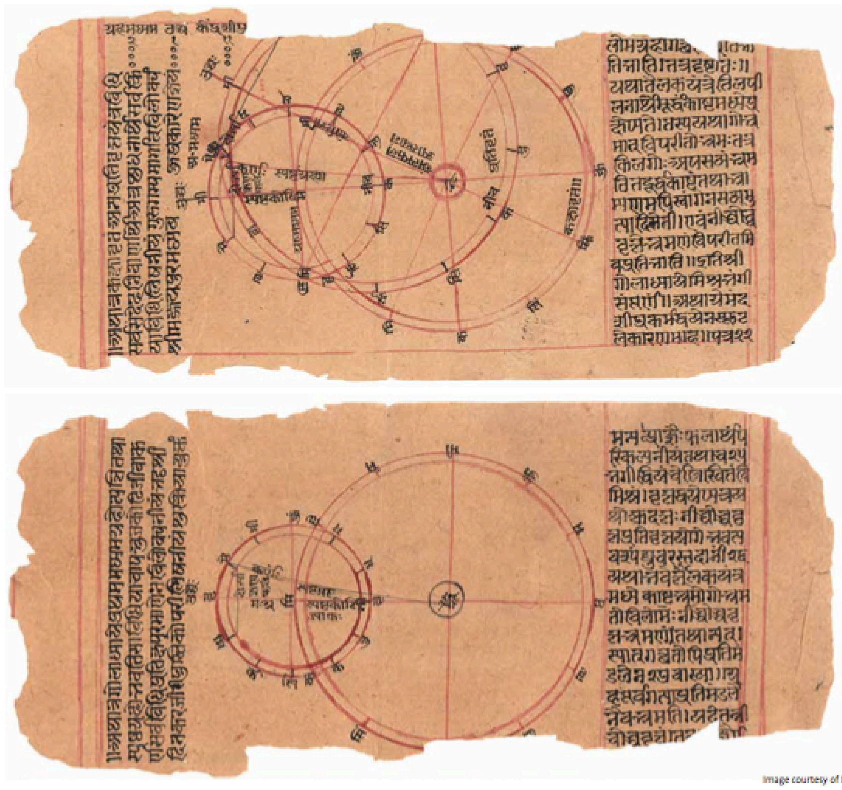

Image courtesy of D Wujastyk

History of Science in India

International Symposium, 19–20 April 2017
University of Canterbury, Christchurch, New Zealand

Speakers include Prof Ramasubramanian, Prof M. S. Sriram, Prof Rama Jayasundar
In conjunction with the New Zealand India Research Institute

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Te Pūtahi Rangahau o Inia ki Aotearoa

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

PROGRAM

Symposium on History of Science in India
April 19-20, 2017
Venue: Law 105, College of Business and Law UC

Wednesday 19 April

9:15am	Welcome: Prof. Sekhar Bandyopadhyay (Director, New Zealand India Research Institute, Victoria University of Wellington)
	Session One (Chair: M. S. Sriram)
9:30	K. Ramasubramanian The art of weaving geometry and trigonometry with poetry: A study based on Nityānanda's *Sarvasiddhāntarāja*
10:30	Aditya Kolachana Evolution of *udayalagna* calculations in India
11:15	Morning tea break
11:35	Venketesvara Pai Role of *maṇḍalas* and *maṇḍaladhruvas* in determining the longitudes of planets in the *vākya* school of astronomy
12:20	K. Mahesh The *Karaṇaprakāśa* of Brahmadeva: A preliminary survey in the light of its commentaries
12:55	B. S. Shylaja and Venketesvara Pai A catalogue of stars derived from Indian astronomy texts
1:15	Lunch break
	Session Two (Chair: K. Ramasubramanian)
2:15	Clemency Montelle The *Candrārkī* of Dinakara: a table text for the sun and the moon
3:00	Keshav Melnad A critical study of the *Jagadbhūṣaṇa* of Haridatta
3:45	Afternoon tea break
4:00	Deepak Paramashivan Sāraṅgī: The sound of one hundred colours
5:30	End of day

