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BOOK REVIEWS

Kenneth Denbigh *Three Concepts of Time*, Springer Verlag, Berlin-Heidelberg-New York, 1981, pp. viii+180.

This is a book written by a scientist with a deep interest in the philosophy of science, in the 'meaning' of fundamental scientific concepts, for scientists of a similar interest. It is not primarily a book on the history of the concept of time, but rather on a scientist-philosopher's own distinctive view of 'time', though inevitably in expounding it he has covered some of the history. Time to him is not a primitive concept; it is a 'composite' notion, a construct derived from inner experience or conscious awareness on the one hand and the changes in the physical world on the other. 'Time' is thus viewed neither as a purely mental nor as a purely physical concept but as a 'bridge' between the two.

He develops three principal and distinct concepts of time—the time of theoretical physics which is an abstract construct or refinement from direct experience, the time of thermodynamics and of the evolutionary sciences such as biology and the time of conscious awareness. Time-as-experienced is unidirectional and is associated with the sense of events 'happening' and of things 'coming into being'. Physics removes this sense of an irrevocable 'ongoing' by deleting the notions of past, present and future as intrinsic. Time in theoretical physics is symmetrical—it does not distinguish between the past and the future. Thermodynamics brings this theory of time as a symmetrical coordinate closer to the 'time' as directly experienced by man by introducing monotonically changing 'entropy' states, the gradient of which correlates completely with man's judgement of the temporal order of events. But though thermodynamics distinguishes the two directions of time, yet it does not display the one direction as being in any sense 'more real' than the reverse direction. Moreover this anisotropy is only a statistical effect, and does not apply to fundamental processes (except for miniscule effects in some weak interactions not discussed by the author).

The author does not regard any one of these concepts of time as being more real than the others. He says, "We are concerned with the different levels of description, and each of the three forms serves its appropriate level satisfactorily. *This is all that is required of 'time' since it is not an existent.* It is not a 'something' whose properties are determinate and are 'out there' to be discovered. It is rather, as has been said, a purely relational concept, one which refers to the relations between events and within processes. As such, the criterion of its usefulness at any one level of description concerns its *adequacy* for the purposes of that level, and not its 'reality'."

Inspite of the author's critical efforts, the concept of time, as he himself admits,

'still bristles with problems.' "Time cannot be explained; it just has to be accepted." Nevertheless it is a lucid and commendable speculative effort to adduce scientific evidence in favour of a concept of time related to creativeness and purpose and to the sense of an open future. Consciousness as a phenomenon plays a dominant role in the author's thinking. He admits being influenced by the notion that "there occurs a steady increase of the total of conscious activity within the cosmos, a process of spiritualisation in the time direction of conscious awareness". One cannot fail to notice the striking similarity with the ideas of Teilhard de Chardin. Sadly no mention is made of his remarkable work "The Phenomenon of Man". Apart from this blemish it is an extremely lucid and readable study of a fascinating subject.

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David Pingree, *Census of the Exact Sciences in Sanskrit*, Series A, Volume 4. American Philosophical Society, Independence Square, Philadelphia, 1981. pp. 447. Price 30 dollars.

Series A of the *Census of the Exact Sciences in Sanskrit* aims at providing all available bibliographical information concerning works in *Jyotiḥśāstra* and related fields, written in India from the earliest known times to the present day, and biographical information concerning their authors. Under *Jyotiḥśāstra* are included (1) *gaṇita* or mathematics and mathematical astronomy, (2) *horā* or horoscopic astrology, and (3) *saṃhitā* or divination. The related fields include cosmogony and geography and those aspects of *prayoga* and *dharma* that involve the determination of the proper times for the performance of the ritual and other acts.

Volumes 1, 2 and 3 of Series A, which appeared in 1970, 1971 and 1976 respectively, contained information concerning authors whose names begin with a, ā, i, ī, u, ū, e, ai, o, au, k, kh, g, gh, c, ch, j, jh, ṭ, ṭh, d, dh, t, th, d, dh, and n. Lists of periodicals and series, books and catalogues, consulted by the author in the compilation of the *Census*, were also given. Volume 4 of Series A, under review, contains information concerning authors whose names begin with p, ph, b, bh and m, and additional information concerning authors already discussed in Volumes 1, 2 and 3. Additional lists of periodicals and series, books and catalogues, consulted by the author subsequent to the publication of Volume 3, are also given.

