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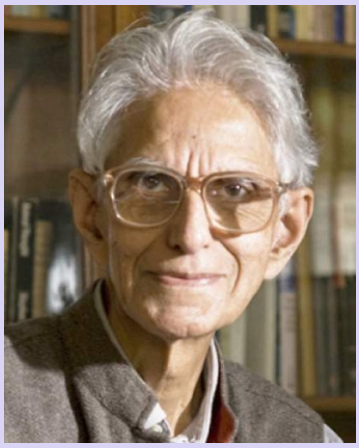
Obaid Siddiqi
Who transformed molecular biology research in India

Obaid Siddiqi



(1932-2013)

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

Concerted efforts needed to help citizens know about climate change: Some useful leads

Dr. R. Gopichandran

The 19th Conference of Parties of the United Nations Framework Convention on Climate Change is just round the corner. Parties will deliberate on financial and institutional mechanisms for mitigation and adaptation in addition to commitments. A large number of side events will typically happen with shrill voices of representatives of civil society institutions doing their best to draw the attention of decision makers. In this context, the voice of citizens as individuals become is important, despite the efforts of the two major stakeholder groups to mainstream them appropriately. The success of fiscal and non-fiscal mechanisms in particular aimed at involving the public has a direct link with the levels of preparedness of citizens to comprehend and engage in well-informed action.

The most important question in this context is whether institutions engaged in science and technology communication know enough about the above stated determinants of response by the public to proposals for concerted action. If not so, what are the efforts to consolidate such an understanding? The present note is to highlight some of the major points as stated above to develop a framework that will also help reveal the determinants of such levels and the architecture of enabling circumstances. It is critical to understand these linkages without which it may not be possible to deliver in response to a felt need. We may in fact end up working at cross purposes.

One of the critical entry points is to help citizens know about "predicted" increases in temperature and scales of impacts. Equally important is awareness on the limits and limitations of assumptions and models. While it may not be necessary to burden them with technicalities, an appropriate depth has to be ensured. Equally important is the need to emphasise on impacts management, rather than getting bamboozled with aspects of the science of the phenomenon of climate change. Impacts at the local level tend to cascade and the link between individual and synergistic links of drivers become significant.

Science and technology communicators may like take note of the initiatives of the Government of India through the "NATCOM" (National Communication) process. NATCOM reports present valuable insights about institutions in India engaged in mitigation, adaptation, science and policy interface. Interestingly the Grantham Research Institute on Climate Change and the Environment[1] in its submission to inquiry on 'Climate: public understanding and policy implications' by the House of Commons Select Committee on Science and Technology presents a detailed framework that can be suitably adapted to the circumstances in respective countries including India. The Yale Project[2] helps differentiate perceptions and their determinants involving visitors to science museums. Shakhashiri and Bell[3] refer to a tool kit that can be used as a valuable info resource aligned with the scope for a focussed involvement of the public in this regard[4].

1. http://www.lse.ac.uk/GranthamInstitute/publications/Policy/docs/PP-inquiry-climate-public-understanding-policy-house-of-commons.pdf
2. http://environment.yale.edu/climate-communication/files/MuseumReport.pdf
3. http://scifun.chem.wisc.edu/BZSPresentations/Science-2013-Shakhashiri-9.pdf
4. http://www.niehs.nih.gov/about/visiting/events/pastmtg/2013/dert-climate/dert_climate_january_2013_panel_62.pdf.

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Obaid Siddiqi

Who transformed molecular biology research in India

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"There are a daring few who define new intellectual quests, and whose courage and leadership create a culture …today, we celebrate Obaid Siddiqi, whose foresight and determination and quiet courage have transformed research in molecular biology in India at least twice and whose scientific successes span many fields of biology. While establishing institutional excellence and instilling an iconoclastic culture of independence and freethinking, these pioneering efforts have led to wide appreciation, both of the beauty and value of Obaid's science and of his leadership in institution building, as models to emulate"

K. Vijay Raghavan, formerly Director, National Centre for Biological Sciences, Bengaluru and presently Secretary, Department of Biotechnology, Government of India
(quoted from NCBS news (http://news.ncbs.res.in/page/professor-obaid-siddiqi-passes-away, retrieved 8 August 2013.)

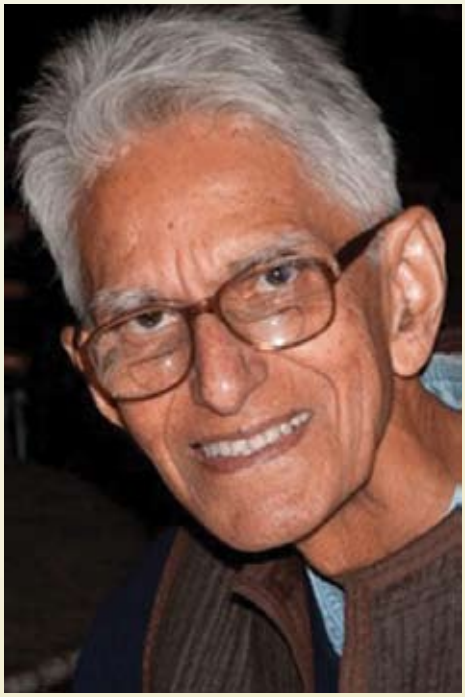
"It is very rare that individuals are institutions in themselves. Such individuals are genuine visionaries who start a wave, who create a school of thought and like a banyan tree keep extending inspiring branches through offshoots much beyond when they are gone. The late Obaid Sidiqqi, who may be rightly considered the father of Indian biology and the last of the giants of the South Asian scene, was one such rare individual."

Sukanta Khurana (countercurrents.org, retrieved 5 August 2013)

"Around Siddiqi, always 'Obaid' to his students and colleagues, it was impossible not to realise that the beauty of pursuing the truly interesting and original, even with its risks of failure, hugely outweighed success from solid, incremental advancements…He transmitted the excitement of big questions together with a liberating lightness of spirit that made these seem accessible. He was particularly drawn to the amateur and the novice. To them, he was a source of both the intellectual inspiration and sympathetic support crucially required during the too-often lonely process of scientific inquiry."

Mani Ramaswami and K.S. Krishnan, in *Current Science*, Vol. 105, No.2, 25 August 2013

Obaid Siddiqi was one of the most eminent scientists of India. His death following a road accident was widely reported in the media. The Prime Minister and the Vice President of India commented on the important role played by Siddiqi in shaping modern science in India. In various reports, obituaries, and write-ups that appeared after Siddiqi's death he was described in many ways: "One of the most outstanding scientists of modern India", "Founder of Indian molecular biology", "Father of modern Indian biology", "India's molecular biology genius", " A renaissance man", "Catalyst of a culture of creativity", "The gentle genius", "Aristocratic and gusty molecular biology guru", "Pioneering neuroscientist", "Celebrated biologist", "Institution builder", "Pioneer of molecular biology research in India", "The greatest biologist that South Asian soil has sprung so far", "A great teacher", "A scientist nonpareil", "True passionate gentleman scientist", "One of the pioneers of *Drosophila* neurogenetics and modern biology", and so on. These epithets aptly summarise Siddiqi's multi-faceted scientific contributions and some of his personal traits.



Obaid Siddiqi

Siddiqi's own personal contributions were in the field of neurogenetics – a branch of science that emerged from advancements in molecular biology, genetics and an attempt to unravel the link between genes, behaviour, the brain, and neurological disorders and diseases. Neurogenetics studies the role of genetics in the development and function of the nervous system. It is called neurogenetics because it draws aspects from the studies of both neuroscience and genetics. Seymour Benzer (1921-2007), with whom Siddiqi had worked, is considered by many as the father of neurogenetics. The main focus of neurogenetics is on how the genetic code an organism carries affects its expressed traits. It may be noted that genetic code is a set of rules following which information encoded within genetic material (DNA or mRNA sequences) is translated into proteins by living cells. The genetic code is very similar in all organisms and it is usually expressed in a simple table with 64 entries.