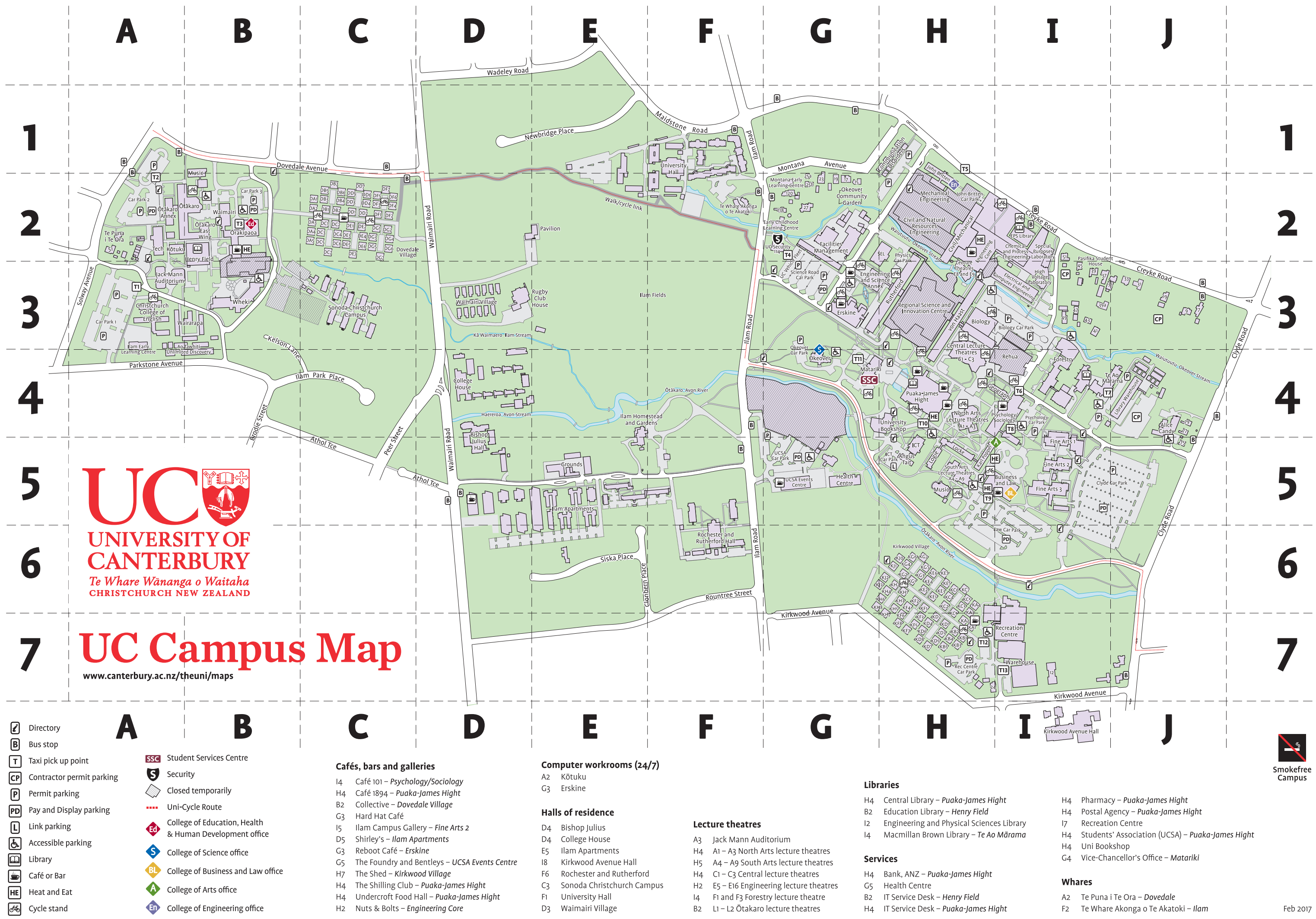
Thursday 20 April

Session Three (Chair: Piers Locke)

