The Jaina Ulterior Motive of Mthematical Philosophy

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"WHEN ACTUAL OBJECTS ARE COUNTED, OR WHEN GEOMETRY AND DYNAMICS ARE APPLIED TO ACTUAL SPACE OR ACTUAL MATTER, OR WHEN, IN ANY OTHER WAY, MATHEMATICAL REASONING IS APPLIED TO WHAT EXISTS, THE REASONING EMPLOYED HAS A FORM NOT DEPENDENT UPON THE OBJECTS TO WHICH IT IS APPLIED BEING JUST THOSE OBJECTS THAT THEY ARE, BUT ONLY UPON THEIR HAVING CERTAIN GENERAL PROPERTIES."

— Bertrand Russell,
'The Principles of Mathematics'
London, 1956, xvii.

1. INTRODUCTION

Mathematics, today, stands as a science which is in some sense a single connected whole. Philosophy (Gr. philein, to love—sophia, wisdom) stands both for seeking of wisdom and the wisdom sought. According to Aristotle, Philosophy is the science which considers truth. Now it means that Mathematical Philosophy is a science of sciences.

The Jaina philosophy, essentially a philosophy of Karma (action) phenomena in nature, sought the solutions and exposition through mathematical manoeuvres. Various research papers have appeared[1] on the mathematical contents and aspects of the Jaina philosophy.

1. (a) Datta, B. B., The Jaina School of Mathematics, B. C. M. S., 21, (1929), 115-145.
   (b) Datta, B. B., Mathematics of Nemicandra, Jaina Antiquary, I, no ii, (1935), 25-44.
   (c) Singh, A. N., Mathematics of Dhavalā-I, Ṣaṭkhaṇḍāgama, book iv, Amaraoti, (1942), v-xxi.
   (d) Singh, A. N., History of Mathematics in India from Jaina Sources, The Jaina Antiquary, 15, no. ii (1949), 46-53 ; and 16, no. ii (1950), 54-69, Arrah.
   (e) Roy, D. M., The Culture of Mathematics among the Jainas of Southern India, etc., Annals of the B. O. R. I., Poona, 8, (1926-27), 145-157.
   (f) Smith, D. E., The Gaṇita Sāra Saṃgraha of Mahāvīrācārya, B. M. (Leipzig), 3, 9 (1908-09), 106-110.
   (g) Jain, B. S., On the Gaṇita Sāra Saṃgraha of Mahāvīra (c. 850 A. D.) I. J. H. S., 12, no. 1, (1977), 17-32.
   (h) Jain, L. C., Tiloyapaṇṇattī Kā Gaṇita, JGM, Sholapur, 1958, 1-109.
   (i) Jain, L. C , GSS of Mahāvīrācārya, Sholapur (1963).
   (j) Jaina, L. C., On the Jaina School of Mathematics, C. L. Smriti Grantha, Calcutta, (1967), 265-292 (eng. Sec.).

The theory of Karma, upto the ninth century, A. D., starting from Guṇadhara (c. 1st century B. C.), entering into the era of Vīrasena, the compiler of the Dhavalā and the Jayadhavalā commentaries, makes use of seven types of linguistic universes : naigama, saṃgraha, vyavahāra, ṛjusutra, śabda, samabhirūḍha and evambhūta : the channels into which flow the description of the objects and their events. In the eleventh century, however, Nemicandra takes recourse to two universes alone (in the Dravya-Saṃgraha), as also followed in the third century, A. D., by Kundakunda : niścaya (determinant) schema and the vyavahāra (usage) schema, into which is laid out the whole theory of Karma. The union of the universes of nayas (schema) is the universe of pramāṇa (measure).

The basic approach of the theory was mathematical, in the sense that it was set—theoretic and system-theoretic, alongwith the application of logic. Nemicandra highlighted this approach through his Gommaṭasāra and Labdhisāra (including Kṣapaṇāsāra), and the commentaries of the succeeding centuries added to them symbolic material for various types of measures of sets (Rāśis), through cardinals or ordinals of fluents, field, time and phase (dravya, kṣetra, kāla, and bhāva).

The system of the Karmic world is defined through postulated soul, non-souls, influx-input, bond restraint-input, decay-output, and emergence output (jīva, ajīva, āsrava, bandha, saṃvara, nirjarā and mokṣa)[1]. The objects and events of the system were installed through four types of recognition : name,

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(k) Jain, L. C., Mathematical Foundations of Karma : Quantum System Theory, I, Anusandhan Patrika, Ladnun, (1973), 1-19.

(l) Jain, L. C., Set Theory in Jaina School of Mathematics, I. J. H. S., 8.1, (1973), 1-27.

(m) Jain, L. C., The Kinematic Motion of Astral Real and Counter Bodies in Trilokasāra, I. J. H. S., 11.1, (1976), 58-74.