Siddiqi's work with Seymur Benzer at the California Institute of Technology (CalTech), USA led to a deeper understanding of the mechanistic basis of neuronal function. Their pioneering work heralded the dawn of behavioural genetics, a field of study that examines the role of genetics in animal (including human) behaviour. Siddiqi's work in the field of neurogenetics

contributed greatly to our modern understanding of how senses such as taste and smell are detected and encoded in the brain. Siddiqi started this work with his PhD student Veronica Rodrigues (1953-2010). They isolated and identified the first collection of genetic mutants with defects in smell or taste in *Drosophila*. They developed some elegant techniques for their pioneering investigations. These techniques still remain relevant.

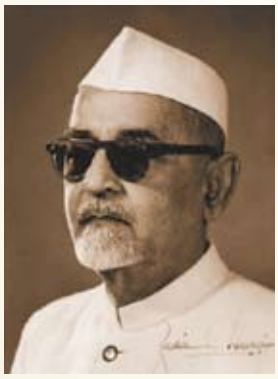
Seymour Benzer

Siddiqi made significant contribution towards establishing molecular biology and neurogenetics research in India. He was a visionary institution builder. He established a vibrant research centre for pursuing research in new frontiers in modern biology in the early 1960s at the Tata Institute of Fundamental Research (TIFR), Mumbai. He joined TIFR at the invitation of its founder Homi Jehangir Bhabha. The Molecular Biology Unit established at TIFR was the first of its kind in the country. It is widely believed that the establishment of this Unit under the leadership of Siddiqi was the most important factor in transforming biological research in India. The Unit later transformed into the present Department of Biological Sciences encompassing various branches of modern biology. After over three decades of the establishment of the Molecular Biology Unit at TIFR, Siddiqi founded another world-class research centre, TIFR-National Centre for Biological Sciences at Bengaluru. These institutions have been trying "to achieve excellence and to nurture fundamental curiosity." K. S. Krishnan, Mani Ramaswami, and Chun-Fang Wu wrote in their editorial entitled "Obaid Siddiqi at 80 and Neurogenetics in India" in *J. Neurogenetics*: "Obaid was the original nucleating force that attracted and initiated several influential Indian biologists, and thereby played a major role in the development of modern biology in India. His easy recognition of excellence and generous support of young scientists of potential are legendary." Siddiqi initiated international collaboration in his field on a sound footing.

Homi Jehangir Bhabha who brought Siddiqi to TIFR

Siddiqi strived to explore new frontiers to the very end of his life. Even after his 80th birthday he was very much involved in active research. Science was a lifelong passion for him. He lived truly a life in science. He loved to talk on science with anyone who evinced interest in it. He was gentle but extremely persuasive. P. Balaram, Director of the Indian Institute of Science, Bengaluru said: "He (Siddiqi) was one of the gentlest scientists I have seen…he loved to talk about his research and work. He was always surrounded by people interested in science: people he mentored and influenced in their fields of research." Siddiqi was totally averse to publicity. His humility was proverbial. He was a warm-hearted person. He took keen interest in sports and literature. He was particularly fond of Urdu literature.

Obaid Siddiqi was born on 7 January 1932 in Basti district of Uttar Pradesh (then United Province) in a family of scholars. His parents were M. A. Qudeer Siddiqi and Umme Kulsum. In his school and college days Siddiqi was not very sure whether he would like to be a scientist. He was interested in many things. On being asked by Matiur Rahman, a science film-maker (who was planning to make a video film on the life and work of Siddiqi) what actually attracted him to become a scientist, Siddiqi replied: "Some people can answer this question very simply by saying that I became very interested in science as a child. But I don't think I could say that. I think my interest in science developed in many other things…I was interested in literature, poetry, politics and sports as a student. So I can't say I realised early that I was meant to be a scientist."



Zakir Hussain, former President of India

It seems Zakir Hussain, the former President of India, played a role in persuading Siddiqi in taking up science as a career. Vijay Raghavan wrote: "Obaid's college days were at Aligarh Muslim University (AMU) in a period when India had just become

A view of the TIFR, Mumbai

A view of the TIFR-National Biological Science Centre, Bengaluru

Siddiqi talking to a student (Photo courtsey: Matiur Rehman)

independent and people all over the world were hankering for a just society and change in much the same manner that we see today. There were many different political trends that resulted in political movements in India and indeed all over the world. Obaid was actually involved in some of these and he could have very well gone into politics as well as science, but was rescued into science by Zakir Hussain, who later became the President of India."

Siddiqi obtained his MSc degree from Aligarh Muslim University in 1953. He specialised in plant genetics. After his MSc he worked as lecturer in AMU (1954-1957). While working as lecturer in AMU he took leave and went to the Indian Agricultural Research Institute (IARI), New Delhi to work as a Research Fellow. At IARI he worked on wheat genetics during 1957-1958. Commenting on his work at IARI he said in his interview to Matiur Rehman: "I worked on wheat genetics. The idea was to work on the resistance of wheat to rust, one of the common diseases. That was my first sort of serious all-time scientific interest. And that work came to an end rather abruptly because after a year, the wheat crop on which we were working was destroyed in a hail storm." His friends suggested that he could go back to AMU and come back again to resume his work. He started thinking on what he should do. In this connection he went to meet M S Swaminathan, then working as a scientist in IARI. Siddiqi told Matiur Rehman: "In fact I remember a conversation with Swaminathan, who was a scientist then. I knew him a little bit. I was not working with him. But I went to him after this crop disaster to talk to him. And when my friends were telling me "all right you can come back and resume your work", Dr Swaminathan said to me "I know your interest and whatever you were to learn from here you have already learnt; so it may be a good idea for you to go somewhere and pursue what your real interests are." And that set me thinking. When I went back to the university I thought of people with whom I could really work and whose work I was interested in. And I started writing to them if I could come and work with them."

Guido Pellegrino Arrigo Pontecorvo, Siddiqi's PhD supervisor

Finally he decided to go to the University of Glasgow, UK, for doing his PhD. At Glasgow he worked on microbial genetics under the supervision of Guido Pellegrino Arrigo Pontecorvo (1907-1999). As part of his PhD work he mapped the pabA gene and in the process he discovered polarised negative interference in crossing-over. He obtained his PhD degree in 1961. Commenting on Siddiqi's PhD work Vijay Raghavan wrote: "At Glasgow, as a PhD student, Obaid mapped the fine structure of the *pabA* gene of Aspergillus by examining intragenic recombination and suggesting that this could be polarised. This work is classic, with Obaid as the sole author of the papers."

