J. of Ramanujan Society of Math. and Math. Sc. **ISSN : 2319-1023**
Vol.3, No.1 (2014), pp. 63-66

A Legend of Mathematics-Bhaskaracharya

Dr. Rama Jain
Department of Mathematics,
M.V.P.G. College, Lucknow (U.P.), India

Received July 22, 2014

Abstract Bhaskara II or Bhaskarachrya was an Indian mathematician and astronomer. His mathematical works Lilavati" and Bijaganita are considered to be unparalleled and a memorial to his profound intelligence. His arithmetic text Lilavati is divided into 13 chapters and covers many branches of mathematics, arithmetic, algebra, geometry, and a little trigonometry and mensuration and methods to solve indeterminate equations, and combinations.

His Bijaganita ("Algebra") was a work in twelve chapters. It was the first text to recognize that a positive number has two square roots (a positive and negative square root). His work Bijaganita is effectively a treatise on algebra

In his treatise Siddhant Shiromani he writes on planetary positions, eclipses, cosmography, mathematical techniques and astronomical equipment.

Birth of Bhaskaracharya

Bhaskara II or Bhaskarachrya was born near Bijjada Bida (in present day Bijapur district, Karnataka state, South India) into the Deshastha Brahmin family. His father Mahesvara was as an astrologer, who taught him mathematics, which he later passed on to his son Loksamudra. Loksamudra's son helped to set up a school in 1207 for the study of Bhskara's writings.

Introduction

Bhaskaracharya wrote Siddhanta Shiromani in 1150 AD when he was 36 years old. It is divided into four parts, Lilawati, Beejaganit, Ganitadhyaya and Goladhyaya. In fact each part can be considered as separate book.

This is a mammoth work containing about 1450 verses. The numbers of verses in Lilawati are 278, in Beejaganit there are 213, in Ganitadhyaya there are 451 and in Goladhyaya there are 501 verses.

Siddhanta Shiromani has surpassed all the ancient books on astronomy in India. It consists of simple methods of calculations from Arithmetic to Astronomy. After Bhaskaracharya nobody could write excellent books on mathematics and astronomy in lucid language in India. Bhaskaracharya used to give no proofs of any theorem.

Lilawati is an excellent example of how a difficult subject like mathematics can be written in poetic language. Lilawati has been translated in many languages throughout the world. Till 1857, for about 700 years, mathematics was taught in India from Bhaskaracharya's Lilawati and Beejaganit. No other textbook has enjoyed such long lifespan.

Bhaskaracharya was the first to discover gravity, 500 years before Sir Isaac Newton. He was the champion among mathematicians of ancient and medieval India. In the Surya Siddhant he makes a note on the force of gravity:

"Objects fall on earth due to a force of attraction by the earth. Therefore, the earth, planets, constellations, moon, and sun are held in orbit due to this attraction."

Bhaskaracharya's contributions to mathematics

Lilawati and Beejaganit together consist of about 500 verses. A few important highlights of Bhaskaracharya's mathematics are as follows:

1. Terms for numbers

Bhaskaracharya has given the terms for numbers in multiples of ten and he says that these terms were coined by ancients for the sake of positional values. Bhaskar's terms for numbers are as follows:
eka(1), dasha(10), shata(100), sahastra(1000), ayuta(10,000), laksha(100,000), prayuta (1,000,000=million), koti(107), arbuda(108), abja(109=billion), kharva (1010), nikharva (1011), mahapadma (1012=trillion), shanku(1013), jaladhi(1014), antya(1015=quadrillion), Madhya (1016) and parardha(1017).

2. Kuttak

Kuttak means to crush to fine particles or to pulverize. Kuttak is nothing but the modern indeterminate equation of first order. There are many kinds of Kuttaks.
As for example- In the equation, $ax + b = cy$, a and b are known positive integers and the values of x and y are to be found in integers.

As a particular example, he considered $100x + 90 = 63y$ Bhaskaracharya gives the solution of this example as,
$x = 18, 81, 144, 207...$ and $y = 30, 130, 230, 330...$
It is not easy to find solutions of these equations but Bhaskaracharya has given a generalized solution to get multiple answers.

3. Chakrawaal

Chakrawaal is the "indeterminate equation of second order" in modern mathematics. This type of equation is also called Pell's equation, though Pell had never solved the equation. Much before Pell, the equation was solved by an ancient and eminent Indian mathematician, Brahmagupta (628 AD). The solution is given in

his Brahma-sphuta-siddhanta. Bhaskara modified the method and gave a general solution of this equation.
For example, he considered the equation

$61x^2 + 1 = y^2$ and gave the values of x = 22615398 and y = 1766319049

There is an interesting history behind this very equation. The Famous French mathematician Pierre de Fermat (1601-1664) asked his friend Bessy to solve this very equation. Bessy used to solve the problems in his head like present day Shakuntala devi. Bessy failed to solve the problem. After about 100 years another famous French mathematician solved this problem. But his method is lengthy and could find a particular solution only, while Bhaskara gave the solution for five cases. In his book 'History of mathematics', Carl Boyer says about this equation,

In connection with the Pell's equation $ax^2 + 1 = y^2$, Bhaskara gave particular solutions for five cases, a = 8, 11, 32, 61, and 67.
For example for $61x^2 + 1 = y^2$, he gave the solutions, x = 226153980 and y = 1766319049, this is an impressive feat in calculations and its verifications alone will tax the efforts of the reader
Henceforth the so called Pell's equation should be recognized as 'Brahmagupta-Bhaskaracharya equation'.

4. Simple mathematical methods

Bhaskara has given simple methods to find the squares, square roots, cube, and cube roots of big numbers.
He has proved the Pythagoras theorem in only two lines. The famous Pascal Triangle was Bhaskara's 'Khandameru'. Bhaskara has given problems on that number triangle. Pascal was born 500 years after Bhaskara. Several problems on permutations and combinations are given in Lilawati. He has called the method 'ankapaash'. Bhaskara has given an approximate value of Pie as 22/7 and more accurate value as 3.1416. He knew the concept of infinity and called it as 'khahar rashi', which means 'anant'.

In the last, we can say that his work is outstanding for its systemisation, improved methods and the new topics that he has introduced. Furthermore, the Lilavati contained excellent recreative problems and it is thought that Bhaskara's intention may have been that a student of 'Lilavati' should concern himself with the mechanical application of the method.

References

[1] Sarkr, Benoy Kumar (1918), Hindu achievements in exact science: a study in the history of scientific development, Longmans, Green and co.

[2] Seal, Sir Brajendranath (1915), The positive sciences of the ancient Hindus, Longmans, Green and co.

[3] Shukla, Kripa Shankar (1984), "Use of Calculus in Hindu Mathematics", Indian Journal of History of Science 19: 95104

[4] Plofker, Kim (2009), Mathematics in India, Princeton University Press, ISBN 9780691120676

[5] Cooke, Roger (1997), "The Mathematics of the Hindus", The History of Mathematics: A Brief Course, Wiley-Interscience, pp. 213215, ISBN 0-471-18082-3

[6] Chopra, Pran Nath (1982), Religions and communities of India, Vision Books, ISBN 978-0-85692-081-3