(n) Jain, L. C., On Certain Mathematical Topics of Dhavalā Texts, I. J. H. S., 11.2, (1976), 85-111.

(o) Jain, L. C., Principle of Relativity in Jaina School of Mathematics, Tulsi Prajna, JVB, Ladnun, 5, (1976), 20-28.

(p) Jain, L. C., The Jaina Theory of Ultimate Particles, (Jaina Darśana evam Saṃskṛti-Ādhunika Saṃdarbha men), Indore University, (1976), 43-55.

(q) Jain, L. C., Divergent Sequences Locating Transfinite Sets it Trilokasāra, I. J. H. S., 12.1 (1977), 57-75.

(r) Jain, L. C., On certain Physical Theories in Hindu Astronomy, Pracya Pratibha, Bhopal, Vol. V. no. 1, 1977, 75-86.

(s) Jain, L. C., Perspectives of System Theoretic Technique in India between 1400-1800 A. D., Jain Journal, Calcutta, 13.2 (1978), 49-66.

(t) Lishk, S. S. and Sharma, S. D., The Evolution of Measures in Jain Astronomy, Tirthankara, 1(7-12), *1975, 83-92.

(u) ————and ————, Role of Pre-Aryabhata Jaina School of Astronomy in the Development of Siddhāntic Astronomy, I. J. H. S., 12.2 (1977), 106-113.

(v) Sikdar, J. C., Eclipses of the Sun and the Moon according to Jaina Astronomy, I. J. H. S., (ibid.), 127-136.

(w) Sikdar, J. C., Jaina Atomic Theory, I. J. H. S., 5.2, (1970), 199-218.

(x) Volodarsky, A. I., About Treatise of Mahāvira, (P. M.), Moscow, (1968), 98-130.

(y) Jain, L. C., On the Contributions, Transmissions and Influences of the Jaina School of Mathematical Sciences, Tulsi Prajna, 3.4., (1977), Ladnun, 121-134.

Note : For a comparative study, Cf. Russell, B., Introduction to Mathematical Philosophy, London, 1960.

1. Tattvārthasūtra, 1.4.

representation, fluent and phase (nāma, sthapanā, dravya and bhāva)[1]. This system was ascertained through description, ownership, means, substratum, life-time and principle (nirdeśa, svāmitva, sādhana, adhikaraṇa, sthiti and vidhāna)[2] The system was also ascertained through the recognition of existence, number, field , contact, time, interval phase and comparability (sat, saṃkhyā, kṣetra, sparśana, kāla, antara, bhāva, and alpabahutva)[3].

Yativṛṣabha (c. 5th century A. D.), in his Tiloyapaṇṇattī, uses several mathematical expressions, whereas Vīrasena uses sentential logic and mathematics for many interesting calculations, yet symbolism seems to have taken a leading role only after Nemicandra systematized ultimately by Ṭoḍaramala (1720-1767). Ṭoḍaramala calls arthasaṃdṛṣṭi (symbolic norm) as the symbol for the measure etc. of fluent, quarter, time and phase. Artha may be interpreted as norm and the saṃdṛṣṭi may mean symbolic representation. Two chapters on the arthasaṃdṛṣṭi were compiled by Ṭoḍaramala to explain in details the symbolic and mathematical expressions occurring in the jīvatattvapradīpikā commentary of the Gommaṭasāra and that of the Labdhisāra. In his samyakjñāna candrikā commentary, the material produced was as far as possible, without symbolic manipulation. Thus the studies were diverted in two directions : one for a mathematician and the other for a non-mathematician. Nemicandra had divided the śruta jñāna into śabdaja and lingaja. Words are numerate, but the events are numerate, innumerate and infinite, hence the use of a linga (symbol) as well (tattvārtha vārtikam, 1/26. Linga is also called a hetu.

2. THE MATHEMATICO-PHILOSOPHIC DEVELOPMENT

There are reasons to believe that from the period of Vardhamāna Mahāvīra, the theory of action gained a greater impetus for inevitable resistance against the demeritorious propensities The scientific explanation of the theory needed extension in the universe of the contemporary knowledge and the universes of the objects, events and various unobservable processes in nature demanded deeper explanation through some unified theory unfolding the universes of bios and the non-bios as well as interaction between bios and matter. The periodicity in nature was already observed through the astral-phenomena and it was the theory of the non-observables which demanded a mathematical cosmology which appeared to have been brought in as treated in the Tiloyapaṇṇattī of Yativṛṣabha[4].

