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A Brief History of Zero

Hermann Minkowski
(Founder of Geometry of Numbers)

(1864-1909)

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

Science fiction—an effective means of communicating science and technology

Dr. Subodh Mahanti

Human beings have an inborn affinity to storytelling. Any idea which is communicated in the form of a story is easily understood. So there is no wonder that science fiction (often abbreviated as sci-fi or SF), or more precisely a good science fiction, containing a core of scientific ideas encased in an envelope of fiction (literature) can play an effective role in science communication. Science fiction often talks of imagined scientific discoveries to be realised in future and how future developments of science and technology would transform or change human society. Science fiction explores the consequences of scientific innovation and in this sense it is a 'literature of ideas'. Science fiction also talks of alien worlds and what will happen when aliens come in contact with human beings. Many well-known scientists and inventors including Albert Einstein and Robert Hutchings Goddard have admitted that they were influenced in pursuing their ideas by reading science fiction. Some of the most visible achievements of the 20th century science and technology like nuclear bomb, journey to Moon, fast and compact computers, air travel, worldwide communication network, etc., were anticipated by science fiction writers. Arthur C. Clarke, one of the greatest science fiction writers, in his futuristic essay titled "On the possibility of using artificial satellites for communication purposes", imagined about communication satellites and geostationary orbits. Although good science fictions often border on fantasy, a line needs to be drawn between science fiction and fantasy. In this context we should remember how the two were distinguished by Rod Sterling: "Fantasy is the impossible made probable. Science Fiction is the improbable made possible." While there may be pure imaginative and speculative ideas in good science fictions, the imaginary elements are largely plausible 'within scientifically established laws of nature.'

Hugo Gernsback, who first attempted to transform science fiction (a term derived from 'scientifiction' originally coined by Gernsback) into a distinct form of literature by editing the first science fiction magazine called *Amazing Stories* (first appeared in 1926), which described science fiction in the following words: "By 'scientifiction' I mean the Jules Verne, H. G. Wells and Edgar Allan Poe-type of story—a charming romance intermingled with scientific fact and prophetic vision." *Amazing Stories* was soon followed by other science fiction magazines like *Astounding Stories* and *Planet Stories.* The scope of science fiction was further broadened; the descriptions of known scientific developments in story form were also included.

In science fiction there are many sub-genres and themes. It seems there are no defined boundaries of science fiction. Robert A Heinlein defined science fiction as "a handy short definition of almost all science fiction might read: realistic speculation about possible future events, based solidly on adequate knowledge of the real world, past and present, and on a thorough understanding of the nature and significance of the scientific method."

Defining the genre, science fiction, has proved to be elusive. *The New Shorter Oxford English Dictionary* (1993) defines science fiction as "fiction based on imagined future scientific discoveries, major environmental or social changes, etc., frequently involving space or time travel or life on other planets." Another English dictionary, *Encarta World English Dictionary* (1999), defines science fiction as a "form of fiction, usually set in the future, that deals with imaginary scientific and technological developments and contact with other worlds." These definitions are correct within their own domains, but all those writings that are going on in the name of science fictions do not fall within the scopes of these definitions. Those who are familiar with the writings that are going on in the name of science fiction in English and other languages including Indian languages would realise that standard dictionary definition of science fiction is not sufficient to include all those writings as science fiction. In fact writings on horror, black magic, fairy tales, or on themes totally opposed to current scientific understanding are often passed off as science fiction.

Historians of science fiction usually regard Marry Shelly as the first science fiction story writer and her work *Frankenstein* (published in 1818) as the first science fiction. However, there were earlier attempts which could be likened to science fiction. Sometime these are called proto-science fictions. For example, Francis Bacon's *New Atlantis* (published first in Latin as *Nova Atlantis* in 1624 and translated in English in 1627), Johannes Kepler's *Somnium* (1634), Daniel Gabriel's *A Voyage to the World of Cartesius* (1692), Jonathan Swift's *Gulliver's Travels* (1726),

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Hermann Minkowski
Founder of geometry of numbers

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Minkowski put forward his concept of space-time, or Minkowski space as it is sometime called, in 1907 in his book *Space and Time*. Einstein himself was very forthright about the extent to which the theory of relativity depended on Minkowski's innovatory work. Space-time was a useful and elegant format for special relativity, and was essential for general relativity, published in 1916, in which space-time is allowed to be curved. It is the curvature of space-time that accounted for the phenomenon of gravitation.

A Dictionary of Scientists, Oxford University Press, 1999

"The views of space and time I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical. Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality."

Hermann Minkowski

Hermann Minkowski's contributions to the development of modern mathematics are very significant. His created the basis for modern functional analysis. He extended the knowledge of quadratic forms to a great extent. He founded a sub-discipline of mathematics called geometry of numbers.

It was Mnkowski who laid the mathematical foundation for Albert Einstein's theory of relativity. Minkowski could realise that Einstein's special theory of relativity could be best appreciated in a non-Euclidean space (now called Minkowski space). Thus while developing the rigorous mathematical structure and geometrical implications of the theory of relativity Minkowski proposed space and time, which were earlier thought to be independent, were linked together in a four-dimensional 'space-time continuum'. The space-time continuum, also called space-time, was conceived by Minkowski to denote the geometry of the physical universe as suggested by the theory of relativity. As we know, in Newtonian physics or classical physics space and time were considered quite separate quantities. But Minkowski demonstrated that the concept of relativity theory made it necessary mathematically to take time into account as a fourth dimension in addition to the three spatial dimension, viz., length, breadth and width. Thus the works of Einstein and Minkowski showed that space and time are actually intimately interlinked. The totality of a space and time as a single four-dimensional continuum is also referred to as event universe or Minkowski

Hermann Minkowski

universe in which the history of a single space point in the course of time must be treated as a curve or line and an event limited both in space and time represents a point. These geometric concepts in Minkowski's universe are often referred as world curves or world lines and world points respectively are to be distinguished from their analogs in normal three-dimensional space. It should be mentioned here that the origin of the idea of the unity of space and time could be traced to the analysis of transformations by Hendrik Lorentz. Minkowski for the first time realised the importance of the Lorentz transformation ideas.

Before Minkowski came up with his space-time model, Einstein's special theory of relativity was viewed by physicists including Einstein himself as a physical theory without realising its geometrical implications. It was Minkowski who studied the mathematical structure of the new theory and its geometrical implications. Minkowski's mathematical ideas and techniques played an instrumental role in Einstein's construction of the general theory of relativity.

Both Minkowski and David Hilbert influenced each other's career. They first came in contact as students in Konigsberg. Minkowski was junior to Hilbert. Later they became colleagues at the University of Gottingen. Both of them moved from pure mathematics to mathematical physics. They were influenced by and reinforced the idea of a "pre-established harmony between mathematics and physics." It was also believed that mathematical sophistication was essential in unveiling the secret of nature. It is well-known that Hilbert greatly influenced the course of mathematical research in the 20th century by suggesting a list of major mathematical problems in his famous 1900 lecture. However, it was not very well-known that it was Minkowski who suggested to Hilbert to take up this theme for his lecture. Minkowski in a letter to Hilbert wrote: "What would have the greatest impact would be an attempt to give a preview of the future, i.e., a sketch of the problems with which future mathematicians should occupy themselves. In this way you could perhaps make sure that people would talk about your lecture for decades in the future." Minkowski and Hilbert were greatly responsible for changing Einstein's perception of mathematics from 'a mere tool

in the service of physical intuition' to 'as the very source of scientific creativity.'

Minkowski taught Albert Einstein mathematics at the Zurich Polytechnic. He had no particular fascination for Einstein as a student. In his correspondence with Hilbert the only student of the Polytechnic referred to was Walter Ritz (1878-1909). He is believed to have said to his later students that he found Einstein's presentation of theory of relativity mathematically awkward.

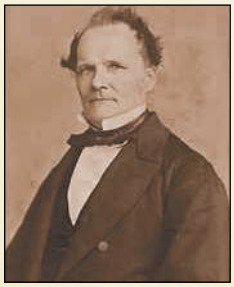
Walter Ritz

Hermann Minkowski was born on 22 June 1864 at Alexoten (Alexotas) in the Russian empire under Tsar Alexander II (near Kaunas in modern-day Lithuania). His parents Lewin Minkowski and Rachel Minkowski (*nee* Taubmann) were of German origin. Minkowski was taught at home till the age of seven. In 1872, his parents moved back to Germany and settled in Konigsberg (now Kalinigrad, Russia). Minkowski attended the Altstadtisches Gymnasium where among his juniors were Wilhelm Wien (1864-1928) and Arnold Sommerfeld (1868-1951), who later became distinguished physicists.

Wilhelm Wien

Ernst Eduard Kummer

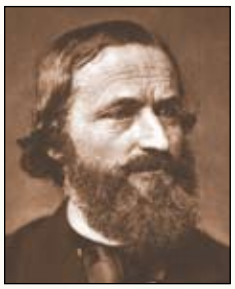
Minkowski joined the University of Konigsberg in April 1880, where he was taught by among others Heinrich Weber, Woldemar Voigt, Adolf Hurwitz and Ferdinand Lindermann. He spent three terms in the University of Berlin where he attended lectures of Ernst Eduard Kummer (1810-1893), Leopold Kronecker (1823-1891), Hermann von Helmholtz (1821-1894), and Gustav Robert Kirchhoff (1824-1887).



Leopold Kronecker

Hermann von Helmholtz

In 1883, Minkowski won the Grand Prix des Sciences Mathematiques of the Paris Academy of Sciences. Minkowski was only 18 years old. He shared the award with the accomplished British mathematician Henry J. S. Smith. The prize was announced in 1881. The topic of the prize was finding a solution to the problem of the number of representations of an integer as the sum of five squares. The problem was earlier tackled by Eisenstein in 1847 and he gave a formula for the number of such representation. However, he had not given any explanation on how he arrived at the formula. In 1867, Smith solved the problem and he also gave proof in support of his result. The Paris Academy of Sciences was not aware of Smith's work while announcing the topic of the prize. Smith submitted an elaborate version of his earlier work on the topic. Minkowski also came up with a solution to the problem while reconstructing Eisenstein's theory of quadratic forms. Minkowski submitted his results to the Academy in the form of a 140-page manuscript. Minkowski's formulation was considered better than that of Minkowski as the former used more natural and general definitions in working out the proof. In 1885, he completed his PhD at Konigsberg under the supervision of Lindermann. His PhD thesis was on quadratic forms. At Konigsberg University Minkwoski came in contact David Hilbert.



Gustav Robert Kirchhoff

Henry J. S. Smith

After PhD he had to undertake obligatory military service and then in 1887 he joined the Bonn University, as a Privatdozent (non-salaried lecturer). In 1892 he was promoted to the rank of Associate Professor. At Bonn started working in the field of mathematical physics. The first problem to be undertaken by him was to find the motion of solids immersed in perfect liquid. This problem was earlier studied by W. Thomson, Kirchhoff, Clebsch, and others. Minkowski developed a method which could be applied to a solid irrespective of its form. At Bonn, Minkowski's interest moved from mathematics to physics. He started spending time at the Bonn's Institute of Physics which at the time was headed by Heinrich Hertz. He even attended a laboratory course. There are reports to indicate that Hertz invited young Minkowski over for dinner. Minkowski's interaction with Hertz did not last long as the latter died in 1894. In the same year Minkowski left Bonn. Perhaps things could have been different if Hertz had lived longer. But it had some decisive impact on Minkowski, he developed an interest in theoretical mechanics. It may be noted that Hertz devised new principles of mechanics in the early 1890s.

While at Bonn, Minkowski also worked on number theory, which led to the formation of the basis of a new sub-discipline in mathematics, the geometry of numbers. In 1896, he gave a detailed account of his geometry of numbers in which he developed geometrical methods for the treatment of certain problems of number theory. He discussed his results in his book on geometry of numbers, Geometrie der Zahlen.