The article under each author gives all available information on his date, ancestry, locale, religious affiliation, and social position; then it lists his works relevant to *Jyotiḥśāstra*, and under each work lists its commentators, its manuscripts and editions, and any discussions on it; and finally there is given the table of its contents and those passages in it that throw light on the author or his works.

Volumes 1, 2 and 3 gave information on 1450 authors. Volume 4 is more voluminous and impressive. It gives additional information on 320 authors already noticed in the previous volumes and articles on 1000 new authors.

The *Census* on the whole is well planned, up-to-date and as far as possible accurate, and will prove to be of great use to all those who are working or have interest in any branch of *Jyotiḥśāstra*.

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Jagadguru Swāmī Bhāratī Kṛṣṇa Tīrthajī. *Vedic Mathematics or Sixteen Simple Mathematical Formulae from the Vedas*, Reprinted, Motilal Banarsidass, Delhi, 1981. Pages 18(+2) +xxx (+6) + 367, plate 1. Price: Rs. 55.00 (Cloth), Rs. 40.00 (Paper).

Vedic Mathematics was first published in 1965 by Banaras Hindu University, Varanasi, as Volume 10 of Hindu Vishvavidyalaya Nepal Rajya Sanskrit Series (under General Editorship of V. S. Agrawala) and was priced Rs. 10/-. This was reviewed by A. K. Bag (*I.J.H.S.*, Vol. 3, pp. 59-60). The present reprint (which also mentions of earlier reprints of 1970, 1971, 1975, and 1978) is an unaltered reproduction of the first edition except for two extra pages (16a and 16b) and changes which resulted due to change of printer, publisher, copyright, and transliteration of certain names. Unaltered reprinting has the great disadvantage of preserving and reproducing (without correction) the printing and other errors of the earlier edition. For instance, on page 362, line 28, the symbol for π still appears as "11".

In her short biographical sketch of the author (pp. i-xi), Mrs. Manjula Trivedi, a disciple of the former, gives the following information: Swami Bharati Krishna Tirtha (as spelt by her), named Venkatraman in his pre-*sanyāsa* days, was born in 1884. His father's name was P. Narasimha Shastri and his Sanskrit teacher was Vedam Venkatrai Shastri. He appeared at the M.A. examination of the American College of Sciences, Rochester, N. Y. (The reviewer does not find this in the LIST given in *Webster's Seventh New Collegiate Dictionary*, Indian edition, 1971) from Bombay Centre in 1903; and in 1904 he passed M.A. examination in further seven subjects which included Sanskrit, Philosophy, English, Mathematics, History and Science (?). He was the Principal of National College at Rajmahendri (*sic*) from 1908 to 1911. He became *sanyāsī* in 1919 and the pontifical head of the Govardhana Maṭha, Puri, in 1925, a position which he held for next 35 years. He toured U.S.A. and U.K. in 1958 and shook off his mortal coil at Bombay on 2nd February, 1960.

It was stated in the first edition of the work (see p. ix) that a collection of over 3000 Sanskrit verses composed by Sw. Bharati Krishna Tirtha was to be published but nothing further is mentioned about the proposal even after 16 years. Regarding the

genesis of *Vedic Mathematics*, Trivedi writes (pp. ix-x) that the author "used to say that he had reconstructed the 16 mathematical formulae from the *Atharvaveda* after assiduous research and *tapas* for about 8 years in the forests surrounding Sringeri". "Obviously these formulae", she continues, "are not to be found in the present recensions of *Atharvaveda*; they were actually reconstructed on the basis of intuitive revelation from materials scattered here and there in the *Atharvaveda*".

It is also stated (pp. x and xx) that the author had written 16 volumes on these 16 formulae, but the manuscripts were lost; and the present volume was rewritten in 1957 from memory. Earlier when the author gave a course of lectures on the subject at the Nagpur University in 1952, he took "Nagpur by storm by his Vedic Mathematics" (p. xvi).

From what is stated above and from the language of the 16 *sūtras* (formulae), it is clear that they are author's own composition in modern Sanskrit but employing the old *sūtra*-style. Hence author's claim that they are "contained in the *Pariśiṣṭa* (the Appendix-portion) of the *Atharvaveda* (p. xv) can be justified only by regarding them, following a suggestion by V. S. Agrawala (see p. 6 of his Foreword), as a new *Pariśiṣṭa* added according to the tradition of formulating subsidiary apocryphal texts. It seems that the author attached the name of Vedas to his work in retaliation to one of his teachers' habit of refuting the opinion that even formulae of modern mathematics are contained in the *Vedas* (see *Bulletin of the National Institute of Sciences of India*, No. 21, 1963, p. 253).