Herein the measure was introduced in form of simile sets and number sets and the ranges of the finite were extended to the numerable and the innumerable. The infinite was treated by an additional idea of inexhaustion in time of a set which was under the process of exhaustion by finite elements or members of the set[5]. The finite process or operation in finite time could not produce an infinite set. Whenever an infinite number in ordinal was required to be generated, it was done so by adding to the finite result a postulated infinite set as per definition of an infinite set given by Vīrasena in the Dhavalā texts.[6] Eleven kinds of

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1. *Ibid* , 1.5.
2. *Ibid*., 1.7.
3. *Ibid* , 1.8.
4. Cf. 1 (h), *op. cit.* (a) Cf. also Saraswati, T. A., The Mathematics of the First Four Mahādhikāras of the Trilokaprajñapti, J. G. R. I. 18 (1961-62), 27-51. (b) Cf. also Saraswati, T. A , Development of Mathematical Ideas in India, I. J. H. S., 4.1, 4.2, (1969), 59-78. (c) Cf. Jain, G. R., Cosmology, Old and New, Indore, (1942). (d) Cf. Muni M. Kumar, II, Viśva Prahelikā, Bombay, (1969). (e) Cf. ch. 1, 2, 3, 5, 7, 8, 9 in Bose, D. M., Sen, S. N., Subbarayappa, B. V., A. A. concise History of Science in India, New Delhi, 1971. (f) Cf. Zaveri, J. S., Theory of Atom in the Jaina Philosophy, Ladnun, 1975.
5. Cf. 1 (j) and 1 (l).
6. Cf. 1 (h).

infinities were defined and the mathematical infinity was elaborated in detail[1]. The important observation is that all types of mathematical and non-mathematical sets were to be treated only through the set of integers or natural numbers alone.

An important treatment of the infinities in the Trilokasāra[2], deserving special attention of the historians of mathematics, is about the fourteen divergent sequences which help to locate (topologically) finite and transfinite sets of various types of objects needed for the exposition of the Karma (action) theory. This records a means of the topological studies comparable to that adopted by Georg Cantor, and those which are indispensable in mathematical sciences. Apart from this, one also gets introduced to the several types of postulated fluents, their properties, and enumeration of their events and interactions through various types of units coglomerated as the fluent sets, the space-point sets, the time-instant sets, and the phase sets. The abstract three mathematical universes accomodate many types of universes of the bios and matter. Thus a philosophical unified universe is introduced mathematically to include all natural phenomena of the astral, human, and the sub-human universes[3].

3. THE SET THEORETIC DEVELOPMENT

For the treatment of any unified system theory, one needs a set-theoretic approach which has gained an unparalleled support of the modern methodology in the development of technology and theoretical as well as practical sciences. About two and a half thousand years ago, this necessity was realized in India in the Jaina School and sufficient material is now available in the Ṣaṭkhaṇḍāgama, Dhavalā, Jayadhavalā Gommatasāra, Labdhisāra, and their detailed commentaries wherein only the set-theoretic material could be traced with mathematical and logical treatment[4]. They give out the secrets of their approaches which may be precisely exposed here as follows :

(A) The basic word for set is 'RĀŚI', akin to Latin, 'RATIO' meaning reason ; the Greek equivalent being, 'horos' (LOGOS), meaning a 'word' and also the 'mind' behind a word. Ṣaṭkhaṇḍāgama exposes its synonym in samūha, ogha, puñja, vṛnda, sampāta, samudaya, piṇḍa, avaśeṣa, abhiṇṇa and sāmānya. Vīrasena has made use of the rāśi practically in every mathematical sentence. Cosmological sets are related in the Tiloyapaṇṇattī and the Trilokasāra, whereas philosophical sets are found based in the Ṣaṭkhaṇḍāgama texts. In the book three of the Dhavalā, the sets of souls in various control and rummage stations are exposed through their measures in fluent, quarter, time and phase. They find symbolic expressions in the commentaries of the Gommaṭasāra Jīvakāṇḍa. All types of sets of ultimate particles and their relations among themselves and those with the soul in Karmic bonds are depicted in various details in the Mahābandha and Gommaṭasāra Karmakāṇḍa texts and the symbolic treatment in the commentaries.[5] These also include statistical details, forming the steel framework of the bios-machine systems described in system-theoretic details in other texts.

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1. Cf. *ibid.*
2. Cf. 1 (r).
3. (a) Vid. Tiloyapaṇṇattī of Yativṛṣabha, Pt. I (1943), Pt. II (1951), Sholapur. (b) Trilokasāra of Nemicandra, Sri Mahaviraji (1976). (c) Vid. also other texts on Karaṇānuyoga Group.
4. (a) Saṭkhaṇḍāgama of Puṣpadanta and Bhūtabali, ed. Shaha Sumati Bai, Phaltan (1965). (b) Vid. also Saṭkhaṇḍāgama, alongwith Dhavalā commentaries by Vīrasena, books 1-16, Amaraoti and Vidisha, 1939-1959. (c) Vid. also Gommaṭasāra, alongwith Jīvatattva Pradīpikā and Samyakjñānacandrikā commentaries ed. by G. L. Jain and S. L. Jain, Calcutta, (c. 1919) ; (i) Jīvakāṇḍa, pp. 1329, (ii) Karmakāṇḍa, pp. 1200 ; (d) Mahābandha by Bhūtabali, books 1-7, Kashi, 1947-1958.
5. Vid. Arthasaṃdṛṣṭi chapter on Gommaṭasāra Jīvakāṇḍa and Karmakāṇḍa in 308 pages, (12c), *op. cit.*