9:00	M S Sriram Approximations, exactness and pragmatisn in Indian astronomy
10:00	Jambugahapitiye Dhammaloka A review of the terminology employed by Śrīpati in the mathematical chapters of the *Siddāntaśekhara*
10:45	Morning tea break
11:00	Sarah Qidwai Science and Islam: Sir Syed the nechari (naturalist)
11:45	Pravesh Vyas Disaster prediction through abnormal animal behavior in ancient India
12:30	Lunch break

Session Four (Chair: Arin Basu)

1:15	Rama Jayasundar Āyurveda: Where the past is still present and also getting ahead of the curve
2:15	Natalie Köhle New insights on the origin of the *tridoṣas*
3:00	John Richardson The 1863 military reforms in sanitation and their wider impact in India
3:45	Afternoon tea break
4:00	Piers Locke Discovering and defending ancient Indian elephant science
4:45	Jane Buckingham Epizootic/epidemic: Cattle disease in Bengal 1864
Evening	Concert: Sarangi The sound of one hundred colours Deepak Paramashivan 7:30pm, Recital Room, UC City Campus, Arts Centre Entrance from the internal quadrangle off Hereford street The “Old Chemistry” building



College of Business and Law is the building found on I5

ABSTRACTS

Symposium on History of Science in India
April 19-20, 2017

Evolution of *udayalagna* calculations in India

Aditya Kolachana
PhD Candidate, Department of Humanities and Social Sciences
IIT Bombay

The determination of the ascendant (*udayalagna* or simply *lagna*), or the rising point of the ecliptic at any given instant, is an important problem in Indian astronomy. This is driven by a cultural association of certain ascendants with an auspicious period for organizing major events like weddings and other religious ceremonies, and a corresponding need to determine the ascendant at the time of birth of an individual. Accordingly, this astronomical problem has been studied in some detail in India.

Starting with Āryabhaṭa, invariably all Indian astronomers have prescribed procedures for the determination of *lagna*. Whereas most astronomers deal with this topic briefly in their *siddhāntas*, a few discuss it in detail through dedicated texts. The *Lagnaprakaraṇa* - attributed to the Kerala astronomer Mādhava - is one such dedicated work which deals exclusively with the determination of the lagna in a number of different ways. In this paper, we take a look at the evolution of *udayalagna* calculations in India, culminating in the procedures described in the *Lagnaprakaraṇa*.

A review of the terminology employed by Śrīpati in the mathematical chapters of the *Siddāntaśekhara*

Jambugahapitiye Dhammaloka
PhD Candidate, School of Mathematics and Statistics
University of Canterbury

Śrīpati was a leading mathematical astronomer in India flourished in 11th century AD whose writings has not yet been much researched. The corpus of his works include 7 treatises which are on mathematics, astronomy, and astrology. The *Siddāntaśekhara* is said to be his magnum opus which chiefly describes the principles of Indian astronomy. Interestingly, two chapters of this treatise, 13th and 14th chapters, are dedicated to arithmetic (*vyaktagaṇita*) and algebra (*avyaktagaṇita*) respectively. This paper examines the terminology employed by Śrīpati in these two chapters and will discuss terms having different meanings, synonymous terms, the derivation of terms, issues of interpreting of them, and some controversial points.

The *Candrārkī* of Dinakara: a table text for the sun and the moon
Dr Clemency Montelle
School of Mathematics and Statistics
University of Canterbury

A set of tables devoted to the sun and the moon, the *Candrārki* was compiled in Sanskrit by Indian astronomer Dinakara along with a short accompanying text, which incorporates additional smaller tables. The epoch of this table text is 31 March 1578 and it survives in at least a dozen manuscripts. Some manuscripts contain the text only, some the tables. Some contain both the tables and the texts. We explore some of the challenges related to editing and analysing these tables.

