Contributions of Ancient Indians in the fields of Mathematics and Sciences

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Any nation should remember its past. This is necessary to rejuvenate its present and to plan its future. Let us have a look at India's heritage.

The Indian subcontinent can legitimately be proud of its very ancient civilization, dating back to millennia before the start of the Christian era. The ancient world's great civilizations include the Egyptian, Babylonian, Sumerian, Assyrian, Indian, Chinese, Mayan, Inca, and Aztec civilizations. Among all these, some sort of cultural continuity, from very ancient times down to the present day, can be claimed only by two, namely Indians and Chinese.

It is well known that ancient India excelled in the fields of philosophy and literature. What about the sciences and mathematics? Let us have an overview of the contributions of the ancient Indians in these domains.

1. The Concept of Zero.

The concept of " zero' has been acclaimed as one of the most brilliant ideas in mathematical thought. It is indeed one of the foundation stones of the entire edifice of mathematics. It was the ancient Indians who "invented' this concept.

It may be remembered here that other ancient arithmetical systems did not have a place for zero. For example, there is no *zero* in Roman numeral system (I, II, III, IV, V, VI, VII, VIII, IX, X etc).

2. The decimal System

This is another great Indian invention. The so-called Arabic numerals we now use (0, 1, 2,3,4,5,6,7,8 and 9) are truly Indian inventions. The Arabs borrowed it from India and the Europeans came to know of it from the Arabs. That is why the system is called the "Arabic numerals" by the westerners.

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It is interesting to recall a personal anecdote here. During a discussion in an intellectual group abroad, a friend of mine, an Iraqian professor, turned to me and said: "I do not understand why you Indians call them *Arabic numerals*! We Arabs call them "raqm ***–al-_hind'***, that is, Indian numerals!"

About this number system, an Arab mathematician who lived in the 9th century exclaims*: "It is mind-boggling to see how the Indians are able to represent any number, however large it be, by just 10 symbols!*

3. The concept of infinity

The *Vedas* contain a famous hymn, which runs as follows:

Om poornamidam, poornamada:
Poornadpoornamudachyate
Poornasyapoornamadaya
Poornameva/vashishyate

Roughly translated, this would be as follows:

This is infinity that is Infinity:
Infinity derives from infinity;
If one subtracts Infinity from Infinity,
Only Infinity remains!

Philosophers have opined that "*poornam*" refers to God. But mathematicians would gladly have it as ***infinity***! In any case, there are several indications that ancient Indians had notions of 'infinity", "than which no greater number can be conceived". This was another brilliant mathematical idea of the ancients.

4. Big numbers

The ancient Indian texts show that big numbers were familiar to the scholars of the day. In Vedas and other ancient literature we find mention of numbers like *prayuta*(10^6), *samudra*(10^9), *parardha* (10^{12}), and *tallakshana* (10^{53}, that is, 1 followed by 53 zeroes!) Let us remember that the biggest number mentioned in Greek literature is only " myriad" which was equal to just ten thousand!

They also had a systematic nomenclature for big numbers. Thus, 60,699 was read as *"shashtimasahasranavatimnava"*. Fractions were well known too. We find that 3 3/8 is referred to *as trayatrayashtaka,* and 1/24 of 5 is described as " *panchasyachaturvimsaka*"

5. Infinite Series

Number series were also known. The series 6,12,24,48,96,192…is called *"swarnamanasashreni"*.The 14th century Kerala mathematician ***Madhava of Sangamagrama***, along with other mathematicians of the Kerala School, studied infinite series, convergence, differentiation, and iterative methods for solution of non-linear equations. Jyestadeva of the Kerala School wrote the first calculus text, the *Yuktibhasha*, which explores methods and ideas of calculus repeated only in 17th-century Europe.

6. Boudhayana's theorem

Boudhayana had stated, earlier than Pythagoras, that "The Square of the diagonal of a rectangle is equal to the sum of the squares on its sides". Pythagoras said: "The Square

on the hypotenuse of a right-angled triangle is equal to the sum of the squares on the other two sides". Both amount to the same; but isn't Boudhayana's theorem the simpler and more elegant of the two?

7. Astronomy

The study of astronomy had made great progress in ancient India. The earliest concept of a heliocentric model of the solar system, in which the Sun is at the centre of the solar system and the Earth is orbiting it, is found in several Vedic Sanskrit texts written in ancient India. Aryabhata (born AD 476), who was likely to have been a *Keralite*, had stated that the earth rotates on its axis. He also said that the earth revolves around the sun and not vice versa. (All this was independently re-discovered by Copernicus in the 15 the century, about 1000 years after Aryabhata!). Varahamihira, Brahmagupta and others had also made great contributions.