In 1894, Minkowski joined the faculty of Zurich Polytechnic, where he joined his former teacher Hurwitz. At Zurich, Minkowski was given a much higher salary and he also got the opportunity to interact with students of engineering and mathematics. He spent about six years at the polytechnic and gave lectures on variety of topics namely analytical mechanics, hydrodynamics, potential theory, variational calculus, number theory, the theory of functions, partial differential equations and algebra. While teaching at the Zurich Polytechnic, Minkowski wanted to teach at Zurich University but he was not permitted to do so. He was not very happy with the situation as he considered the Polytechnic as a school "from which a complete knowledge of mathematics could not be obtained."

In 1902, Minkowski returned to the University system, this time Gottingen University. A new chair (this was to be the third chair) of mathematics was specifically created for Minkowski. It was an extraordinary move. This was possible because of interest taken by Hilbert in inviting Minkowski to Gottingen. Hilbert had earlier moved to Gottingen at the invitation of Felix Klein (1849-1925), the German mathematician, one of the great formative influences on the development of modern geometry. Klein had taken up the chair of mathematics at the Gottingen University in 1886 and took up the task of building Gottingen into a great centre for mathematics. To realise his objective Klein persuaded the authorities to create another chair in pure mathematics and invited Hilbert to occupy it. Hilbert had already an offer from the Berlin University to join the Lazarus Fuchs' chair in mathematics. Hilbert decided to take up the Gottingen offer provided Minkowski was allowed to join him and Klein at the Gottingen University. It was at Klein's insistence that the Prussian educational authorities decided to create an unprecedented third chair of mathematics so that both Hilbert and Minkowski could be brought to Gottingen. After coming to Gottingen Minkowski was mainly concerned with mathematical physics. In 1905 Minkowski joined Hilbert in organizing a seminar for reviewing the progress in the theories of electron. In 1907 they conducted a joint seminar on the equations of electrodynamics. In the remaining two years of his life (1907-1909) Minkowski was totally involved in the study of the equations of electrodynamics and the theory of relativity postulated by Einstein. Minkowski reformulated the special theory of relativity in terms of space-time continuum. He demonstrated that the main conclusions of the theory could be derived by using only mathematical principles and there was no need to take recourse to experiments. Minkowski's treatment raised the theory to 'a level of clarity and sophistication that surpassed by far Einstein's original one.' Well-known physicists like Max von Laue and Arnold Sommerfeld further extended Minkowski's ideas. Laue's introductory textbook on the special theory of relativity, published in 1911, happened to be the first textbook on the subject that used Minowski's formulation.

Minkowski wanted to settle the Four-colour Map conjecture, but eventually he did not succeed. It is interesting to note that before he took up this problem he had remarked that the problem was not solved because only third-rate mathematicians worked on it and he had also asserted: "I believe I can prove it." But later on realising that he could not provide a satisfactory proof he said: "Heaven is angered by my arrogance, my proof is also defective."

Minkowski died on 12 January 1909 in Gottingen, Germany. His death was sudden. He was just 44 years old at the time of his death.

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(This article is a popular presentation of important points on the life and work of Hermann Minkowski available in the existing literature. The idea is to inspire younger generation to know more about Minkowski. The author has given the sources consulted for writing this article. However, the sources on the Internet are numerous and so they have not been individually listed. The author is grateful to all those authors whose works have contributed to writing this article.)

A brief history of zero

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'Googol, can you say what is common in duck, egg and love?'

The question came from my uncle. I was doing my math homework and he was absorbed with some intricate problems in mathematics when suddenly he popped the question to me.

I fumbled for a second. I did not have a clue about the answer.

'Do you want more clues?' uncle asked me again seeing my blank look.

'Well, yes…' I was not sure how much that would help.

'Well, here is a cryptic clue for you: *number delivered in a circular letter*,' said he.

'I suppose all letters delivered by postman are rectangular. I did not see a circular letter ever,' I tried to reason with him.

'Fool, the word *letter* is a pun'.

This time uncle was seemingly upset over my hurried reply without giving much thought to it.

Well, before you also try thinking with me, let me introduce myself first. I am Googol. Of course, this is my nickname, but I like the name very much. And everybody calls me by this name. When I was born, my mathematician uncle gave this name to me.

My uncle later told me that the name *googol* carries an interesting story. In 1938, Dr. Edward Kasner (1878-1955), a mathematician, asked his nephew Milton Sirotta, then nine years old, to think a name for a really big number, namely, 1 with a hundred zeros after it (10^{100}). Milton came up with the name *googol*. Then, at the same time, to name a still larger number, Dr. Kasner coined the term *googolplex*. It was first suggested that a *googolplex* should be 1, followed by writing zeros until you got tired. This was a description of what would happen if one actually tried to write a *googolplex*, but as you can presume that different people got tired at different times. The *googolplex*, then, is determined as a specific finite number, with so many zeros after the 1 that the number of zeros is a *googol* (10^{googol}). A *googolplex* is much bigger than a *googol*; much bigger even than a *googol* times a *googol*. These inventions caught the public's fancy and are often mentioned in discussions of very large numbers. In this context, let me give you another bit of information that Dr. Edward Kasner wrote a book with James Newman titled *Mathematics and the Imagination*.

Now about my uncle's riddle. I tried to get the information from the cryptic clue. The clue that that word *letter* is a pun led me to think about our alphabetic letter. And here we have the circular letter 'O' and the number delivered with that letter is... 'Oh, I got that!' I exclaimed, 'the answer is Zero'.

But still I was not sure about how to relate zero with *duck*, *egg* and *love*. So I commented, 'But uncle, how are other three words related with zero?'

'Well, you know when a cricketer gets a *duck*…'

'Yes, when he scores no run that means zero.'

'And in tennis or badminton, you might have heard the score as 10-*love*.'

'And in that case also the score *love* means zero.'

'The French word for *egg* is *l'oeuf*. Now since *zero* looks more or less similar in shape as that of an egg, so *l'oeuf* after some changes became *love*, which the present reason of calling a zero as *love*.'

'There are of course a lot of names given to *zero* or something conceptually as zero like *cipher*, *aught*, *nought*, *naught*, *not*, *nil*, *null*, *nothing*, *none*.'

'And I have heard people say the letter 'O' to say zero like O-1-3-1 to represent 0131.'

'Yes, you are right. Sometime it is quicker and easier to pronounce monosyllable words. That may be the reason for speaking 'O' as zero. Of course, there are some incidences where something like 'O' was used by early mathematicians to represent zero.'

'He must have been a genius who discovered zero!'

'Indeed he was. But there is a long history of zero…'

'Tell me something about it,' I was very eager to know.

'Initially, the zero as a number was not available. There was the idea of empty space, which may be thought of conceptually as similar to zero. Babylonians around 700 BC used three hooks to denote an empty place in the positional notation. They used a symbol sort of like a "Y" for one, and a symbol sort of like "<" for ten.'

'What about Greek mathematicians?' I asked.

'Yes, almost during the same time, Greek mathematicians made some unique contributions to mathematics. The interesting feature is that Greek mathematics is mostly based on geometry. Euclid wrote a book on number theory named *Elements*, but that was completely based on geometry. The newer system of Greek mathematics, which is more than 2000 years old, used Greek letters for 1 to 9, 10 to 90, and 100 to 900. 1 was written as 'A' (alpha), 10 as 'I' (iota), and 100 as 'Π' (rho). They did use a limited place system, so '111' was written as 'ΠIA'. For 1000 and above they used a mark such as ',' or '/' before the number of thousands. So, '1000' is ',A' or '/A' , and ten thousand is ',I' or '/I'.

'So there was no concept of zero even for Greek mathematicians,' I wondered.

'Not exactly like that. Greek astronomers might have felt the need for empty space and began to use the symbol 'O'. It is not clear why they favoured the particular notation. It may be related with the first letter of the Greek word for nothing namely *ouden* or it may come from *obol*, a coin of almost no value.'

'I think the Romans also did not have any idea of zero, since I know Roman number system has letters, like 'X' for 10,' I said.

'You are right. Roman numerals for 1, 10, 100, and 1000 are I, X, C, and M. It is interesting that Greeks or Romans relied more on the Abacus that they used to perform arithmetic operations such as addition, subtraction, division, or multiplication and they may not have thought of any operation related with zero.'

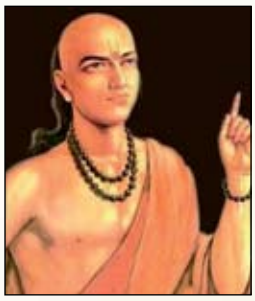
'So zero was not there in the mind of those early Greek or Roman mathematicians,' I said.

'Yes, in early history of most of these civilisations, there is no concrete evidence of zero or its use. This may be due to conceptual

difficulty to figure out something, which would represent nothingness.'

'What about Indian civilisation?' I got interested.

'Around AD 650, the use of zero as a number came into Indian mathematics. The Indians used a place-value system and zero was used to denote an empty place. In fact there is evidence of an empty placeholder in positional numbers from as early as AD 200 in India. Around AD 500 Aryabhata devised a number system, which had no zero as a positional system, but used it to denote empty space. There is evidence that a dot had been used in earlier Indian manuscripts to denote an empty place in positional notation. For example, to represent '100' it would be two dots after 1.'



Aryabhata 500 AD

'So use of zero as number started,' I said.

'In AD 628, Brahmagupta wrote *Brahmasphutasiddhanta* (The Opening of the Universe), and attempted to give the rules for arithmetic involving zero and negative numbers. He explained that given a number, if you subtract it from itself you obtain zero. He gave the following rules for addition, which involve zero: *The sum of zero and a negative number is negative, the sum of a positive number and zero is positive; the sum of zero and zero is zero.* Similarly, he gave the correct rules for subtraction also.

Brahmagupta 628 AD

'Brahmagupta then said that any number when multiplied by zero is zero, but when it comes to zero, he gave some rules that were not correct. But remember, when the concept was just developing, it is quite usual that he would make mistakes. So it was an excellent attempt to visualise number system in the light of negative numbers, zero and positive numbers.'

'Brahmagupta seems to be a genius!' I exclaimed.

'In AD 830, Mahavira wrote *Ganita Sara Samgraha* (Collections of Mathematics Briefings), which was designed as an update of Brahmagupta's book. He correctly stated the multiplication rules for zero, but again gave incorrect rule for division by zero.'

'So could anybody make the correction?' I said.

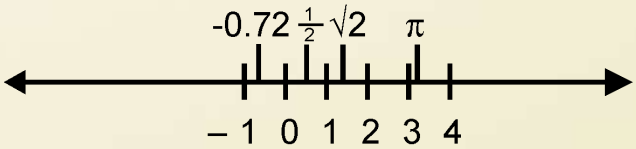
'After 500 years of Brahmagupta, Bhaskara tried to solve the problem of division by stating that any number divided by zero as infinity. Well, conceptually though it is still incorrect, but Bhaskara did correctly state other properties of zero, such as square of zero is zero and square root of zero is also zero.'

'So Indian mathematicians developed the concept of zero and stated different mathematical operations involved with zero. But how did the concept spread to all over the world?' I asked.

'The Islamic and Arabic mathematicians took the ideas of the Indian mathematicians to further west. Al-Khwarizmi described the Indian place-value system of numerals based on zero and other numerals. Ibn Ezra, in the 12th century, wrote *The Book of the Number*, which spread the concepts of the Indian numeral symbols and decimal fractions to Europe.

'In 1247 the Chinese mathematician Ch'in Chiu-Shao wrote *Mathematical Treatise in Nine Sections*, which used the symbol 'O' for zero. In 1303, Chu Shih-Chieh wrote *Jade Mirror of the Four Elements*, which again used the symbol 'O' for zero.

