J C Bose and Free Knowledge Systems

K. Gopinath
IISc

Anti-patent before his time!

- "On a personal level, Bose believed in free exchange of scientific knowledge and strongly believed that knowledge grows by sharing it with fellow scientists. The idea of the commercialization of science was so repugnant to him that in the founding charter of the Bose Research Institute, he included a clause that no member of his institute may be allowed to apply for a patent for any idea and/or device that he developed,"
  - "Centennial of the Semiconductor Diode Detector," DIPAK L. SENGUPTA, TAPAN K. SARKAR, AND DIBAKAR SEN, PROCEEDINGS OF THE IEEE, VOL. 86, NO. 1, JANUARY 1998
- Machlup & Penrose (1950) in J. of Economic History state that Profs Bolley and Kronauer (chemical and mechanical technology) from Zurich Inst of Tech wrote a doc against patents in 1862.
  - In this study, no other scientists or technologists finds a mention...
  - No Bose either!

Bose's mm microwave research

- In 1895, Bose first demonstrated at the then Presidency College the transmission and reception of electromagnetic waves at 60 GHz over a distance of 23 meters.
  - At this freq, “easy” to show “optical” properties of electromagnetic waves
- “Further work at millimeter wavelengths was almost nonexistent for nearly 50 years. J.C. Bose was at least this much ahead of his time”
  - D T Emerson, IEEE Trans on Microwave Theory and Techniques, Dec 1997, Vol. 45, No. 12, pp.2267-2273
- Addressing the gathering at Presidency College, [the President of IEEE] Staeker said [in 2012] IEEE recognises the fact that Bose had introduced MM wavelength techniques at least 50 years before anyone else did…

Bose and Marconi

- Bose's demonstration of remote wireless signalling has priority over Marconi but Bose did not want to patent it
  - DT Emerson, IEEE Trans on Microwave Theory and Techniques, Dec 1997, Vol. 45, No. 12, pp.2267-2273
- But Marconi got the Nobel prize!
- A fairer Nobel Prize would have been that Bose, Tesla, Marconi share the prize!
  - One can give Marconi also a share of the prize because
    - He did original work on long-distance wireless communication
      - Also, invented the Morse code modulator of Hertzian waves
    - He was also a good salesman for others' ideas, incl that of Tesla's who fought with Marconi doggedly till the US courts in '43 clearly said that Marconi violated Tesla's patents.

- Note that Bose refused to patent his "coherer" (for microwaves) and Marconi then “stole” it and claimed it as his own.
  - Marconi made a very minor modification and claimed that he got the device from the Italian navy and called it the “Italian coherer”
  - Kept changing his story also!
- Bose had presented his work in Royal Inst in 1895 and published in the proceedings (therefore checkable) but nobody wanted to believe/give credit to Bose
  - Bose a student of Lord Rayleigh and not exactly “unknown”
  - “....at the initiative of Lord Rayleigh, the University of London awarded the degree of doctor of science to Bose on the basis of this work. The quality of the research was so impressive that the University of London made an exception so that Bose was not required to defend his thesis in person at the university.” op.cit.
- Essentially, Bose's ideas became “common property” and privatised
- No “CopyLeft” idea at that time!
  - If you use some software from the “free software” world, your extensions also become free (legally also!)
    - Stallman used this in GNU license
  - Bose may have used such an idea if avlbl at that time...

- THE WORK OF JAGADIS CHANDRA BOSE: 100 YEARS OF MM-WAVE RESEARCH (revised Feb 1998) https://www.cv.nrao.edu/~demerson/bose/bose.html
  - D.T. Emerson, National Radio Astronomy Observatory, Arizona.
- Conclusions of this paper:
- "Research into the generation and detection of millimeter waves, and the properties of substances at these wavelengths, was being undertaken in some detail one hundred years ago, by J.C. Bose in Calcutta. Many of the microwave components familiar today - waveguide, horn antennas, polarizers, dielectric lenses and prisms, and even semiconductor detectors of electromagnetic radiation - were invented and used in the last decade of the nineteenth century.
  - At about the end of the nineteenth century, many of the workers in this area simply became interested in other topics. Attention of the wireless experimenters of the time became focused on much longer wavelengths which eventually, with the help of the then unknown ionosphere, were able to support signalling at very much greater distances.
- Paper's abstract:
- "Just one hundred years ago, J.C. Bose described to the Royal Institution in London his research carried out in Calcutta at millimeter wavelengths. He used waveguides, horn antennas, dielectric lenses, various polarizers and even semiconductors at frequencies as high as 60 GHz; much of his original equipment is still in existence, now at the Bose Institute in Calcutta. *Some concepts from his original 1897 papers have been incorporated into a new 1.3-mm multi-beam receiver now in use on the NRAO 12 Meter Telescope*."

