. 473.
49 Kapadia 1937: xxiii. Glossary is as fol-
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.

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 Tatvaśārtvārtika 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” (सूक्षमनिगोदलब्धयपूर्यपक्तेषुज्ञानः).

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” (परमाणु), “space-point” (प्रदेश), and “infinitesimal fraction of time” (समया) 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 (भाव). 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 (भाव) and knowledge are. भावनम् भाव means “to be is existence (भाव, 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 (वर्ण), etc. while those of the former are knowledge (ज्ञान), conation (दर्शन), and “conscious attentiveness” or attention (उपयोग).

Knowledge is the essence of soul. There is no soul without knowledge.

There is no knowledge or knowability without soul.

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 सूक्षमनिगोदलब्धयपूर्यपक्तेषु see GoŚājiKā, 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 GoŚājiKā, 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 (साधारण).” See GoŚājiKā, p. 55. “Labdhyparyaptā (absolutely non-developable) souls are those that shall die within an antarmuhūrtā without becoming developable. Their age-duration is eighteenth part of the time of one pulse beat of a healthy person.” See GoŚājiKā, p. 56.

51 ADvāSū, p. 358 and ADvāSū, 427–466, pp. 269–297. TaVā, v. 3:38, pp. 206 and especially 396.

52 GoŚājiKā, 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).\textsuperscript{55}

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.\textsuperscript{54} Prior to this information it states that “indivisible corresponding-sections” (\textit{avibhāga praticchedas}) of omniscience are \(I_u\).\textsuperscript{55} J. L. Jaini writes in simple terms that the number of units (\textit{avibhāga praticchedas}) of perfect knowledge (\textit{kevalajñāna}) is \(I_u\).\textsuperscript{56}

Now we are able to form the following opinions. The “indivisible corresponding-section” of knowledge is its unit. \(I_u\) 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” (\textit{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.\textsuperscript{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.

\textsuperscript{53} GoSaJīKā, Introduction, p. 11.
\textsuperscript{54} TriŚ, v. 52, p. 48. Glossary is as follows. Scriptural knowledge (\textit{śrutajñāna}), clairvoyance (\textit{avadhijñāna}), and omniscience (\textit{kevalajñāna}).
\textsuperscript{55} TriŚ, vv. 48–51, pp. 46–48.
\textsuperscript{56} GoSaJīKā, 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.
\textsuperscript{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 Hispaniensis (c.1140 CE), and Rollandus (c.1425 CE). 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. 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.

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

an vnitie is no number but the beginning and original of number.

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.

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.

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, affirm not only that an unit or one, is a number, but also that every fraction or part of an unit, 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 logistic76 (λογιστική or the art of calculation) of the Greeks seems to be somewhat like the reckoning-measure of the Jainas. The arithmetic (άριθμητική 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 $I_{iω}$ 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-Echod (“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 “euyery fraction or parte of an vnite is a number” but the unit was indivisible for both of the Greeks\textsuperscript{78} and the Jainas.\textsuperscript{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 $I_m$, 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,\textsuperscript{80} logarithms,\textsuperscript{81} raising a number to its own power,\textsuperscript{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\textsuperscript{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

\textsuperscript{78} See “Another notion ... incapable of division.” in the section “Ancient Greek Approaches” above (p. 219).
\textsuperscript{79} See Table 3 and the discussion in the section “Why was Unity not Employed..." above (pp. 215–218).
\textsuperscript{80} Jadhav 2009: 35–55.
\textsuperscript{81} Jadhav 2002: 261–267; 2003: 53–73.
\textsuperscript{82} Jadhav 2008: 139–149.
\textsuperscript{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.
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. 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.

