ISSN : 0972-169X
Registered with the Registrar of Newspapers of India: R.N. 70269/98 Postal Registration No. : DL-11360/2003

DREAM 2047

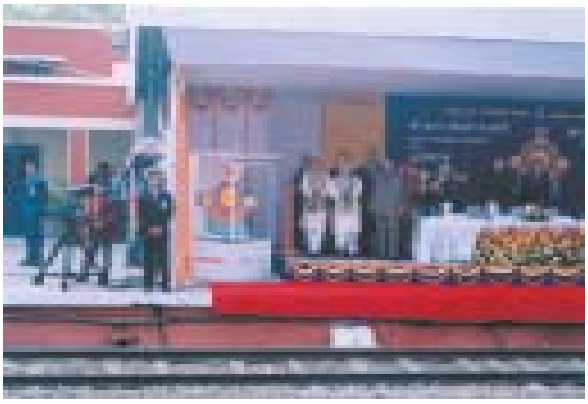
December 2003 Vol. 6 No. 3 Price: Rs. 0.50

VP News

Vigyan Rail Flag Off

Hon'ble Prime Minister of India, Shri Atal Bihari Vajpayee flagged off Vigyan Rail – Science Exhibition on Wheels on December 15, 2003 from Delhi-Safdarjung Railway Station. In his address he stated Vigyan Rail is the carrier of the message of India's progress in science and technology. He said: "Ours is an ancient country reborn in the modern world. We want to preserve and strengthen our centuries old cultural heritage and traditional values."

Dr. Murli Manohar Joshi, Hon'ble Minister (Science and Technology, Ocean Development and Human Resource Development), Shri Nitish Kumar, Hon'ble Minister (Railways), and Shri Bachi Singh Rawat, Hon'ble Minister of State (Science & Technology) addressed the function. Shri B.R. Patil, Hon'ble Minister of State (Railways), Shri M.V. Kamath, President, Vigyan Prasar were also present on the dais. Among the other dignitaries present on the occasion were Prof. V.S. Ramamurthy, Secretary, DST and Shri R.K. Singh, Chairman, Railway Board . More than 400 school children also participated in the function.



Shri Atal Bihari Vajpayee, Hon'ble Prime Minister is flagging off Vigyan Rail. Dr. M. M. Joshi, Hon'ble Minister (S&T, Ocean Developement & HRD), Shri Nitish Kumar, Hon'ble Minister (Railways) are also seen.

Vigyan Rail ready to be flagged off.

Inside

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

Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi - 110 016 & Printed at Saurabh Printers Pvt. Ltd., B-280, Okhla Industrial Area, Phase - I, New Delhi - 110 020
Editor : Dr. V.B. Kamble

The Journey Begins

Vigyan Rail – Science Exhibition on Wheels was flagged off by Shri Atal Bihari Vajpayee, Hon'ble Prime Minister of India, on 15 December 2003 from Delhi Safdarjung Railway Station. He said on the occasion, "Ours is an ancient country which is reborn in the modern world. We want to preserve and strengthen our centuries old cultural heritage and traditional values. Also, we want that India should have the top place in the modern world". Dr. Murli Manohar Joshi, Hon'ble Minister (Science and Technology, Ocean Development and Human Resource Development), Shri Nitish Kumar, Hon'ble Minister (Railways), and Shri Bachi Singh Rawat, Hon'ble Minister of State (Science and Technology) also voiced similar feelings. Indeed, Vigyan Rail – Science Exhibition on Wheels attempts to echo these very thoughts.

During its entire journey, Vigyan Rail – Science Exhibition on Wheels will help people become aware how science and technology has helped our country of a billion plus take giant strides on its way to self reliance in the fields of agriculture and food production, medicines and pharmaceuticals, defence, space, and how India is on a fast track to becoming a super power in the field of Information Technology. At the same time, the exhibition would focus on the arduous path and the determined efforts of our scientists who have made it possible and immensely contributed to the social and economic growth of the country. In this sense Vigyan Rail – Science Exhibition on Wheels is the saga of Indian Science – from the early Vedic period till the modern times.

Through this column, we have often voiced the concern about our younger generation turning a Nelson's eye towards taking up science as a career and have argued that our school children are rarely exposed to the excitement of science. They are unaware of the challenges and thrills offered by a scientific career. In the absence of such an exposure, no wonder students shy away from this challenging profession. Given that the social and economic development of a country depends on how strong its scientific base is, it becomes all the more imperative to convey the thrill and excitement that a scientific career offers to our children, especially at secondary and senior secondary levels. Visit to the Vigyan Rail is expected to expose our younger generation - especially the school children - to the thrill, challenges and opportunities a scientific career offers.

There is no reason why one should look to the West for greener pastures. They are already available on this very soil. What is more, it is necessary to realize that better opportunities do not mean monetary gains and lavish life styles, but the overall improvement in the quality of life. An important message the Vigyan Rail – Science Exhibition on Wheels is expected to spread is that India is a land of opportunities and challenges – be it any sphere of human activity and that a scientific career is as satisfying and rewarding as any other.

Putting together the Vigyan Rail - Science Exhibition on Wheels was both a challenge and an opportunity. The preparations began nearly a year and a half ago. Concretization of idea took another six months. The project document was discussed both internally and externally at length. The guidance and cooperation by the Ministry of Railways was exemplary. In particular I would like to mention the name of Shri Sandeep Silas, Director, Information and Publicity, Railway Board, and his wonderful colleagues. The enthusiasm of the participating Ministries / Departments was contagious. True, there were a few hiccups during the execution of the project, say, late arrival of contents and materials from a few Ministries / Departments, some nodal officers unable to find sufficient time off their regular duties and so on. But, pace picked up as the deadline approached, and the entire exhibition train was ready before the flag off. The train returned to Delhi Safdarjung Railway Station after the flag off about an hour later and was stabled there until 21 December, 2003 for the Delhiites to visit the exhibition. Considering the positive response to the Vigyan Rail at Delhi, we do hope it would be received with enthusiasm elsewhere in the country as well.

The journey has already begun. Kindly do visit the Vigyan Rail – Science Exhibition on Wheels when it arrives in your city and let us know your opinions and suggestions.

❒ V. B. Kamble

Editor : **V.B. Kamble**

Address for correspondence : Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-110 016; Tel : 26967532; Fax : 26965986
e-mail : vigyan@hub.nic.in
website : http://www.vigyanprasar.com

Vigyan Rail – Science Exhibition on Wheels

Participating Departments / Ministries

National Council of Science Museums
Ministry of Environment and Forests
Department of Atomic Energy
Department of Information Technology
C-DOT : Department of Telecommunication
Ministry of Water Resources and Central Water Commission
Department of Ocean Development
Council of Scientific and Industrial Research
Defence Research and Development Organisation
Ministry of Non-Conventional Energy Sources
Indian Council of Agricultural Research
Indian Council of Medical Resarch
Indian Space Research Organisation
Department of Biotechnology
Vigyan Prasar
India Meteorological Department
Survey of India
Technology Information, Forecasting and Assessment Council

Inaugural function of Vigyan Rail. (From L to R) : Shri M.V. Kamath, President, VP, Hon'ble Lt. Governor of Delhi, Shri Vijay Kapoor, Hon'ble Minister of Railways, Shri Nitish Kumar, Hon'ble Prime Minister, Shri Atal Bihari Vajpayee, Hon'ble Minister of Science & Technology, Ocean Development & HRD, Dr. Murli Manohar Joshi, Hon'ble Minister of State (Science & Technology), Shri Bachi Singh Rawat and Hon'ble Minister of State, Railways, Shri B.R. Patil

Hon'ble Minister S&T, Dr. M. M. Joshi showing Vigyan Rail Mascot in the press conference. Hon'ble Minister of State, S&T, Shri Bachi Singh Rawat is also seen