In 1961, Siddiqi while working with Alan Garen at Cold Spring Harbor Laboratory (1961) and the University of Pennsylvania (1961-1962), USA, discovered suppressor of nonsense mutations in the gene for alkaline phosphatase. This work played an important role in the identification of the stop codons in the genetic codes and the mechanism of chain termination during protein synthesis. Vijay Raghavan wrote: "In elegant and brilliant experiments, Siddiqi and Garen discovered the suppressors of "nonsense" mutations. This work stimulated research on conditional mutations of bacteria and viruses and was directly important to the discovery of "nonsense" codons, the stop signals in the genetic code." Stop codons, also called termination codons or nonsense codons, signal the termination of translation, the process of forming a polypeptide (chain of amino acids). Translation is the second major step in gene expression in which the messenger RNA (mRNA) is 'read' according to the genetic code to relate the DNA sequence to the amino acid sequence in proteins. Thus translation may be viewed as decoding instructions preserved in DNA for making proteins. A stop codon is a nucleotide triplet with messenger RNA that signals a termination of translation. Stop codons are point mutations in sequence of DNA. Three stop codons in RNA are UAG (amber), UAA (ochre) and UGA (opal). In DNA these codons are TAG (amber), TAA (ochre) and TGA (opal, also called umber). Amber mutations (UAG) were the first set of nonsense mutations to be discovered, isolated by Richard Epstein and Charles Steinberg and named after their friend Harris Bernstein (whose last name means "amber" in German). Ochre mutation (UAA) was the second stop codon mutations to be

Alan Garen

Siddiqi in canteen (Photo courtsey: Matiur Rehman)

Siddiqi taking a stroll
(Photo courtsey: Matiur Rehman)

discovered. It was named ochre to match the name of the amber mutants. After carrying out a series of mutation experiments, Sydney Brenner concluded that the amber and ochre mutations corresponded to the nucleotide triplets "UAG" and "UAA" respectively. Opal mutations (UGA) were the last set of nonsense mutations to be discovered.

In early seventies Siddiqi went to California Institute of Technology, USA as a Visiting Professor. At CalTech, Siddiqi's work with Benzer led to the identification of several genes that control nerve conduction and synaptic transmission, the process of information transfer at a synapse (the minute space between a nerve cell and another nerve cell, muscle cell, etc.). The work of Siddiqi and Benzer helped to develop a deeper understanding of the mechanistic basis of neuronal function.

From TIFR, Mumbai Siddiqi moved to Bengaluru as the Founder-Director of the TIFR-NCBS. After his retirement from NCBS, he was made a National Research Professor.

Siddiqi was a member of the Royal Society of London, the US National Academy of Scences, Washington, and the Third World Academy of Sciences, Trieste. He was elected to the principal science academies of India. He was the President of the Indian Academy of Sciences, Bengaluru. He was the recipient of several awards and honours including Bhatnagar Award (1976), Padma Bhushan (1984), INSA Golden Jubilee Medal (1986), Birla Smarak Kosh National Award (1989), Goyal Foundation Prize (1991), INSA Aryabhata Medal (1992), Pride of India Award of the AFMI, USA (2004), B. C. Roy Award for Biomedical Research (2004), Padma Vibhushan (2006), and Sir Syed Ahmad Khan International Award for Life Sciences (2009). He was awarded honorary Doctor of Science degrees by Aligarh University, Banaras Hindu University, Jamia Hamdard, Kalyani University, Indian Institute of Technology Kharagpur, and Central University of Hyderabad.

He held Visiting Professorships at Yale University, Massachusetts Institute of Technology, California Institute of Technology, and Cambridge University. He was a life member of Clare Hall, Cambridge University. He was the Chancellor of the Maulana Azad National Urdu University.

Siddiqi died on 26 July 2013 following a road accident on 21 July 2013. He was 81. At the time of his death he was a National Research Professor and was actively engaged in research. He was buried at Quddisa Qabristan, Jay Mahal Road, Bengaluru.

As mentioned earlier, after Siddiqi decided to take science as a career, it became a life-long passion. He worked following his own principles. As Vijay Raghavan wrote: "quite often, people chase surrogate markers of success—awards and recognition—forgetting the initial passion that brought them into research. But Prof. Siddiqi's life is an example of how much can be achieved by adhering to principles, and equally important, how much one can change by refusing to accept the many shackles of the system."

We would like to end this article by quoting Sukanta Khurana: "His interests ranged from classical music, history, visual arts, to several sports. Apart from hundreds of email exchanges over years on our common interest on olfaction and learning, my conversations with him on excavations of megalithic pottery in South India, population genetics of migration from South to South East Asia, and people-to-people contact amongst citizens of different countries of South Asia, remain some of my cherished intellectual interactions. I have not met another renaissance man of his stature despite having worked amongst several big names of the science and art world. He was truly the last of the league of Meghnad Saha, Homi Bhabha, and CV Raman from India, with none comparable in sight in future."

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11. Sources on the Internet other than the ones mentioned above.

(The article is a popular presentation of the important points on the life and work of Obaid Siddiqi in the existing literature. The idea is to inspire the younger generation to know about Obaid Siddiqi. The sources consulted for writing this article have been listed. However, all the sources available on the Internet have not been individually listed. The author is grateful to all those authors whose writings have contributed to writing this article. The author is also grateful to the sources from which the illustrations/photographs have been reproduced.)

Experiments and Explanations

"Mechanics is the paradise of the mathematical sciences because by means of it one comes to the fruits of mathematics."

Leonardo da Vinci

Rintu Nath
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Yesterday I went to the National Science Centre on a day-long visit to do hands-on science experiments and to learn exciting scientific facts. It was indeed an enjoyable experience to explore different science galleries that explain science in simple and lucid language. I was particularly fascinated with the hands-on science section.

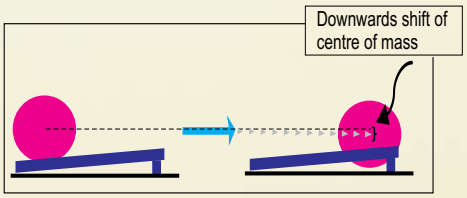
Back home, I could not wait discussing with my uncle about those interesting and wonderful hands-on experiments.

'Googol, how was your trip to the science centre?' uncle asked.

'Uncle, it was very good. Particularly, the hands-on experiments section was fantastic, ' I said.

'That is how you learn science by doing the real experiments. The experiments not only make science exciting, these are also useful ways to help understanding the underlying scientific theory and concepts. Well Googol, tell me which one you liked the most?'

Experiments not only make science exciting, these are also useful ways to help understanding the underlying scientific theory and concepts



'I saw a double cone moving upwards as if it was defying the gravity!' I said.

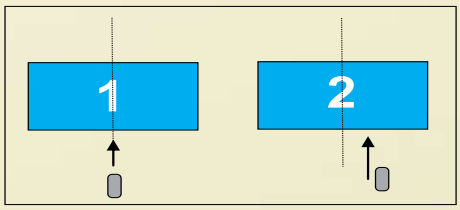
'Does it actually defy the gravity?' Uncle asked.

'No, it does not defy the gravity. The centre of mass of the double cone actually moves downwards, in the direction of the gravitational pull. The trick is in the shape of the rail – an inclined 'V' shaped rail is used in the demonstration. As the double cone is released, due to the gravitational pull, the double cone start moving. Due to the 'V' shape of the rail, the centre of mass of the cone goes downwards, however due to the side elevation of the rail it appears that the cone is moving upwards.' I explained.

'Good. However, you have missed one point – the shape of the object – in this case, it is a double cone. Due to its shape, even when it goes downwards along the 'V' shaped rail, it becomes difficult to notice the small downwards movement. Circumference of a double cone at mid point is very big compared to its edges. Initially the centre of mass of the double cone is much above the rail as it is placed at the narrow end of the 'V' shaped rail. That is why even though the cone does ascend the slope, its centre of gravity will actually move downwards. However the experiment is to be set up in the right way.' uncle explained.

'Another point is that the observation must be done from one side of the rail – otherwise elevation will not be visible.'

'That's right. A few days back I saw a very interesting demonstration. Let me explain you the demonstration. A vertically aimed rifle is placed below a wooden block and fired. The bullet hits the block exactly at the centre of the plane facing the rifle, enters the block and gets embedded to the block. Due to the impact, the block, along with the embedded bullet moves upwards.