In his Preface (pp. xiii-xxx), the author talks of 'The Astounding Wonders of Ancient Vedic Mathematics' and says that "the *Vedas* should contain within themselves all the knowledge needed by mankind" (p. xiii). But in the opinion of an earlier reviewer, "His (author's) effort to glorify the *Vedas* and Hindu culture by these false claims will only create revulsion of feeling when the truth is known" (see *Vishveshvaranand Indological Journal*, Vol. 4, Part 1, March 1966, p. 109). Anyway the exaggerated claims do not help in historical studies of ancient Vedic sciences.

However, the *Vedic Mathematics* is valuable and significant from several points of view. It has the merit of originality and unfolds a fresh method of approach. It has great educational value in that the techniques given for performing some mathematical operations are simple, and the results are obtained quickly. A large number of topics are covered such as multiplication, division, factorization, recurring decimals, partial fractions, square and cube roots, algebraic equations (quadratic and simple cubics etc.), alphabetic numerical system, Pythagorean theorem, value of π, simple differentiation, etc.

Compiled from stray references in the text of the book, the editor has given a consolidated list of the 16 *sūtras* along with 13 sub-*sūtras*. The arithmetical applications of these *sūtras* are of absorbing interest and cover most of the book. Here we shall

illustrate the use of one *sūtra* which has not been fully explained in the text. The ninth *sūtra* is:

चलनकलनाभ्याम्
'*Calana-kalanābhyām*

whose literal meaning is

"By differentiation".

As such this formula is, therefore, just a general statement. For its use in solving quadratic equations, the following is the fuller form or rule

चलितकलितवर्गो विवेचक"
'*Calita-kalita vargo vivecakaḥ*'

which is quoted by Brij Mohan (*B.N.I.S.I.*, No. 21, p. 254) who had the privilege of attending author's lectures on the subject delivered at the Banaras Hindu University, Varanasi, in 1949. The meaning of the above rule is:

"The square of the differential coefficient is (equal to) the discriminant."

That is, the solution of

$$ax^2+bx+c=0 \tag{1}$$

is given by

$$(2ax+b)^2=b^2-4ac \tag{2}$$

Here $(2ax+b)$ is the differential coefficient of the left-hand-side of (1), and (b^2-4ac) is the discriminant of the equation (1). The relation (2) indeed yields the correct solution. Herein is illustrated the power, simplicity, and quickness of the *sūtras*. It may be pointed out that a result equivalent to (2) is also obtained by applying the famous Hindu rule "*caturāhata-vargasamairūpaiḥ* etc." which was given by Śrīdhara more than a thousand years earlier.

Every student and teacher of mathematics should be keenly interested in the book. Besides historical errors (which are out of question to discuss in the context), there are a few printing and other mistakes. For instance, on page 169 (at two places) "$\neq 1$" should be read as "± 1" (being roots of $y^2=1$). Then, the Fifth Proof (p. 351) of the Pythagoras Theorem is not proper as it is based on the distance-formula (of Coordinate Geometry) which itself is, usually, derived by using that very Theorem.

In short, *Vedic Mathematics* has enormous educational and cultural value. It has inspired several scholars to delve into the matter, derive more results by using the formulae, and develop further similar material. For instance, we have *A Peep Into Vedic Mathematics* by B. R. Baliga (Trichur, 1979). Then there is the dissertation on *A Study of Vedic Mathematical Principles and Their Validity in Relation to Modern Mathematics* by P. N. Mehta who was awarded an M. Phil. degree for it by the South Gujarat University in 1981.

Vedic Mathematics has attracted even foreign scholars. For instance, a series of lectures on the subject was given at the University of London Union in 1980 by J. Pickles and A. P. Nicholas in whose opinion the book is a "quite remarkable work" (Nicholas' letter of 17th June, 1980 to E. E. Swingler). In India a talk on the subject was given by S. I. Husain (of Aligarh Muslim University) during the 4th Conference of the Indian Society for History of Mathematics held at the University of Delhi in December, 1980.

In fact, *Vedic Mathematics* has opened a new field of study, investigation and further research, and a new class of mathematical literature.

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