ITINERARY OF VIGYAN RAIL

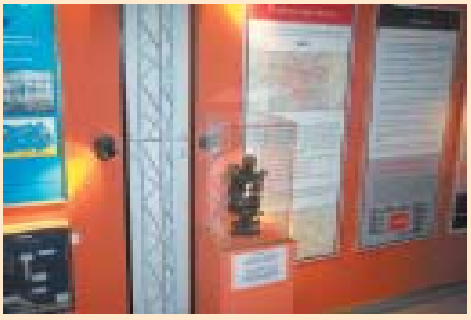
DATE	No. of Days	STATION
15.12.2003	7	DELHI-SAFDARJUNG
22.12.2003	3	CHANDIGARH
25.12.2003	3	AMBALA
28.12.2003	2	HARIDWAR
30.12.2003	4	DEHRADOON
03.01.2004	3	KATHGODAM
06.01.2004	3	BAREILLY
09.01.2004	5	LUCKNOW
14.01.2004	4	KANPUR
18.01.2004	6	ALLAHABAD
24.01.2004	5	VARANASI
29.01.2004	4	MUZAFFARPUR
02.02.2004	3	SAMASTIPUR
05.02.2004	2	BARAUNI
07.02.2004	4	NEW JALPAIGUDI
11.02.2004	4	NEW ALIPURDUAR
15.02.2004	6	GUWAHATI
21.02.2004	3	DIMAPUR
24.02.2004	4	DIBRUGARH
28.02.2004	5	PATNA
04.03.2004	3	DURGAPUR
07.03.2004	3	HATIA
10.03.2004	8	HOWRAH
18.03.2004	4	BHUBANESWAR
22.03.2004	5	VISHAKHAPATNAM
27.03.2004	5	DURG
01.04.2004	4	NAGPUR
05.04.2004	7	SECUNDERABAD
12.04.2004	4	TIRUPATI
16.04.2004	7	CHENNAI
23.04.2004	3	KANYAKUMARI
26.04.2004	5	HIRUVANANTHAPURAM
01.05.2004	3	ERNAKULAM
04.05.2004	2	PALGHAT
06.05.2004	4	COIMBATORE NORTH
10.05.2004	8	BANGALORE
18.05.2004	3	HUBLI
21.05.2004	4	MADAGAON
25.05.2004	3	RATNAGIRI
28.05.2004	8	MUMBAI CENTRAL
05.06.2004	5	PUNE
10.06.2004	5	VADODARA
15.06.2004	7	AHMEDABAD
22.06.2004	5	RAJKOT
27.06.2004	7	BHOPAL
04.07.2004	4	AGRA
08.07.2004	5	JAIPUR
13.07.2004	2	KOTA
15.07.2004	3	AJMER
18.07.2004	5	JODHPUR
23.07.2004	4	BIKANER
27.07.2004	4	FIROZPUR
31.07.2004	5	AMRITSAR
05.08.2004	4	PATHANKOT
09.08.2004	4	JALANDHAR
13.08.2004	3	KURUKSHETRA
16.08.2004	5	DELHI-SAFDARJUNG

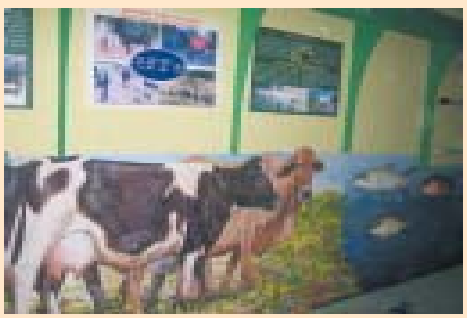
Nodal Officers of different Ministries/ Departments discussing the plan/layout of their exhibits for Vigyan Rail.

Hon'ble Minister of State, S&T, Shri Bachi Singh Rawat, Shri R.K. Singh, Chairman, Railway Board, Shri M. V. Kamath, President, VP and Prof. Ramamurthy, Secretary, DST, meeting the nodal officers of different Ministries / Departments participating in Vigyan Rail.

Hon'ble Minister of State, Science and Technology, Shri Bachi Singh Rawat and Shri R.K. Singh, Chairman, Railway Board, monitoring the progress of working of exhibits.

Schools children attending the inaugural function of Vigyan Rail.





Glimpses of exhibits in Vigyan Rail

Paul Adrien Maurice Dirac

The Unifier of Quantum Mechanics and Relativity Theory

❑ Subodh Mahanti
e-mail: mahantisubodh@hotmail.com

"The opposite of a correct statement is a false statement. But the opposite of a profound truth may well be another profound truth."

Paul Dirac

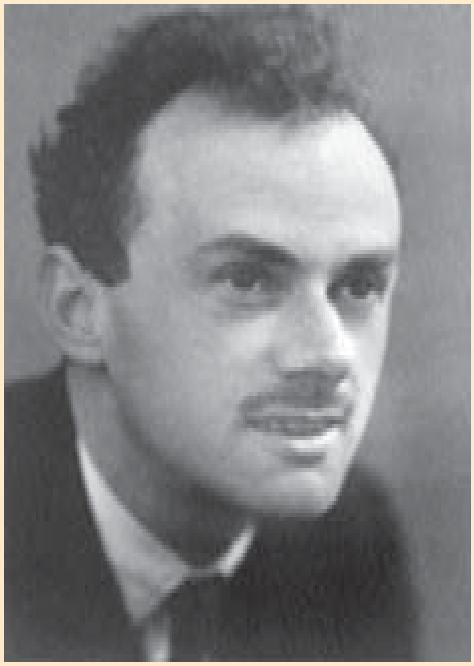
"…it is more important to have beauty in one's equations than to have them fit experiment…It seems that if one is working from the point of view of getting beauty in one's equations, and if one has really a sound insight, one is on a sure line of progress."

Paul Dirac

"An era in physics came to an end when Paul Adrien Maurice Dirac passed away on 20th October, 1984, at the age of 82. Our last surviving link with the birth of quantum mechanics was also broken with his death. Anyone acquainted with the development of modern physics would be well aware of the range, depth and profound beauty of Dirac's work and ideas which appeared in steady and staggering profusion over half a century."

N. Mukunda in *Images of Twentieth Century Physics* (2000)

Paul Adrien Maurice Dirac is regarded as one of the greatest theoretical physicists of the 20th century. In fact he will always rank one of the greatest scientists of all time. Dirac's work was mainly concerned with a branch of science known as quantum mechanics. It takes considerable time and effort to develop familiarity with quantum mechanics. However, it is not something beyond comprehension. It is quantum mechanics which has provided us the best model we have of the physical reality. We find the use of quantum mechanics in many technological applications including quantum optics and nanoelectronics. It may not be very far away when computers will be developed based on quantum logic. The present article does not attempt to explain Dirac's contribution in quantum mechanics but merely states his accomplishments and briefly touches upon his other aspects of life.



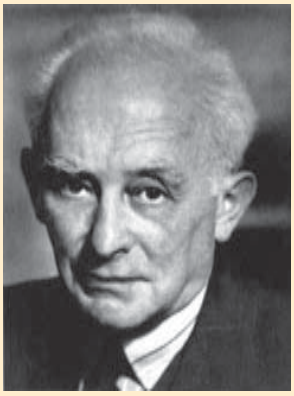
Paul Dirac

Dirac was a founder of quantum mechanics. In 1926, slightly later than Max Born (1882-1970) and Pascual Jordan (1902-80) in Germany, Dirac developed a general theoretical structure (formalism) for quantum mechanics. By applying the ideas of Einstein's special theory of relativity to quantum mechanics, Dirac unified the theories of quantum mechanics and relativity. This gave birth to the relativistic form of quantum mechanics. His relativistic quantum mechanics described the properties of the electron and corrected the failure of Schrodinger's theory to explain electron spin, discovered by George Eugene Uhlenbeck (1900-88) and Samuel Abraham Goudsmit (1902-78) in 1925. In his attempt to unify quantum mechanics and relativity theory he came up with an elegant equation, which is called Dirac equation. While working out the solution of his equation in 1930, Dirac predicted the existence of antiparticle of electron—a particle with the same properties as electron but with positive charge. Carl David Anderson (1905-91) confirmed Dirac's prediction in 1932 by discovering a positively charged electron, which he called positron. Dirac's argument applies all particles, and not just electrons. It meant wherever matter existed its mirror or antimatter must also exist. Werner Heisenberg termed Dirac's prediction of antimatter as "the most decisive discovery in connection with the properties or nature of elementary particles." Dirac's vision of quantum mechanics was marked by its generality and simplicity. Thus Albert Einstein (1879-1955) said: "Dirac, to whom in my opinion we owe the most logically perfect presentation of quantum mechanics." Niels Bohr (1885-1962) said: "Of all physicists, Dirac had the purest soul". Though Dirac's work mainly concerned with the mathematical and theoretical aspects of quantum mechanics, but he also made outstanding work on the magnetic monopole, fundamental length, the delta function, etc.

According to Dirac the principle of mathematical beauty is the key concept in the relationship between mathematics and physics. He said: "The research worker, in his efforts to express the fundamental laws of Nature in mathematical form, should strive for mathematical beauty. I should still

take simplicity into consideration in a subordinate way to beauty."

Dirac had a scintillating academic career. He wrote his first research paper at 22. At the age of 28 Dirac was elected a Fellow of Royal Society of London. He became a Lucasian Professor (a chair once held by Isaac Newton) at the Cambridge University at 31. He received the Nobel Prize at 33. He produced about 200 research papers. Of these about 90 were devoted to the development of quantum theory. All his papers were truly original and contained path-breaking ideas. N. Mukunda wrote: "The number of scientific papers that Dirac wrote is not particularly great. A bibliography compiled at the time of his 70th birthday contained a little over one hundred publications; in all it may run to some 200 papers or so. But the number and variety of entirely original and trail-blazing ideas in these papers are truly stupendous." Dirac was something more than a genius. The mathematician Mark Kac divided geniuses into two classes—the ordinary geniuses and the "magicians". While one can imagine that the achievements of the first category of geniuses—that is the ordinary geniuses, might be emulated by others with enormous hard work and a bit of luck but the achievements of the second category of geniuses or the so called the "magicians" are so astounding that one fails to see how any human mind imagined them. Dirac was truly a "magician".