Maximum height up to which the block rises is measured. In another case, the bullet hits the block – but not at the centre – a bit off centre. In this case also bullet gets embedded inside the block. Due to the impact this, the block rises up and the maximum height is measured. However, in this case, as the bullet hits the block off-centred, the block also rotates while moving upwards. In the first case the block did not rotate and went almost straight up. Let us assume the first block reaches a maximum height h_1 and the second block reaches maximum height h_2. Can you tell me the relation between h1 and h_2?' uncle asked.

'It seems that in the second case maximum height attained by the block will be lesser compared to the first case. In the second case the block is rotating as well as moving upwards. Hence energy will be spent in rotation as well as taking the block straight up. In the first case the block did not rotate – hence the entire energy is spent in lifting the block straight up.' I tried to reason.

'Your explanation seems logical. However, experimental observations show that both blocks reach exactly the same height. Multiple observations taken by the precision camera and measuring instruments confirmed this. This is another example where in-depth observations contradict our common sense, unless we look at it with scientific reasoning – just like the demonstration you saw at the science centre – the upwardly moving double cone.'

'I can't believe it! Please explain the reason behind it.'

'The observations can be explained easily using the concept of conservation of linear momentum. As the bullet hits the stationary wooden block and gets embedded in it, both the block starts moving with the same velocity after the impact. Let us assume 'm' is the mass of the bullet, 'M' is the mass of the wooden block, 'u' is the velocity of the bullet when it hits the wooden block and 'V' is the velocity of the block and the embedded bullet after the impact. Using the conservation of linear momentum,

Initial total linear momentum = Final total linear momentum

i.e. $m \times u = (m + M) \times V$

Initial linear momentum is $m \times u$ as the wooden block was stationary ($M \times 0$) and final linear momentum is $(m + M) \times V$ as both the wooden block and the bullet get the same velocity. Therefore, in both cases the blocks get same initial velocity $V = V = \frac{m \times u}{(m + M)}$. As a result, the wooden block will reach the same maximum height. However, this explanation is not sufficient to explain the observed phenomena. Googol, can you tell me why?' uncle asked.

'In the second observation there is rotational motion as well. Where from the energy to rotate the block is coming?' After all, both blocks are receiving the same amount of energy from the bullet.' I wanted to know.

'In the first observation, as the block is moving straight up – only the translational kinetic energy is considered. However, in the second observation, both translational as well as rotational kinetic energy are to be considered. During the observation, the rotational speed is also measured and rotational kinetic energy is calculated. It can be measured that the rotational kinetic energy is almost half the total energy. Theoretically, the block in the second case should have reached only half of the first case. However, observations were contrary to this.'

'I am confused now – if the total energy is divided equally between the rotational and translational kinetic energy, how the block in the second case is able to reach the same height as that of the first block? After all both the blocks are receiving the same energy from the bullet and the first block has only translational energy,' I wanted to know.

'My dear Googol, theoretically it does sound impossible. Therefore we need to look carefully whether energy transmitted by the bullet to the block is same in both the cases. In the second case, that is, when the bullet hits off-centre, one end of the block is displaced more compared to the other end. Hence the impact time to stop the bullet increases. As a result energy transmitted by the bullet to the block is more compared to the first case. Practical observations suggest that the energy received by the block in the second case is almost double compared to the first case.' Uncle replied.

'Uncle, it is clear that energy received by the second block is more than the first one. However, one thing is still not clear to me. How the second block is receiving more energy from the bullet just by increasing the impact time?' I wanted to know.

'Good question, Googol. The value of Impact is obtained as a product of force and time (Impact = Force × Time). For a given impact, if the time is increased, force decreases. For the second block, when the bullet is piercing through the wood, due to reduction of the force, the bullet would pierce lesser distance compared to the first block. Therefore more energy is lost in case of the first block in piercing the bullet through the wood.' Uncle replied.

'But uncle, you said both the blocks will receive same initial velocity as per the conservation of linear momentum – then both the blocks should reach the same maximum height!'

'In the second case the block also starts rotating as the bullet hits off-centre. Hence angular momentum will also be conserved. Remember, momentum is always conserved – kinetic energy is generally not conserved as there are other losses like heat energy, sound energy and energy losses due to friction. However total energy is always conserved. In the block and bullet example, we may consider other losses are almost same for both the blocks. Therefore we are left with rotational and translational kinetic energy only. Both are conserved separately.'

'I understand now. The bullet is able to transmit more energy in the second block as it loses lesser energy. It loses lesser energy as it pierced lesser distance compared to the first wooden block,'

'That's precisely what is happening. However, when the piercing length was measured in both the wooden blocks, it was found that it is shorter by only a few millimetres in the second block!'

'But uncle, a few millimetres can be a measurement error also.'

'Yes – that is possible. Inaccurate measurements in any experiment may cause erroneous explanation of the observed result. To deal with that situation the experiment need to be performed a number of times and reading is taken every time independently. We know that in this case the experiment was carried out a number of times and every time all relevant measurements were taken. At every occasion, the piercing length in the second block was less compared to the first block. Therefore the measured data may be considered as consistent with the observed phenomena,' uncle replied.

> In-depth observations may lead conceptual understanding of physical phenomena. In fact, this is the very basis of experiencing and learning science.

'I have another doubt. The second block has the rotational as well as the translational motion, each of which shares almost equal energy. The first block has only a straight motion, therefore has only the translational energy. How does a few millimetres difference in piercing length account for 50% more energy to the second block?' I wanted to know.

'Most of the energy is lost when the bullet pierced through the wooden block. The piercing length is about 3 cm. There are other losses like heat energy loss, sound energy loss etc. Only a fraction of the total energy is transmitted to the block to lift it upwards. For example, if the energy of the bullet is say 100 unit, may be 90 unit is lost and only 10 unit energy is lifting the block. For the second block, even if the piercing length is less by only a few millimetres, gain in energy that is transmitted to the block will be substantial,' uncle replied.

'Please tell me how to measure the maximum height reached by the second block when it is rotating?'

'It is easy. You have to measure the maximum height of the centre of mass – not of any edge. Considering both blocks are identical, centre of mass of both the blocks are at the same location. A measuring scale may be placed at the background of the experiment location and a high speed camera can take frame by frame pictures. That is how one can measure exact height reached by each block,' uncle replied.

'It is quite clear now. Thank you for explaining this exciting experiment to me.'

'I appreciate your inquisitiveness Googol. I have given only one example to explain how keen and in-depth observations may lead conceptual understanding of physical phenomena. In fact, this is the very basis of experiencing and learning science. Experiment, observe and explain everything scientifically.' ■

Gokulananda Mohapatra

Doyen of popularisation of science in Odiya

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The most prominent personality in science popularisation in the Odia language, Prof Gokulananda Mohapatra, passed away on 10 July 2013 at the age of 91. He was not the first to write about science in Odia, but his entry into the field around 1945 brought about vast changes – not only in the quality and breadth of the writings, but also in the acceptance both among the professionals and the public. His pioneering contributions included bringing together existing writers and initiating newer ones through his organisational activities; launching of science periodicals and developing tools like glossary, writers' directory and encyclopaedias.

Gokulananda Mohapatra

Early life and education

Gokulananda Mohapatra was born on the 24 May 1922 in the village Kuansa near Bhadrakh town in eastern Odisha into a well-to-do family. His immediate family consisted of his parents, father Bijaya Gobinda and mother Fukadebi, and three sisters, and two brothers. He was the youngest. Gokulananda lost his father when he was too young to feel the impact, but the loss of a sister and the only brother during his youth unsettled his college studies to some extent. The last incident also created family compulsions that led to his early marriage.