Sāraṅgī: The sound of one hundred colours
Dr Deepak Paramashivan
University of Alberta

Ancient Indian literature is replete with an innumerable number of references to different kinds of musical instruments. These instruments were primarily used to accompany the Vedic recitation and post-sacrifice ceremonies as well as popular music. During the 13th century, the *mela-paddhati* system of music which is currently practiced in India, was invented and introduced by the great scholar and sage Shri Vidyaranya Swamy, marking a crucial point of departure in the Indian music, from the era of the traditional Grama and Murchana systems. The musical instruments too underwent many morphological transformations to cope with the change in the music system which led to their current state of sophistication of design and construction. Currently there are many musical instruments from India that are popular at a global level, such as Veena, Sitar, Sarangi, Santoor, Tabla, Mridanga, etc.

This presentation will focus on evolution of Sarangi, an ancient and endangered bowed instrument from India known for its soulful sonority and an uncanny ability to reproduce almost all the myriad emotional expressions that emanate from the human voice. It is a fretless instrument with over 40 sympathetic steel strings and three main playing strings made of guts which are pressed against by the cuticle above the nail to produce various notes.The Sarangi has always remained in the background as an accompaniment instrument and was restricted predominantly to accompany vocalists and courtesans' music in Kings' courts and in certain socially restricted places called the Kothas. It was only in the mid 20th century that the Sarangi was popularized as a solo instrument by eminent Sarangi players such as Ustad Bundu Khan, Ustad Bade Sabri Khan Ambale Wale and, notably Pandit Ram Narayan who toured extensively and established this instrument as a solo concert instrument in the global music arena.

The presentation will be followed by a live demonstration of the instrument, various styles (gharanas), their structure, and pedagogical tools developed by various per-

formers to learn this instrument.

Epizootic/epidemic: Cattle disease in Bengal 1864
Dr Jane Buckingham
Department of History
University of Canterbury

This paper considers the outbreak of disease among cattle at the first Agricultural Exhibition held in India on 24 January 1864. It focusses on the report presented by the Bengal Presidency Surgeon Dr C. Palmer and shows the interaction of colonial and Indian concepts of disease in both humans and animals as elements in the construction of colonial veterinary medicine.

The 1863 military reforms in sanitation and their wider impact in India.
John Richardson
PhD Candidate, Department of History
University of Canterbury

The sanitary reforms of the 19th century had a great impact on the health of both civil and military populations. In India the impact of this sanitary movement was felt as a response to a perceived threat to British colonial dominance. Although initially the proposed sanitary reforms of 1863 were primarily intended to simply improve the health of the British military population in India, the evidence and data gathered for this purpose led to detailed recommendations for improving both military and public health within India. Indeed, the conclusion reached by the sanitary commissioners challenged the perception that India itself was unhealthy due to its climate and environment and argued that many Indian cities could be rendered as healthy as contemporary European cities.

A critical study of the *Jagadbhūṣaṇa* of Haridatta
Keshav Melnad
PhD Candidate, Department of Humanities and Social Sciences
IIT Bombay

The astronomical table text named *Jagadbhūṣaṇa* of Haridatta, written in Mewar, Rajasthan, is the first of its kind to enunciate a set of cyclic planetary tables. As per the text, the author is a follower of the *Brahmapakṣa* and sets the epoch as 31 March 1638. Here, we explore a few highlights of this work based on a critical study taking into account a few of the available manuscripts.

The *Karaṇaprakāśa* of Brahmadeva: A preliminary survey in the light of its commentaries

Dr K. Mahesh
Department of Humanities and Social Sciences
IIT Bombay

In the tradition of Indian astronomy, karaṇa texts have played a major role in substantially simplifying the numerical computations that have to be carried out for preparing *pañcāṅgas*. These texts may be considered as manuals for simplifying the calculations prescribed in the *siddhānta* treatises. Many *karaṇa* texts have been composed by various astronomers by choosing different epochs close to their time. The *Karaṇaprakāśa* is one of such texts which was composed in 1092 CE (1014 Śaka) by Brahmadeva (c. 1060–1130 CE), the son of Chandrabudha, who was a resident of Mathurā in India. It is evident from the opening verse of the work that this closely follows the *Āryabhaṭīya*. The fact that it has more than half a dozen commentaries suggests its popularity. Presently, we have two commentaries with us. The first one is named *Karaṇābharaṇa* authored by Śaṅkaranārāyaṇa Joyisa (17th century CE) and the second one is the *Sadvāsanā* by Sudhākara Dvivedī (19th century CE). During the talk, we will try to highlight some of the special features of the *Karaṇaprakāśa* in the light of these two commentaries.