ACKNOWLEDGEMENTS

Except for a few changes including its title this paper was presented in National Symposium on Jaina Mathematics, held at Kundakunda Jñānapīṭha, 2004:170; Basham 1986:291; Kumar 1997:47; Schubring 2000:50.
Indore (India) during December 22–23, 2019. I take this opportunity to thank the organizers, including Prof. Anupam Jain, of the symposium for inviting me. I would like to place on record my thanks to Prof. Peter Flugel (London) for taking an interest in this paper and encouraging me. I wish to thank the anonymous referees for their constructive comments and suggestions offered to improve this paper. I am highly grateful to Prof. Dominik Wujastyk, the editor of this journal, for all his help making this paper into a publication.
## TABLES

**Measure** (पमान, Skt. pramāṇa)

| Measure (पमान, Skt. pramāṇa) | 1 Matter-measure (दातवपपमान, Skt. dātvappamāṇa) | 4 Existence-measure (भावपपमान, Skt. bhāvāppamāṇa) |
|--------------------------------|--------------------------------------------------|---------------------------------------------------|
| 1.1 ‹Measure› based on space-point (पदेशानिप्फण, Skt. pradeśanippan) | 1.2 ‹Measure› based on division (विभागनिप्फण, Skt. vibhāganippan) |
| 1.2.1 ‹Volume or capacity› measure (मान, Skt. māna) | 1.2.2 Raising-measure, i.e., weighing-measure ‹using balance› (उम्मान, Skt. ummāna) |
| 1.2.3 Linear-measure (अमान, Skt. avamāna) | 1.2.4 Reckoning ‹measure› (गणिमा) |
| 1.2.5 Measure for precious metals (पदिमान, Skt. pratimāna) | 4.1 Attribute-measure (गुणपपमान, Skt. guṇapramāṇa) |
| 4.2 Viewpoint-measure (नायपपमान, Skt. nayapramāṇa) | 4.3 Number-measure (संख्यपपमान, Skt. saṃkhyapramāṇa) |
| 4.3.1 Number ‹measure› as name (नामसंख्या, Skt. nāmasaṃkhyā) | 4.3.2 Number ‹measure› as notional installation (तवक्ष्यांसंख्या, Skt. tvaṃkṣyāṃsaṃkhyā) |
| 4.3.3 Number ‹measure› as physical aspect (द्रव्यांसंख्या, Skt. dravyasāṃkhyā) | 4.3.4 Number ‹measure› as simile (अवमाझांसंख्या, Skt. avamāsāṃkhyā) |
| 4.3.5 Number ‹measure› as magnitude ‹of the scriptures› (परिनामाझांसंख्या, Skt. parināmāsāṃkhyā) | 4.3.6 Number ‹measure› as knowledge (ज्ञानांसंख्या, Skt. jñānāṃsaṃkhyā) |
| 4.3.7 Number ‹measure› as counting (गणनांसंख्या, Skt. gānaṇāṃsaṃkhyā) | 4.3.8 ‹Measure of› shell as essence (भावाशांक्ष्णा, Skt. bhāvāsaṃkhyā) |

Table 1: The classification of measure according to the Anuyogadvāra Sūtra.

85 ADvsSū, 313–314, pp. 227–229; 316, p. 231; 427; p. 357; 477; pp. 397 and 423. Also see ADvsSū, pp. 54–55, 269, 316, 341–342 and 384.
| Tattvārthavārtika Measure (pramāṇa) | Trilokasāra Measure (māṇa, Skt. māna) |
|------------------------------------|--------------------------------------|
| 1 Worldly (laukika) measure       | 2 Post-worldly (lokkotara) measure   |
| 1.1 Volume or capacity- measure (māna, example: śoḍaśikā, kuḍava, etc.) | 1.1 Volume or capacity- measure (māna, Skt. māna, example: pathā (Skt. prasthā)) |
| 1.2 Raising-measure, i.e., weighing-measure (ummāna) | 1.2 Raising-measure (ummāna, Skt. unmāna, example: tula (Skt. tulā, balance)) |
| 1.3 Linear-measure (avamāna, example: danḍa, etc.) | 1.3 Capacity-measure (omāna, Skt. avamāna, example: culuya (Skt. culuka, hollowed palm)) |
| 1.4 Reckoning (gaṇipamāṇa) or reckoning-measure (gaṇipamāṇa) | 1.4 Reckoning-measure (gaṇipamāṇa, Skt. gaṇipamāṇa) |
| 1.5 Measure for precious metals (pratimāna) | 1.5 Measure for precious metals (padipamāṇa, Skt. pratipamāṇa or pratimāṇa, example: guṃjā (Skt. guṃjā, rosary pea or ‘guṃjā berry used as a weight’)) |
| 1.6 Suggestion-measure (tatpramāṇa) | 1.6 Suggestion-measure (tappadipamāṇa, Skt. tatpratipamāṇa) | **Note:** To determine the amount required, to pay for horse 'offered for sale by examining its body parts' |
| **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 (jaghaṇa) | one ultimate-particle (eka paramāṇu) | one space-point (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 (suhumanīgodesu puṇṇesu vāna, Skt. sūkṣmanigotideśu apiṁreṇu jāṇa) |