Ancient Indian astronomy books contain poetic expressions like "the borrowed light of the moon" and "the fantastic march of the sum through the *ksheerapatha*". Eclipses, seasonal fluctuations, equinoxes were all calculated accurately. The stars and zodiacal signs were identified and classified and named.

8. Physics, Chemistry and metallurgy

The 6th century BC Indian philosopher Kanaada was the first person who went deep systematically into the structure of matter. He propounded the first Atomic Theory of matter. Kanaada said that matter is composed of units called "anus", which are indivisible. John Dalton arrived at similar conclusions only in the nineteenth century!

An iron pillar believed to be cast in the Gupta period around the 5th century stands by the side of Qutub Minar World heritage site in Delhi. It is 7.32 m tall, with a diameter of 40 cm at the base tapering to 30 cm at the top, and is estimated to weigh 6 tonnes. Standing in the open for last 1500 years, it has withstood wind, heat and water without rusting, except for very minor natural erosion. This kind of rust-proof iron could not have been made until iron and steel was discovered earlier.

Let us also remember the metal mirrors (Aranmula*kannadi*) of the Kerala metal smiths too. They still make these metal mirrors which rival ordinary glass mirrors in quality.

An influential Indian metallurgist and alchemist was Nagarjuna. He wrote the treatise *Rasaratnakara* that deals with preparations of many chemical compounds. It gives a survey of the status of metallurgy and alchemy in the land. Extraction of metals such as silver, gold, tin and copper from their ores and their purification were also mentioned in the treatise.

9. Cosmology

The ancient Indians had developed a cosmology of their own. They conceived of a brahmanda, which gave birth to the universe. (How similar is this to the idea of Lemaitre who thought of a "cosmic egg", and whose ideas led to the Big Bang theory!)

The Indians also considered a "cyclical

universe", with the Day of the Brahma, the Night of the Brahma, and an endless repetition of these . Each cycle was a "*kalpa*". Professor Carl Sagan says: "The similarity between our modern cosmoloical theory of the cyclical universe and the ancient Hindu concepts of *kalpa* and *kalachakra* is really astounding!"

10. Ayurveda, chemical technology

The science of medicine in ancient India is known as "Ayurveda", literally, "the science of life or longevity" in Sanskrit from "ayur" (age or life) and "veda" (knowledge). Ayurveda constitutes ideas about ailments and diseases, their symptoms, diagnosis and cure, and relies heavily on herbal medicine, including extracts from several plants. Ayurveda, the Indian system of medicine, has stood the test of time and is poised to become popular all over the world. Charaka, Susruta, Vagbhata and others were great medical scientists and physicians, and surgeons too. The medicines included *kashayas, bhasmas, sundooras, lehyas, asavas, arishatas, thailas, etc.*

Fermentation techniques were widely practiced. Various types of alcoholic drinks (*soma, sura, madhu etc.)* were known.

11. Conclusion

We have merely glimpsed randomly here about some of the achievements of the ancient Indians. Let us remember that these achievements were made at a time, when the ancestors of the present Europeans lived like uncivilized tribals.

Truly we thus have a great heritage to be proud of, not only in philosophy and literature, but also in the sciences and mathematics.

It is gratifying to note that after attaining independence from the colonial yoke of Britain, free India has made remarkable progress in science and technology. We have made spectacular achievements in nuclear science, space science, agricultural self-sufficiency (green revolution), milk production (white revolution) telecommunication and so on. We have had great leaders in science such as Sir C V Raman, Dr. J.C Bose, Professor P C Ray, Dr. S.N. Bose, Dr. Meghnad Saha and others. Modern India has great leaders of technology like Dr. Homi J. Bhabha, Dr. Vikram Sarabhai, Dr. M.S. Swaminathan, Dr. Varghese Kurien, Dr. Sam Pitroda, Dr. A.P.J. Abdul Kalam, Dr. B.N.R. Rao and others.

Our latest great achievements, namely the ***Chandrayaan*** and the ***Mangalyaan*** (Mars Orbital Mission or MOM) have done all Indians proud. We are the fourth nation (after USA, Russia and Japan) to hoist our national flag on the surface of the moon. It is our *Chandrayaan* which established the presence of water on the moon. Our MOM is well on its way to the planet Mars. It is expected to orbit Mars by September 2014.

Yes, we had a great past, we have a vibrant present and we look forward to a glorious future! Think of that. Get inspired with positive thinking to build a great India of tomorrow.