'In around 1200, Leonardo Fibonacci wrote *Liber Abaci* where he described the nine Indian symbols together with the sign '0'. However, the concept of zero took some time for acceptance. It is only around 1600 that zero began to come into widespread use after encountering a lot of support and criticism from mathematicians of the world.'



'So *shunyam* given by our forefathers was recognised in the world and made its place permanently as zero,' I commented.

'Interestingly, the word zero probably came from the Sanskrit word for *shunyam* or the Hindi equivalent of *shunya*. The word *shunyam* was translated to Arabic as *al-sifer*. Fibonacci mentioned it as *cifra* from which we have obtained our present *cipher*, meaning empty space. From this original Italian word or from alteration of Medieval Latin *zephirum*, the present word zero might have originated.'

'That's really interesting. Uncle, I have a question. I have still a dilemma regarding division with zero. Could you please clarify more?' I expressed my problem.

'Well dear, it will take some more time for clarification. I will take it on some other day,' uncle remarked and again became engrossed with his problem after this long discussion.

I had also to finish my homework, so I stopped for the time being. But zero was moving in my brain, and many questions started coming in my mind regarding this amazing concept of *nothing*. ■

- What's in a name?

Portuguese	: zero
Italian	: nullità
French	: zéro
German	: null
Spanish	: cero
Danish, Indonesian	: nol
Dutch	: nul
Finnish	: nolla
Hungarian	: zero
Norwegian	: null
Swedish	: noll

- Words similar or closer to meaning of *zero* are *cipher*, *aught*, *nought*, *naught*, *not*, *nil*, *null*, *nothing*, *none*.
- Probably the synonymous word (*z*)*ero* and (*n*)*il* produced the word *zilch*, which is a slang meaning nothing. Sometime a person is also called *zilch* to indicate as being insignificant or nonentity.
- The word *goose egg* is another slang for *zero*, especially when written as a numeral to indicate that no points have been scored.
- In mathematics, the terminology *infinitesimal* indicates a function or variable continuously approaching zero as a limit.
- *Nilpotent* is an algebraic quantity that when raised to a certain power equals zero.

How the tiger got its stripes?

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Alan Turing, founder of computer science, mathematician, logician, famous for deciphering Nazi secret codes during World War II, turned his mathematical mind to one of the natural world's most enduring riddles: How tigers got their stripes. Sixty years after his suicide, experimental evidence has confirmed his theory.

Rudyard Kipling's *Jungle Book* tells a tale of how the tiger got its stripes; as the tiger ran towards the cave, the trees and creepers on his path carved black stripes upon its yellow hide. Indeed it may be enchanting 'just so stories', but how really does tiger's stripes, leopard's spots, cow splotches and the lines of zebra fish emerge?

Although many legends spun stories to explain the tiger's stripes, the real reason is adaptation of the animals to its environment – camouflage. This adaptation occurred over millions of years of evolution. The tiger's vertical stripes would appear as bands of shadow and light in the tall grass. The stripes break up and hide the outlines of its body as it hunts, making it hardly noticeable. If the stripes help tiger to blend in the grassland, the spots of leopard make help it merge with clumps of plants and with leaves of trees which it climbs. In like manner intricate patterns on variety of coral fish make it blend in the background of coral reef making it harder for the predator to spot. But how these patterns emerge in the development of the organism from its embryo was a mystery.

Turing's proposition was a simple idea – reaction-diffusion mechanism. In his influential paper "The Chemical Basis of Morphogenesis," published way back in 1952, he speculated that regular repeating patterns in biological systems are generated by just a pair of morphogens that work together as an 'activator' and 'inhibitor'. The way in which they interact would dictate where cells grow, creating familiar patterns on the fur of animals.

The skin colour tone is the result of melanin production – higher the melanin darker we are; lower the production, lighter the skin tone. Just as when we pour milk in the tea, it eventually spreads and creates uniform light brown colour, as the melanin is produced and diffused in normal circumstances it should create a particular shade of skin colour. However, Turing showed that, if you had two chemicals – an activator that produces a colour and an inhibitor that blocks it – then the result of the skin colour is stable but non uniform. His simple mathematical equations, partial differentials, showed that when the activator and inhibitor diffuse at different rates, it can generate exquisite variety of patterns seen in the animal world.

These equations can generate the endless variation seen in nature, from polka dotted Dalmatian dogs to chequered giraffe. This elegant model yields simple predictions; while a spotted animal can have a striped tail, a striped animal will never have a spotted tail – precisely what we see in nature. Using these mathematical equations, computer applets and programmes has been made to generate delicate patterns in computer generated animations.

How does it work? When he was asked to explain, Turing used an analogy – of human flesh eating cannibals, analogous to activator, and celibate missionaries, corresponding to inhibitors. Cannibals can reproduce and increase their population; but some of them who come into contact with missionaries may have a change of heart and themselves may convert to one. The missionaries, being celibate, can only make more missionaries by recruiting cannibals. In ordinary circumstances, eventually this reaction will result in stable mix of two – a large circle of cannibals in the island surrounded by a thin ring of converted missionaries.

But if both cannibals and missionaries are mobile and they could move about the island, the game changes. Now imagine that missionaries have access to bicycles, making them move faster than cannibals. This differential mobility – diffusion – makes a substantial difference in the outcome. As cannibals could mate and beget children, in their immediate surrounding their numbers would increase. Some of them would be converted into missionaries, who would be able to cycle off to faraway places converting more cannibals into missionaries. Close by, cannibals increase their own numbers. Far away, they actually inhibit themselves by producing missionaries. The rate at which the reaction – conversion to missionaries – occur, and diffusion – how quickly the cannibals and missionaries are moving – determine the eventual pattern.

This model also explains very well why the stripe pattern of one tiger is not same as the other; and why the pattern on a tiger changes as it gets older. Unlike the fingerprints the patterns on the skin are not stamped onto it according to a genetically encoded blueprint. They are living patterns produced by the ongoing tango between the activator and inhibitor molecules.

Turing had done his equations for one-dimensional space; when the model was tested for two dimensional plane, striped patterns in addition to spotted patterns often emerged. Mathematical biologists considered

Turing's model as the basic mechanism explaining many examples of stripe patterns observed among animal coating. Just by tweaking four variables, for each of the two morphogens – the rate of production, the rate of degradation, the rate of diffusion and the strength of their activating/inhibiting interactions – we could obtain elaborate patterns on the animal hide. The idea was stunning; but was just a speculation.

Until now scientists have only been able to simulate Turing's theory using computer models, but in a fitting tribute to the centenary of this genius, which falls in this year, researchers have found the exact chemicals in action. In a paper published in the recent issue of *Nature Genetics*, researchers from King's College London have described first ever experimental work corroborating Turing's model.

In this path-breaking experiment, instead of the stripes of the tigers the researchers examined the development of the regularly-spaced ridges found in the roofs of the mouths of laboratory mice. Carrying out experiments in mouse embryos, the team firstly identified the pair of morphogens – fibroblast growth factor and Sonic hedgehog – influencing the formation of the ridges in the mouth. By increasing and decreasing the activity of these morphogens, the researchers showed that the patterns of the ridges in the mouth palate are affected in ways predicted by Turing's equations.

Alas, the very same year his theory of morphogenesis was published, he was criminally prosecuted for being a homosexual; in Britain being gay was considered a criminal act. He was given a choice – to be subjected to hormone therapy or face imprisonment. He opted for hormone therapy, but frustrated, he committed suicide by ingesting cyanide, just two years later. In 2009, the British Prime Minster made a public apology on behalf of the government for the shameful treatment met out to Alan Turing for his sexual orientation.

Continued from page 43 (Science fiction—an effective means of communicating science and technology)

and Voltair's *Micromegas* (1752). Kepler, who is regarded as founder of celestial mechanics, wrote *Somnium*, to explain and defend heliocentric model of the solar system. Though *Somnium* is not remembered as an example of science fiction, it demonstrated that scientific discussion in fictional contexts might have advantages.

The important early works of science fiction like *Looking Backward* (1888) by Edward Bellamy, Jules Verne's *From the Earth to the Moon* (1865), *A Journey to the Centre of the Earth* (1872), and *Twenty Thousand Leagues Under the Sea* (1873), H. G. Wells' *The Time Machine* (1895), *The Invisible Man* (1897), *The War of the Worlds* (1898), *The Island of Dr. Moreau* (1896,) and *The First Men in the Moon* (1901), played a decisive role in influencing later science fiction writers.

Three most important science fiction writers in the post-second World War were Isaac Asimov, Arthur C. Clarke, and Robert A. Heinlein. They are called by many as the three Grand Masters of the Golden Age of science fiction that followed the 'pulp era' (when science fiction magazines were printed on pulp paper) of the 1920s and '30s. The Golden Age is the era during which science fiction gained wide public attention and many classic science fiction stories were published.

There are innumerable web resources on science fiction. Some of the most important international science fiction magazines in English are: *The Magazine of Fantasy & Science Fiction*, *Analog Science Fiction and Fact* (first published as *Astounding Stories* in 1930), *Asimov's Science Fiction*, *Strange Horizons*, *Another Realm*, *Interzone*, *770*, *Not One of Us*, *Challenger*, and *Clarkesworld Magazine*.

The important international awards for promoting science fiction writing include *Hugo Award* of the World Science Fiction Society at Worldcon, the *Nebula Award* of the Science Fiction and Fantasy Writers of America, *John W. Campbell Memorial Award* for best science fiction novel, and *Theodore Sturgeon Memorial Award* for short fiction. The last two awards are given at the annual Campbell Conference of the Center for the Science Fiction at the University of Kansas. There are national awards on science fiction in many countries.

The first science fiction story in India was probably written by Jagadananda Roy in 1857, but it was published in 1879. The story (*Shukra Bhraman*) was on journey to Venus. Acharya Jagadis Chandra Bose, one of the pioneers of modern Indian science, wrote a science fiction story in Bengali in 1896 on the theme of taming a storm. Science fiction writing in Hindi and Marathi also began towards the end of the 19th century and early 20th century. *Ashcharya Vritant* ('Description of Wonders' by Ambika Dutta and published in 1894), *Chandralok ki Yatra* ('Journey to the Moon' by Kashi Prasad Singh in 1900), and *Ashchryajanak Ghanti* ('Wonder Bell' by Satyadev Parivrajak in 1908) are usually cited as early science fiction writing in Hindi. Other Indian languages followed. Today science fiction is being written in all major Indian languages. There are a quite few accomplished science fiction writers in different Indian languages. The two most talked about science fiction writers in India are Jayant Vishnu Narlikar, an internationally acclaimed astrophysicist, and Satyajit Ray, the celebrated film-maker.

There are attempts, though sporadic, to promote science fiction writing in Indian languages. There is an Indian science fiction portal: www. Indianscifi.com. *Vigyan Katha*, a quarterly science fiction magazine in Hindi, is being published since 2002 by the Indian Science Fiction Writers' Association. Indian Association for Science Fiction Studies has also been trying to promote science fiction studies in India. An anthology of science fiction stories by Indian writers from different Indian languages (*It Happened Tomorrow*) was brought out in 1993. The anthology, edited by Dr. Bal Phondke, a well-known science fiction writer, was published by the National Book Trust, India.

In India there is a need to widen the community of science fiction writers and promote the culture of good science fiction writing. This important medium should be utilised particularly by the gifted writers, science communicators and scientists to communicate science in story form, to stretch the imagination of future scientists and innovators, and to enlighten people about the possibilities of probable benign use of emerging developments in science and technology leading to social catastrophe. Ideally 'good science fiction of today is the reality of tomorrow'.

