Two Mathematical Texts in the Fourteenth Century

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After Brahmagupta treated the fundamental operations (*parikarman*) together with the eight procedures (*vyavahāra*) and the equations separately in his *Brāhmasphuṭasiddhānta* (628 A.D.) chapters 12 and 18, mathematical topics were divided into two fields, *pāṭīgaṇita* and *bījagaṇita*. The *Līlāvatī* and the *Bījagaṇita* (1150) by Bhāskara II are works in the respective field. Bhāskara's two books and some other Sanskrit mathematical texts written before them have been edited, investigated, and in part translated into English. Compared to these works, few works composed after the twelfth century have been fully studied. This does not mean that Indian mathematicians did not develop mathematics, but only that the originals have not been published.

Two mathematical texts composed in the fourteenth century are available in print. One is the *Gaṇitakaumudī* in Sanskrit, and the other the *Gaṇitasārakaumudī* in Apabhraṃśa, a middle Indic language. The *Gaṇitakaumudī* (GK) is a complete Sanskrit mathematical work written by Nārāyaṇa Paṇḍita in 1356. This book illustrates the development of Indian mathematics after Bhāskara. In addition to the traditional topics such as fundamental operations and the eight procedures Nārāyaṇa adds more procedures. He and Bhāskara include the procedure of solving the indeterminate equation of the first degree, called *kuṭṭaka*, and the combinatorics (*aṅkapāśa*) in their *pāṭīgaṇita* texts. Nārāyaṇa adds the procedure of solving the indeterminate equation of the second degree, called *vargaprakṛti*, and magic square (*bhadragaṇita*)

The *Gaṇitasārakaumudī* (GSK) is one of the seven treatises written by Ṭhakkura Pherū. It consists of five chapters. The first three chapters treat the traditional topics. The remaining two chapters contain supplementary material derived from diverse areas of contemporary life. The GSK gives some methods to construct magic square (*jaṃta*, Skt. *yantra*) in chapter four. Both the GK and the GSK gives the rule for the verification of multiplication. The GSK does not include *kuṭṭaka*, *vargaprakṛti* and *saṅkramaṇa*. The operation to find two numbers when their sum and difference are given, called *saṅkramaṇa*, was given first so far by Brahmagupta in his *Brāhmasphuṭasiddhānta*, chapter 18 dealing with equations. The *Līlāvatī* includes this rule. The investigation of the contents of the two mathematical texts shows some characteristics of Indian mathematics.