| Tattvārthavārtika | intermediate (madhyama) | two, three, four, etc. space-points based (dvitirucūtraḍi-pradeśātmaka) | two, three, four, etc. space-points (dvitircūtraḍi-pradeśāḥ) | two, three, four, etc. samayas (dvitircūtraḍi-samayaḥ) | knowledge that other souls possess (anyajīvānāṁ) |
|-------------------|-----------------|-------------------------------------|---------------------------------|-----------------------------------------------|------------------------------------------------------------------------|
| Trilokasāra       | intermediate (majhima, Skt. madhyama) | various kinds (ānyayaiḥam, Skt. anekavidham) | various kinds (ānyayaiḥam, Skt. anekavidham) | various kinds (ānyayaiḥam, Skt. anekavidham) | knowledge that other souls possess (anyajīvānā Ham) |

| Tattvārthavārtika | highest (utkṛṣṭa) | great-aggregate (mahāskandha) | entire space (sarvaloka) | anantakāla (infinite time) | knowledge that Kevali possesses (kevala jāṇa) |
|-------------------|-----------------|---------------------------------|------------------------|--------------------------|------------------------------------------------------------------------|
| Trilokasāra       | highest (vara)  | all matter (sayaladarśa, Skt. sakaladrāśa) | entire space (sarvanāgāsa, Skt. sarvanākāśa) | entire present, past and future time (sarvakāla, Skt. sarvakāla) | knowledge that Jinendra possesses (nāna jīnesu, Skt. jīna jīnesu) |

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

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

ADvaŚū1 मलधारगुच्छीयाचार्यश्रीमद्मेघचन्द्राचार्यबिरचितवृत्तियुक्त् श्रीमदन्तुण्डगहरारासूतम् [Anuyogadvara 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.

ADvaŚū2 Miśra, M. K. (1953) (ed.), मूलसूताइन: श्री दशवैकाळिकसूत्र, श्री उत्तराद्ययमसूत्र, श्री नंदीसूत्र तथा श्री अनुयोगदारासूत्र का शुद्ध मूलपाठ = Mūla Suttāṇi (Beawar: Śāntilāla Vi. Śetha).

ADvaŚū3 Miśrimalajī Mahārāja ‘Madhukara’ et al. (1987) (eds.), श्री आयर्रिक्षतथिवरिचत अनुयोगदारासूत्र (मूल पाठ, हिन्दी अनुवाद, विवेचन परिशिष्ट पुस्तक) = Anuyogadvarasūtra (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).

ADvaŚū4 Amara Muni, Tarun Muni, and Surana ‘Saras’ (2001) (eds.), सिचत अनुयोगदार सूत्र. मूल पाठ - हिन्दी - अंग्रेजी अनुवाद, विवेचन तथा रंगी चित्रों सहित = Illustrated Anuyogadvāra Sutra, trans. S. Bothara, 2 vols. (Delhi: Padma Prakāśana), https://jainelibrary.org/book-detail/?srno=007656, (on 11 Apr. 2021); vol. 2.

ADvaŚū5 Līlamabāī Mahāsātī et al. (2009) (eds.), श्री अनुयोगदार सूत्र (मूलपाठ, शब्दार्थ, भावार्थ, विवेचन, परिशिष्ट [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.