(B) Under classification of the sets there are unitary elements of sets, fundamental measure units of sets, fixed fluent sets, point sets, instant sets, smallest, biggest and intermediary sets, null set, concept, indivisible-corresponding-sections sets of controls etc., transfinite sets, sets of vector-group of matter, sets in relation to Karma structures and functions, and variable sets.[1]

(C) Under the treatment of sets are the analytical methods, the method of reductio-ad-absurdum being very common. The method of one-one correspondence for comparing transfinite sets has been used by Vīrasena (c. ninth century), appearing again in works of Galileo and Cantor. Virasena also used the methods of measure, reason, explanation, abstraction, cut, division, spread and removal for illustrating and exposing the measure of sets, leading to norms applications in the theory of Karma. Apart from the above, in the Dhavalā, one could find the applications of the laws of indices, the theory of logarithms to finite and infinite types of bases, the continued fractions and squarepiling (vargaṇa-saṃvargaṇa), etc.[2]

(D) Comparability is the modern mothod applied in syntopology. In Saṭkhaṇḍāgama texts, this is called alpabahutva which studies into the knowledge of the order of smallness or largeness of sets in neighbourhoods in relation to seven tautos (tattvas) or nine syllable-norms (padārthas), at various locations of natural phenomena. This method is also called the very nature of the numbers and is of three types : that about souls, non-souls and mixed, as well as of no-āgama types. The comparabilities are detailed into one's own place, in other place and in general. The relations used in comparabilities are as follows : small, equal, smallest, non-existent, distinctly great, distinctly small, summable times, non-summable times, infinite times, numerable or innumerable part, decrease and increase, least passive and most intense and so on[3].

(E) Out of the fourteen topological sequences, the three dyadic sequences are very important as they make use of the well-ordering theorem and certain other postulates which are comparable to the Cantor's works under contrast[4]. Sequential relations in the sets are found through comparison and logarithms.

(F) The various treatment of the sequences and comparabilities appear to lead to certain antinomical, paradoxical and fallacious results which are contrasting to the world of the finite results, yet the method of their postulation saves them from the trouble and the results are without contradictions. The paradoxes of Eleatic Zeno can be easily explained away through the Jaina mathematical principles of the existence of the finite space-points and time-instants in finite segments of space and time,[5] although in a finite segment in analytical methods, transfinite and finite sets could be established under abstract representation[6]. Most of the paradoxes could be explained away from the universe of the infinities through the methods of the alpabahatva and the sequences (dhārās). The set of instants in the future time is infinite times that of set in the past time, appears to be paradoxical, yet it has been postulated. The axiomatic method has been adopted in the statement of comparability of sixteen sets[7] and this appears to be pursued in exposing the comparability of many other sets.

The above leads to the conclusion that even ordinary operations of mathematics over sets also found extension[8] and extended definitions. Not only the notations in digits and alphabets but also geometrical figures were used for depicting the sets in equations and such developments[9]. It appears that the contradictory

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1. Cf. 1 (l), *op. cit.*
2. Cf. 1 (n), *op cit.*
3. Cf. 1 (l), *op. cit.*
4. Cf. 1 (q), *op. cit.*
5. Cf. 1 (i), intr. pp. 1-34, *op. cit.*
6. Cf. 1 (n), *op. cit.*
7. Cf. 1 (n), *op. cit.*
8. Cf. 1 (c), 1 (d), and 1 (n), *op cit.*
9. Cf. 1 (s), *op cit.*

universes of their semantical expressions got consistency in their naya system needed for the set-theoretic and system-theoretic approaches, and the concepts of the union, intersections and disjointness of sets are all implied in the descriptions of the Ṣaṭkhaṇḍāgama texts. Even the biggest set of Omniscience was kept as supremum and adaptable to any onset of inclusion of any knowledge of any number of universes of objects and events of processes of interactions between bios and matter or independently of them.[1] The source material on sets in the Jaina School surpasses the modern material so much so that the results obtained in the former appear to be consistent and complete in so far as they have been applied to their model of the Karma theory, an appealing abstract approach today yet perhaps applied in the past.[2]

4. THE MATHEMATICO—SYSTEM—THEORETIC DEVELOPMENT

In the modern technological world, this development has been quite late and during the last thirty years or more, the concepts of a bios-system or an engineering system for remote controls or optimality, realizability, controllability and observability have been based on consistent set theories and mathematical models[3]. The Karma theory detailed in the Mahābandha, Kasāyapāhuḍa, Gommaṭasāra and Labdhisāra[4] is based on the set-theoretic approach : there are Karma structural sets, universes and operators, operands, and transforms. The instant-effective-bond (Samayaprabaddhavarga, vargṇā, spardhaka, guṇahādi, nānā-guṇahāhi, anyonyābhyasta set, are well-defined for Karmic particle sets and their controls measured in sets of indivisible-corresponding-sections (avibhāgī-praticched). For a comparison of the Karma theory with that of the present system theory the author has already contributed a paper on the system theory[4]. The essentials of the Karma theory may be precisely exposed as follows :

(i) The Yoga and Moha as operators, having norms.