Diode

- Bose first to use a semiconductor junction (cat-whisker galena diode) to detect radio waves. His I/V graph for a semiconductor is almost identical with what we study even now in introductory texts (surprisingly even with a "sharp" 0.7V knee)
- As Vivekananda insisted and got the patent on a semiconductor diode for Bose, there is no question who invented the diode first but very few in India know about it!
  - Patent for a point-contact semiconductor rectifier for detecting radio signals
  - Nivedita and her friend got the patent for Bose as Bose was not very keen!
  - Bose, J. C. "Detector for electrical disturbances," U. S. Patent 755,840 (Filed September 30, 1901. Issued March 29, 1904)
- Centennial of Bose's semiconductor diode detector observed by IEEE a decade ago
- Recently (2012), IEEE installed a plaque at Bose Inst recognizing Bose as diode's inventor.

Relevance of copyleft

- Stronger parties can typically use other's ideas without credit if no copyleft
- Many discoveries and inventions in the ancient world liberally assigned to Greeks
  - Becomes apparent when you think about contributions of Romans to science and technology
    - Viaducts and others engineered by Romans acknowledged but not their scientists or mathematicians
    - A Wikipedia search for Roman scientists has atmost 6 entries!
      - (Astronomers) Acoreus, Adrastus of Cyzicus, Theon of Alexandria, Gaius Julius Hyginus, Gaius Sulpicius Gallus
      - Lucilius Jr. (administrator) but a a poet??? a scientist???
    - Romans ruled the world at that time for almost 600 years (much longer than Greeks ever did)
  - Medieval compilers of information (after crusades) in Europe (c.1200) transcribing from Arabic sources added their biases
- Repeatedly happened wrt discoveries and inventions made in India
  - Invention of zero => first credited to “Arabic” lands
  - “Pythogoras” theorem => Baudhayana's theorem
  - “Fibonacci” numbers => Pingala's numbers
  - “Pascal's traingle=> Meru Prasthana
    - Also many theorems in combinations and permutations
  - Madhava series for pi/4 and for tan x (called “Gregory series”)
  - Paramesvara (15^{th} c) => Mean Value Th; Bhaskara II: “Rolle” Th
  - Early notions of “infinitesimal calculus”
    - eg. d(sinx)=dx.cosx (given in 932AD by Munjala's Laghumaanasa)
  - Chakravaala method for solving “Diophantine eqns”

Combinations

- Susruta (Charaka Samhita) 2000+ years before
  - Medicine: sweet, sour, salty, peppery, bitter or astringent
  - Mix
    - any 2 qualities: 15 possibilities (${}^6C_2$)
    - any 3 qualities: 20 possibilities (${}^6C_3$)
    - any 4 qualities: 15 possibilities (${}^6C_4$)
    - any 5 qualities: 6 possibilities (${}^6C_5$)
    - any 6 qualities: 1 possibility (${}^6C_6$)
- Bhaskara (c.1150) (Lilaavati)
    - ${}^nC_k$ formula: (n(n-1)...(n-k+1))/(k(k-1)...1)

Combinatorics (Pingala's/Gopala's #s)

- Gopala (< 1135 CE) and Hemachandra (c. 1150): find number of rhythmic patterns for *n* beats (F(*n*)) with anudruta (1-beat) and druta (2-beat):
  - F(*n*) = F(*n*-1) + F(*n*-2)
    - Fix one anudruta as the 1st part. Remaining (*n*-1) beats have F(*n*-1) distinct possibilities
    - Next, fix one druta as the 1st part. Remaining (*n*-2) beats have F(*n*-2) distinct possibilities
    - Sum gives F(*n*)
  - Pingala (500 BCE) &c already seems to be familiar with these
  - Often called “Fibonacci” numbers
    - Fibonacci wrote (about 1202) a book using “Arabic” texts that discussed Indian mathematics
    - Name given only in c. 1870's by Lucas who proved 2^127 -1 is prime using these numbers