After primary schooling in the native village and secondary school education in Bhadrak town he joined Ravenshaw College in Cuttack in 1941. At that time science courses were avoided because it was difficult to pass. However, with persuasion from some senior science teachers, he opted for the ISc Course and then moved on to BSc with Chemistry Honours. He joined the Presidency College, Calcutta (now *Kolkata*) in 1945 for his post-graduate studies in chemistry. The final examinations were to be held in 1947, but had to be put off because of the communal riots. Having obtained the M.Sc. degree in 1948 he joined Ravenshaw College, Cuttack, as a demonstrator and got started in his long career in teaching and research. During this time he pursued his research work for a PhD degree and received the same in 1958. He was among the first few to receive a doctorate degree in Odisha. He then joined Brandeis University in the USA for post-doctoral research and worked with Prof. A.R. Todd on DNA structure from June 1961 to November 1963. He went abroad with his wife and two of the five children, the eldest and the youngest. During that period it was very rare for people from Odisha to go abroad with families.

Popular science writing

The first atom bomb was dropped on Hiroshima in 1945 when Gokulananda was a student in Kolkata. The event created a lot of excitement around the world. It also generated a flurry of writings in the local newspapers in Kolkata. This motivated Gokulananda to write an article in Odia on the topic of the atom bomb, which is generally considered the first popular science writing in Odia in modern times on a contemporary theme.

Popular science books

By this time the magazine-publishing activity in Odisha was nearly 100 years old and many important periodicals had appeared during this period. But during the 1940s most of these were facing declining fortunes for various reasons and the avenues for publication of science articles were rather limited. However, Mayadhar Mansingh, the progressive editor of a newly launched literary magazine, *Sankha*, agreed to publish the article by Gokulananda. Unfortunately, this first manuscript on the atom bomb got lost somewhere in the press and was never seen again in its original form. But a beginning was made and Gokulananda followed it up in 1946 with a second article on *Contributions of Coal Tar to Modern Science*, and wrote about 25 articles by the time he completed his studies in Kolkata.

Also during this period Gokulananda did regular science programmes for general public through the radio. There being no radio stations in Odisha, the Kolkata Centre used to broadcast a half-hour Odia programme every night from 9:30 PM to 10:00 PM and Gokulananda Mohapatra was given time at least once a month for presentation on science topics. A major problem Gokulananda faced in course of writing in Odia language was the non-availability of any technical glossaries. However, being in Kolkata he had ready access to some English-Bengali glossary of technical terms and started developing a technical glossary in Odia using these as guides. This is a reflection on his far-sightedness and seriousness as a science writer.

Back in Cuttack

After joining taking up his job at Ravenshaw College in 1948, Prof. Mohapatra continued with his writings. But the foundation of science popularisation in a local language was

far from being a firm one at the time. New writers were hesitant, as writing for general public and that too in a local language was looked down upon by most professionals. A new challenge and opportunity had appeared around this time which probably turned the tide in the writers' favour. That was the introduction in 1947 of a high school science paper in Odia language. At that time the high school examinations in Odisha were conducted under the Patna University and the medium used to be English up to 1944. The medium was changed to Odia in phases, and in 1947 it was the turn of science subject.

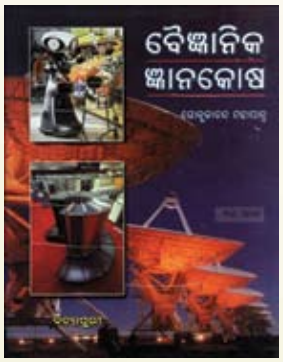
A major problem faced by the students during the changeover was the lack of textbooks in Odiya and the problem was most acute for science because of the technical terms. Avery bold step was taken by Prof. Mohapatra in the matter and he brought out a science text book for the matriculation syllabus along with Harihar Pattnaik (Botany) in 1948. This drew a lot of criticism from fellow college teachers who considered writing for school children to be below their dignity. But the Mohapatra-Pattnaik effort was highly appreciated by the public and also by those college teachers who were setting the question papers. Slowly but surely the criticism died down and science writing in Odia, be it for the public or for the school children, found general acceptance.

The popular acceptance and encouragements from various editors helped Prof. Mohapatra to move forward and eventually, it led to the publication of his first book in 1949 titled *Bigyana Bismaya* (Wonders of Science), a collection of eight articles on topics like telescope, cosmic rays, Penicillin, DDT, artificial diamond, Paludrin (an antimalarial drug), etc. The book ran into 100 pages and was priced at 4 annas (one-fourth of a rupee). This was a pioneering event as it was the first book in Odia which could be called a popular science book. It was well received both for its style of presentation, marked by simple and lucid language and its contents which touched upon new scientific discoveries.

Science books for children

From writing to organising

By now there were several college teachers and doctors who had taken to writing popular science in Odia. Practically all educational facilities being concentrated in Cuttack, they were in close contact with one another. Thus the idea of forming an association gained ground among them and Prof. Mohapatra, then a young demonstrator in chemistry, played a leading role in it. As a student in Kolkata he had come in contact with the Bangiya Bigyan Parishad, which was formed by Satyendranath Bose, P. C. Rakshit, and others 1948, and this provided a ready model for them to follow. Most senior faculty members were either sceptical or unsympathetic towards the idea. Still the persuasions continued and a science popularisers' association was born on 7 August 1949. The association, named Bigyan Prachar Samity, held its first meeting with an attendance of nine members – six from Ravenshaw College and three from the Medical College.



Science encyclopaedia

Later, more college teachers and other professionals joined the Samity, which continued to grow with the active involvement of Prof. Mohapatra. He was deeply involved in all Samity affairs including the editing of its magazine and other publications. He not only guided the activities of the Samity, but also nurtured it by earmarking the earnings from some of his books to cover its expenses during its early days. Later, he constructed a hall on his residential premises for the use of the Samity. He rarely missed its fortnightly sessions. The last meeting of the Samity attended by him was on the 9 December 2012 – only about seven months before his death. It is no wonder that most people equate the Bigyan Prachar Samity with Gokulananda Mohapatra in many different ways.

Science fiction

With the encouragement of Prof. Mohapatra many younger members took to popular science writing. The meetings of the Samity became regular and provided a forum for presentation of articles and discussions. Particular attention was paid to the Odia words used for various concepts and to their standardisation. These articles were then published in various periodicals and many compiled into books in refined form. During the 1950s and 1960s Prof. Mohapatra became the most prolific producer of such popular science articles and books. During the late-1950s he even started a publication unit to bring out a series of books which the existing publishers were reluctant to take up because of the high costs involved. Fortunately, the series was successful enough for other publishers to take over and to relieve Prof. Mohapatra of the added burden. The Bigyan Prachar Samity started organising regular seminars where several writers made contributions on a particular topic. These were then edited, mostly by Prof. Mohapatra, and published.

In order to help the newer writers in polishing their styles, launching of a periodical was accepted as the best solution as it would also provide the readers with varied presentations of science matters. Thus the first post-independence science periodical in Odia – *Bigyan Prava* – was launched in 1973. It may be mentioned that a science periodical in Odia named *Bigyan Darpan* was in publication during 1880 to 1883. While the Bigyan Prachar Samity provided the edited contents for *Bigyan Prava*, it was managed by an established publisher. However, the arrangement was not found to be satisfactory and the Samity started publishing its own magazine *Bigyanaloka*

in 1977. Prof. Mohapatra, a prime mover behind the idea, took up the editorial responsibilities himself and continued with it till 2007 when the magazine folded up.

In course of time several other science popularisation groups came up at major colleges around Odisha modelled after Bigyan Prachar Samity and the 1960s became a very active and productive period in the history of science writing in Odia language. Fruitful collaborations developed among the individual writers/groups and several publishers and a wide variety of popular science books became available for the interested public. During this period Prof. Mohapatra and others took a leading part in writing science textbooks in Odia which were much appreciated by the school teachers and students.