Max Born

George Eugene Uhlenbeck

Dirac was born on August 08, 1902 in Bristol England. His father Charles Adrien Ladislas Dirac taught French at the secondary school attached to the Merchant Ventures College in Bristol. Charles Dirac was a Swiss citizen and he was educated at the University of Geneva. He came to England around 1888. Dirac's mother was Florence Hannah Holten, the daughter of a Master Mariner of a Bristol Ship. Before her marriage, Florence was working in a library. Dirac was one of three children. He had an older brother and a younger sister. Dirac's childhood was not a happy one. Dirac's father Charles was very strict with his children. He insisted that only French be spoken at the dinner table. As there was no exception to the rule, Dirac was the only person to dine with his father. The other members of the family dined in the kitchen. Since Dirac had to speak with his father only in French, he

Pascual Jordan

spoke very little. He took lot of time to frame proper sentences. Perhaps this was the reason for Dirac's pronounced tendency to speak very little and the utmost care he took in choosing words while speaking. Dirac once said: "I had no social life at all as a child…My father made a rule that I should talk to him in French. He thought it would be good for me to learn French that way. Since I found I could not express myself in French, it was better for me to stay silent than talk English. So I became very silent from an early age." Because of his father's dominating personality hardly anybody came to meet the Diracs. Dirac's elder brother Reginald Charles Felix Dirac wanted to become a physician but his father forced him to study mechanical engineering at Bristol. He obtained a third class degree and he started working as a draftsman with an engineering firm. Reginald committed suicide at 24. After this incident Dirac was totally elienated with his father. Perhaps Dirac thought his father was in some way responsible for his brother's suicide.

The first school, which Dirac attended, was Bishop Primary School. Dirac's exceptional mathematical ability showed itself at an early age. In his school he was given rather advanced books on mathematics for independent study. His father also encouraged his son to develop his mathematical ability. At the age of 12 Dirac entered the Merchant Ventures Secondary School. Commenting on his school Dirac wrote: "The Merchant Ventures was an excellent school for science and modern languages. There was no Latin or Greek, something of which I was rather glad, because I did not appreciate the value of old cultures. I consider myself very lucky in having been able to attend the school…I was rushed through the lower forms, and was introduced at an especially early age to the basis of mathematics, physics and chemistry in the higher forms. In mathematics I was studying from books, which mostly were ahead of the rest of the class. The rapid advancement was a great help to me in my latter career."

Samuel Abraham Goudsmit

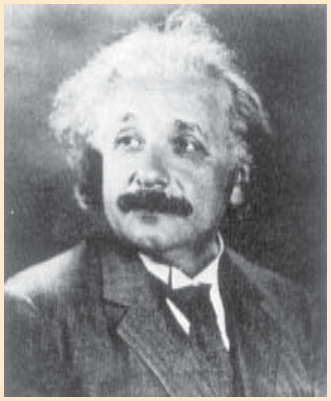
After completing his secondary school education in 1918, Dirac decided to study electrical engineering at the University of Bristol. This is in spite of the fact that his favourite subject was mathematics. However, in those days the only possible career for a mathematician was school teaching. As Dirac wanted to avoid the profession of a

school teacher, he ended up in studying electrical engineering. He obtained his degree in electrical engineering in 1921. However, he could not find a permanent job as an engineer. In the meantime his interest in mathematics had become more intense. He unsuccessfully attempted to study mathematics at Cambridge. The reason for his not been able to study mathematics at Cambridge was financial. Though he obtained a scholarship to study mathematics at St John's College at Cambridge but it was not enough for meeting his financial needs. He failed to get additional support from the local education authority. He was not given the additional support because his father had not been a British citizen long enough for his son to be eligible for such support. However, Dirac got an opportunity to study mathematics at the Bristol University without paying fees.

Carl David Anderson

As a student of electrical engineering he did hardly any experimental work. In any case Dirac was not good at practical work. He did not appreciate the fact that topics such as atomic physics and Maxwell's electromagnetic theory were excluded from electrical engineering course. However, his engineering studies had a bearing on his future work in mathematical physics. Particularly the use of approximations that he learnt while studying engineering exerted a strong influence on his later work. The use of approximation strengthened his confidence in the intuitive approach to problem solving and which in turn led him to believe that to construct a theory expressing fundamental law of nature one need not have the exact knowledge of actualities. It can be done being guided by intuition. He was of the opinion that a physicist must be satisfied to work only with approximate knowledge of reality—the actual phenomena were too complex to be understood in a precise way. On the influence of engineering studies on his work in mathematical physics Dirac himself said : "If I had not this engineering training I should not have had any success with the kind of work that I did later on, because it was really necessary to get away from the point of view that one should deal only with results which could be deduced from known exact laws, in which one had implicit faith."

Niels Bohr



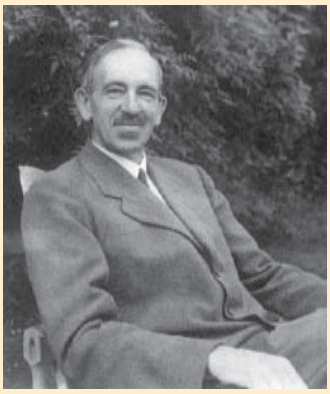
Albert Einstein

He obtained a first class honours degree in mathematics in 1923 and he was awarded a grant to undertake research at Cambridge. Because of his fascination with the general theory of relativity, Dirac was interested in working with Ebenezer Cunningham. But Cunningham had as many students as he was prepared to take and so Dirac started working under the supervision of Ralph Howard Fowler(1899-1944), who had collaborated with Niels Bohr in his pioneering work in atomic physics. R. H. Dalitz and R. Peierls while writing on Dirac in *Biographical Memoirs of Fellows of the Royal Society of London*, wrote: "Fowler was then the leading theoretician in Cambridge, well versed in the quantum theory of atoms; his own research was mostly on statistical mechanics. He recognized in Dirac a student of unusual ability. Under his influence Dirac worked on some problems in statistical mechanics. Within six months of arriving in Cambridge he wrote two papers on these problems. No doubt Fowler aroused his interest in the quantum theory, and in May 1924 Dirac completed his first paper dealing with quantum problem. Four more papers were completed by November 1925."

It was after going through the proofs of Werner Heisenberg's paper on uncertainty principles that Dirac got a clue to formulate for the first time a mathematically consistent general theory of quantum mechanics in correspondence with Hamiltonian mechanics. The paper was sent to Fowler and who in turn passed it to Dirac. After reading the paper for the second time Dirac realized "that it (Heisenberg's paper) provided the key to the problem of quantum mechanics. Dirac's work on quantum mechanics became the basis for his Doctoral thesis on Quantum Mechanics. It is important to note that before submission his doctoral thesis, Dirac had published eleven papers. Dirac was awarded a PhD degree in 1926. He then went to Copenhagen to work with Niels Bohr. From Copenhagen he moved to Gottingen in February 1927 where he interacted with J. Robert Oppenheimer (1904-67), Max Born, James Franck (1882-1964) and Igor Yevgenevich Tamm (1895-1971). He also spent a few weeks in Leiden before he returned to Cambridge.

In 1927 Dirac was elected a Fellow of St John's College, Cambridge. In 1930 Dirac was elected a Fellow of Royal Society of London. He was only 28 years old. What is more Dirac was given the honour on the very first occasion his name was put forward. This was an indication of the extremely high opinion that Dirac's fellow scientists had of him. In 1930 Dirac published *The Principles of Quantum Mechanics*. In this book Dirac developed the so-called transformation theory of quantum mechanics that furnished a machinery for calculating the statistical distribution of certain variables when others are specified. Commenting on the book one reviewer wrote: " Dirac was not influenced by the feeding frenzy in experimental phenomenology of the time. This

has given Dirac's book ...a lasting quality that few works match." This book confirmed Dirac's stature as the 20th century Newton in the minds of many physicists. Thus N. Mukunda wrote: " This book is often compared for its spirit and style to the *Principia* of Isaac Newton." It has guided several generations of physicists. His other published works include *Lectures on Quantum Mechanics* (1966), *The Development of Quantum Theory* (1971), *Spinors in Hilbert Space* (1974), and *General Theory of Relativity (*1975).



Ralph Howard Fowler

In 1932, Dirac was appointed Lucasian professor of mathematics at the Cambridge University. He held this post for 37 years. The post was once held by Isaac Newton. Stephen Hawking succeeded Dirac.

In 1937 Dirac married Eugene Paul Wigner's sister Margit, whom she met at Priceton. This was second marriage for Margit. She had two children Judith and Gabriel Andrew from her first marriage. Both the children adopted the name of Dirac.