(See Knuth, Art of Computer Programming, Vol1. p. 79-80)

Fibonacci's account

There, following my introduction, as a consequence of marvelous instruction in the art, to the nine digits of the Hindus, the knowledge of the art very much appealed to me before all others, and for it I realized that all its aspects were studied in Egypt, Syria, Greece, Sicily, and Provence, with their varying methods; and at these places thereafter, while on business, I pursued my study in depth and learned the give-and- take of disputation. But all this even, and the algorism, as well as the art of Pythagoras I considered as almost a mistake in respect to the method of the Hindus. Therefore, embracing more stringently that method of the Hindus, and taking stricter pains in its study, while adding certain things from my own understanding and inserting also certain things from the niceties of Euclid's geometric art, I have striven to compose this book in its entirety as understandably as I could, dividing it into fifteen chapters. Almost everything which I have introduced I have displayed with exact proof, in order that those further seeking this knowledge, with its pre-eminent method, might be instructed, and further, in order that the Latin people might not be discovered to be without it, as they have been up to now.

(from THE AUTOBIOGRAPHY OF LEONARDO PISANO, RICHARD E.GRIMM University of California, Davis, California, Fibonacci Quarterly, Feb'73)

Narayana Pandita (1356)

- Ganita Kaumudi
  - Generalizes F(n) to sum of the last *q* terms. eg.
  - “A cow gives birth to a calf every year. The calves become young and they begin giving birth to calves when they are three years old. Tell me, O learned man, the number of progeny produced during twenty years by one cow.”
  - Let V(n) be number of cows incl the 1st mother cow at n years. Assume at starting time (0th year), a calf
  - For n>3, V(n)= 1+V(n-3)+V(n-4)+...+V(1)+V(0)+3
  - For n<=3, V(0)=1+1, V(1)=3, V(2)=4

Madhava series (c. 14Th century)

व्यासे वारिधिनिहते रूपहृते व्याससागराभिहते।
त्रिशरादिविषमसङ्ख्याभक्तमृणं स्वं पृथक् क्रमात् कुर्यात्॥

πd= 4d/1 - 4d/3 + 4d/5 – 4d/7 + ...

equivalent to

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} \cdots$$

Vyasa: diameter
Vaaridhi, Saagara: 4
Nihata: divided
Roopa: one
Abhihata: mult
Trishah: 3
Aadi: and other
Vishama: odd
Sankhya: numbers
Abhaktha: subtract
Pruthak: separately
Kramaath: in seq
Kuryath: do

Very Slow convergence
Faster methods also given by another Madhava series (now called Madhava-Gregory series) such as
Π/6 = $\tan^{-1}(1/\sqrt{3})$ =
$1/\sqrt{3}[1 - 1/3.3 + 1/5.3^2 – 1/7.3^2 + ...]$

Mathematics (Kerala)

- Careful calculation of planetary orbits using infinite series to high accuracy
  - Nilakantha Somayaji (1444–1544) Tantrasangraha 1500 AD (Kerala)
  - Jyeshthadeva (c. 1500 – 1610) Yuktibhāṣā, Ganita-yukti-bhasa (Kerala)
  - Predecessors
    - Paramesvara (1370-1460)
    - Madhava (c. 1350 – 1425) Kerala (near Kochi)
    - Bhaskara II (1114–1185) Karnataka/Ujjain/Sahyadri
      - Originator of many ideas in calculus
- George Gheverghese Joseph (A Passage to Infinity: Medieval Indian Mathematics from Kerala and Its Impact, 2009) and CK Raju (Cultural Foundations of Mathematics, 2007)
  - Credible hypothesis of transmission of many ideas of calculus from Kerala to Europe in 16th c. CE thru Jesuits in Kerala

Note that decimal arithmetic in Europe discussed first only in 1585 by Stevin Simon!