Glossary of scientific terms

Range of Prof. Mohapatra's writings

Prof. Mohapatra's writings were characterised by their simple language, lucid style and the wide variety of topics covered. The range covered, in addition to popular presentations on contemporary science themes, travelogue, biography, science fiction, text books and works of reference like encyclopaedia and glossaries. Among his popular science books were several specifically written for children. Prof. Mohapatra wrote 125 books including textbooks, science fiction, popular science books, books for children, and also reference books.

By 1952 Prof. Mohapatra had published numerous popular science articles and 4 books and was well established as a writer. And this was the year his first science fiction book *Man outside the Earth* was published. The novelty of this work in Odia literature created a big excitement and fascinated most young readers. He followed it up with several other books like *Artificial Satellite*, *Flying Saucer*, *Death of the Moon*, *Death of Motherhood*, *Silent Twilight* and some science fiction short stories.

His books for children include *Which is Heavier* (science stories based on numbers), *True or False* (explanations against superstitions), *How Pictures Speak* (on 'talking' cinema), *Liquid Air and Hot Ice* (uncommon states of matter). Presented in an entertaining story-telling style these short books try to leave a deep impression on the young minds. These are also a reflection on the versatility of Prof. Mohapatra in adapting his writing to different types of readers.

Prof. Mohapatra did not publish many translated works. But his most notable was that of C.V. Raman's *Aspects of Science*, which he rendered into Odia under the title *Bigyanara Drushya* during 1957 which was published by the National Book Trust.

Reference works

Towards the end of his writing activity he took up the long-term work of compiling a science encyclopaedia in Odia. This effort bore fruit in 2005 in the form of a two-volume illustrated publication of about 1400 pages. He followed this up with his work on a comprehensive dictionary of science with short description of the terms and with illustrations as needed. He corrected the proof sheets of this work till the end and it is currently under print.

From the very beginning Prof. Mohapatra had been stressing upon the need for adaptation, coining, and standardisation of words required for science writing in local languages. He pursued the matter through the regular sessions of the Bigyan Prachar Samity and compiled a working glossary for the use of its members, which was published subsequently. As the first Director of the Odisha State Bureau of Textbook Preparation and Production, Prof. Mohapatra took forward his interest in glossaries and initiated the work on the development of subject-wise volumes. The *Dictionary of Chemistry* prepared by him during this phase is a very valuable contribution. Prof. Mohapatra had an interest in the historical and philosophical development of science in general and of chemistry in particular. Accordingly, some of his books in Odia dealt with these areas.

Other organisational activities

For several decades all public science activities in Odisha involved the Bigyan Prachar Samity and Prof. Mohapatra. He was a most sought-after speaker at all school and college science functions. During the 1990s different types of science-based workshops were conducted around the state and Prof. Mohapatra was a willing resource person in many such events. His favourites, of course, were the science-writing workshops.

Another work he took deep interest in and contributed much to was the project on compiling a history of science writing in Odisha during 1850 to 1950 initiated by Vigyan Prasar and carried out by Srujanika. Starting with the exploratory meeting in November 2007 till the completion of the project in December 2010 there were many meetings, reviews and personal discussions at his residence relating to this work. His personal reminiscences provided valuable insights into the transition of science writing in Odia from the period up to 1930s and during post-1940s and his role in it. He keenly read many of the articles collected from over 100-year-old magazines and never failed to marvel at the words used by these writers of the bygone era.

A Professor and a human being

Prof. Mohapatra was, of course, most widely known as the chemistry teacher he was. He was on the faculty of Ravenshaw College, which for a long time was the major institution for higher studies, especially in science, in Odisha. Hence a very large number of science graduates got to know him during their youth and most cherished the memory for ever

Prof. Mohapatra was born into affluence but had experienced difficult periods in life which he did not forget. This, combined with his natural tenderness, made him a helpful person willing to share his resources. Besides the universal personal benevolence he showed, he made significant contributions to several institutions and established many endowments during his lifetime. Most of the endowments are for science-related awards in the areas of science education and popularisation and many of these favour the youth. Thus his acts will continue to encourage newer generations as his presence did for the generation past.

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Professor Man Mohan Chaudhri

A pioneer of science broadcasting in India (1935-2013)

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Science in the media in India has a rather recent history. While All India Radio had an occasional interview of one scientist or the other, it was really with the start of Doordarshan in 1965 when it started its daily national broadcast that the idea of bringing in science through television got initiated. First it used to borrow from abroad such as the BBC programme by David Attenborough, or the Carl Sagan shows from the US. But the major fillip came with two national catalysts: one with the closed circuit TV facility that was part of the educational activities at the IIT in Kanpur around 1966 /67, and the start of the Satellite Instructional Television Experiment, or SITE, initiated by Dr E V Chitnis through the Space Applications Centre in Ahmedabad, as part of the Indian Space Research Organisation (ISRO). It was around this time too that Prof Man Mohan Chaudhri, originally trained as a physicist, joined IIT in Kanpur and took quickly and seriously on to television. He was a major force in the CCTV experiment and in campus programmes at IIT Kanpur, and when the SITE initiative started, he became part of it. This then was the birth of Man Mohan Chaudhri as a science media expert and an educationist.

Prof. Man Mohan Chaudhri

Today this pioneer in science education and science broadcasting is no more. Prof Chaudhri passed away peacefully in sleep on 16 August 2013 at his home in DLF Qutub Enclave in Gurgaon near New Delhi. Born in October 1935, Man Mohan was a Lucknow boy, where he went to school and college and then joined the PhD programme at Delhi University where he obtained his PhD in physics. Following this he went over to the University of Iowa in the US as a postdoctoral fellow and returned to India to join the IIT Kanpur in 1966/67. But by 1970, taking advantage of the in-campus CCTV as the catalyst, he switched to Film and Television and studied ETV at London and travelled extensively around the world under Ford Foundation Fellowship. Returning to IIT he produced films and TV programs.

In campus, apart from his teaching and research activities, Man Mohan had particular interests in a variety of other aspects of human intellectual endeavours. He took to painting seriously and carried on his painting passion until the last day .One of his earliest paintings was in fact a portrait of his wife Dhruti (*nee* Chhaya) in 1965, after about four years of his marriage (in Iowa) with her. At IITK he took keen interest and helped bring fine arts and serious cinema into the campus.

Leaving IITK in 1976 Chaudhri moved to Delhi as Professor and Head in the Department of Teaching Aids of the National Council for Educational Research and Training (NCERT). In 1984 he was appointed the first Joint Director of the Central Institute of Educational Technology, NCERT. He set up six State Institutes of Educational Technology as the National Project Director of an UNDP Project 'INSAT for Education'. During his tenure in NCERT he worked on various National and International projects and committees of UNDP and Govt. of India.

Upon voluntary retirement from NCERT in 1990, joined Times Television of Times of India as General Manager and in 1991 started the unforgettable science series 'Turning Point' with Naseeruddin Shah on Doordarshan national network. After producing 27 episodes of it, he moved to Jain TV to look after their news and business telecasts.

In September 1995 Chaudhri joined as Director of the Consortium for Educational Communication (CEC), an Inter-University Centre of the University Grants Commission to look after its 17 Media Centres and the UGC-CEC telecasts on Doordarshan. He started three new media centres, a newsletter, a national educational video competition and 'Prakriti', an annual film festival on environment, development and human rights. He scripted, produced and directed five films related to sciences and education and more than hundred videotapes besides numerous posters, charts and tape slide sets. He won the National Film Award and Cup of Rome for his film 'Atoms' and bagged international prizes for his video productions. He was a member of the Jury at the Mumbai International Film Festival, 2000.