Dirac was an extremely modest man. He never talked about the importance of his own work. He was ever ready to acknowledge his debt to others. Once commenting on his work Dirac said: "Well, from the initial idea of Heisenberg, one could make fairly rapid development, and I was able to join in it. I was just a research student at that time. I was lucky enough to be born at the right time to make it possible for that to be so." On another occasion he said: "It was very easy in those days for any second-rate physicist to do first-rate work. There has not been such a glorious time since then. It is very difficult now for a first rate physicist to do second-rate work".

James Franck

Dirac had an unusual personality. He was extremely shy. He avoided company. Dirac spent most of his time alone in libraries. His only pastime was solitary walk. He was reluctant to take part in conversation. Dirac is well-known for clarity and simplicity in his writing. Bohr commenting on Dirac's style of writing said: "Whenever Dirac send me a manuscript, the writing is so neat and free of corrections that merely looking at it is an aesthetic pleasure. If I suggest even minor changes, Paul becomes terribly unhappy and generally changes nothing at all."

Robert Oppenheimer

Like many other great personalities innumerable stories have become attached to Dirac. Most of these stories had to do with Dirac's unusual logic and precision that he adopted while interacting with world. Often such stories do not represent the true facts. But in case of Dirac all the stories are claimed to be true. George Gamow in his *Thirty Years that Shook Physics* wrote: "Now it often happens that 'absent minded professor' stories grow up around famous scientists. In most cases these stories are not true, merely inventions of wags, but in case of Dirac all the stories are really true, at least in the opinion of this writer... Being a great theoretical physicist, Dirac liked to theorise about all the problems of daily life, rather than to find solutions by direct experiment. Once at a party at Copenhagen, he proposed a theory according to which there must be a certain distance at which a woman's face looks its best. He argued that at d=infinite one cannot see anything anyway, while at d=0 the oval of the face is deformed because of the small aperture of the human eye, and many other imperfections (such as small wrinkles) become exaggerated. 'Tell me, Paul,' I asked, 'how close you have seen a woman's face?' 'Oh', replied Dirac, holding his palms about two feet apart, 'about that close'". After Dirac delivered a lecture at the University of Toronto, somebody in audience asked during the question period; "Professor Dirac, I do not understand how you derived the formula on the top left side of the blackboard." Dirac did not reply. He simply said: "This is not a question, it is a statement. Next question, please." As mentioned earlier that Dirac's writing was marked for its clarity and simplicity. Niels Bohr, while writing a paper with many hesitations and redrafting once remarked in Dirac's presence : " I do not know how to finish this sentence." To this Dirac replied: "I was taught at school that you should never start a sentence without knowing the end of it." Once Leonidovich Pjotr Kapitza (1894-1984) had given an English translation of Dostoevski's Crime and Punishment. When Dirac went to return the book, Kaptza asked: "Well, how do you like it?" Dirac's only comment was: "It is nice, but in one of the chapters the author made a mistake. He describes the Sun rising twice on the same day." An interesting interaction with Dirac was narrated by his colleague Jagdish Mehra:

Igor Yevgenevich Tamm

Eugene Paul Wigner

Leonidorvich Pjotr Kapitza

Erwin Schrodinger

"The weather outside was very bad, and since in England it is always respectable to start a conversation with the weather, I said to Dirac, 't is very windy, Professor.' He said nothing at all, and a few seconds later he got up and left. I was mortified, as I thought that I had somehow offended him. He went to the door, opened it, looked out, came back, sat down, and said, 'Yes.'"

Dirac traveled extensively and studied at various foreign universities including Copenhagen, Gottingen, Leyden, Wisconsin, Michigan and Princeton. Dirac visited the erstwhile Soviet Union a number of times. During 1973 and 1975 Dirac lectured on the problems of cosmology in the Physical Engineering Institute in Leningrad. Dirac also visited India. After retiring from the Lucasian Chair of Mathematics at Cambridge in 1969, Dirac went with his family to Florida in United States of America. He held visiting lecturership at four US universities before he was appointed Professor of Physics at Florida State University in 1971.

Dirac received the Nobel Prize in Physics 1933 at the age of 33. He shared the Prize with Erwin Schrodinger (1887-1963). At the first instance Dirac was contemplating to turn down the Prize on the grounds that he did not relish publicity. But on being pointed out that he would receive far more publicity in case he decided to refuse the Prize, he accepted it. Though Dirac could invite his parents but he only invited his mother and not his father, a reflection of his strained relation with his father. Some of the other honours that Dirac received are: Fellow of the Royal Society of London (1930), the Order of Merit (1933), Royal Society Royal Medal (1939), Royal Society Copley Medal (1952), Royal Socity Bakerian lecturer (1941). While Dirac refused to accept honorary degrees but he accepted membership of academic societies. Among these academic bodies included USSR Academy of Sciences (1931), Indian Academy of Sciences (1939), Chinese Physical Society (1943), Royal Irish Academy (1944), Royal Society of Edinburgh (1946), Instut de France (1946), National Institute of Science of India (1947), American Physical Society (1948), Pontifical Academy of Sciences, Vatican City (1958), Royal Danish Academy (1962) and Academy of Sciences Paris (1963).

Dirac died on October 20, 1984 in Tallahassee, Florida, USA. In November 1995 a plaque was unveiled in Westminster Abbey commemorating Paul Dirac. The memorial address was present by Stephen Hawking.

We would like to end this article by quoting Dirac on what he had to say about quantum mechanics: "... the present form of quantum mechanics should not be considered as the final form. There are great difficulties...with the present quantum mechanics. It is the best that one can do up till now. But one should not suppose that it will survive indefinitely into the future. And I think that it quite likely that at some future time we may get an improved quantum mechanics in which there will be a return to determinism and which will, therefore, justify the Einstein point of view."

References

1. *Dirac: A Scientific Biography* by Cambridge: Cambridge University Press, 1990.
2. *Reminiscences About a Great Physicist: Paul Adrien Maurice Dirac*. Edited by Behram N. Kursunoglu and Eugene P. Wigner. Cambridge: Cambridge University Press, 1987.
3. *Images of Twentieth Century Physics* by N. Mukunda. Hyderabad: Universities Press India Limited, 2000. (Published in collaboration with Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore).
4. *The Oxford Companion to the History of Modern Science* J. L. Heilborn (edited by). Oxford: Oxford University Press, 2003.
5. *The Cambridge Dictionary of Scientists* (Second edition) by David, Ian, John and Margaret Millar. Cambridge: Cambridge University Press, 2002.
6. A Dictionary of Scientists. Oford: Oxford University Press, 1999.
7. *The History of Science from 1895 to 1945* by Ray Spangenburg and Diane K. Moser. Hyderabad: Universities Press (India) Limited, 1999.
8. *Chambers Biographical Dictionary*. New York: Chambers Harrap Publishers Ltd., 1997.
9. *Paths of Innovators* by R. Parthasarathy. Chennai: East West Books (Madars) Private Ltd., 2000.

◆◆◆

Nobel Prize in Physics 2003

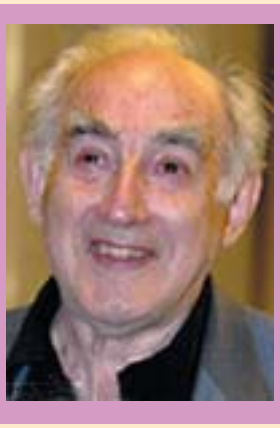
❑ Biman Basu
e-mail: basu_biman@yahoo.com

It is well known that temperature is a measure of atomic and molecular movement in matter. As a substance is cooled the atomic movement slows down, ultimately ceasing altogether at a temperature of - 273.16° Celsius, or absolute zero. Some materials show strange behaviour when they are cooled to a few degrees above absolute zero – some metals totally lose resistance and allow electric current to pass without any loss, while in some liquids viscosity vanishes entirely making them flow in strange a manner without any friction. The Nobel Prize in Physics for 2003 has been awarded to two American and one Russian physicist – Alexei A. Abrikosov of Argonne National Laboratory, Argonne, Illinois, USA; Anthony J. Leggett of University of Illinois, Urbana, Illinois, USA; and Vitaly L. Ginzburg of P.N. Lebedev Physical Institute, Moscow, Russia – who have made decisive contributions concerning above two phenomena of superconductivity and superfluidity.

The Dutch physicist H. Kammerling Onnes discovered the phenomenon of superconductivity in 1911. He was particularly interested in the properties of substances at low temperatures and had succeeded in producing liquid helium, which has an extremely low temperature. When Onnes investigated the electric conductivity of mercury, he found that when the metal was cooled by means of liquid helium to a few degrees above absolute zero, its electric resistance vanished. He named this phenomenon superconductivity. Although no theoretical explanation could be found for this phenomenon, it was evident that it could have far-reaching significance in a modern society that was becoming more and more dependent on electricity. Onnes was awarded the Nobel Prize for Physics in 1913 for this work.