(ii) The tetrad of measures of configurations (prakṛtis), points (pradeśas) or particles, transformed into Karmic phenomena, life-time (sthiti) and energy-level of impartation (anubhāga) of the nisusus (niṣekas) in Karma-stay-structure (Karma sthiti racanā).

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1. Cf. 1 (k), 1 (w), and 1 (s), *op cit.*
2. Vid. (a) Wilder, R. L., Introduction to the Foundations of Mathematics, New York, 1952.
   (b) Kneebone, G. T., Mathematical Logic and the Foundations of Mathematics, an introductory survey, London, 1963.
   (c) Fraenkel, A. A., and Bar-Hillel, Y., Foundations of Set Theory, Amsterdam, 1958.
   (d) Fraenkel, A. A., Abstract Set Theory, Amsterdam, 1953.
   (e) Ākos Csaszār, Foundations of General Topology, Oxford, 1963.
   (f) Mathematics in the Modern World, ch. iv, The Foundations of Mathematics, San Francisco, 1968.
3. Vid. (a) Kalman, R. E., Lectures on Controllability and Observability, Luglio, 1968.
   (b) Kalman, R. E., Falb, F. L., Arbib, M. A., Topics in Mathematical System Theory, T. M. H., Bombay, 1969.
   (c) Harmon, L. D., and Lewis, E. R., Neural Modelling, Physiological Reviews, vol. 46, (July 1966), 513-591.
   (d) System Theory in Jaina School of Mathematics, I. J. H. S., 14.1, (1979), pp. 29-63.
   (e) Cf. 24 (f) *op cit.*, ch. v.
4. (a) Kasāya Pāhuḍa of Guṇadhara, Jaya Dhavalā Commentary, Mathura, (1944), vols. 1-13.
   (b) Kasāya Pāhuḍa, Cūrṇisūtra of Yativṛṣabha, Calcutta, 1955.
   (c) Labdhisāra of Nemicandra, commentary by Ṭoḍaramala, (c. 1919), Calcutta, including Artha-Saṃdṛṣṭi Chapter.

(iii) The causality concept of simultaneity of events connected with bios and Karmic particles sets.

(iv) Yoga operator being responsible for configuration and particle bonds and the Moha operator being responsible for life-time and energy-level bonds.

(v) The order-bound phenomena of events of instantaneous nature in the time set of the past, present and future.

(vi) The bio-phase-rise and its dual phase-rise of the Karmic nisusus simultaneously, working for the mutual feed-back of each other prolong the life-system, constituting input values, and input functions every instant.

(vii) Before rise of karmic display there is a proportionate time-lag, except that for longevity configuration (āyu prakṛti).

(viii) There are norms of mathematical objects corresponding to inputs of Yoga and Moha structures.

(ix) There is state-existence of the tetrad of the Karma totality of the past, and the present instant corresponds to the transition of state, depending upon the action of input of Yoga or Moha phases. The niṣeka structure is transformed during this process, time also being an independent operator.

(x) There are output values and output functions, every instant. These are also variables depending upon the decrease or increase in the norms of the Yoga and Moha.

(xi) Impedance (saṃvara) also works as an input, in so far as it reduces the Yoga and the Moha quantities.

(xii) The fluent measure, quarter measure, time measure and phase measure of the universe souls, non-souls, soul's merits and demerits, influx of the Karmic matter, its impedance, disintegration, bond and emergence in relation to the eight types of karmas, forms the statistical data of the karmic universe, apart from other details of various Karmic universal set[1].

(xiii) There are ten operational phases of bonds, namely, bonding, state-transition, rise, premature-rise, uptraction (in state matrix), downtraction, transmutation, subsidence, nidhatti and nikācita.

(xiv) There is an order in which ending of the tetrad of bond occurs.

(xv) There is a sequence of annihilation of state, and a rule of life-time cut for life-time state.

(xvi) There is a law for the down-tract and a law for reduction of impulse (energy-level)

(xvii) The three operators (the low-tended, the unprecedent and the invariant) are responsible for attainment of correct vision, similar to that in the Omniscient.

(xviii) The complete emergence results in Omniscience and infinite controls.

