



Sri Rajaditya's Vyavaharanita and Lilavati. Padmavathamma, Krishnaveni and K. G. Prakash (eds and translations to English and modern Kannada). Published by Padmavathamma, No. 28, 2nd Cross, 4th Main, 3rd Stage, Gokulam, Mysore 570 002, India. 2013. 496 pp. (hardbound). Price: Rs 600/US\$ 75.

In the pre-Aryabhata period, the contribution of Jains mainly to arithmetic and mensuration is significant. Their remarkable achievements are recorded in the famous Prakrt texts like *Jambudvipa prajñapti* and *Suryaprajñapti* dating back from 500 to 200 (BCE).

In the history of mathematics in India and mathematical pedagogy, the 9th century popular mathematician from Karnataka, Mahaviracarya occupies a significant place. He is indeed the crowning glory of the succession of the great Jain mathematicians. Among his numerous contributions, the truly pioneering ones are: (i) the general formula for ${}^n C_r$, and (ii) an approximate expression $\sqrt{(16a^2 + 24b^2)}$ for the circumference of an ellipse, what he calls *ayatavrtta*, Mahavira's 9th century Sanskrit work *Ganita-sara-sangraha (GSS)* was translated to Telugu by Pavuluri Mallana in the 11th century. A large number of the manuscript copies of *GSS* have been discovered in Kerala. This establishes the tremendous popularity of Mahaviracarya and his text. In fact, *GSS* enjoyed the status of a textbook in the major part of South India for nearly three centuries, perhaps until it was replaced by the *Lilavati* of Bhaskaracarya-II in the 12th century. Daivajna Vallabha composed commentaries on *GSS* both in Telugu and Kannada. Amichandra translated *GSS* into Rajasthani dialect. A good number of Kannada versions/commentaries are said to be preserved by the Jain monasteries in Karnataka.

Continuing this tradition of mathematics in Karnataka, we have Rajaditya in the 12th century. While Mahavira's *GSS* is in Sanskrit, Rajaditya's text *Vyavaharanita* is in hala(e)gannada, old Kannada. Obviously, Mahavira had a great influence on Rajaditya. But the latter confesses that his works are meant for practical utility, while those of his predecessors are for scholarship in mathematics.

Rajaditya was a Jain poet and mathematician. He is credited to have composed in old Kannada the mathematical texts, *Vyavaharanita* (mathematics of transactions), *Ksetraganita* (mensuration), *Vyavaharatna*, *Lilavati*, *Citrahasuge* and *Jainaganita sutrodharana* (examples for Jaina mathematics).

The *Vyavaharanita* was first edited by Mariyappa Bhat (University of Madras) and published by the Government of Madras in 1955. The edition was based on three manuscripts then available with the Oriental Manuscripts Library, Madras. Bhat in his edition had acknowledged that a lot of errors had crept into the emendations of the text.

In the book under review, the editors-cum-translators have eminently succeeded in presenting the original text in old Kannada and translating the same to English as well as to modern Kannada. Further, they have provided mathematical explanations and even worked out the problems given in the text in a style and language intelligible to the present-day students.

Rajaditya's *Vyavaharanita* is believed to be the first available mathematical text in Kannada. There are differences of opinion regarding Rajaditya's date. Generally he is placed in the 12th century CE. In that case, Bhaskara II (born 1114 CE) and Rajaditya were contemporaries, both belonging to the closeby regions of Maharashtra and north Karnataka respectively. Incidentally, we are celebrating the ninth birth centenary of Bhaskara II this year (2014). In *Vyavaharanita*, there are references to Vishnunrupa (King Vishnu) identified with the historically famous ruler Vishnuvardhana who ruled during 1111–1141 CE. Towards the end of his introductory chapter (*Pithika Prakarana*), Rajaditya pays reverence to the Jain guru Sri Shubhachandra in old Kannada as follows:

'Idu subhacandra-deva-yogindra pada-ravinda madhukarayamana manasanandita sakalaganita tattva vilasa

vineyajana vinuta sri rajaditya viracitamappa vyavaharanitadol pithika prakaranam samaptam.'

In corroboration of the contemporaneity of Rajaditya with the said religious celebrity, inscription no. 117 of Shravanabelagola (the famous Jain centre in Karnataka) states that guru Shubhachandra passed away in 1123 CE. Based on these facts many historians conclude that Rajaditya flourished around 1120 CE in the court of the famous ruler Vishnuvardhana of the Hoysala dynasty.