Three American physicists John Bardeen, Leon Neil Cooper, and John Robert Schrieffer gave the explanation of superconductivity in 1957, and their theory came to be known as the "BCS theory" (named after the initials of their surnames). According to this theory some of the negatively charged electrons in a superconductor form pairs, called Cooper pairs. These pairs of electrons flow along attracting channels formed by the regular structure of the positively charged metal atoms in the material. As a result of this combination and interaction the current can flow evenly and superconductivity occurs. The paired electrons are usually thought of as a condensate, similar to the drops of liquid that form in a cooled gas. Unlike an ordinary liquid this "electronic liquid" is superconductive. Bardeen, Cooper and Schrieffer shared the Nobel Prize for Physics in 1972 for their theory of superconductivity.

Alexei A. Abrikosov



Vitaly L. Ginzburg

Anthony J. Leggett

Two types of superconductors

Besides extreme conductivity, superconducting materials also have the property of being able to displace magnetic flows completely or partly. Those that displace magnetic flows completely are called type-I superconductors; in these materials if the surrounding magnetic field becomes too strong, the superconductive property disappears. The BCS theory could explain only the property of type-I superconductors. It was, however,

found inadequate for explaining superconductivity in the technically most important materials, called type-II superconductors, which allow superconductivity and magnetism to exist at the same time and remain superconductive in high magnetic fields.

Alexei Abrikosov, working at the Kapitsa Institute for Physical Problems in Moscow, succeeded in formulating a new theory to describe the phenomenon of type-II superconductors. Using a description of superconductivity in which the density of the superconductive condensate is taken into account with the aid of a wave function, Abrikosov was able to show mathematically how the wave function can describe vortices and how the external magnetic field can penetrate the material along the channels in these vortices. This description was a breakthrough in the study of new superconducting materials and is still used in the development and analysis of new superconductors and magnets.

Vitaly Ginzburg at the P.N. Lebedev Physical Institute, Moscow, had developed an alternative theory for type-I superconductors, which proved to be so comprehensive that it was also valid for the new type. Although these theories were formulated in the 1950s, they have gained renewed importance in the rapid development of materials with completely new properties, especially the development of the so-called high-temperature superconductors, for which the German physicist Georg Bednorz and the Swiss physicist Alex Müller were awarded the Nobel Prize for Physics in 1987.

Our knowledge of superconductivity has led to revolutionary applications. New compounds with superconductive properties are being discovered all the time. Materials can now be made superconductive at increasingly high temperatures and strong magnetic fields. In the past few decades a large number of high-temperature superconductors have been developed.

Superfluid helium

The lightest inert gas, helium, exists in nature in two isotopic forms. The usual form is represented as 4He, where the '4' stands for the number of nucleons in the atomic nucleus, viz., two protons and two neutrons. In the unusual form, 3He, the atomic nucleus has only one neutron, so it is lighter. In helium that occurs naturally 3He is found to the extent of one part in about 10 million. Only in the last 50 years it has been possible to produce large amounts of 3He, in nuclear power reactors. At normal temperatures the gases of the two isotopes differ only in their atomic weights.

If helium gas is cooled to low temperatures, approximately 4 degrees above absolute zero, i.e., -273.15°C, the gas passes into liquid form, it condenses. This happens in the same way as when steam condenses into water. If the temperature is not too low, the liquids of the two isotopes of helium have similar properties. Liquid helium is used widely as a coolant, in superconducting magnets, for example.

If, however, liquid helium is cooled to even lower temperatures, dramatic differences arise between the liquids of the two isotopes; quantum physical effects appear that cause the liquids to lose all their resistance to internal movement, they become superfluid. But this occurs at quite different temperatures for the two isotopes and they exhibit a wide range of fascinating properties, such as flowing freely from openings in the vessel they are kept in, by climbing up the walls, for example. These effects can be explained only by means of quantum physics.

The fact that 4He becomes superfluid was discovered by the Russian physicist Pyotr Kapitsa, among others, in the late 1930s. This phenomenon was explained almost immediately by the young Russian theoretical physicist Lev Landau, who was awarded the Nobel Prize for Physics in 1962 for this discovery. The transformation from normal to superconducting liquid, which for 4He occurs at approximately 2 degrees above absolute zero, is an example of Bose-Einstein condensation, a process that has also been observed more recently in gases.

For the 3He isotope the transformation into the superfluid state was discovered in the early 1970s by the American physicists David Lee, Douglas Osheroff and Robert Richardson, who shared the Nobel Prize for Physics in 1996 for their discovery. One reason why this discovery came so much later is that the transformation occurs at a very much lower temperature; approximately 1,000 times lower than for the 4He isotope.

The theoretician who first succeeded in explaining the properties of superfluid 3He in a decisive way was Anthony Leggett, who in the 1970s was working at the University of Sussex in England. His theory helped experimentalists to interpret their results and provided a framework for a systematic explanation. Leggett's theory, which was first formulated for superfluidity in 3He, has also proved useful in other fields of physics, e.g., particle physics and cosmology.

As superfluid, 3He consists of pairs of atoms, and its properties are much more complicated than those of the superfluid 4He. In particular the pairs of atoms of the superfluid have magnetic properties, which means that the liquid is anisotropic, it has different properties in different directions. This fact was used in experiments in which studies were made of the liquid immediately after its discovery. By means of magnetic measurements it was revealed that the superfluid 3He has very complex properties, exhibiting a mixture of three different phases. Superfluid 3He is a tool that researchers can use in the laboratory to study other phenomena as well. In particular the formation of turbulence in the superfluid has recently been used to study how order can turn into chaos. This research may lead to a better understanding of the ways in which turbulence arises – one of the last unsolved problems of classical physics.

◆◆◆

Coriander

❑ T V Venkateswaran
tvv123@rediffmail.com

'Love it or leave it' appears to be the only two reaction to Coriander; some just love the flavour and taste others just hate it. One can even speculate the East- West divide- while most Westerners loathe coriander and its taste; most Asian could not do without it. On this subject, much more so than politics, people are either on one side of the fence or another, no cat on the wall stance. Those who hate coriander reproach describe the flavour of coriander leaves as (cilantro) soapy tasting, and that the seeds to be most unpleasant odor- "like bed bugs," or "burned rubber". Though it is said that the liking or disliking coriander is predisposed, not much evidence is available to conclusively presume genetic curse.

Coriander plant, seeds, and flower

The Greek name of the plant, *koríannon*, is derived from *kóris* "gnat", because of the aroma of the leaves. Greek *kóris*, meaning bedbug, because of the unpleasant, fetid, bug-like odour of the green herb and unripened fruits. It was loaned to Latin *coriandrum* and eventually entered all Western European languages. The term *cilantro*, used in Latin America for coriander leaves, goes back to the same Latin word, but was probably transferred via Medieval Latin *celiandrum*. It is called as 'Kothamalli' in Tamil. The suffix 'malli'- refering to Jasmine implies it's sweet fragrence. In Hindi it is called as Daniya.

Although cilantro or coriander are most often associated with the cuisines of Mexico and Asia, the herb originated in the southern reaches of the Mediterranean- Asia minor. Coriander has been found in Egyptian tombs dating back 3000 years. It is even mentioned in the Bible in Exodus 16:31, where manna is described as "small round and white like coriander seed." The ancient Hebrews originally used cilantro root as the bitter herb in the symbolic Passover meal.

Thanks to the Romans and their conquests, coriander's use and legend spread to Europe and Asia, where it appeared in recipes for potions used as aphrodisiacs in China during the Han dynasty (207 BC-200 AD). The Romans themselves used coriander with cumin and vinegar as a preservative, which they rubbed into meat. In literature, coriander is mentioned as an aphrodisiac in The Tales of the Arabian Nights.

The coriander plant yields two primary products that are used for flavouring purposes: the fresh green herb and the spice. The latter is the dried form of the whole mature seed capsule (fruit) but is frequently termed 'coriander seed' in commerce. The odour and flavour of these two products are markedly different. While generally only the fruits (or dried pods) leaves are consumed, In Thailand, even root is considered a delicacy. Fruits and leaves posses totally different flavour and can therefore not substitute each other. While the fruit is often used only after drying, the process of drying destroys fragrance from leaf. The herb is used for culinary flavouring purposes in Asia, the Middle East, and Central and South America.

Actually, the plants forms leaves of two different shapes: The base leaves are broad, and are reputed for the better flavour. Leaves attached to the stems are pinnate and their flavour is said to be less fresh.

Main constituents

The taste of the fresh herb is due to an essential oil (0.1%) that is almost entirely made up of aliphatic aldehydes with 10 to 16 carbon atoms. One finds both saturated (decanal) and á,â unsaturated (*trans*-2-tridecenal) aldehyds; the same aldehyds appear in the unripe fruits. In the ripe fruits, the content of essential oil is comparably low (typically, less than 1%); the oil consists mainly of linalool (50 to 60%) and about 20% terpenes (pinenes, ã-terpinene, myrcene, camphene, phellandrenes, á-terpinene, limonene, cymene). Other constituents include alpha-pinene , terpinene , limonene (=carvene), p-cimene).