Superconductivity:
Yesterday, today and tomorrow

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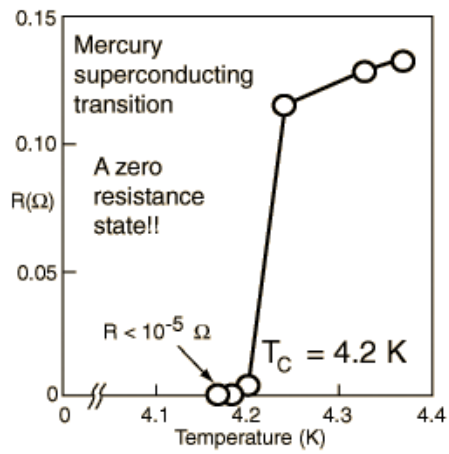
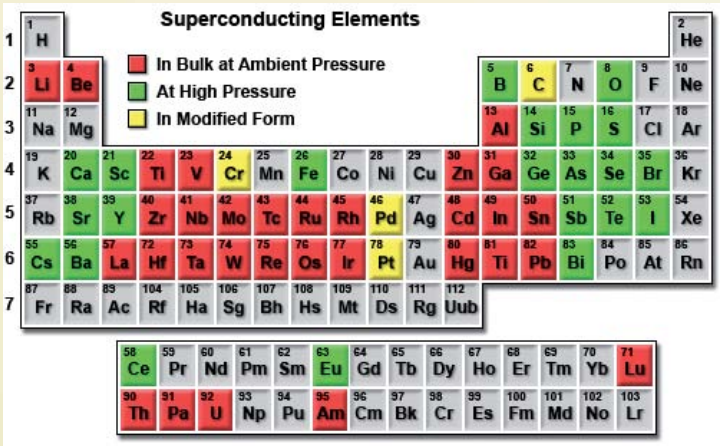
Superconductivity, which is the complete absence of electrical resistance in a metal, was discovered nearly a hundred years ago. Superconductors are used in many applications, e.g., for transmitting electrical power without loss of electrical energy due to heating; for production of magnetic fields in MRI machines; for novel kinds of high-speed trains; and for mapping the ultra-small magnetic fields in our brain. Novel applications, some on a large scale, are being developed and refined. The very strange phenomenon has fascinated scientists ever since its discovery and continues to, partly because it keeps appearing in new and completely unexpected materials and in poorly understood ways. A major dream among scientists and inventors is to discover a material which can be a superconductor at room temperatures so that revolutionary applications can enter every home. In this article, we try to touch on some of these subjects, starting from its discovery, going on to the present state of affairs, and mentioning the future.

Superconductivity was discovered unexpectedly in 1911, in the laboratory of Kamerlingh Onnes, in Leiden, Holland. Onnes had succeeded (in 1908) in liquefying helium, which is a gas lighter than air, and constitutes a large part of the Sun which is called helios in Greek, whence the name for the gas. Helium becomes liquid about only four degrees above the absolute zero or at 4K. Onnes was awarded the Nobel Prize in 1913 for this revolutionary breakthrough. It was found that mercury, when cooled to this extremely low temperature, suddenly loses all electrical resistance; the precise temperature below which it happens is 4.2K. Since then, it has been found that nearly half the elements in the periodic table become superconducting, and thousands of compounds and alloys do. All this happens, however, on cooling the material to extremely low temperatures below a certain critical value. As an aside, one can say that till 1987, the cooling substance had to be helium, mostly in the liquid form, and so superconductivity was a phenomenon confined to those special laboratories where liquid helium was available. In 1987, a new family of substances called cuprates, containing rare earth and transition metal atoms (e.g.,$YBa_2Cu_3O_7$)



Electrical resistance versus temperature for a sample of mercury near four degrees above absolute zero, as originally observed by K Onnes in 1911. (hyperphysics.phy.astr.gsu.edu)

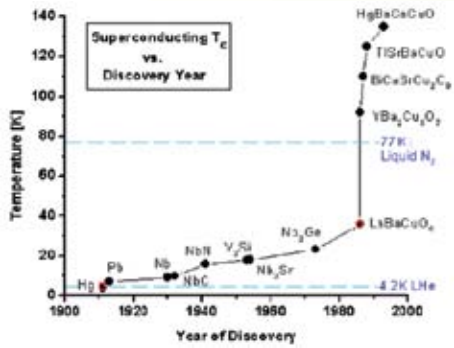
Was found to be superconducting at liquid air temperatures (about 90 K). With this discovery of 'high-temperature' superconductivity, superconductivity moved from the laboratory to industry (liquid air is an industrial product; it costs about as much as milk). However, it turned out to be quite a challenge to develop and adapt these new materials ('cuprate superconductors') for reliable and large scale applications; the process is going on. A dream is to move superconductivity from the industry to home.



The Periodic Table showing elements which are superconductors at ambient pressure (red), under pressure (green) and in a modified form (yellow). (magnet.psu.edu)

In the years after its discovery in 1911, many elements and alloys were found to superconduct. An obvious application was to use a superconducting wire to transmit electrical power without its getting heated and losing a part of this electrical power because of ohmic resistance to the passage of electrical current. It turned out however that the magnetic field produced by the current flowing in the wire could destroy its superconductivity if the field was more than a (generally) small critical value, typically of order a few hundred gauss. This fact held up other applications as well, e.g., generation of large magnetic fields using superconducting wire coils for electromagnets, for many decades till about 1960. Interestingly, a related phenomenon was discovered by two German physicists, Walther Meissner and Robert Oschenfeld in 1933, namely that a superconductor completely excludes a magnetic field; if we apply a magnetic field to a superconductor, it penetrates only a very thin skin of it, about 10^{-4} cm in thickness and not beyond, provided the field is smaller than the critical value. Above this value, superconductivity is destroyed and the magnetic field penetrates fully.

The superconductor thus turns out to be a very strange piece of metallic material indeed. Because the electrical conductivity is infinite, there can be no electrical field inside it even when an electrical current flows through it (Ohm's law!); and the Meissner effect implies that there is no magnetic field inside it either! The puzzling thing is that the material which has a measurable electrical resistance just above a temperature (T_c say) has vanishing resistance just below it. Whatever was causing electrical resistance, though fully



Superconducting transition temperature T_c vs Year of discovery. (library.thinkquest.org)

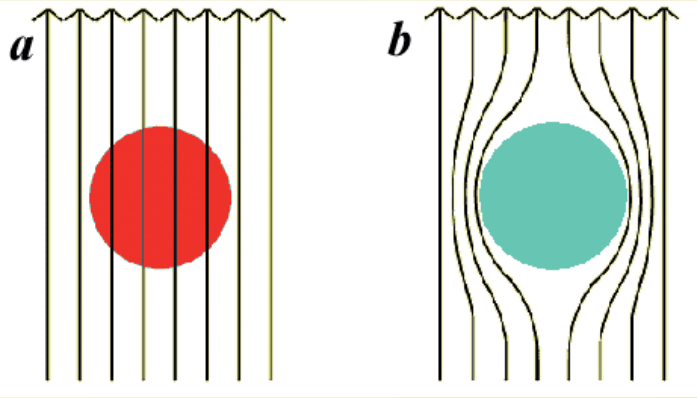
present, is no longer effective. And, to boot, there is no magnetic field inside it either anymore!

It is no surprise therefore that after the discovery of superconductivity in 1911, almost all the great physicists of the twentieth century, e.g., Albert Einstein, Niels Bohr, Werner Heisenberg, and Richard Feynman tried to understand how this happens. The mystery defied a solution for nearly four decades. The reason for superconductivity had to be subtle but had to lead to powerful consequences. In some crude terms the difference between a superconductor and its 'normal' parent is small. For example, the superconductor is more stable than the Non-superconducting metal electronically in energy by less than a part per million. One can infer this quite reliably from the facts that critical temperatures and critical magnetic fields for superconductivity are very low. One cannot account for the electronic energy of a solid (typically, a cubic centimetre of it has about 1023 nearly free electrons) with anywhere near this accuracy; precision of one per cent is already considered good. Yet this small difference leads to a dramatic reorganisation of electrons which totally transforms their behaviour.

The mystery was unravelled over more than two decades, in several stages. In 1936, the German physicist Fritz London hypothesised that for a superconductor, the electrical current density is proportional to the vector potential (in terms of which electrical and magnetic fields can be expressed) and showed that both the infinite electrical conductivity of a superconductor and the penetration of a magnetic field into only the 'skin' of the superconductor are consequences of such a single simple, characteristic connection. The proportionality constant determines this penetration depth.

A giant step forward was taken by Vitaly Lazarevich Ginzburg and Lev Landau, two Russian physicists, in 1950. They argued that the fundamental 'super' characteristic of a superconductor arises from the fact that in a single, macroscopically coherent state, it has a single wave function. That is, a single complex number describes the state of a macroscopic body consisting of the order of an Avogadro number (~10^{23}) of electrons, all moving around in it and subject to incessant thermal agitation. This is a stupendous assumption; the means all these electrons, moving through miles of superconducting lead wire, for example, are assumed to be in concert, in phase.

Ginzbuerg and Landau assumed that a property called macroscopic phase coherence is the secret of superconductive behaviour, assumed. This 'phenomenological' theory of superconductivity is a deep theory that identifies its cause and explores consequences. It is considered a model phenomenological physical theory because it is a complete description of the organising principle and its consequences at a particular level of organisation. Ginzburg and Landau were able to describe, in a unified way, a large number of properties of a superconductor through their approach.



Magnetic lines of force for a uniform small magnetic field (H<Hc) in which a metallic sphere is placed. The red sphere is for T>Tc and the blue sphere is for T<Tc. The magnetic field inside the sphere is seen to be zero in the latter case (Meissner effect). (web.mit.edu)

An early (and practically very consequential) application of the Ginzburg-Landau theory was made by Alexei Alexeyevich Abribosov in 1952. He showed that there is a class of superconductors which exist in a mixed phase; namely in a magnetic field, the superconductor consists of an intimate mixture of non-superconducting metal and superconductor. A crude analogy is to Swiss cheese; the Swiss cheese consists of many holes surrounded by cheese. The holes stand for the normal metal 'punched' in the superconducting cheese by the magnetic field. (The number of 'holes' is proportional to the magnetic field; with each hole, one can associate a quantum of magnetic flux). From this analogy we can (correctly) conclude that so long as the cheese is continuous, the system is still superconducting. This then means that there is a type of superconductor which continues to be superconducting even in a large magnetic field. These 'type II' superconductors indeed exist and are the basis of the large superconducting magnets industry (for example the MRI machine has them). The Large Hadron Collider, a gigantic particle accelerator that was turned on at CERN, Geneva (Switzerland) in 2008, has about 6,000 such magnets of different kinds, each made of Nb-Ti alloy cables, producing inhomogeneous magnetic fields with maximum values of up to 100 kilogauss (the Earth's magnetic field is less than half a Gauss over much of its surface).

The Ginzburg-Landau approach leaves (at least) one thing unexplained. What is the origin of this macroscopic phase coherence or what is the mechanism whereby the ~10^{23} electrons act in concert? Two obvious things that work against the coherence of so many electrons, enabling them all to be in phase, and to be described by a single function are the following. After all, electrons necessarily repel each other (they all have the same electric charge and like charges repel), and there operates an exclusion principle due to Wolfgang Pauli (a Swiss physicist) that no two electrons can be in the same quantum state. This last mystery was clarified by John Bardeen, Leon Neil Cooper and John Robert Schrieffer (American physicists) in 1956. The natural instantaneous repulsion between electrons can be overcome by a retarded effective attraction between them caused by the exchange of lattice vibrations.