The above constitutes the essence of hundreds of pages of mathematical theory of the Karma system and its equation of motion. The philosophical treatment might have invited a lot of doubts, yet solved through doubt-explanation method of discourse. Here again one finds axiomatic method of postulating an existence of the Karmic bond of a bios as being ab-aeterno. The bios and the bond Karmic matter being independent, in so far as their transformation depend upon the phase in which they pass through. They appear as inter-related for interactions, yet transforming according to their own controls, own thresholds and limits and so on, at the simultaneity of their absolute scale of time[2]. The existence being the property of a

1. Cf. Artha Samdrṣṭi I GKK, p. 190, *op. cit.* and pp. 215-230.
2. Sikdar, J. C., The Jaina Concept of Time, Research Journal of Philosophy, Ranchi, 4.1 (1972), 75-88.

fluent, it manifests in its free forms during an indivisible instant, generating, annihilating and eternal in itself. The fluent itself is the cause and effect of its own transformations due to its own phase.

Similarly the astronomical system in the Tiloyapaṇṇattī appears to be based on the following principles[1] :

(i) Divisibility ad infinitum of space and time units in practice is impossible.[2]

(ii) By virtue of motion an ultimate particle of matter could be existent at more than a single space-point within an indivisible instant.[3]

(iii) In nature, the physical phenomena as well as bios phenomena, has the frequency of occurence[4].

(iv) A closed path when deformed topologically does not lose its invariant property.[5]

(v) The implicit cosmological principle that no system has any special position and as such the relativistic kinematics holds invariance for the derivation of the dynamical laws of the universe from kinematically equivalent geometrical path. The general formula of the orbits appears to be[6] $r = \frac{f+g\,\theta}{h+k\cos\theta}$

(vi) Seasons change with precession of equinoxes[7].

The above marks the system as a principle theory which adopts the analytical method, its basic elements not being constructed hypothetically, but discovered emperically. The basic concepts and principles form the general characteristic of the natural process. Such a theory has the advantage of being logically perfect and have a secured foundation. However if a single principle fails or if an inconsistency arises the whole structure has to be remoulded for it is impossible to retain its originality. The principles require to be powerfully supported by experience and should be logically reconcileable[8].

The Greeks and later the Indians appear to have evolved the constructive theory which follow the synthetic method in which attempts are made to find out a simple and formal scheme to construct a representation of more complex phenomena. The success obtained in understanding a group of natural phenomena, means that the process has been covered through the constructive theory which is complete, adaptable, clear and could be remodelled without shattering the whole structure.

5. THE MATHEMATICO—LOGICAL DEVELOPMENT

Now the Syadvada system of predication will be discussed. The system[9] worked very deep in evolving the method of expressing and exposing the Karma system as a statistical tool, side by side, the

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1. C. 1 (r), *op cit.*
2. Cf. 1 (h), intr. Cf. also 1 (i), intr. *op cit.*
3. Cf. 1 (0), *op cit.*
4. Gommaṭasāra, Jīvakāṇḍa, vv. 557-660. Cf. Sarvārthasiddhi of Pūjyapāda, (reality), Calcutta, (1960), 56-60.
5. Cf. 1 (d), 1 (m), *op cit.*
6. Jain, L. C., On the Spiro-Elliptic Motion of the Sun implicit in the Tiloyapaṇṇattī, I. J. H. S., 13.1, (1978), 42-49.
7. Jain, N. C., Jaina Pañcāṅga, Jaina Siddhanta Bhaskar, 8.2., (1941), Arrah, 74-80.
8. Vid. "What is the Theory of Relativity?" The London Times, November, 28, 1919, (Einstein, Ideas and Opinions, London, 1956, 227-232).
9. (a) Vid. Haldane, J. B. S., The Syādvāda System of Predication, Sankhya, The Indian Journal of Statistics, vol. 18, parts 1 and 2, (paper received, nov. 1956), pp. 195-200.
   (b) Mahalanobis, P. C., The Foundations of Statistics, Dialectica, vol. 8.2, 15/6/1954 & Sankhya, I. J. S., 18.1 and 2, 183-194.

mathematical pursuits, before the development of symbolic expressions, at the time when sentenial and syncopated expressions found their place in texts as well as in lectures[1]. The works of Yativṛṣabha and Vīrasena are testimony to this. According to Yativṛṣabha, the suborder of third prābhṛta of the tenth vastu, in the fifth pūrva, called Jñāna Pravāda, is of five types : ānupūrvī, nāma, pramāṇa, vaktavyatā, and arthādhikāra. Vaktavyatā (assertoriality)-sub-order is of three types : svasamaya, parasamaya, and tadubhaya[2]. A quotation by Vīrasena asserts, 'Relative to controls and events, that fluent is one without leaving its various-own-forms and positively it is many, relative to its own controls and events, without leaving its one-ness. Thus, O, Jaina, the object in infinite forms is stated in sentences, in order, through part acceptance phase[3]. He further exlains, 'Relative to dravyārthika naya, there is one-ness in one and many. Relative to paryāyārthika naya, from an arbitrary 'one' number, the remaining 'one' numbers are different, therefore there is many-ness in them. Relative to naigama naya, the dvitva (duality) etc., phase comes into being, which leads to acceptance of number-division.'[4] In this style Vīrasena puts up the doubt, "The past time is ab-aeterno, how can its measure be established ?" The explanation is, ' No, because, if its measure is not recognized, its non-existence will be infered. But the knowledge of its being ab-aeterno happens to be, hence it will be having beginning, and as this is also not so, because there is contradiction in such a recognition."[5]