In toasted coriander fruits, pyrazines are formed as the main flavour compounds.

The composition of the volatile oil, which determines the odour and flavour character, has been of particular fascination to chemists. In the unripe fruit and herb, aliphatic aldehydes predominate in the steam volatile oil and are responsible for the peculiar, fetid-like aroma (an important flavour component of Thai cuisine). On ripening, the fruits acquire a more pleasant and sweet odour and the major constituent of the volatile oil is the monoterpene alcohol, linalool. In the unripe fruit, two types of volatile oil canals are present. One type is located on the periphery of the fruit and these canals contain a volatile oil comprised predominantly of aldehydes. The second type of canals is buried in the mericarp of the fruit kernel and the composition of their volatile oil is very different. The major component is linalool together with some other oxygenated monoterpenes and monoterpene hydrocarbons. As the fruit ripens on the plant, the peripheral canals flatten, begin to lose their volatile oil, and the odour of the fruit changes. On drying

SCIENTISTS AT the department of spices and plantation crops of the Horticultural College and Research Institute (HC&RI), Tamil Nadu Agricultural University (TNAU), Coimbatore, have developed a high-yielding variety of coriander, which yields bold and attractive coloured grains with high essential oil content.

The new variety was released for commercial cultivation early this year at the TNAU.

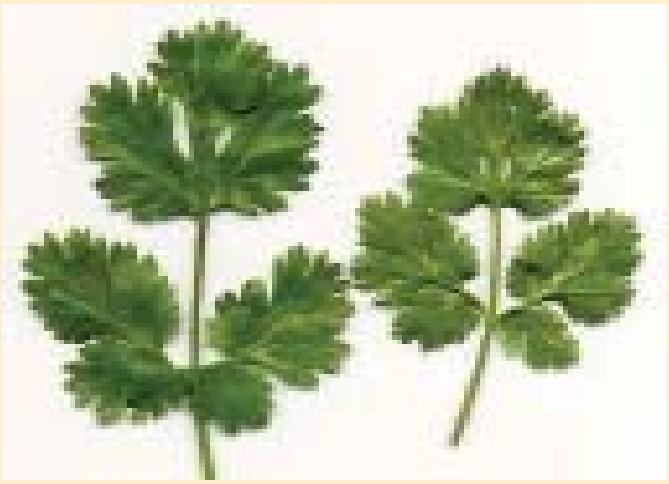
Christened "CO (CR) 4", the coriander has a short duration (65-70 days). It can be cultivated under rainfed and irrigated conditions.

The new variety is a selection from the germplasm collections received from the Regional Agricultural Research Station, Lam, Guntur in Andhra Pradesh, and it has been found to be highly suitable for both the dry lands and black cotton soils of Tamil Nadu, according to the scientists, who developed this variety.

The plants of the new CO (CR) 4 variety grow up to a height of 35 cm, and have a distinguishing pink colouration at the basal portion of the main stem. They are semi-erect in growth habit with shorter internodes. The plants flower in 30-35 days after sowing. They produce bold, oval grains, which are attractive straw yellow in colour. A thousand grains weigh about 18.6 g. The variety has recorded an average yield of 587.2 kg grains per hectare in irrigated condition, and the rainfed crop has registered an average output of 539.4 kg grains per hectare. The irrigated crop has recorded a 24.57 per cent more yield than the popular variety CO 3, and the rainfed crop has yielded 16.02 per cent more than that of CO 3. Since this comes to harvest in about 70 days as compared to 85 to 105 days of CO 3, this variety has been found more suitable for crop rotation, mixed cropping and inter-cropping systems. It has been found to have field tolerance to wilt, powdery mildew and aphids.

to around 7% moisture content, the outer canals completely lose their volatile oil but the inner canals remain intact and the characteristic odour and composition of the volatile oil of the spice are attained.

The essential oil obtained through steam distillation of the fruit is a colourless or pale-yellow liquid. The aroma has been described as pleasant, sweet and somewhat woody and spicy, with a floral-balsamic undertone and peppery-woody topnote as the characteristic features. The flavour is described as mild, sweet and spicy-aromatic yet somewhat warm and slightly burning. In depth analyses of the oil have identified 203 individual components in coriander fruit oil. The 18 main components constitute 97% of the total oil, however, when reconstituted they did not result in giving the odour impression of coriander oil found in the natural sample. This implies that major sensory effect of the oil comes from the 180 trace components that occur, on average, in concentrations of about



Upper and Lower leaves

0.01% or less. The inclusion of unripe fruits or other over-ground parts of the plant during distillation of the fruit imparts an obnoxious odour to the oil. The organoleptic properties of the distilled oil tend to deteriorate during prolonged storage especially if left exposed to light and air. Coriander seed is also processed via steam distillation for the extractable essential oil of which d-linalool is the major constituent. The oil is then used in the perfume and food industries.

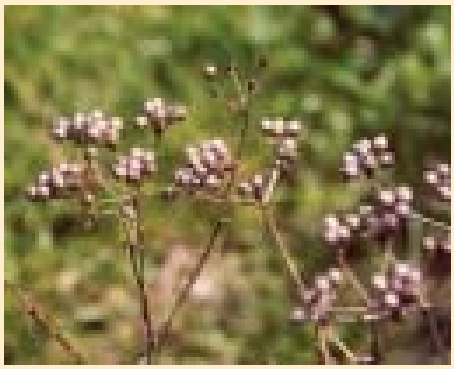
Coriander Cuisines

Coriander fruits are a common spice in many countries of Europe, Northern Africa, West, Central and South Asia. Coriander is an essential part of *curry* powder and Indian *masalas* as well in Northern India (*garam masala*) as in the South (*sambaar podi, Rasa Podi*); furthermore, Ethiopian *berebere*, which much resembles Indian spice mixtures, contains coriander fruits. Lastly, it should be noted that also Latin American cuisine makes much use of them. Roasting or frying, much practised in India and Sri Lanka, enhances the flavour.

Coriander leaves (also called coriander green) are popular over the most part of Asia. Used in India regionally (e.g., in Maharashtra), they are indispensable in Thailand, Vietnam and parts of China, where the chopped leaves appear as decorations on nearly every dish. Arabic cooking makes use of both coriander leaves and fruits. *Zhoug* (or *zhug*), a spicy paste typical for Yemeni cookery, is a recipe that contains both coriander leaves Use of coriander leaves is also frequent in Latin America, especially México (e.g., in *salsa*). Whole coriander is used in pickling spices, for meats and pickles. The seeds are also used to flavor alcoholic beverages, such as gin, and in liqueurs. They are used as a flavouring for bread, and yield an essential oil for soaps and perfumes. The fruit has been used to flavor cigarette tobacco.

Medicinally, coriander is said to be Stimulant, aromatic and carminative. Carminatives are plants that are rich in aromatic volatile oils that stimulate the digestive system to work properly and with ease, soothing the gut wall, reducing any inflammation that might be present, easing griping pains and helping the removal of gas from the digestive tract.

Fruits (seeds) of Coriander



Coriander Plant – flowers

The plant

Coriander, (Coriandrum sativum) belongs to Apiaceae (syn: Umbelliferae) - Carrot family is also called chinese parsley or as cilantro coriander. While for most chefs, cilantro refers to the green leaf coriander refers to the fruit, nonetheless, coriander is commonly used to refer both products by general public. Coriander is a relatively easy to grow annual, requiring partial shade to full sun, moderately rich soil, and good drainage.

Coriander is heat-loving annual herb. It is erect and has a tap root. The flowering stem, which is slender and smooth, reaches a height of 20-120 cm. It has delicate fernlike foliage with pinkish white flowers in flat clusters. The flower, in compound umbels, bears small white or pink flowers. Hermaphrodite and staminate flowers may occur in each umbel. The fruits are nearly globular, 3-4 mm in diameter, and are yellow-brown when ripe. The beige fruit (mistakenly called seed) is round, ribbed and/or spiked. The fruits consist of two hemisphere-shaped halves enclosed in the ovary wall - single-seeded mericarps. The unripe fruits smell of bedbugs, but become pleasantly aromatic on ripening. Though Coriander grows on a fairly wide range of soils, it does best on well-drained loam and sandy-loam soils. The seed is planted with their husk.

It is mainly a crop of tropics and extensively grown in India, France, Spain, Russia, Italy, Holland, Burma, Pakistan, Mexico, Guatemala and USA. In India, it is cultivated in all the states and constitutes an important subsidiary crop in the black cotton soils of Deccan and South India and rich silt loams of North India. One-lakh acres are under coriander cultivation in Andhra Pradesh and Tamil Nadu. On an average India produces 200,000 mt per year from about 4.0 lakh hectare.

We cannot harvest coriander herb (fresh leaves) and seeds (fruit) from the same plant!. If we are interested in harvesting the herb, we would have to cut and remove the flower stalks as and when they are formed. Once the plant has flowered and set the taste of the leaves become harsh to taste. If we need coriander (fruit/seeds) then we need to let the flowers set- then the leaves will no longer taste right.