Chaudhri loved to paint and exhibited his paintings at Ames, Iowa, USA, Lucknow, Kanpur, Delhi, and Gurgaon. He was involved in organising workshops for primary school teachers towards science teaching and appreciation of creativity, joy and freedom for children. He started and ran a Book and Film Club at the Gallerie Alternatives in DLF, Gurgaon for more than a decade, an oasis in an intellectual desert. He taught and brought up his two foster grandchildren. He was a Visiting Professor to NCERT for a year during 2007-08 and kept painting till his last day.

Chaudhri leaves behind his wife Dhruti (herself a teacher who taught at the MS University Baroda, and started a children's nursery, called *Kishlaya*, while staying at the IIT-K campus, and a good singer), and two daughters Sujata (a corporate executive turned music student) now based in Dubai and Anuja (a yoga expert and teacher) now based in the bay area near San Francisco.

(Dr. D. Balasubramaian is a former director of the Centre for Cellular and Molecular Biology in Hyderabad and a renowned scientist and popular science writer. He is at present Director of Research, L V Prasad Eye Institute, Hyderabad.)

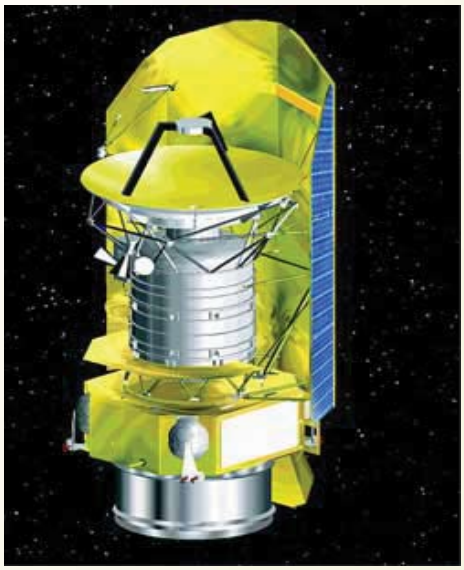
Herschel Space Telescope with World's Largest Mirror

■ Kali Shankar

The European deep space observatory Herschel has stopped functioning in April 2013 after it ran out of its stock of coolant. At launch the space observatory had a store of 2,300 litres of liquid helium as coolant, which served to keep its instruments and detectors cooled to a temperature close to absolute zero (–273·15°C). Launched on 14 May 2009, this space-based telescope was the world's most powerful infrared space telescope which had the largest single-piece mirror, having diameter of 3·5m. Before this, the largest primary mirror used in a space telescope was a 2·4m-diameter mirror used in the Hubble Space Telescope (HST). The James Web Telescope scheduled to be launched in 2018 as successor of HST will have a mirror of 6·5m diameter.

The Herschel Space Observatory of the European Space Agency (ESA) has proved to be a very successful mission for obtaining information about the birth of stars and galaxies. This telescope, which is 7·5m long and 4·0m wide, was launched from the spaceport in Kourou, French Guiana, with the help of Ariane 5 rocket. Another satellite, called 'Planck' was also launched along with this telescope. Herschel Space Observatory was designed to work in the far infrared and sub-millimetre wavelength range (55 – 672mm). The three main instruments carried by this observatory were the HIFI (Heterodyne Instrument for the Far Infrared), PACS (Photodetector Array Camera and Spectrometer), and SPIRE (Special and Photometric Imaging Receiver).

The Herschel Space Observatory was positioned at the second Lagrange point L2 of the Earth-Sun system (at a distance of 1·5 million kilometres from the Earth) where it reached two months after to its launch. The scheduled mission duration of Herschel observatory was 3 years, but it functioned for 3 years 11 months and 18 days (till 29 April 2013). This observatory was named after Sir William Herschel, the world-renowned astronomer and the discoverer of the infrared region of the spectrum and the planet Uranus.



Herschel Space Observatory

The Findings of Herschel Observatory

Launched in 2009, Herschel Space Observatory has unfolded the mysteries of the coolest regions of stars and galaxies. According to John Gransfeld, the Assistant Administrator of Science Mission Centre of NASA Headquarters, Washington D.C., "Herschel gave us the golden opportunity of peeping into the darkness filled and the cold regions of the universe. The success achieved has demonstrated how NASA and European Space Agency can collaborate together to unfold the intricate mysteries of astronomy."

This space observatory was named after the German-born English astronomer Sir William Herschel

Some of the rare findings/discoveries made by this space observatory are as follows.

- During its mission, the Herschel Space Observatory discovered long, filamentary structures in space around which the matter needed for the formation of dense stars was present.
- For the first time, the presence of oxygen and some other molecules in space, which were never observed before, was detected. The imaging of the molecules in different regions has helped researchers to have a better understanding of the life cycle of the stars and planets and the origin of life.
- The space observatory discovered high-speed outflow round the black holes in active galaxies. Scientists believe this outflow will be able to evacuate the surrounding regions and as a result the process of future star formation would not be possible.
- The Herschel Observatory helped gather new information regarding many distant galaxies, and also revealed information regarding the process of star formation in the galaxies.
- The study of the comets in our solar system by the Herschel Observatory has provided the proof that the comets were instrumental in bringing copious amounts of water to Earth.
- In collaboration with the NASA's Spitzer Telescope, the Herschel Telescope revealed the presence of a very large asteroid belt around the bright star Vega.

Some other findings of the Herschel Space Observatory are as follows. The discovery of some very young starts which, for the first time, were seen near the Orion 'cradle' and revelation of planet-forming disc that is constituted of the same material that surrounds the T W Hydrae star – an orange dwarf star approximately 176 light-

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Social Anxiety Disorder

Ways to quell the irrational fear

Dr Yatish Agarwal
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Social anxiety disorder is a condition that commonly develops in the early years from late childhood to early adulthood. It is far more common than you would think. Although no definite facts and figures exist for this part of the world, an estimated one in 10 people suffer from it in the developed countries.

The signs are rather tell-tale: you suffer from an overwhelming fear of embarrassing yourself or of being humiliated in front of other people in social situations, say, for instance, when you are eating or speaking in public. You feel terribly self-conscious, anxious, and might wish to run away from the situation.

Complex in nature, and of uncertain origin, the disorder may develop from a general tendency to be anxious. People who are lacking in self-esteem are more likely to develop the condition. The disorder may begin with a sudden episode of intense anxiety in a social situation, which then becomes the main focus of the phobia, perpetuating itself time and again, unless you break out of it.

Some people recall a stressful situation as the trigger for their symptoms. They then become conditioned to be anxious in similar circumstances. The key, however, lies in finding a way out. Few people who suffer from it realise that the disorder is amenable to treatment. It can be dealt with effectively, provided you are game to taking psychological counselling, medication and developing some simple coping skills. These robust therapies can help you gain confidence and improve your ability to interact socially.

Recognising the symptoms

A chronic condition, also known as social phobia, social anxiety disorder affects a person's emotions and behaviour. It can also cause significant physical symptoms.

Emotional and behavioural signs and symptoms

- Fear of situations in which you may be judged
- Worrying about embarrassing or humiliating yourself
- Intense fear of interacting with strangers
- Fear that others will notice that you look anxious
- Anxiety that disrupts your daily routine, work, school or other activities
- Avoiding doing things or speaking to people out of fear of embarrassment
- Avoiding situations where you might be the centre of attention
- Difficulty making eye contact
- Difficulty talking

Physical signs and symptoms

- Blushing
- Sweating
- Trembling or shaking
- Fast heartbeat
- Upset stomach
- Nausea
- Shaky voice
- Muscle tension
- Confusion
- Diarrhoea
- Cold, clammy hands

However, always remember that feelings of shyness or discomfort in certain situations are not necessarily signs of social anxiety disorder. This is particularly so in children. Comfort levels in social situations vary from individual to individual due to personality traits and life experiences. Some people are naturally reserved and others are more outgoing. What sets social anxiety disorder apart from everyday nervousness is that its symptoms are much more severe, causing you to avoid normal social situations.

