India's Work in Math

India's work in science is both very old and very young: young as an independent and secular pursuit, old as a subsidiary interest of her priests. Religion being the core of Hindu life, those sciences were cultivated first that contributed to religion: astronomy grew out of the worship of the heavenly bodies, and the observations of their movements aimed to fix the calendar of festival and sacrificial days; grammar and philology developed out of the insistence that every prayer and formula, though couched in the dead language of Sanskrit, should be textually and phonetically correct. The scientists of India, for better or worse, were her priests.

In 476, the same year some historians mark as the fall of Rome, the Indian mathematician Aryabhata was born. (He was the first person to conceive of the principle of gravity, which he defined as "attraction towards the center.") In 499 he published *Aryabhatiya* in which he used the decimal point value system. He reported he had found the value of pi to four figures (3.1416, although he did not say how he had figured this out), drew up a table of sines, and provided a system of trigonometry more advanced than anything known to the Greeks. He described algebraic identities and indeterminate equations of the first degree. He explained eclipses, solstices and equinoxes, announced the earth was a sphere and rotated on its axis, devised original methods to determine square and cube roots, and wrote:

> The sphere of the stars is stationary,
> and the earth, by its revolution, produces,
> the daily rising and setting of planets and stars. [Durant 526]

Mathematicians during Gupta India figured out some of the most advanced mathematical processes in history and scientists made major discoveries in physics and medicine as well. Math in Gupta times was more advanced than in any other nation in antiquity. Indian mathematicians had a clear concept of abstract numbers, as distinct from numerical quantity of objects or lengths. Indian mathematicians devised a rudimentary algebra that led to the study of numbers for its own sake. While mathematicians in what was left of the Roman Empire continued to calculate with Roman numerals, Gupta mathematicians had mastered place numbers and were using zero.

Brahmagupta (598-660) developed a clear understanding of algebraic equation. He divided equations into four categories: 1) Simple, 2) Simultaneous, 3) Quadratic, and 4) those involving two unknown quantities. He discussed positive and negative numbers, indeterminate equations of the first and second degree, square and cube roots, and cyclic quadrilaterals. He systematized the astronomical knowledge of India, but rejected Aryabhata's theory of the

revolution of the earth. Writes Durant:

> These men and their followers adapted to Hindu usage the Babylonian division of the skies into zodiacal constellations; they made a calendar of twelve months, each of thirty days, inserting an intercalary month every five years; they calculated with remarkable accuracy the diameter of the moon, the eclipses of the moon and the sun, the position of the poles, and the position and motion of the major stars. They expounded the theory, though not the law, of gravity when they wrote:
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> The earth, owing to its force of gravity,
> draws all things to itself. [Durant, 527]

Bhaskara (1114 C.E. [1036 A.H.] – 1178) was another brilliant Indian mathematician. He and others understood the import of positive and negative quantities, evolved sound systems for extracting square and cube roots, and could solve quadratic equations and certain types of indeterminate equations. Bhaskara understood the mathematical implications of zero and infinity and stated that infinity was the result of dividing any number by zero. He established mathematically what had been recognized in Indian theology at least a millennium earlier: that infinity, however divided, remains infinite, represented by the equation $\infty/x = \infty$.

[Adapted from:

Will Durant. *The Story of Civilization. Part One*. New York: Simon and Schuster, 1935. p. 526

And

A.L.Basham, *The Wonder that was India*. New Delhi: Rupa & Co, 1994. p. 498]