To understand the latter, we imagine an electron whizzing past the lattice of ions. The ions are temporarily shaken up in

some atomic sized region by the passage of this electron. The heavy ions return slowly to their equilibrium position like a pulled spring returns to its normal position with a characteristic time scale, which is about a hundred times the electronic time scale. This is because the ions are massive and the electrons are almost ten thousand times lighter. But well after the first electron has left the scene and before the ions return to their equilibrium state, another electron comes to the same region and gets attracted to the deformation, or effectively to the other electron which caused the deformation but is no longer there! Because of this attraction, Cooper found that the two electrons, if of opposite momenta, will necessarily bind no matter how weak the effective attraction! Now the exclusion principle does not apply to the bound pair of electrons (a pair of two or any even number of electrons can be in the same state). It is also inevitable that at sufficiently low temperatures, 10^{23} or so electron pairs of this kind condense to a single-phase coherent state. This macroscopic wave function can be thought of as that of the centre of mass of the huge object made up of ~10^{23} bound electron pairs. It can deform internally around 'obstacles' without losing its integrity, somewhat like a large boa constrictor, which can swallow things while remaining a live boa constrictor! This is the long sought microscopic mechanism for the origin of superconductivity. Interestingly though we are presenting here the story of the understanding of superconductivity as if it developed in a chronological and logical sequence, the fact is that Bardeen, Cooper and Schrieffer (BCS) were unaware of the work of Ginzburg and Landau. A year after the BCS work, Lev Gor'kov, then a student of Landau, showed that the superconductor wave function of Ginzburg and Landau is actually the average probability amplitude of a 'Cooper' pair, thus completing the story.

This is the yesterday of superconductivity. It appeared to have attained maturity by 1957-1960, and the next thirty years seem like a period of consolidation. Suddenly, in 1987, J. Georg Bednorz and K. Alexander Müller, working in an IBM laboratory in Switzerland, discovered that a ternary copper oxide, a cuprate, was superconducting at unprecedentedly high temperatures. Very soon, many new cuprate families were discovered; as mentioned earlier, one of them ($Y\ Ba_2Cu_3O_7$) goes superconducting below about 100K, well above the liquid nitrogen temperature of about 90K. All this was astonishing to physicists and materials chemists since most oxides are good insulators; these oxides in particular happen to be bad metals, are brittle, and look like black, gritty, toothpowder. Why do they become superconducting, and what uses can we put them to? This is a large part of the today of superconductivity, stretching into tomorrow. We still do not know the answers to the two questions above, as we amplify below.

When superconductivity was discovered in the cuprates in the late 1980's there was enormous excitement and hope that a new era has dawned in which applications (imagined and unimagined) will usher in a revolution, like the transistor did (think of the mobile phone for example, or the computer). This has not happened partly because it has proved difficult to bring the materials to the form needed (e.g., wires and tapes) and partly because they have to be kept cooled in liquid air to at all function as superconductors.

Nevertheless, there are an increasing number of applications. A spectacular example is cables which transmit electrical power. In areas where a large amount of electrical power needs to be transmitted, specially clad cuprate wires come into their own. In Manhattan, New York City, USA, a jumble of these wires supplies electrical power to the 'city that never sleeps'.

One effect of the discovery of superconductivity in cuprates is that it has freed our minds from the belief that superconductors are creatures of the ultracold laboratory world. The last twenty years have seen the discovery of new families of superconductors with unlikely constituents and improbable temperatures at which they begin to superconduct (though, unfortunately, still at temperatures below that at which air or nitrogen liquefies). Two examples are the compound magnesium diboride (MgB_2), which consists of two unlikely elements and is easy to make (with T_c = 35K), and transition metal pnictides, for example, the family $LaO_{1-x}\ F_x\ FeAs$. (Pnictides are binary compounds of the nitrogen group.) The highest known T_c is about 50K in this group of compounds.

Another feature of superconductivity today is that the nature of the strangeness of cuprates as electronic matter is coming home to us largely because high quality materials are being made, novel experimental approaches have been developed, and existing tools have been refined. It is becoming clear that these are qualitatively unlike any metal hitherto known to us. It is being insistently realised that high-temperature superconductivity in cuprates (with the characteristic electronic nature) is one of central unsolved mysteries in physics; it is quite strange that this is so after a generation of research and nearly two lakh papers on a material that almost any laboratory can make! Though scientific research activity on cuprates is beginning to wane after this intense and prolonged (but futile?) effort, the mystery is there. While there is a strong and natural tendency to believe that superconductivity of the new superconductors can be understood in terms of the Bardeen Cooper Schrieffer (BCS) theory of conventional (or yesterday's) superconductors, this faith seems to increasingly fly in the face of facts about them.

What of superconductivity tomorrow? One dream which refuses to die is of making a Room-temperature superconductor. If we could make one and applications enter every home, then indeed there will be a technological revolution unlike any that human society has seen. Experience with known superconductors has taught us that there are no reliable guides on where to look for room-temperature superconducting materials. Given this, every now and then there are claims of a new compound or alloy which has the right behaviour; in all cases so far, further work has shown these claims to be false. But the search continues and will continue.

At a more sedate level, there is the search for understanding of what we have today, among superconductors. This includes cuprates and pnictides. Maybe, the two directions of departure will meet; the discovery of a room-temperature superconductor will help us understand superconductivity better, or maybe it will be the other way around!

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99th Indian Science Congress

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The annual sessions of the Indian Science Congress have become the largest congregations of scientists in the country, which is traditionally inaugurated by the Prime Minister. The event is supposed to showcase the best in Indian science and an occasion for the Prime Minister to announce some major policy initiatives of the government related to science. The recently concluded 99th session was no exception. In his inaugural speech Prime Minister Manmohan Singh reiterated his government's commitment to give a boost to the science and technology sector in the country and outlined the road map to take Indian science to new heights in the coming decades.

Expressing concern that countries like China had overtaken India in terms of position in the world of science, the Prime Minister said, although India's scientific output in terms of published papers have increased in recent years, there is need to do much more to change the face of Indian science. He emphasised the need to increase the total expenditure on research and development as a percentage of GDP to at least 2 per cent by the end of the 12th Plan Period from the current level of less than 1 per cent. He laid emphasis on ensuring a major increase in investment in research and development by industry and strategic sectors along with innovative approaches to tackling S&T problems, which can be done by increasing public-private partnership and greater interaction between publicly owned science and technology institutions and industry. He stressed on expanding basic science infrastructure while enlarging the reach of international collaboration. He called for greater alignment of the science and technology sector with the inclusive development needs of the country, especially to address the challenging problems of the poor and the under-privileged.

Held in the picturesque campus of the Kalinga Institute of Industrial Technology in the temple town of Bhubaneshwar in the eastern state of Odisha, the Science Congress brought together some 15,000 delegates from India and abroad, including three Nobel laureates. The Congress included 35 special lectures, and 30 plenary sessions and panel discussions. There was a healthy participation from women scientists in the science congress, which had 'Science and Technology for Inclusive Innovation – Role of Women' as its theme. Significantly, the session was presided over by an eminent woman scientist Dr. Geetha Bali, vice chancellor of the Karnataka State Women's University, Bijapur.

Prime Minister inaugurating the 99th Indian Science Congress (Photo: PIB)

A panel discussion on 'Science Policy Making' was organised on the first day in which several prominent scientists and science administrators took part. Initiating the discussion, Dr K. Kasturirangan, Member, Planning Commission, underlined the need for change in paradigm in science inputs. He said society needs to be made aware of scientific issues and social scientists must be taken on board in framing science policy. He stated that there is a need for significant enhancement of the corporate sector R&D expenditure to at least 1% of the GDP by attracting investments and engagement of corporate sector in R&D through policy and reforms.

Dr. V. M. Katoch, Director General, Indian Council of Medical Research, called for use of new technology to take medical services to remote areas. He said human resource development in health care needs to be top priority and child mortality needs to be reduced at any cost.

Nobel laureate Rolf Zimkernagel delivering public lecture (Photo: Biman Basu)

Dr. S. Ayaappan, Director General, Indian Council of Agricultural Research, emphasised the need to encourage local solutions to agricultural problems. He said there should be more flexibility in doing science.

Prof. Samir K. Brahmachari, Director General, Council of Scientific and Industrial Research, stressed on the need to empower the youth and said the new science policy should factor this in to enable us to build models that the world follows. He said India has done so very well in science in the past because the leadership roles and positions in the past were given to younger scientists like Shanti Swarup Bhatnagar, G. N. Ramachandran, Vikram Sarabhai and Satish Dhawan who brought laurels to Indian science.

Dr. T. Ramasami, Secretary, Department of Science and Technology, Government of India, announced that a new science policy is currently being drafted and will be available to the country before the centenary Science Congress next year. Pointing out that the science policies of 1958, 1983 and 2001 were 'public policies for science', he said the paradigm that is being worked out now is a 'science policy for the public' that would benefit the people of the country at large.

There were also public lectures delivered by eminent scientists. Among the speakers were Nobel laureate Prof. Rolf Zinkernagel who described in his inimitable style 'Why we do not have a vaccine against HIV or TB'. He said all infectious cells have characteristic structures called glycoproteins, which in HIV is highly variable

and variable glycoproteins are too difficult to tackle with antigens. HIV has a million variants and any effective vaccine against HIV would need to be a composite with one million variants.

Delivering his public lecture on 'Commemorating the Year of Science', Prof. M.S. Swaminathan, the noted agricultural scientist and policy maker and Chairman, M.S. Swaminathan Research Foundation, stressed the importance of making the indigenous knowledge and conservation ethics and harnessing of transformational technologies as the focus of the 'Year of Science' in India. The year 2012-13, which marks the centenary year of the Indian Science Congress, is being observed as the 'Year of Science'. He said we should concentrate on marrying traditional knowledge and participatory research, with local communities as primary stakeholders as well as partners. Citing the examples of the traditional agricultural system of Koraput in Odisha and the below-sea-level farming system perfected by inhabitants of the Vembanad region in Kerala, he said local communities in several parts of the country had been conserving indigenous knowledge for centuries at their own cost and it was high time that sufficient encouragement, support and incentives were extended to the custodians of our traditional knowledge.

Prof. Swaminathan cited ICT as an example of a transformational technology that has now made possible dissemination of agro-ecological information even on mobile phones. He cited the example of the Jamsetji Tata National Virtual Academy whose young volunteers have been operating village knowledge centres, providing information to villagers in easy-to-understand language. Similarly, fisheries were getting transformed with information being provided to fishermen on wave length and location of fish.

Dr Parviz Koohafkan, Director of the Land and Water Division in the Natural Resources Management and Environment Department of Food and Agricultural Organisation, underlined the importance of farmers with small land-holding, as they produce the bulk of the world's food. Speaking on 'Heritage and Food Security in an Era of Climate Change', he said the FAO has started recognising such agricultural practices since 2002 and has so far identified about 200 adaptive agricultural systems worldwide as 'Globally Important Agricultural Heritage Systems' (GIAHS). These are indigenous old farming systems still very viable for sustainable agricultural development and food security in the present day context of climate change. He further added that in many parts of the world, old agricultural practices are being revived for the sustainable development of agriculture. In other words, history is repeating itself in agricultural sciences.

Missiles displayed by DRDO at the Pride of India Expo (Photo: Arvind Khanna)

The topic of Prof. Samir Brahmachari's public lecture was 'Science 2.0: Open Source Drug Discovery'. He narrated how the idea occurred to him, how he could network many scientists, students, researchers, entrepreneurs together under one virtual group for a noble cause – affordable health. He said, as a community driven open innovation platform OSDD works on three cardinal principals, 'Collaborate', 'Discover' and 'Share'. It provides a global platform where the best minds can collaborate and collectively contribute to solve the complex problems associated with discovering novel therapies for neglected tropical diseases.

Delivering a public lecture on 'Research and Innovation: Many Dimensions', Dr R Chidambaram, Principal Scientific Advisor to the Government of India, emphasised that research should not always be profit-oriented and that for certain problems some amount of altruism needed to be built in. He emphasised that research should not always be profit-oriented and that for certain problems some amount of altruism needed to be built in. He described 'pre-competitive applied research' and 'directed basic research' as two alternative innovation possibilities, which need to be supported by the government. He also emphasised on re-innovation; that is, once a concept was understood it should be transformed to suit local needs.