  - *His notation still clumsy: eg.3.73 (modern c.1612) written as 3**0**7**1**3**2**.*
    - "But nobody established their daily use before Stevin. He felt that this innovation extremely significant" (from Wikipedia)
  - *Decimals developed earlier by Al Kashi (Iran: 1380-1429)*

Wallis and Brouncker

- Wallis derived
  - 4/pi = 3/2 * 3/4 * 5/4 * 5/6 * 7/6 * 7/8 * ...
- “At this point Wallis showed his work to Brouncker who, according to Wallis, thought it through for himself and suggested an entirely different form for the fraction:
  - 1+1/(2 + 9/(2+25/(2+49/(2+81/...))))”
    - Catching Proteus: The Collaborations of Wallis and Brouncker. I Squaring the circle by JA Stedall - 2000
- “Wallis clearly realized that some explanation was needed but failed to persuade Brouncker to ‘show his working’ and so attempted the task himself in a lengthy scholium...” op.cit [without success]
- “Wallis never returned to the problem of how Brouncker made his discovery: in *A Treatise of Algebra* 30 years later, he merely restated the result. Succeeding generations of mathematicians, however, have continued to be intrigued by Brouncker’s work.” op.cit.

- “Brouncker’s appointment [as President of Royal Society] was made as much in recognition of his personal and political qualities as his mathematical skills.” op.cit.
- “He gave few clues as to how he obtained his results” op.cit.
- “Brouncker emerges as a skilled and intuitive mathematician.” op.cit.
- Simpler explanation instead of the British historian's refusal to go behind the scenes:
  - Brouncker had access to books of the Kerala Mathematicians 15-16th c. (Nilakantha, etc) where these were worked out starting from Madhava in the 14th c.
    - See for eg. Ch.3 of CK Raju “Cultural Foundations of Mathematics”
  - Hence reluctance to explain the method/sources.

Another example

- Enough evidence that Fermat and others had come into contact with Indian works on mathematics and happily appropriated it. Most telling example is that of solutions of $61x^2 + 1 = y^2$ that Jayadeva/ Bhaskara II solved about 5-8 centuries earlier and this precise equation was sent by Fermat as a challenge to European mathematicians (again without revealing the source)
- Again from Wikipedia: "Jayadeva (9th century) and Bhaskara (12th century) offered the first complete solution to the equation, using the chakravala method to find (for the notorious N = 61 case):
  - x = 1 766 319 049 and y = 226 153 980.
- This case was first “solved” in Europe by Brouncker in 1657–58 in response to a challenge by Fermat,..."
- Remarkable that within a year it was solved without any explanation of the method! Chakravaala method was systematically explained in the Indian tradition.

Digestion of Botanical Knowledge

- Hortus Malabaricus 1678-1693: ethnobotanical account of Malabar
  - "author" Van Rheede (Commissioner General of Dutch East Indies Co)
  - Actual authors:
    - Itty Achudem (a Ayurveda Vaidyan and a Ezhava)
    - Ranga Bhatt, Vinayaka Bhatt, Apu Bhatt (Konkan Brahmanas)
    - Countless (200+) other informers/collectors of plant species
  - Historian Richard Grove argues that Hortus M. is a "profoundly indigenous text"
    - Indigenous Knowledge and the Significance of South-West India for Portuguese and DutchConstructions of Tropical Nature by Richard Grove: Modern Asian Studies, Vol. 30, No. 1 (Feb., 1996), pp. 121-143
  - When first published in 17th century, scientists in Europe acclaimed Hortus Malabaricus as a milestone in the field of plant science.
    - KS Manilal, HORTUS MALABARICUS AND THE ETHNOIATRICAL KNOWLEDGE OF ANCIENT MALABAR, Curr. Sci. '84
  - Hortus M. ranked by Linnaeus as one of two greatest works that contributed to his systematics (other work being Oxford botanist Dillenius's Hortus Elthamensis)
    - Londa Schiebinger: Lost Knowledge, Bodies of Ignorance, and the Poverty of Taxonomy as Illustrated by the Curious Fate of Flos Pavonis, an Abortifacient in "*Picturing Science, Producing Art*", ed. Caroline A. Jones, Peter Galison, 1998

But “surprisingly”:

- Linnaeus (1737) banned use of any language other than Greek or Latin for naming plants
  - “generic roots not derived from Greek or Latin roots are to be rejected”
    - Artificial names (divorced from locale or usage) OK as long as “seen to be derived” from Gk/Latin roots
      - ensure no trace of indigenous culture!
      - decontexualize the plant and tradition
    - eg. naming an abortifacient used in Kerala (zetti-mandaru) as *Poinciana pulcherrima* after some Governer of French Antilles acceptable!
  - All foreign terms and names “barbarous” and banned
    - But European mythology, etc. OK

- Londa Schiebinger: Lost Knowledge, Bodies of Ignorance, and the Poverty of Taxonomy as Illustrated by the Curious Fate of Flos Pavonis, an Abortifacient in “*Picturing Science, Producing Art*”, ed. Caroline A. Jones, Peter Galison 1998

Nature of Botanical Enquiry in Malabar: Manilal op. cit.