Further the mathematical import of the following logic for fineness decision is worthy of attention. Vīrasena mentions, "Many preceptors state that it is fine, that which is accumulation of many points. It has also been stated—Time measure is fine, and quarter measure is finer, because in an innumerable part of a finger, there are innumerable kalpas. But this assertion is not eventuated, because on such a recognition, fluent description will follow the quarter description. Doubt : How is this ? Explanation : Because, in a fluent finger, composed of infinite point-like ultimate particles, relative to embedding, there is only one quarter finger, but relative to counting, there are infinite quarter fingers. Hence quarter is fine and fluent is finer, because there are infinite quarter-fingers in a fluent finger."[6]

Thus Syādvāda appears to show relational universes and not the probable universes. Due to relation, an object may be small or great, or both, or a combinatorial situation of all these. As a theory of relations Syādvāda is also a theory of dynamic and static functional structures with constructibility, consistency, and completeness. It was beyond Boole's logic and Russell's symbolic logic. It formed a complete system of universes of assertions negations and unassertoriality. This formed a landmark in the logical foundations of the 'post-universal' mathematics, providing mathematical properties of one-ness and manyness as well as intermediary-ness to the object. For example : logarithm of two to the base two was given as one, that of four as two, and that of three was regarded as unassertorial for it had a value in between one and two, although it was not needed to be calculated in approximation the school dealt with.

(c) Mehta, M. L., Psychological Analysis of Jaina Karma Philosophy, Thesis, B. H. U., Amritsara (1954).

(d) Kothari, D. S., Reality and Physics : Some Aspects, Jour. of Phys. Edn., 8.2, Jan. 1978, pp. 1-6.

(e) Barlingay, S. S., A Modern Introduction to Indian Logic, New Delhi, (1976), pp. 4, 5, 6-7, 9, 62, 72, 73, 88.

(f) Muni Nathmal, Jaina Nyāya Kā Vikāsa, Raj. Univ., Jaipur, 1977. For bibliography, vid. pp. 175-179.

1. Cf. 1 (s), *op. cit.*
2. Cf. 26 (b) *op. cit.*
3. Cf. 12 (b), Book 3, p. 6, v. 5.
4. Cf. *ibid*, p. 30.
6. Cf. *ibid*, pp. 27-28.

The use of the word "ARTHA SAMDRṢṬI" shows that it meant the introduction of symbolic norm and not the symbolic logic. The sombolic norm then paved the way to post-universal mathematics due to introduction of the relations in all perspectives. Logic brings forth contradictions, whereas the norms introduced by Syādvāda removes them, extending the symbolic logic to symbolic norms, or mathematics to extended 'post-universal' (lokottara) mathematics of measures and norms. According to Godel, in any system broad enough to contain all the formulas of a formalized elementary number theory, there exist theorems (formulas) that can neither be proved nor disproved within the system. Syādvāda system allows such a situation in the karma system where assertorial and non-assertorial phenomena occur in nature. For example, a free soul or a free particle could travel a distance of fourteen rājus within an indivisible instant, implying its existence in a stretch of fourteen rājus within the indivisible instant—a paradoxical situation.'

In addition to the above, Mahalanobis found in Syādvāda a close relevance to the concepts of probability, and the phrases used in Syādvāda to have a special significance in relation to the logic of statistical inference. 'Syāt' means relative, 'Vāda' means assertion. The seven predicates may be described as follows : 1. Relatively, it is ; 2. Relatively, it is not ; 3. Relatively, it is and it is not ; 4. Relatively, it is non-assertorial ; 5. Relatively, it is and yet is non-assertorial ; 6. Relatively, it is and it is not as well as it is non-assertorial. The above form the dialectic of seven-fold predications, save that the word 'is' above may be replaced by 'is existent'. The word 'non-assertorial' has been used by other authors as indeterminate, indescribable, inexpressible and indefinite. The situation is comparable also to the propositional and non-propositional statements of Russell.