In his public lecture on 'Basic Research and Human Daily Life', Nobel laureate Dr. Kurt Wuthrich described showed how his work on nuclear magnetic resonance spectroscopy (NMR) led to unravelling of the 3D structure of proteins and DNA and how its application has revolutionised medical diagnosis, drug discovery, and drug design. Since the functional properties of proteins are determined by their structure an understanding of the 3D structure is essential for drug-protein interaction studies, which are crucial for drug designing. He said, curiosity driven research, which is basic research, provides clues to basic findings that impact the daily life of mankind.

Delivering a public lecture on 'Academic opportunities for shaping a better future', Nobel laureate Prof. Richard R Ernst, emphasised the role that academic and academic institutions play in shaping a beneficial global future for all. He said they are the educators and motivators of the future leading heads in politics, business and academia. According to him, research is indispensable for sustainable development, saving resources, improving health and reducing gap between the rich and the poor, he said. Quoting from Mahatma Gandhi, he said "we must be the change we want to see. Science without conscience ruins the show. He advised the scientific community to become both founders of society and at the same time be optimistic because, as the eminent philosopher Karl Popper had said, "We all are jointly responsible for what will come."

An exhibition showcasing India's achievements in science and technology – 'Pride of India Expo' was inaugurated by Union Minister of Science & Technology and Earth Sciences, Shri Vilasrao Deshmukh inaugurated the science exhibition on 3 January. The Expo had four main

Former President A.P.J. Abdul Kalam inaugurating the Children's Science Congress (Photo: KIIT)

components – *Vigyan Jyot*, Exhibition, a one-day symposium, and a "Hall of Pride", dedicated to Acharya Prafulla Chandra Ray, father of modern chemistry in India, whose 150th birth anniversary was celebrated last year. More than 700 exhibitors and 150 organisations including CSIR, DRDO, and DAE participated. Replicas of Prithvi, Agni and Brahmos missiles were major attractions.

In keeping with the focal theme, the first Women's Science Congress was also held in the same venue. It was inaugurated by Ms Nirupama Rao, India's Ambassador to the US. She said that while the country's immense growth was appreciable, for the growth to be meaningful it should be inclusive. It should provide enabling opportunities for women in the country. The absence of women in science meant the exclusion of a majority of the population. Ms Rao said that the real problem lies in retention of women in science. Women leave science due to home and family related problems. There was a need to put in place mechanisms that would create mid-career opportunities, self-employment opportunities and S&T parks in areas such as food science etc.

The KIIT campus was also the venue of the 19th Children's Science Congress, which was inaugurated by the former President of India Dr. APJ Abdul Kalam, who has become an icon for Indian children. Addressing a gathering of more than 10,000 school students from the city and outside, Dr Kalam impressed on the young audience the significance of being a scientist. Science removes mental blindfolds, he said. He exhorted the children to set their sights much beyond the sky and strive to develop themselves into unique individuals that the world would remember for times to come.

Coincident with the Science Congress, a festival of science films Rashtriya Vigyan Chalchitra Mela and Competition was also held, which brought together both amateur and veteran film makers with a delightful collection of science documentaries. Fifty-nine science documentaries on various topics were screened at the festival, which was hosted by Vigyan Prasar.

In all, the 99th Indian Science Congress not only brought forth many key issues regarding science in India; it also offered to those interested in science a unique opportunity to meet and interact with those who make science.

The 100th Indian Science Congress next year will be held in Kolkata, the venue where the first Science Congress was held in 1914. Prime Minister Manmohan Singh will preside over the centenary edition hosted by Calcutta University.

Interview with Anil Menon

Renowned science fiction writer Anil Menon was born in Kerala (1964). In the early 70s, his father was sent on deputation to Mwanza, Tanzania. Most of his primary schooling was done at the Isamilo Primary School in Mwanza. On return from Tanzania in 1976, he completed the rest of his schooling in Mumbai and then joined the M.S. University of Baroda for B.E. (Electrical). His fascination with computers and software, took him to the United States for graduate studies in computer science. He worked for a while in California, where he found his life partner Saras Sarasvathy. He did his Ph.D. (1995) on mathematical models of evolutionary computation from Syracuse University. He worked for a variety of software start-ups after that, notably, Cerebellum Software and Whiz bang Labs. By 2004, he started writing science fictions and wrote several wonderful SF stories. His debut SF novel, *The Beast with Nine Billion Feet* (2010) was shortlisted for 2010 Crossword-Vodafone Children's Book award (India), and the 2011 Parallax Award (US). His science fiction has been translated into German, French, Chinese and Hebrew.

Anil Menon was in Lucknow to attend a workshop on Science Fiction writing supported by Vigyan Prasar where Manish Mohan Gore of VP spoke to him. Here are excerpts from the interview.

MMG: India has a rich and glorious history of creativity and writing. Apart from mainstream literature, the genre of Science Fiction (SF) has had its moorings on Indian soil. How do you visualise Indian SF in global perspective?

AM: Many of the Indian writers are writing fairly good SF. Amitabh Ghosh, a brilliant SF writer is the first Indian to win the Clark Award in 1995 for his outstanding SF *Calcutta Chromosomes*. We have the writers and they have SF stories, but we don't have outlets (magazines, etc.) where our SF are welcomed. Very few magazines publish SF in India.

MMG: Being an Indian, how do you feel concerned with Indian SF?

AM: I am very optimistic and I think that workshops are useful in transforming semi-professional writers into professional writers. I do come to India regularly to attend SF workshops. This year, I am here to participate in a two-day workshop on SF writing in Indian languages. In a workshop

Anil Menon

about 15 writers meet each other whereas more than 15 new writers are made. Agencies like Vigyan Prasar can play a vital role in promoting such SF writers.

MMG: In the universities of western countries, SF is listed on a course prescribed for its academic study while in India it is

Manish Mohan Gore (R) with Anil Menon

still struggling for getting a well established foundation. Many of the Hindi writers like Sampurnanand, Acharya Chatursen Shastri and Rahul Sankrityayan wrote SF, but still it is not adopted by Hindi writers. Is anything lacking here to validate this genre?

AM: I think we would be in a position to establish this fertile genre here at least after one or two more generations. The seeds of SF have been sown in Indian soil. I suggest that successful Indian writers should contribute to the making of a solid edifice of SF writing in India. I do want to do many things for Indian SF.

MMG: Eminent Indian scientist and popular SF writer Jayant Vishnu Narlikar says that SF can be a useful tool for enlightenment of the society. He hopes that Indian SF writers will grow and promote good works in different languages. I would like to have your comment on this view of Narlikar.

AM: I agree with Narlikar. Only I need to add that the motive of science is not cent percent pure. Science is also politicised in many ways. Science has to be accurate and we the SF writers have to be critical.

MMG: Unlike the western scientists, Indian scientists do not take interest in SF writing. That is why authentic Indian SF is not coming up. Do you agree with this view?

AM: Partially. We should focus on writers. Naiyar Masud lives in Lucknow and he writes in Urdu and his SF is translated in America. A writer with the sound knowledge of science and its developments can create good SF; on the other hand a scientist cannot if he does not have creative writing skill. But the workshops can prepare very good writers who can write wonderful SF.

MMG: A layman and generally children have great interest in SF, but as you said earlier that we don't have magazines who publish SF. In such a situation, how can we fill this vacuum?

AM: Asimov – this is my only answer. Anybody can understand his stories. Translated versions of Asimov's stories are the wonderful and relevant way. And of course, Vigyan Prasar can bring out such volumes. The stories of Indian SF writers should also be translated in regional languages. Jagadish Chandra Bose's SF story *Polatak Tufan* (originally in Bangla written in 1896) was translated into English recently.

MMG: Which of your SF work do you like most and why?

AM: SF based novel *The Beast with Nine Billion Feet.* This work is influenced by the life of Benjamin Franklin who was a popular scientist as well as a noted politician. In this novel, the main character, a geneticist decides to create an open resource of

Science Fiction Workshop at Lucknow

Vigyan Prasar in collaboration with National Book Trust and TSALIIM (Team for Scientific Awareness on Local Issues in Indian Masses) organised a two-day national level workshop in Lucknow on 26-27 December 2011 on the theme "Science Fiction writing in regional languages". In this workshop SF writers and experts of Hindi, Bangla and other regional languages were present. On the first day, senior Hindi SF writer Devendra Mewari said that SF in Indian languages is not well taken by the audience while in other countries this genre is very popular. During the workshop, SF expert Dr. C.M. Nautyal shared his view and said that in an ideal SF, a harmony of literary elements and science elements are essential. In his keynote address Dr. Arvind Mishra said that SF is a very prosperous genre of writing and its many definitions reflect this. Special invited speaker and American SF writer Anil Menon said Hindi SF writers are writing very well but their contribution at international level is meagre and we have to take steps to change this. Popular science fiction writer Shukdeo Prasad said that SF is not the flight of imagination. SF must has a scientific base.

Dignitries of the SF workshop (L to R) Anil Menon, Hemant Kumar, C.M. Nautyal. Devendra Mewari and Arvind Mishra.

Other prominent speakers in this workshop were Pankaj Chaturvedi, Harish Goel, Chandan Sarkar, Hemant Kumar, Vineeta Singhal, Zishan Haidar Jaidi, Amit Kumar Om, Vishnu Prasad Chaturvedi, Mukul Shrivastava, Bushra Alvera, and Subhash Rai. During the workshop forty participants wrote their SF stories and learned the attributes of good SF writing from the expert SF writers. Dr. Zakir Ali Rajnish, Secretary, TSALIIM thanked all the SF writers and participants at the end of the workshop.

genetics. He wants to free the intellectual property right on the genetic code and makes it open to all. This novel was written for the youngsters of 20-25 age groups and it took almost two years to complete. I enjoyed writing the novel. Writing short stories is very challenging because it's all too easy to do. Novels, on the other hand, are not easy to do. They require a lot of cogitation. I relished the larger canvas, the freedom to really speculate. I think it'll be hard to go back to writing short stories.

MMG: You belong to South India. How would you evaluate the status of SF writing in South Indian languages?

AM: Not in good health. SF has been written in Tamil and some other south Indian languages like Kannada and Telugu but they could not develop themselves as in Bangla. Famous Tamil SF writer Sujatha Rangrajan is doing well. The script of the popular Bollywood movie *Robot* was written by him. He invented many of the Tamil equivalent words like *Endhiran* for Robot. Unfortunately, he is no more; he passed away in 2008.

MMG: Translated versions of classic SF works could impress the Indian readers. How can it be actualised?

AM: A hard nut to crack. Authenticity is diluted in the translations and it is still a problem of today. Translators should have the mastery of both the languages as well as the cultures. If we succeed to do so, then it will be wonderful.

MMG: From your experience, what should be the major components of a good SF?

AM: It should be entertaining and must have an excellent idea to further develop into a story. The future component is not necessary and it should be an option. *A Long Day* came in 2007 and it portrays the present.

Why medicinal plants are important



Amit Kumar Goswami[1] Rakesh Kumar[2] Kumar Bharat Bhushan[3]

Herbal drugs are staging a comeback and herbal 'renaissance' is happening all over the globe. A vast diversity of herbal ingredients, major proportion of which is derived from the wild, provide the resource base for the herbal industry. The herbal drug market continues to grow at the rate of 15% annually. Out of some 2,50,000 higher plant species on Earth, more than 80,000 are of medicinal value. The traditional systems of medicine continue to cater in to the medicinal needs of about 80% of the world population. However, modern systems of medicine cater to only about 20% of population.

Medicinal plants form a numerically large group of economically important plants which provide basic raw materials for medicines. They are used in the form of crude drugs in the form of dried parts of the plants (root, stem, wood, bark, leaves, flowers, fruits seeds, and also whole plants) or their extracts. These plants and their products not only serve as a valuable source of income for farmers with small land holdings and entrepreneurs but also earn valuable foreign exchange by way of exports. Some of the important medicinal plants are described here with their therapeutic uses.