New Insights on the Origin of the *Tridoṣa*

Dr Natalie Köhle
Postdoctoral Fellow
Australian Centre on China in the World
The Australian National University

The *tridoṣa* are the main concept in any Indic physiology or pathology. Yet to date there is no scholarly consensus as to when and how the initial formation of this triadic conception of wind, bile, and phlegm (*vāta, pitta,* and *kapha*) took place. Some scholars suggest that it evolved from the old Indo-Arian duality of water (*soma*) and fire (*agni*). Others hold that *vāta* should be considered an essential part of the triad all along. On the basis of my research, which takes its point of departure from the earliest Chinese translation terminology for the *doṣa-s* and takes into consideration the Āyurvedic classics and early Buddhist texts, I propose a different answer: *pitta*, and *kapha* are tied to emerging Indic conceptions of digestion and the *tridoṣa* evolved from there.

Discovering and defending ancient Indian elephant science
Dr Piers Locke
Department of Sociology and Anthropology
University of Canterbury

What counts as scientific knowledge and how best to evaluate culturally diverse forms of expert knowledge practice are issues that have generated contentious yet productive debate. Arguing for a plural and inclusive understanding of science unconstrained by the colonising, historical prototype emerging from the European Enlightenment, this paper considers the status of knowledge about elephants in Sanskrit literature. Explored in the course of the author's ethnographic research on captive elephant management in Nepal, this paper challenges the views of some scholars who have dismissed this literature as mere folklore and rhetorical fancy. Noting continuities and convergences with contemporary knowledge and practice, I draw on the work of Sanskrit literature specialists and elephant ecologists to assert the significance of a tradition of applied, systematized knowledge about elephants that fits well with current behavioural and physiological understanding. Finally then, I ask if we should consider the knowledge contained in this literature as scientific, and why it might matter if we do?

Disaster prediction through abnormal animal behavior in ancient India
Dr Pravesh Vyas
Department of Vastushastra
Shri Lal Bahadur Shastri Rashtriya Sanskrit Vidyapeetha (Deemed University)
New Delhi

Nature speaks to us constantly, communicating to us about the world through its varied expression. This truth has been universally acknowledged by indigenous cultures throughout the world. From the very ancient time Indians were observing animal behavior to predict future happenings as in India animals were considered as indicators for future predictions. The method of observing animal behavior became a separate field of science which was called *Śākunaśāstraṃ*. Today this science is somewhere related to "Ethology". Abnormal animal behavior before disasters is explained in some detail in *Jyotissaṃhitā* books like the *Bṛhatsaṃhitā* of Varāhamihira (5th Century A.D., writer of famous text *Pañcasiddhāntikā*), the *Vasantarājaśākunaṃ*, the *Adbhutadsāgara*, the *Bhadrabāhusaṃhitā* also in many ancient epics (like the *Rāmāyaṇa* and the *Mahābhārata*) and the *Purāṇās*.