In order to record the medicinal properties of the plants he collected, Rheede gathered his local experts around him, who used to discuss the matter thoroughly among themselves, coming to an agreement acceptable to all so that no one among them attributed either superior or inferior virtues to the plants. It is interesting to see what Rheede himself has written about this: *"I often attended a most delightful entertainment for instance when these Brahman and gentile philosophers disagreed and disputed with each other by weight of arguments, which they took from maxims, rules, verses from antiquity, and books of their ancestors who were renowned for their learning. Indeed they disputed and strongly defended their own opinions, but with incredible modesty, such as you might even miss in the most distinguished philosophers of the world, without any acerbity, mental disturbance, or neglect to respect each other's opinions. They honour antiquity and the first inventors of their sciences with the most pious reverence, and by them they judge their own views and also their own experiences, and they subject them to their authority. And, as regards medicine and botany, the knowledge of these sciences is preserved in verses, the first line of which begins with the proper name of the plant, whose species, properties, accidents, forms, parts,, location, season, curative virtues, use, and the like they then describe highly accurately. They did this so skillfully that, if anyone mentioned the proper name of some plant, any Brahman will at once answer you, stating whatever has been and can be said about it. Although, however, this method of teaching, which requires a tenacious memory, seems to be rather difficult, still they impress these verses with playful ease on the memory of the young, which they say is them strongest. Later the docile minds of adolescence and manhood retain them faithfully. The first inventors of these disciplines (namely medicine and botany) is considered to be so old that they show books by authors of whom all affirm by constant asservation that they lived four thousand years age."*

Zinc Production in India

- Zinc distillation and metallurgical usage pioneered in India
  - At least 2000 years back but in a large scale 800 years back
  - China started manufacture 400 years back using techniques from India
  - Europe only 300 years back (technology from India again)
- Zinc a difficult to work with due to its low boiling point (907°C)
  - Need special distillation techniques
- Industrial scale production pioneered in Rajasthan (Zawar)
  - Estimates: at Zawar: 1 MT of metallic zinc and zinc oxide from the 12th to 16th centuries. Another estimate: 60KT of metallic zinc
- England took the technology of zinc smelting from India in 1736 and William Champion patented it! (whose family became a big in brass/zinc in 19^{th} c)
- British metallurgy documents do not mention zinc at all prior to this transfer.
- Yet, today's Eurocentric accounts of history ignore India's industrial production of zinc.

Estee Lauder

- Aveda, a successful company in US (subsidiary of cosmetics giant Estee Lauder) has cornered a good part of the upmarket Ayurveda worldwide using Indian sources!
- “In 1970, Horst, on a trip to India, was introduced to the healing properties of Ayurveda (the traditional Hindu longevity medicine) and aroma, and suddenly his vision for his company (thus the name Aveda) was born.” (from Wikipedia)

Truth Claims or Belief Systems

- Christianity originated as a reaction to both Hebrews and Greeks
  - Surprisingly, its current heritage is from these two sources almost exclusively
    - Medieval authors preferred Greek sources as the source of their knowledge systems even if the knowledge originated elsewhere
    - Elaborate histories created to facilitate this
  - However, Greek “culture”/religion disappeared and Hebrew culture a minority now
- Currently, one sees tendencies to assimilate what is “good” in Indic systems but in an asymmetric manner
  - Esp in “consciousness” studies
  - Erase the sources of contributions so that earlier Indic insights are completely obscured but appear in a “new scientific” garb

Free Knowledge Systems

- CopyLeft (GPL, LGPL)
  - V2: Linux kernel an excellent example
  - V3: great relevance in “cloud systems”
- Creative Commons
  - Many versions to give producers of knowledge fine grained control
- Aron Swartz: freeing “court records” and “journal papers”
  - Publications of Academic Research: who owns them?
  - Recent US Govt decision on free access after 1 year of pubs of research funded by Govt
- Sec 66A of IT Act (2000)
  - Problematic for Internet in India

Conclusions

- Copyleft types of ideas critical in preserving freedom of thought and choice
- Future will be “information” dominated
  - Who controls what this “information” is, how it is produced, how it is labelled, wins...
  - Free Knowledge Systems one way to escape this very cynical and competitive landscape