Bahera

Bahera: This is botanically known as *Terminalia bellerica*. It belongs to family Combretaceae. This tree is found in India, Sri-Lanka, Malaysia and many other Asian countries. Some of the major chemical constituents of *Terminalia bellerica* are triterpenoids, polyphenols and fixed oil. Parts used are bark and fruits. The fruit is one of the ingredients of *triphala* formula of Ayurveda, which is commonly prescribed in treating asthma, biliousness. It has been traditionally used for curing eye and skin diseases, boost immunity and resistance against infectious diseases. It can be used to expel or destroy parasitic worms, and also as an antiseptic, astringent, laxative, and tonic.

The seed oil is used for treating skin diseases and premature graying of hair. Chewing baked pieces of the fruit is beneficial in treating respiratory ailments, cough, cold, hoarseness of voice and asthma. The fruit powder is beneficial in wound dressing to arrest bleeding.


Brahmi

Brahmi: It is also known as thyme or *Neer brahmi*. Botanically known as *Bacopa monnieri*, it belongs to family Scrophulariacae. It is distributed in moist habitats and water edges throughout tropical and subtropical India, Pakistan, Afghanistan, Nepal, Sri Lanka and other tropical countries. Chemical constituents of *brahmi* include alkaloids such as brahmine and herpestine; saponins such as d-mannitol and hersaponin, and monnierin; and flavonoids such as luteolin and apigenin. *Brahmi* is also effective in controlling cough, fever, and diabetes. In Siddha system of medicine, the plant has been prescribed against painful joints, peripheral neuritis, constipation, and burning feeling during urination.


Sweet basil

Sweet basil: Commonly known as *tulsi*, it is botanically known as *Ocimum basilicum* and belongs to family Lamiaceae. It is also known by name of sweet basil. It is a tender low-growing herb. Depending on the species and cultivar, the leaves may taste somewhat like anise, with a strong, pungent, often sweet smell. Basil oil has various chemical compounds that include α-pinene, camphene, β-pinene, myrcene, limonene, cis-ocimene, linalool, methyl chavicol, γ-terpineol, citronellol, geraniol, methyl cinnamate, and eugenol. The plant is used for cough, asthma, bronchitis, severe conjunctivitis, giddiness, catarrh, earache, headache, and dyspepsia.

Turmeric: Commonly known as *haldi*, it is scientifically known as *Curcuma longa* and belongs to family Zingiberaceae. Rhizomes of the plant are used. Major constituents are ar-turmerone, α-turmerone, β-turmerone, and β-ocimene. It is used as a remedy for wounds, bruises and sprain, and skin problems. It is also effective as a digestive aid and in liver protection. Wild turmeric is recognised as a medical herb with strong antibiotic properties. It possesses anti-inflammatory, blood-vitalising and anti-tumour properties. Ginger contains aromatic volatile oils that help to remove excessive lipids from the blood, reduce aggregation of platelets, and reduce inflammation.

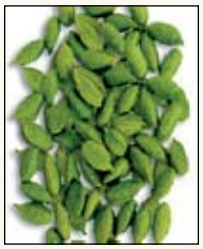
Asparagus: Known as *Satavar*, *Satavari*, and *Satamuli* in Hindi,it is botanically known as *Asparagus racemosus* belonging to family Liliaceae. It is a creeper growing about 1 to 2 metres tall, and is found in all types of forests and plains. It is known as the 'Queen of herbs' in Ayurvedic system of medicine. The plant part used is the tuber. Important chemical constituents include a polycyclic alkaloid called asparagamine A; steroidal saponins, shatavaroside A, shatavaroside B, and filiasparoside C; and isoflavones. Asparagus is used to relive pain, to induce milk secretion, and as an aphrodisiac. The roots are useful in nervous disorders, dyspepsia, tumours, throat infections, bronchitis, and general debility. The herb is useful for treating anorexia (a prolonged disorder of eating due to loss of appetite), insomnia, and also hyperactive children and people who are under-weight. Asparagus is considered a rejuvenating female tonic for overall health and vitality. It is used for treating sexual debility, infertility in both the sexes, and menopausal symptoms and to increase milk secretion during lactation.


Asparagus:

Ginger: Commonly known as *adrak*, thebotanical name of the plant is *Zingiber officinale* and belongs to family *Zingiberaceae.*


Ginger

It is a herbaceous perennial with upright stems and narrow medium green leaves arranged in two ranks on each stem. The plant part used is the rhizome. Chemical constituents of ginger are phenols, alkaloids, and mucilage. Ginger has digestive properties. Ginger compounds are active against a form of diarrhoea which is the leading cause of infant death in developing countries. Ginger has been claimed to decrease the pain from arthritis. It may also have blood thinning and cholesterol lowering properties.


Cardamom

Cardamom: In Hindi, it is known as *elaichi*. It is botanically known as *Elettaria cardamomum* and belongs to family *Zingiberaceae.* Cardamom is a rather typical looking ginger plant except that it is huge, standing as much as 3.7 m tall. The fruits are thin-walled, smooth-skinned, oblong, greenish capsules. Each contains 15-20 aromatic reddish brown seeds. It is found up to the height of 750 to 1,500 metres above mean sea level. In India, it is found in Western Ghats and the coastal areas, especially of Gujarat, Maharashtra, Kerala and Karnataka. Fruits and seeds of cardamom are used. Chemical constituents of cardamom include α-pinene, β-pinene, sabinene, myrcene, α-phellandrene, limonene, 1,8-cineole, γ-terpinene, p-cymene, terpinolene, linalool, linalyl acetate, terpinen-4-ol, α-terpineol, α-terpineol acetate, citronellol, nerol, geraniol, methyl eugenol and trans-nerolidol. Seeds of cardamom are carminative (prevents the formation of gas in the alimentary tract) and digestive. It is used to treat asthma, bronchitis, cardiac disorders, anorexia, thirst, nausea, painful or difficult urination, dyspepsia, and burning sensation.

Periwinkle: Commonly known as *sadabahar*, it is botanically known as *Catharanthus roseus*. It belongs to family Apocynaceae. It is also known as Madagascar periwinkle. The plant is a native of Madagascar and from there it has spread to India, Indonesia, Indo-China, the Philippines, South Africa, Israel, USA and other parts of the world. Leaves and roots of the plant are used in the pharmaceutical industry and in Ayurvedic medicines to treat different diseases like diabetes, hypertension and cancer. It has medicinal importance owing to the presence of alkaloids like ajamalicine, serpentine and reserpine, which are well known for their blood-pressure lowering and antispasmodic properties. Vinblastine and vincristine are alkaloids found in periwinkle. The alkaloid vincristine sulphate is being marketed under the trade name Oncovin for use against acute leukemia, while vinblastine sulphate is used as Velbe to cure Hodgkin's disease and other lymphomas and choriocarcinomas (cancer of the placenta). Root bark of the periwinkle plant contains the alkaloid alstonine, which has been used traditionally for its calming effect and its ability to reduce blood pressure. The anti-cancer drugs, namely Vincristine and Vinblastine are produced from periwinkle, which is helpful in the treatment of leukaemia in children and also lymphoma.


Periwinkle


Liquorice

Liquorice: It is also known as *mulethi* or *jasthimadhu*. Botanically, it is known as *Glycyrrhiza glabra*. It belongs to family Papilionaceae. It is widely distributed in Spain, Italy, Greece, Syria, Iraq, India, Afghanistan, Turkey, parts of USSR and China. Plant parts used are roots and bark. The dried rhizome and root of the plant is used as flavouring agent and the taste ingredient in pharmaceutical and confectionery industries. Glycyrrhizin, a triterpene glucoside, is the principal constituent of *G. glabra* which is 50 times sweeter than sugar. The root contains flavones, iso-flavanoes and coumarins including a 4-methyl coumarin, liqcoumarin, glabridin and glabrene. The dried peeled or unpeeled underground stems and roots of the plant constitute the drug which is an important constituent of all cough syrups, throat lozenges, and pastilles. It has been used in Arab system of medicine for more than 600 years from where it has been adopted to modern medicine.


Ashwagandha

Ashwagandha: Also known as *asgandh* and Winter cherry, the plant is botanically known as *Withania somnifera*. It belongs to family Solanaceae. It is found wild in Bastar District of Madhya Pradesh, all over the foot hills of Punjab and Himachal Pradesh and Western Uttar Pradesh in the Himalayas. The main chemical constituent of *ashwagandha* is the alkaloid withanine. The other alkaloids are somniferine, somnine, somniferinine, withananine, pseudo-withanine, tropine, pseudo-tropine, cuscohygrine, anferine and anhydrine. The leaves contain steroidal lactones, which are commonly called withanolides. *Ashwagandha* increases the count of white blood cells and prepares the body to produce antigens against various infections and allergies. It is also considered as a tonic for the heart and lungs, as its regular intake controls the blood pressure and regulates the heartbeat. It has a strong nourishing and protective effect on the nervous system. The berries can be used as a substitute for rennet to coagulate milk in cheese making. The berries and leaves are traditionally used a topical treatment for tumours and tubercular glands, carbuncles and ulcers.

Bhringaraj: It is botanically known as *Eclipta alba* and belongs to family Asteraceae. It is found in India, Bangladesh, Mayanmar, Malaysia, and Sri Lanka. Leaves and roots of the plant are used. Chemical constituents include the alkaloids ecliptine and nicotine.Bhringaraj is used in Ayurvedic treatment for the prevention of repeated miscarriage and abortion. It is also used to relieve post delivery uterine pain. The decoction prepared from the leaves of this herb is used to reduce uterine bleeding.


Bhringaraj

The extract obtained from the leaves of this plant is mixed with honey and given to infants for expulsion of worms. This herb is also considered to have anti-aging properties. It is used as a general tonic in case of debility. The juice of the leaves of Bhringraj is given to children for the treatment of respiratory tract infections. It is useful in curing night blindness, eye diseases and headache.

Stevia: It is scientifically known as *Stevia rebaudiana* and it belongs to family Asteraceae. It is found in North-Eastern Paraguay USA, Brazil, Japan, Korea,Taiwan and South East Asia. A substance called rebiana, which is a trade name for zero-calorie sweetener containing mainly steviol glycoside, is extracted from stevia. Stevia is also rich in flavonoids and terpenes. Other constituents include stevioside, which is considered sweetest natural sweetener. It imparts 250 times more sweetness than table sugar and 300 times more than sucrose. Leaves of the plant are used. Stevia inhibits tooth decay and slows the formation of plaque – a sweetener that is actually good for the teeth. Stevia has the potential to increase mental alertness, decrease fatigue, improve digestion, and regulate blood pressure. Considerable quantities of stevia are used in the manufacture of herbal preparations for flavour and to make them more palatable.

Stevia

Aloe vera: Known as *ghee kunwar* in Hindi, it belongs to family Lilliaceae. Aloe is grown largely in South Texas, USA, Mexico, India, South America, Central America, Australia and Africa. Three main constituents are barbaloin, isobarbaloin and ß-barbaloin. Freshly collected leaves and pulp of the plant is used. Aloe juice helps in digestive disorders. Constipation, diarrhoea, indigestion, irritable bowel syndrome, etc., are cured by the flushing action. The deposits of toxins and unwanted substances in our diet which keep accumulating in the intestines prevent the absorption of essential nutrients causing nutritional deficiency, lethargy, constipation, lower back ache. Aloe juice helps flush out these residues, boosting the digestion and giving a greater feeling of well-being. It repairs arthritis damaged tissue and lowers glucose and tri-glyceride levels in diabetic patients.