Āyurveda: Where the past is still present and also getting ahead of the curve

Prof. Rama Jayasundar
Department of NMR, All India Institute of Medical Sciences
New Delhi

Of the knowledge assets India holds, Āyurveda occupies a prime position. The subject of Āyurveda (health) is a topic still very much central and of deep relevance to today's world. In addition, Āyurveda is also one of the few Indian Knowledge Systems that has also kept alive its vibrant tradition to date. Despite Western medicine being the frontline medical system in India, Āyurveda continues to address many health issues thereby contributing to the healthcare, independent of the allopathic system of medicine. The world is going through an unprecedented and extraordinary health crisis. Unprecedented because ill health has become a fact of life and many diseases are vying with each other to take the top slot as a serious health hazard. Extraordinary because despite having filled in huge details about human biology & diseases and developing sophisticated technologies to study the most subtle structures in the body, diseases are on the increase. There is growing realisation that conventional western medicine alone cannot handle the mushrooming of diseases underscoring the need for the use of other systems of medicine. All these underline the importance of looking at the large body of documented knowledge and experience of Āyurveda, which has perhaps the longest unbroken health tradition in the world. Is Āyurveda, with its hoary past and an entirely different approach to health and disease, to be considered one of the past glory of India or does it have contemporary scientific relevance? What are its methodologies and how do they compare to the technology based modern medicine? Now is the perfect time to look back, ask these questions and move forward. The lecture will explore these aspects from both modern and historical perspectives. The lecture will also address the following: (i) Historical texts pertaining to Āyurveda (ii) The other disciplines which have contributed to the development of Āyurveda (iii) Circumstances that led to the ayurvedic insights on health and disease (iv) What were the questions posed? (v) What are the epistemic standards set by the founders of the ayurvedic science? (vi) What was their worldview and how did it affect their standpoint on health? (vii) How did the knowledge get disseminated?

The art of weaving geometry and trigonometry with poetry: A study based on Nityānanda's *Sarvasiddhāntarāja*

Prof K Ramasubramanian
Cell for Indian Science and Technology in Sanskrit
Department of Humanities and Social Sciences
IIT Bombay

Scholarly investigations on the history, philosophy and practice of mathematics across different cultures has proved beyond the shadow of a doubt that the 'muse of mathematics can be wooed in many different ways'. However, it is not so well known that mathematics can also be fused beautifully with poetry.

While most of the works in Indian astronomy or mathematics, after the 5th century CE, have been composed in metrical form, not all works have been found to have great *poetic value*, that is worth mentioning. Blending mathematics with beautiful poetry is an art by itself, and a few astronomer-mathematicians like Śrīpati (11th cent.), Bhāskarācarya (12th cent) and Nityānanda (17th cent) seem to have been exceedingly successful in taking this art to great heights.

During the talk, by considering a few passages from Nityānanda's *Sarvasiddhāntarāja*, particularly dealing with the computation of sines, we would like to demonstrate how he has been able to intricately weave geometry and trigonometry into the fabric of beautiful poetry with great delicacy.

Science and Islam: Sir Syed the nechari (naturalist)

Sarah Qidwai
PhD Candidate, IHPST
University of Toronto

Sir Syed Ahmad Khan (1817-1898) established one of the most influential movements in India, the Aligarh Movement, laying the foundations for Muslim nationalism. Traditionally, scholars have focused on two major aspects of Sir Syed and his movements, the religious reforms he proposed and the rise of Muslim nationalism. I am proposing a third line of inquiry, the development of Sir Syed's views on the relationship of science and the Quran. Early in his life, Sir Syed believed that Islamic faith was simply based on the interpretations of the Quran and Sunnah (sayings of the prophet Muhammad). However, from 1862 onwards, he introduced scientific evidence as proof of Islam along side the Quran. For him, scientific inquiry aimed to uncover the laws of nature. Since the natural world was created by God, this line of inquiry also led to God. My paper will investigate the factors that led Sir Syed to introduce science to religion and the impact of this shift on the creation of his first Scientific Society in 1864.