Seeds, once harvested are dried until they have turned from green to brown, then are stored in dry and airtight containers. The fragrance of the seed changes as it dries. To release the best flavor, crush the seeds in a mortar just as you are ready to use them. The leaves do not dry well and should be used fresh. To store coriander leaf, cut off the stem ends and place the bunch in a glass of water and keep it refrigerated until you use them. Rinse the leaves just before use. It is important to add leaves to the end of your cooking as the flavor does not last long.

◆◆◆

Letters to the Editor

I convey my sentiments for your remarkable Editorial Note – THE ROAD TO SPACE – (Monthly News letter "DREAM 2047", March 2003). Indeed, space mission is the highest of all enterprises of mankind. Other domains of human endeavour like genetic engineering, human cloning or discovery of remedy against incurable disease of cancer are all secondary to this mission. The US as a pioneering nation has been magnanimous to associate an Indian daughter in this space odyssey. We fully agree with your that Space shuttle Columbia did not bring back Kalpana Chawla to earth, but she has recorded India's glory in the space infinite.

B.K. Mahajan
Asstt. Administrator Officer, O/O The Comptroller and Auditor General of India, 10, Bahadur Shah Zafar Marg, N.D. 110002

The 'History of Science' section of your magazine claims my first attention. Lives and contribution of Sisir Kumar Mitra, Albert Einstein have been portrayed in an absorbing manner. So are the articles like 'A Brief History of Zero' by Rintu Nath (March 03), 'The Making of Pi' by the same author (June 03) which induce interests to a person in a field other than Mathematics, like me. The 'New Horizons' also display some fabulous scientific development of very recent time.

Chandan Paul
Deshbandhu Road, Kol-130, (W.B.)

Kudos for writing (so vividly) the life history of scientists of the country/world and how things took shape in their mind.

Sarthak Panda
S.K. Dash Complex, Sakhipara, Sambalpur (Orissa) 786001

Dream 2047 I have been reading for last three years. This magazine has proved a great help to me in imparting knowledge to my students. I went through the article about Sisir Kumar Mitra and found it advantageous for my students.

Saroj Kumar Joshi
Jajodiya Senior Madhyanik School, Sujangarh, Distt. Churu (Rajasthan) 331507

National Center for Radio Astrophysics

Aiming for world class radio astronomy

❑ Dilip M. Salwi
e-mail: dilipmsalwi@hotmail.com

"Where is the National Center for Radio Astrophysics (NCRA) located?" Very few persons would be able to answer this question but instead if it is asked, " Where is the Giant Meter-wave Radio Telescope (GMRT) located ?" the prompt response from many would be "Narayangaon or Khodad, near Pune"! Yes, the GMRT is today the most popular radio telescope in the country and its location is known to all astronomy-lovers. But few know that the GMRT is a part of the NCRA, whose office is located in the sprawling, wooded and green campus of the Pune University, Pune – only a road separating it from the popular Inter-University Center for Astronomy and Astrophysics. Still fewer know that the NCRA is the newly formed center of the radio astronomy group of the prestigious Tata Institute of Fundamental Research (TIFR), Mumbai.

A view of the National Center for Radio Astrophysics at Pune

"We've a rare radio astronomy facility," said Prof R.Nityanand, Director, NCRA, " which is not available elsewhere in the world. We provide access to the unique and powerful GMRT to all our students and researchers". Indeed, the GMRT is the only radio instrument of its kind operating at meter-wavelengths, which is now accessible to any student or researcher of radio astronomy all over the world. With two unique radio telescopes, excellent digital and analog electronics laboratories, a network of sophisticated computer facility for image processing and other applications and a well-equipped specialized library on astronomy and astrophysics, the NCRA is today the best place to be in for any lover of radio astronomy in the country. In fact, its doors are open to any radio astronomer in the world with an innovative and original project in radio astronomy and astrophysics.

Radio astronomers at work in the NCRA

The origin of the NCRA can be traced to the vision of Homi J.Bhabha, who founded the TIFR in 1945, with the express objective of providing research facilities and laboratories for Indian scientists so that they could work at the cutting edge of science in the country itself after her Independence. Moreover, he believed in building research groups around capable scientists willing to take up challenging scientific projects. So, when a group of radio astronomers working abroad showed their desire to come back to India to conduct frontline research in radio astronomy he not only brought them into the TIFR fold but also agreed to provide them all facilities for pursuing radio astronomy in India. Using the hardware available in those days after the Second World War, the first radio telescope was set up in the country at Kalyan, near Mumbai, in 1963. Among those newly recruited radio astronomers who went on to convince Bhabha of the need of a novel radio telescope and the desire to build it with indigenous knowhow and materials was Prof Govind Swarup.

Before his untimely death Bhabha even selected the site for what is today known as the Ooty Radio Telescope (ORT) installed at Ooty, (now Udagamandalam), Tamil Nadu. Under the dynamic leadership of Prof Swarup, the ORT was indigenously designed and built. It became operational in 1970. So flourished the 'Radio Astronomy Group' in the TIFR with its office in Bangalore, which has an easy access to Ooty. Subsequently, the ever zealous Prof Swarup again designed the GMRT and had it indigenously built and installed at Khodad village, near the small town of Narayangaon on the Pune-Nasik highway. With a growing radio astronomy group and a frontline radio telescope facility fast coming up at Khodad, the TIFR set up in meanwhile the full-fledged NCRA with Prof Swarup as its first Project Director to manage the construction and installation of the GMRT; the telescope became fully operational in 1999. Today, the GMRT Project has a separate Director S.Ananthakrishnan, a leading radio astronomer, to take care of its functioning, maintenance and researches.

With 30 giant parabolic dish antennas , each 45 meters

contd. on page...20

Computers and Health

Tips on comfortable and healthy computer time

❑ Dr. Yatish Agarwal
e-mail: dryatish@yahoo.com

Most of us spend long hours working on computers each day. If we are careless, that can ill affect our health. The eyes take the maximum stress, but the muscles and the bony skeleton also suffer, particularly if we do not pay attention to our posture. Yet, all it takes to ease the strain

is to follow some simple safety rules that can make computer time comfortable and enjoyable. These correct habits are best picked right in childhood but, obviously, it is never too late. Let's take a close look at the basics:

Choose your workstation well. While buying your computer station, make sure it's friendly on your body. The height of the PC, your chair, the level of the keyboard and the mouse should be so well matched that you could go at it for hours without feeling any difficulty. The recommended working posture is:

- The body should directly face the keyboard and terminal,
- The back should be straight, and feet flat on the floor,
- The eyes should be aligned at or slightly below the top of the screen, and
- The thighs, forearms, wrists, and hands should be roughly parallel to the floor.

Any other position is bound to impose strain on some or the other part of the body. That's why, ideally, you must always try the chair by placing it before the table and the PC you wish to use, before making the final buy. You may also opt for adjustable chairs and tables—they permit fine-tuning and this allows their use by other family members.

Locate your workstation at a proper place. Set up your PC monitor in such a way that you do not face any glare or reflection from the window and overhead lights. It is best to place the PC monitor at right angles to windows. This way the sunlight is neither directly behind the monitor nor behind you, and therefore, does not reflect off the screen. If this is not feasible, use blinds or drapes to cover the windows.

Remember, if your eyes are exposed to glare for a long period of time, it can lead to much eyestrain and headache.

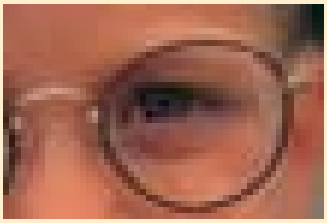
Take regular breaks. The single most beneficial behavioural change to reduce the chance of injury is to take frequent, short breaks. After working for about an hour, do some simple stretches for half-a-minute, or take a short walk. If the pressure of work is too much, the least you can do is to change your position every 15 minutes. This simple measure can go a long way in bringing down stress on the body and ensuring that you can carry on with your work comfortably.

Likewise, give your eyes a break too. Look away from the screen every now and then. Shut your eyes while you take the phone. Carry out other office tasks in between working on the computer to provide the much needed relief to your eyes and body.

Blink frequently. Yes! It helps. Each blink wets the eye with natural tears. These tears, milked from the tear glands located in the eye, keep the surface of the cornea and conjunctiva wet and healthy. However, while working on a PC the focus on the monitor screen is generally so intense that the blinking rate of the eye suffers a drop. With that, the flow rate of the tears also drops and this causes a break in the tear film. As a result, the surface of the cornea and conjunctiva develop dry spots and are exposed to possible evaporation. Since computers became commonplace, dry eyes have become far too common. This leads to discomfort and irritation in the eyes, and can also impair vision.

If you are faced with this problem, consult your eye doctor. He could prescribe artificial teardrops that can help make things comfortable.

Use spectacles. Always ensure that your vision is properly corrected while you are working on the computer monitor. Any laxity at this end will add to weariness of your eyes.