The above seven universes are necessary and sufficient to exhaust the possibilities of all knowledge in forms of norms of measures (pramāṇa) and schema (naya) and many-ended-ness (anekānta) of a variable object.[1] According to Mahalanobis, the fourth category, being a synthesis of three basic modes, the third denoting inexpressibility, indefiniteness or indeterminateness, supplies the logical foundations of the modern concept of probability. But the fact, that the positivity of the statement leads to statistics and not to probability, has urged many scholars to deny the inclusion of the probabilistic situation asserted by Mahalanobis.

The methodology of the Syādvāda system seems to have motivated the trend of symbolization of the relational semantic material of Karma theory, and after Vīrasena, imperfect attempts may be traced in the later commentaries.[2]

The system theoretic approach demands causality in practical schema, whereas the determiniastic schema in Jainology may be put up in words of Satkari Mookerjee, and may be said to have an important hearing on modern scientific attitude, "..... ...neither synchronism nor succession is believed by the Jaina to be essential characteristic of causal relation. Causality is a relation of determination. The effect is that whose coming into being is necessarily determined by the being of another. The determinant is called the cause and the determinatum is called the effect. The determinant may be synchronous with the determined or may be separated by an interval . . .[3]" He further states, "What is the organ of the knowledge of

1. (a) Nyāyāvatāra of Siddhasena Divākara (c. 480-550 A. D.).
   (b) Āpta Mīmānasā of Samantabhadra (c. 600 A. D.).
   (c) Syādvāda Mañjarī of Malliṣeṇa (1292 A. D.).
   (d) For a comprehensive bibliography, cf. Jaina, H. L., Bhāratīya Saṃskṛti men Jaina Dharma Kā Yogadāna, Bhopal, 1962.
2. Cf. 12 (c), and 27. *op cit.*
3. Mookerjee, S., The Jaina Philosophy of Non-Absolutism, Calcutta, 1944, p. 190.

causality ? The Jaina answers that it is the perception of the concommittance in agreement and difference . . . The Jaina takes the observance of concommittance in agreement and in difference to be one observation. . . . The Jaina posits a twofold cause for the perception of universal relation—an internal and an external condition . . ."[1] Samantabhadra asserts, "Yadvastu bāhyam guṇadoṣa sūte—rnimitta mabhyantaramūla hetuḥ, adhyātmavṛttasya tadaṅgabhūvta—mabhyantaram kevalamapyalam te."[2] The absolute time scale in Jainology is governed by the concept of the indivisible instant interval postulate, and it seems to have caused the above understanding of reality, plurality, and multiforms as well as infinitely diversified aspects of the universal omniscience which comprises of many comparable infinities of Karmic and other structural and functional equations of natural phenomena in individual and statistical details, of the unified system theory of bios and matter as well as of other fluents.

Mahalanobis commented upon the probability implication of the Syādvāda system through the example of a coin, whereas the indeterminate type of implication of the system has been put forth by Haldane in the quantitative aspect of the indeterminate solutions of equations under enquiry. He says that solutions like square root of minus one are non-assertorial so far as imaginary numbers are not taken into being (as was asserted by Mahāvīrācārya in the ninth century). This aspect leads to the many truth values logical system of the Syādvāda, which is without uncertainty. Existence without assertion are found in many mathematical situations, as existence of curves without tangents, or tangent to a circle from a point within a circle, or else expressibility of square root of two through decimals, or else also the existence of the principle of generation of infinite limit numbers postulated by Cantor. In technology as well, situations arise where circuits for the intermediary of yes and no contacts are indispensable for go ahead matters, and they are dealt with without assertorial commands, automatically. It thus seems that there are biological as well as material situations and events which go on automatically without assertorial cognizance, without being interrupted by silence, and it may be said that the bios-technology of the future will have to take into account such eventual contacts for reproducing types of machines having ingenious feed-back generators as well as annihillators.

6. CONCLUDING REMARKS

Indeterminacy and uncertainty are two different aspects, and the former does not ensure the certainty of knowledge, although one may not be aware of that universe of its measure. The motive of the Jaina School, thus had an ulterior aspect, for a philosophical attitude with mathematical determinacy of an Einsteinian approach.

The knowledge of the subsets of indivisible-corresponding-sections of all knowledge (Omniscience or Kevala Jñāna), must have had a great bearing on the mathematico-philosophic pursuits of the School, and the challenge of several types of indeterminacy, paradoxes, contradictions, antinomies and fallacies might have been boldly faced in that ancient era of scientific awakening, in India. The Greeks, as it appears in history, paced back, and it was due to the unparalleled attempts and invincible struggle of George Cantor that he could introduce the theory of sets in spite of great opposition and introduction of several antinomies and paradoxes etc.

The study into the foundation of Jaina mathematical philosophy, thus requires a revision of its symbolic material through a team of interdisciplinary scholars for the fact that the progress into the deeper investigations has suffered in the absence.

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1. *ibid.*, p 190.
2. Vṛhadsvayambhūstotra of Samantabhadra, v. 59.