However, scholar Venkatasubbaiah argues that many Hoysala dynasty kings had the same name. So also quite a few religious gurus bearing the name Shubhachandra flourished during different times. On the basis of many inscriptions, Venkatasubbaiah builds up the family tree of an army chief by name Dakarasa. Further, he identifies that brothers Bharata and Bahubali were sons of the army chief Mariyane II and in the kingdom of Ballala II (referred to as Vishnunrupala) eventually became rulers of many provinces by 1183 CE. Venkatasubbaiah maintains, on epigraphical evidence, that the highly revered Jain guru Shubhachandra lived during that period and concludes that mathematician Rajaditya flourished around 1190 CE. By then, Bhaskara II would have been 76 years old. In fact, the epochal year of Bhaskara's astronomical handbook *Karana Kutuhalam* is 1183 CE.

Rajaditya's effortless poetic style and use of *chandasa* (*vrittasa*, metres) establish that he was a highly accomplished poet in haleagannada, besides being a good mathematician. *Vyavaharanita* text comprises topics (*prakarana*) like (i) *pithika* (introduction), (ii) *paribhasa* (technical terminology), (iii) *trairasika* (rule of three), (iv) *pancharasika* (rule of five), *besta* and *mishra rasi* (odd and mixed quantities) and (v) *pancha*, *sapta* and *nava rasi* (rules of five, seven and nine). The translators have added two appendices (*anubandha*). They point out that sometimes, there is disparity between a formula given in the texts and the corresponding comment (*tiku*). Such comments are included in appendix (*anubandha*)-2.

Rajaditya's place: Rajaditya describes eloquently his birth place *Puvinabage* in four or five stanzas. The name resembles the present-day towns Huvinahadagali and Bagevadi in North Karnataka. His

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patrons were the brothers, Bharata and Bahubali. Rajaditya worshipped deity Nemitirthankara.

Lilavati text: This text of Rajaditya in old Kannada is totally different from its popular namesake composed by the famous mathematician–astronomer, Bhaskara II. Although some modern scholars opine that the cited old-Kannada text *Lilavati* is not by Rajaditya. The translators have successfully countered their arguments and established that Rajaditya is indeed the author of the text.

An interesting example is given by Rajaditya in his *Lilavati* which results in 3×3 , 5×5 , ... magic squares.

Example: A queen has lady attendants whose numbers are (differently) squares of 3, 5, 7,.... She gives them cows which yield quantities of milk corresponding to the serial numbers of the attendants as 1, 2, 3,... ‘*serus*’ (*seru* is a volume measure). The distribution of cows according to the milk they produce is to be done equally.

The solution is given by magic squares of odd orders like 3×3 , 5×5 , etc. We have, for example, the distribution of milk among $3^2 = 9$ and $5^2 = 25$ attendants as shown in Figure 1 *a* and *b* respectively. The total yield of milk is 15 and 65 *serus* respectively.

Thus, the author goes on constructing, magic squares of even higher odd orders, viz. 7×7 , 9×9 and 11×11 .

After Rajaditya of the 12th century, there came another eminent mathematician in Karnataka by name Timmarasa, who belonged to Srivatsa gotra. He provided a good number of geometrical figures with their areas in his old-Kannada text, *Ksetraganita*. His father’s name was Laksmarasa and he belonged to a place called Kambha to the west of Ghanagiri, identified as Penugonda in modern Andhra Pradesh. Kambha is now called Kambham.

a	8	1	6
	3	5	7
	4	9	2

b	17	24	1	8	15
	23	5	7	14	16
	4	6	13	20	22
	10	12	19	21	3
	11	18	25	2	9

Figure 1. *a*, 3×3 magic square. *b*, 5×5 magic square.

Six centuries later, there figures another mathematician in Karnataka by name Balavaidyada Celuva, who is said to have composed in Kannada a text called *Lilavati* in 1775 CE.

In the field of astronomy we have Raghunatharaja who wrote a commentary in Sanskrit on the *Aryabhatiya* around 1597 CE. He has used the commentaries of Bhaskara I (629 CE) and Suryadava Yajva (b. 1191–92 CE) and goes deep into the details, thus making his commentary truly valuable. Raghunatharaja proudly declares his kingship in Karnataka:

‘sri karnata vamsa kalasambudhi
kaustubhena’.

The editors-cum-translators as also the publisher richly deserve our thanks and congratulations for bringing out the two earliest known Kannada works on mathematics with English as well as modern Kannada translations.

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