Aloe vera

Mint

Mint: Also known as *pudina* and mentha. It is botanically known as *Mentha arvensis*. It belongs to family Lamiaceae. Other species are *Mentha piperita* (pepper mint), *M. spicata* (spear mint), and *M. citrata* (Bergamot mint). Mint is believed to have originated in the Mediterranean basin and spread to the rest of the world. Leaves of the plant are used. The main constituents of the oil are menthol (65-75%), menthone (7-10%), and menthyl acetate (12-15%) and terpenes (pipene, limonene and comphene). Menthol is used in the flavouring of large number of pharmaceutical and oral preparations like tooth pastes, dental creams, confectionery, beverages and other items like tobacco, cigarettes, *pan masala*, etc. Menthol itself finds extensive use in medicine in the treatment of nasal and bronchial catarrh. It is also occasionally employed as a carminative.

Conclusion

Medicinal plants and their various products are important due to absence of side-effects on health. To meet the ever increasing domestic and international demands, it has now become imperative to produce the quality raw materials in significant quantities. This can only be achieved by developing suitable agro-techniques for different medicinal plants in various climatic zones of the country. There is need of organised marketing and trade of medicinal plants and their various products. There is a need to conserve the important plant species which are now neglected and under extinction due to deforestation. Some species are on the verge of extinction due to heavy exploitation by pharmaceutical industries. Excessive deforestation resulted in losing important treasure of unique medicinal plants. So there is urgent need to protect such wild species and, simultaneously, to develop suitable agro-techniques for their large scale multiplication so that their field cultivation is made possible, to fulfil rising demand of raw material for pharmaceutical industries.

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Letters to the editor

The Golden Ratio

I enjoyed reading the article on the Golden Ratio by Rintu Nath in the March issue of Dream 2047. It is well written and should contribute in generating interest in maths even in those who can handle only the high-school level maths. I find all the diagrams and boxes in the article well drawn and written. I have particularly liked the box on 'Golden ratio and the Fibonacci series'. I also liked the desk calendar on Mathematical Year brought out by Vigyan Prasar.

Professor A. N. Maheshwari
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Fastest finger first

In the era of information and communication technology one need not only to be action-oriented but at the same time also needs to be fast to be first and get recognised. *Dream 2047* always stands first in reaching the target group.

The information given is handy to discover where one stands. The editorial of Dr Subodh Mahanti (April 2012) covers history, geography, etc., of India; his biographies of scientists reveal the glorious past to the mysterious present. His suggestion to publish the books in local languages with attractive cover page is relevant to reach the base of the pyramid. The story of the Indian wonder girl Poorvie makes the learned to learn and unlearn. Biman Basu's piece on the SORS technique reveals how much is yet to be learnt and to be done based on research in basic sciences. I would also appreciate the fast action in updating the change of address.

Kudos to all connected with the magazine!

Dr S N Shetti
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For better fitness and health

I would like to thank and congratulate Dr. Yatish Agarwal for his writings on fitness and how to keep healthy heart and life. Such writings on a regular basis could certainly help in achieving the bigger goal of a Healthy India.

Bhuwan Kumar
bhuwankumar007@gmail.com

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An asset

I would like to thank you for sending copies of *Dream 2047* regularly to my college. Your magazine has become a periodical asset in seminar library of my college. Celebrating every year with a particular theme is highly appreciated. I wish from the bottom of my heart that Vigyan Prasar sails smoothly and continues to encourage young scientists of today to march towards 'Dream 2047' and beyond!

Dr. Ranjit Jena
Senior Reader in Botany & Consultant in Medicinal Aromatic Plants & Drugs,
Salipur College, Salipur-754202

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National conference on science communicators addressing women's issues

National Centre for Science Communicators, Mumbai organised a National Conference on Science Communication - Addressing Women's Issues jointly with Vigyan Prasar and National Council of Science Museums, Kolkata at Birla Industrial & Technology Museum, Kolkata on 7-8 January 2012. There were around 125 participants including science communicators, teachers, and scientists from different parts of the country who took part in discussions on the challenges women face and their possible solutions.

The welcome address was delivered by Mr. A. P. Despande, Chairman, NCSC, Mumbai, who talked about the need for the conference. He said that women's education started in India much before it started in other countries including UK and USA. However, today, women enjoy more liberty in other countries. India need to look into this problem in a more realistic way, specially with regard to giving equal opportunity to girls in education, giving fair chance in job opportunities, removing myths and misconceptions about women and taking care of health of women.

Ms. Kinkini Dasgupta Misra, Scientist-E, VP in the inaugural address talked about Vigyan Prasar's effort to promote and propagate a scientific and rational outlook in society, nurture interest in science, encourage creativity, develop capacity for informed decision making and develop linkages with organisation engaged in science popularisation in identifying gap areas, and create needs for women for the development of programmes and resource material to enable women to make informed choices and take appropriate decision for improving their quality of lives. She also stressed on the activities and programmes of VP and how VP is aiming towards development of science communication programme targeting women at different levels in the society. The inaugural address was followed by the address of Mr. G.S. Rautela, DG, NCSM, who spoke about the importance of gender issues in S&T communication. He described the activities carried out by NCSM for women such as S&T awareness activities, confidence building through engagement, and engaging girls in S&T activities.

Prof. E. Candotti, an eminent physicist from Brazil and UNESCO Kalinga Prize winner was the Guest of Honour at the conference. He talked about the international political trends and the scientist's understanding of people's knowledge. He spoke about the presence of women in science and technological men's domains, comparing the average working hours for formal and informal works spent by men and women. He discussed about the role of manual work in S & T popularisation and in opening new paths to find the deeper ethical meanings as scientific explanations and ethical commitments could live together in mutual respect. Er Anuj Sinha, Former Director, Vigyan Prasar made a presentation on S & T Communication for Gender Empowerment. He emphasised on innovative communication strategies to reach mothers, teachers and health workers. He outlined the focus areas as income generation, drudgery reduction, water and sanitation literacy, disaster resilience, animal health, and soil health.

Prof. E. Candotti, Brazilian physicist and Kalinga Prize winner; Mr. G.S. Rautela, DG, NCSM and other dignitaries in the inaugural session

Technical Sessions

The conference had four sessions namely (1) Engaging women in science communication towards women empowerment; (2) Challenges – Education, Gender Differences, etc.; (3) Myths and Misconceptions – Women related Issues; and (4) Health Awareness in Women.

In the first session, Kinkini Dasgupta Misra, Scientist-E, VP talked about the role of science communication towards empowering women in society by inculcating scientific temper and strengthening awareness by understanding the needs of the women.

Dr. T. V. Venkateswaran, Sciencist-E, VP presented his views on the gendered nature of science and the gendered media coverage, and highlighted the role that need to be played by science communicators for bringing about gender equity. A meta-analysis of the perceptions of students of management on myths and misconceptions about women in management in Kerala was presented by Archana Subhash. She said, perceptions parading as paradigms with significant citation indices are accepted as myths and anecdotal narrations are regarded as misconceptions. The objective was to elicit studied responses to differentiate uncritical acceptance of stereotypes and to sensitise them on real politik of business world. Dr. S.B. Roy, Head, Uranium Extraction Division, BARC, Mumbai emphasised that women have been and will continue to be a valuable asset to nuclear industry, and efforts need to be made to combat all outdated stereotypes and misconceptions. Encouraging women to pursue careers in science and technology is clearly beneficial to everybody.

In the second session, Prof. Mukund M. Hambrade, DG, CGCST, Raipur presented a paper on democratisation of science and technology where he emphasised that democracy has always been extrovert and people-oriented while the science and technology have remained introvert and laboratory-oriented. Democratisation of science and technology means developing science and technology for, of and by the people. Prof. H.P.S. Kalra of Punjab University, Patiala presented a study of perceptions of science communication and related subject among researches in Punjab

University, which indicate significant difference on perceptions of science communication among male and female researchers, while differences among researchers from different subjects in sciences, and social sciences were not significant.

A paper on "Gender Differences in Science Education: an exploratory study on postdoctoral scholars" was presented by Ms. Sohini Basu of ASCI, Hyderabad in which she said the education attainment in certain areas including science, technology, engineering and mathematics (STEM) is incredibly gendered with boys and men outnumbering girls and women in some areas at rates as high as three to one. She emphasised that exploring gender differences between experiences in higher levels of STEM education, i.e., postdoctoral education, helps individuals understand the ways in which those levels of education affect women's decisions to continue on their path to becoming scientists. Prof. Smita S. Lele, HoD, Food Engineering & Technology Department, Institute of Chemical Technology, Mumbai said that women have taken massive strides to uplift their status in a male dominated society in the last few decades. In the field of science, the participation of women has been on the rise. Today, the choice of a woman to become a scientist and/or a student of natural science is governed perhaps by her desire to leave a mark and/or contribute to society at large. Opportunities for a career in science are readily available as there is far more acceptance from peers and most importantly there is a belief in the woman herself that she could make a difference.

In the third session, Mr. Santosh Takale of BARC, Mumbai, made a presentation on superstitions and women and how they are exploited and harassed. The real cruelty behind the superstitions or blind faith is that it creates mental slavery; the person stops thinking and opens the doors for the exploitation. Mr.A.P. Deshpande, Dr.Paresh Vaidya and Dr.Prakash Kondekar made poster presentations.

In the fourth session, Mrs. Alka Naik discussed the importance of education of women for developing a healthy nation through her presentation on "Health Awareness in Women". Education is a powerful driver of health. Education is a key part of strategies to improve individual's wellbeing and society's economic and social development. Educated women tend to provide better guidance to their children and also promote education of girl children Education is a crucial part of plans and policies to improve individual's wellbeing and societies economic and social development. Education contributes directly to the growth of national income by improving the productive capacities of the labour force. She emphasised that women's ability to choose the number and timing of the birth of their children is the key to empower women as individuals, mothers and citizens.

Prof. E. Candotti, Guest of Honour addressing the audience in the inaugural session

Dr. Irfana Begum of VP shared her experience with programmes on Health Awareness in Women through EduSAT Network organised by Vigyan Prasar. She mentioned that through the network VP mobilises the women to make them aware of their own and their family's health.

Audience at the conference

Dr. (Smt.) Beena Sharma, Research Associate, CCST, Raipur presented her views on Health Awareness in Women with the use of traditional medicinal plants in Raipur District of Chhattisgarh. Medicinal plants have always been the principle sources of medicine in India. India has a rich traditional knowledge and heritage of herbal medicine. Findings of a study show the increased use of traditional medicines among the natives of the study area. The study highlighted the potential bilateral benefits and limitations in the use of herbal and home remedies by the women of Chhattisgarh.

Prof. Indira Chakravarty, Chief Advisor, Public Health Engineering Department, Govt. of West Bengal talked about the changing nutritional scenario in our country and role of awareness in women. She emphasised the need to attend the issues that are yet to improve a lot such as nutritional status (diets), anaemia, and infection rates. She suggested that causative factors should be identified and all stake-holders involved in the process should be covered. Dr. A.P. Jayaraman, Dean Academic, SISCOMS, Kerala presented a paper on "High Impact of Women as Facilitators of Science Communications: Kerala Model". Kerala ranks first among Indian states in Human Development Index with 0.921 in 2011 and has also admirably high Gender Equality Index and Gender Empowerment Measure. Science communication activities led to the development of the smokeless high fuel-efficient fire hearth and demonstrated its efficacy and efficiency to the women of the house. This was a single critical variable of empowerment. Ease, duration and frequency of interactive science communication with the women folk multiplied manifold and set off a chain reaction. He emphasised that science literacy contributes to human development by providing tools to make meaningful and intelligent sense of the world. It also empowers individuals to make informed and enlightened decisions related to critical aspects of their lives.

The conclusion drawn from the discussions at the valedictory function is that dissemination of science and technology is the prime step to address the women's issues, and gender bias in the society. Science and technology helps women to become informed decision makers to improve their quality of life and thus help in the empowerment of women and to create an unbiased society. It was emphasised that attempts will be made to develop innovative communication strategies to reach women at different levels.

(Kinkini Dasgupta Mishra) ■