ADvaŚū6 Punyavijaya, M., Mālvanī, D., and Bhojak, A. M. (1968) (eds.), सिरितिवाचगर्भिरं नंदिसुतां निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं निरिक्षितं
GoSājīKā Jaini, J. L. (1927) (ed. and trans.), Gommatasara Jīva-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 Shah, M. O. (1926) (ed. and trans.), श्रीमहोपायकीविचारलिङ्ग-भाषाभाष-श्रीमहोपाय-श्रीविज्ञातिश्रीमहोपाय-श्रीलोकक्रमाश [lokaprakāśa of Vinayavijaya Gāṇi. Part I, Cantos 1–11] (Bombay: Jivanacanda Sākaracanda Jhaveri for Shri Agamodaya Samiti), ARK: ark:/13960/t8vb3cz6b; Page references are to the PDF.

LoPra2 Vajrasenavijaya Ganīvara (1996) (ed.), श्री विनयविजय गणिविचित श्री लोकक्रमाशः भवं भागः...सर्ग 32 ती 37 सुधी भाग ५ [Lokaprakāśa of Vinayavijaya Gāṇi, 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., Phulacandra, Bālacandra, Devakinandana, and Neminātha-tanaya-ādinātha (1949) (eds.), श्री-भगवत्त-पुषपदन्त-भूतबिल-पूणीतः ष्ठिढंकागमः श्रीवीरस एचायर्विचित-धवला-टीका-समिवतः तत्व चतुर्मेषे वेदनामपधेमे ... कृतानुयोगवारः = Ṣaṭkhaṇḍāgama of Puṣpadanta and Bhūtabalī with Dhavalā commentary of Vīrasena, Book 9, trans. H. L. Jain et al. (Amarāvatī: Śrimanta Setha Śitābarāya Lakṣmīcandra), https://jainelibrary.org/book-detail/?srno=001403, (on 15 Apr. 2021); Reprinted Solapur 2005.

TaVā Jain, M. K. (1953) (ed.), Tatvārthavartik of Shri Akalank Deva with Hindi Translation ... with Introduction, Appendices, Variant Readings, Comparative Notes etc. (Jnāna-Pītha Murtevi Jain granthamala, Sanskrit Grantha 10; Kāshi: Bhāratiya Jñānapīṭha), ARK: ark:/13960/t7xm3qm63; Reprinted, Bharatiya Jñanpith, New Delhi, 1999.

TrīSā Mukhtāra, R. J. and Pāṭanī, C. (1975) (eds.), श्रीमहोपायक्रमकर्तिविचित किरोक्तारः (श्रीमहोपायक्रमज्ञिविचितक्रमकर्तिविचित) (श्रीविनयविजयक्रमागम) विलक्पे (श्रीविनयविजयक्रमागम) विलक्पे [Trīlokasāra of Nemicandra. With Mādhavacandra Traivedya’s Sanskrit commentary and Āryikā Viśuddhamati’s Hindi commentary] (Śrī Śivasāgara granthamala; Śrī Mahāvīraji (Rājasthāna): Lāḍamala Jain), 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 (Bhagavatī); 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 Bhārati*, 8/1-4: 44–5.

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

Heath, T. (1921), *A History of Greek Mathematics* (Oxford: The Clarendon Press), *ARK*: ark:/13960/t4th9hh39.

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 Bhārati*, 30/2: 139–49.

—— (2009), ‘On the Figurate Numbers from the Bhagavatī Sūtra’, *Gaṇita Bhārati*, 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 Simhatilaka 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 Anuogaddārāin 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 Bhārati, 29/1–2: 81–100.

Singh, A. N. (1942), ‘Mathematics of Dhavalā’, ŚaKhaĀ, 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.
Please write to (wujastyk@ualberta.ca) to file bugs/problem reports, feature requests and to get involved.

The History of Science in South Asia • Department of History and Classics, 2–81 HM Tory Building, University of Alberta, Edmonton, AB, T6G 2H4, Canada.