Never use bifocal lenses. While ordering for your correction glasses, warn your optometrist about the amount of close work you do. Special lenses are sometimes necessary. Bifocals, in particular, are not recommended. They force you into unnatural neck positions that can damage your neck vertebrae.

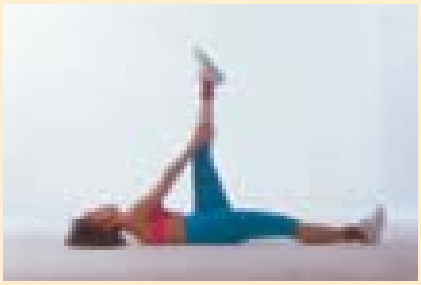
Avoid too much contrast. The eye works best if the object in focus is surrounded by a field illuminated to the same or slightly less degree. Too much contrast between the areas under observation and surrounding areas causes rapid alterations of adaptation and fatigues the eye.

Adjust the brightness control. Turn the brightness down to dim level and then adjust the contrast to make up the difference. Never light up your screen to high levels of brightness.

Invest in the anti-glare feature. Some monitor screens are equipped with an anti-glare feature. It is always a good idea to invest a bit of money on this facility. It may keep you from being bleary-eyed at the end of the day.

Use a task light. It is always preferable to illuminate documents that you need to work on. Use a desk light for this purpose.

Work at body fitness. Many years ago, the US National Institute of Occupational Safety and Health published a report that 25 per cent of keyboard operators suffer the occupational cervico-brachial syndrome. They strain the muscles and ligaments of the neck, arm, shoulder and back and suffer from frequent inflammation of tendons.



You should work at lowering these risks. Restrict the stresses and strains by keeping your body fit and well oiled. A regular exercise programme has many benefits—and one of them would be to keep out of the repetitive strain injuries that the neck and torso tend to suffer when you spend long hours on the computer keyboard. Doing brisk walking most days of the week, and exercises to keep the muscles of the neck and back ship shape, can certainly work to your advantage.

---

contd. from page...22

in diameter, spread along the three arms of a Y-shaped configuration, each about 14 kilometers long, and a cluster of antennas at its center, the GMRT is the world's most powerful aperture synthesis radio telescope in the frequency range of about 50 to 1500 MHz. Using this powerful world class facility, researches in radio astronomy are being conducted for the detection and study of pulsars, even the latest milli-second pulsars, the detection of proto-galaxies or proto-clusters in the early universe through the observation of the red-shifted radio line emitted by atomic hydrogen, and for the detection of non-thermal radiation from the population of 'old' relativistic electrons in a variety of galactic and extragalactic radio sources. In recent times, the NCRA is also collaborating with the California-based Search for Extra-Terrestrial Intelligence (SETI) Institute in their efforts to track signals from extraterrestrials in the southern skies because the GMRT is closer to the equator than the radio telescopes available in North America.

Earlier, the ORT, a parabolic cylindrical reflector about 500 meters long and 30 meters wide, which could track celestial radio sources for about 10 hours a day by rotating about an axis parallel to the axis of rotation of the earth, also conducted frontline researches in radio astronomy. Apart from studying various aspects of radio astrophysics, namely, solar wind, interstellar medium, powerful radio galaxies and quasars, and the cosmological evolution of the universe, it discovered as many as eight new pulsars. In recent times, its electronic feedback system has been re-done leading to a considerable improvement in its sensitivity and observational power.

"With the latest state of art technology in electronic receiver systems and fibre-optic communications available in the GMRT", said Prof Nityananda, talking about the career opportunities at the Center,

" we offer opportunities for doing Ph.D. both in radio astronomy and computer software applications. We therefore give entry to both M.Sc. in physics and B.E./B.Tech students with strong foundation in physics. At a lower level, we also offer our Graduate Studies Programme which leads to a Ph.D. degree awarded by Pune University". Students can opt for researches and studies in astronomy and astrophysics, radio astronomy, instrumentation, image processing applications and development of astronomical software. Besides, the Center also offers a short-term summer programme, called `Visiting Students Research Programme' , which enables college students to spend up to six weeks on specific research projects at the Center. Highly motivated students are selected from this programme for post-doctoral and other fellowships at the Center.

While researches, studies and training are in progress at the Center, efforts are also on to improve the existing infrastructure and facilities for keeping in pace with the latest developments in radio astronomy. Research groups especially of basic physics and computational science are being strengthened. " A five year programme is on anvil," said Prof Nityananda about the future programmes at the Center, "for making the GMRT more versatile for various radio astronomical studies as well as for combating the growing radio interferences".

◆◆◆

Recent Developments in Science and Technology

Semiconductor Could Soup Up Solar Cells

In recent weeks, some of the most powerful solar flares ever witnessed have sent electrically charged gas shooting toward the earth in so-called coronal mass ejections. But even without such impressive displays, the sun provides a wealth of energy to our planet. Unfortunately, this effected the quality of solar cells in terms of its efficiencies which have restricted to 30 percent in the laboratory and less than 20 percent in commercial cells. A novel crystal described in the journal *Physical Review Letters* may change that, however. Scientists report that the semiconductor material could form the basis of solar cells with nearly 50 percent efficiency.

In a standard photovoltaic cell, the Sun's rays are converted into electricity when electrons within the material are knocked loose. To accomplish this the incoming light must have a specific energy, known as the band gap. Incident light with less energy will not be absorbed, while the portion of more energetic radiation above the band gap will be lost. In an attempt to alleviate this problem, Kin Yu of Lawrence Berkeley National Laboratory and colleagues investigated the properties of a new semiconductor material comprising an alloy of zinc, manganese and tellurium.

The researchers added oxygen impurities to the crystal, which resulted in a crystal having three band gaps instead of the customary one These three absorption edges span much of the solar spectrum These alloys are good candidates for the multi-band semiconductors envisioned for high efficiency photovoltaic devices. The scientists further added that the efficiency could be increased to as much as 56 percent by changing the ratio of the atoms or replacing manganese with magnesium.

Source Physical Review letter, Nov 2003

Recyclable plastic

A novel plastic made by compressing a powdered mixture of two polymers has been produced at room temperature for the first time. The breakthrough holds the promise of plastics that are much more recyclable and more energy efficient to produce. Plastic items are normally made by heating materials to 200°C or more and then shaping them in a mould. Reheating conventional plastics during recycling degrades the material, eventually rendering it unusable.

Using pressure instead means plastics can be remolded without any thermal degradation. It also means less energy is required, potentially slashing costs. When the pressure process was first demonstrated in 1998, it still required substantial heat. But Anne Mayes and her colleagues at the Massachusetts Institute of Technology have now made the "baroplastics" with no extra heat. They did by carefully selecting two polymers with different properties, and treating them so that they linked together in nanometre-scale layers.The two polymers used were polystyrene, which is rigid, and polybutyl acrylate, a soft acrylic. These materials can be processed at very low temperatures.

Source: Nature (Vol 426, p 424) ,Oct 2003

Imaging Technique May Diagnose Breast Cancer Without Biopsy

A technique that combines high-level magnetic resonance imaging (MRI) with a new spectroscopic method may result in an accurate, non-invasive way to make breast cancer diagnoses. In this technique, MRI is used to detect breast lumps, while spectroscopy measures molecules known to accumulate in cancer cells.

According to the researchers at The Cancer Center at the University of Minnesota have developed a magnetic resonance spectroscopy (MRS) method that quantifies breast tissue levels of choline (tCho) compounds. Previous investigations of the diagnostic utility of MRS did not quantify tCho levels in breast masses, which limited the ability to differentiate between benign and malignant lumps detected by MRI.

The application of MRS to breast cancer has unique technical demands. The problem lies in the composition of the breast, whose irregular distribution of fatty and glandular tissue makes it difficult to establish reference points against which to measure tCho levels. This method accounts for these tissue variations, using water as a reference compound and a mathematical approach to help "fit" or see choline levels relative to other compounds.

Source: University of Minnesota news

Superprocessor

IBM and the University of Texas at Austin plan to build a processor capable of churning out more than trillion calculation per second –faster than many of today's top supercomputers.

The architecture for the chip is based on a new concept called blocked oriented execution. Whereas most chip can handle just a few calculations at a time , a processor based on Trip architecture will be able to perform large blocks of them simultaneously. The prototype chip is expected to operate at 500 MHz. Which means its internal clock would complete 500 million cycle second . That add up to about 32 billion operations per second theoretically.

Source : New Scientist, Oct 2003

Compiled by : Kapil Tripathi

Corrigendum

In the November 2003 issue of "Dream 2047" (page-28) it was reported that "Bigyan Diganta, the be-monthly science magazine, published by Bigyan Prachar Samiti…". However, "Bigyan Diganta" is being published by Orissa Bigyan Academy. The mistake is highly regretted. We are thankful to Prof. B.C. Gochhait, Secretary, Orissa Bigyan Academy, for pointing out the mistake.