A catalogue of stars derived from Indian Astronomy texts

Shylaja B S
Jawaharlal Nehru Planetarium
High Grounds, Bengaluru
and
Dr Venketeswara Pai R.
Indian Institute of Science Education and Research (IISER), Pune

Almost all texts of Indian astronomy have a chapter dedicated to instruments used for observations. Coordinates of stars in all texts of Indian astronomy are expressed as *dhruvaka* and *vikṣepas*, which are different from the conventional Right Ascension / declination or longitude / latitudes. A compilation from different texts extending up to the medieval period for the coordinates of about 106 stars reveals several interesting facts. Stars with larger values of declination have double entries in some catalogues. The ambiguity in respect of a few stars in crowded star fields gets resolved by extending the necessary corrections for the different techniques of observation. In spite of the knowledge on the precession corrections (specifically mentioned) the lists continue to list the coordinates as specified in the *Sūryasiddhānta*.

Most of the texts have entries of the 27 stars corresponding to the zodiac. Our compilation includes the other stars which are not part of the zodiac. The study also reveals many original Indian names and names borrowed from the Arabs. Earlier studies concentrated only on the corrections for precession and resulted in multiple identifications for the same star. Identifications for some unidentified stars are proposed with possible sources of error in coordinates leading to ambiguity. This study has also revealed that the method of denoting the coordinates in the text of Nityānanda appears to be special.

Approximations, exactness and pragmatisn in Indian astronomy

M.S. Sriram
Prof. K.V. Sarma Research Foundation
Adyar, Chennai

Ancient astronomy was largely about finding the correlations among the motions of the celestial objects-the Sun, the Moon and the stars to begin with, to include the planets later. A day, a month and an year are the natural time-markers. *Vedāṅga Jyotiṣa* (estimates of the date of composition range from 1300 BCE to 500 BCE) is the earliest Indian text with quantitative results. Here, we have a 5-year Yuga system, with 5 years, 62 lunar months (67 sideral months), and 1830 days. The Sun and the Moon are at the same position in the stellar background, namely, the beginnig of the asterism, *Śraviṣṭhā*, which was also the winter solstice. It was probably realised that the concept of a 5-year cycle was an approximation, which makes all the (arithmetical) calculations like those related to the beginning of a *tithi*, *nakṣatra* etc. very simple.

Later, we have the *siddhāntic* astronomy beginning with *Āryabhaṭīya* (c. 499 CE) , with a *mahāyuga* of 43,20,000 years, and which includes the computation of planetary positions. Here, we see a pragmatic approach. The planetary calculations are based broadly on epicycle models, with considerable flexibility, and improved understanding over centturies. Within the *siddhāntic* tradition, we have the *karaṇa* texts, where the computations are performed using tables which incorporate approximations of various kinds, including those for the sine and cosine functions, and texts with just tables. We also have *candravākya*s based on the fact that the Moon completes nearly 9 anomalistic cycles in 248 days. Corrections are applied later to take into account, the small change in the anomaly after 248 days.

However, exactness is demanded in situations where it is possible. This is true for instance in finding the east-west direction, the relation between the time and the length of the shadow, and many other formulae related to the diurnal problems. It is also true of eclipse calculations.

Role of *maṇḍalas* and *maṇḍaladhruvas* in determining the longitudes of planets in the *vākya* school of astronomy

Dr Venketeswara Pai R.
Indian Institute of Science Education and Research (IISER), Pune

The term *vākya* literally means a sentence consisting of one or more words. In the context of astronomy, it is the string of letters in which numerical values associated with some physical quantities are encoded. The *vākya* method of finding the true longitude of the Sun, Moon and the planets (sphuṭagraha) is a brilliantly designed simplified version of the methods outlined in the various *siddhāntas*. As per the *siddhāntas*, we first find the mean longitudes of the planets and then apply a few *saṃskāras* to get their true positions. On the other hand, the *vākya* method, by making use of a few series of *vākyas* presents a shortcut directly leading to the true longitudes of the planets at certain regular intervals, starting from a certain instant in the past. *Maṇḍalas* and *maṇḍaladhruvas* are two such instances which play a major role in the determination of planetary longitudes. In this talk, we would explain the concepts of those two parameters and the rationale for obtaining them. The two astronomical treatises used for the study are *Karaṇapaddhati* of Putumana Somayājī (1532 CE) and *Vākyakaraṇa* of 1282 CE whose authorship is unknown.