Common, everyday experiences that may be difficult to endure when you have social anxiety disorder include interacting with strangers, using a public restroom or telephone, returning items to a store, writing in front of others, making eye contact, entering a room in which people are already seated, ordering food in a restaurant, being introduced to strangers, or initiating conversations.

Social anxiety disorder symptoms can change over time. They may flare up if you're facing a lot of stress or demands. Or if you completely avoid situations that would usually make you anxious, you may not have symptoms. Although avoidance may allow you to feel better in the short term, your anxiety is likely to persist over the long term if you don't get treatment.

Worrying about having symptoms

When you have social anxiety disorder, you realise that your anxiety or fear is out of proportion to the situation. Yet you're so worried about developing social anxiety disorder symptoms that you avoid situations that may trigger them. This type of worrying creates a vicious cycle that can make symptoms worse.

What are the causes?

Social anxiety disorder likely arises from a complex interaction of environment and genes. Possible causes include:

Genetic traits

Anxiety disorders tend to run in families. However, it isn't entirely clear how much of this may be due to genetics and how much is due to learned behaviour.

Brain chemistry

Natural chemicals in your body may play a role in social anxiety disorder. For instance, an imbalance in the brain chemical serotonin may be a factor. Serotonin is a neurotransmitter that helps regulate mood and emotions, among other things. People with social anxiety disorder may be extra-sensitive to the effects of serotonin.

Overactive brain

A structure in the brain called the amygdala (an almond-shaped mass of gray matter in the front portion of the temporal lobe – part of the cerebral cortex in either hemisphere of the brain lying inside the temples of the head) may play a role in controlling the fear response. People who have an overactive amygdala may have a heightened fear response, causing increased anxiety in social situations.

Negative experiences

Children who experience teasing, bullying, rejection, ridicule or humiliation may be more prone to social anxiety disorder. In addition, other negative events in life, such as family conflict or sexual abuse, may be associated with social anxiety disorder.

Risk factors

Social anxiety disorder is one of the most common mental disorders. It usually begins in the early to mid-teens, although it can sometimes begin earlier in childhood or in adulthood.

A number of factors can increase the risk of developing social anxiety disorder, including:

Family history

You are more likely to develop social anxiety disorder if your biological parents or siblings have the condition.

Environment

Social anxiety disorder may be a learned behaviour. That is, you may develop the condition after witnessing the anxious behaviour of others. In addition, there may be an association between social anxiety disorder and parents who are more controlling or protective of their children.

Temperament

Children who are shy, timid, withdrawn or restrained when facing new situations or people may be at greater risk.

New social or work demands

Meeting new people, giving a speech in public, or making an important work presentation may trigger social anxiety disorder symptoms for the first time. These symptoms usually have their roots in adolescence, however.

Being different that draws attention

Facial disfigurement, stuttering, and other health conditions can increase feelings of self- consciousness and may trigger social anxiety disorder in some people.

Complications

Left untreated, social anxiety disorder can be debilitating. Your anxieties may ruin your life. They can interfere with work, school, relationships or enjoyment of life. You may be considered an underachiever, when in reality it is your fears holding you back, not your ability or motivation. In severe cases, you may drop out of school, quit work or lose friendships. Social anxiety disorder can cause:

- Low self-esteem
- Trouble being assertive
- Negative self-talk
- Hypersensitivity to criticism
- Poor social skills

Social anxiety disorder can also result in:

- A poor work record
- Low academic achievement
- Isolation and difficult social relationships
- Substance abuse
- Excessive drinking
- Suicide

What might be done?

See your doctor if you fear and avoid normal social situations because they cause embarrassment, worry or panic. If this type of anxiety disrupts your life, causes severe stress and affects your daily activities, you may have social anxiety disorder or a condition that requires treatment to get better.

You may start by seeing your family doctor. After your initial appointment, your doctor may refer you to an expert trained in this field who can help make a firm diagnosis and create the right treatment plan for you.

The psychiatrist or psychologist may ask you a number of questions to determine the diagnosis. S/he will ask you to describe your signs and symptoms, how often they occur and in what situations. S/he may review a list of situations to see if they make you anxious or have you fill out psychological questionnaires to help pinpoint a diagnosis. There is no laboratory test which can diagnose social anxiety disorder.

The criteria for the diagnosis include:

- A persistent fear of social situations in which you believe you may be scrutinized or act in a way that's embarrassing or humiliating.
- These social situations cause you a great deal of anxiety.
- You recognize that your anxiety level is excessive or out of proportion for the situation.
- You avoid anxiety-producing social situations.
- Your anxiety or distress interferes with your daily living.

Social anxiety disorder shares symptoms with other psychological disorders, including other anxiety disorders. Your doctor will want to determine whether one of these other conditions may be causing your social anxiety, or if you have social anxiety disorder along with another psychological disorder. Often, social anxiety occurs along

with other disorders, such as substance abuse problems, depression and body dysmorphic disorder (a type of mental illness in which the affected person is concerned with body image, manifested as excessive concern about and preoccupation with a perceived defect of their physical features).

Treatments and medications

The two most common types of treatment for social anxiety disorder are medications and psychological counselling. These two approaches may be used in combination.

Psychotherapy

Psychological counselling (psychotherapy) improves symptoms in most people with social anxiety disorder. In therapy, you learn how to recognise and change negative thoughts about yourself.

Cognitive behavioural therapy is the most common type of counselling for anxiety. This type of therapy is based on the idea that your own thoughts, and not other people or situations, determine how you behave or react. Even if an unwanted situation won't change, you can change the way you think and behave.

Fear of public speaking is one of most common social anxiety disorder. The disorder can be treated effectively with medications and desensitisation therapy.

Cognitive behavioural therapy may also include desensitisation (exposure) therapy. In this type of therapy, you gradually work up to facing the situations you fear most. This allows you to become better skilled at coping with these anxiety-inducing situations and to develop the confidence to face them. You may also participate in skills training or role-playing to practice your social skills and gain comfort and confidence relating to others.

Yoga, relaxation, and stress management techniques such as deep breathing can also be a big help.

Medications

Several types of medications are used to treat social anxiety disorder. However, selective serotonin reuptake inhibitors (SSRIs) are often the first type of medication tried for persistent symptoms of social anxiety. These include Paroxetine, Sertraline, Fluvoxamine, and Fluoxetine.

The serotonin and norepinephrine reuptake inhibitor (SNRI) Venlafaxine also makes a good option.

To reduce the risk of side effects, your doctor will start you at a low dose of medication and gradually increase your prescription to a full dose. It may take up to three months of treatment for your symptoms to noticeably improve.

Your doctor may also prescribe other medications for symptoms of social anxiety. For instance, you may be asked to try several different antidepressants to find which one is the most effective and has the fewest unpleasant side effects.

Some anti-anxiety medications like benzodiazepines may also work well for you. Although they often work quickly, the biggest risk with them is they can be habit-forming. They are therefore often prescribed for only short-term use. They may also be sedating. If your doctor does prescribe anti-anxiety medications, make sure you try taking them before you are in a social situation so that you know how they will affect you.

Some people do well with beta-blocker pills. These medications work by blocking the stimulating effect of epinephrine (adrenaline). They may reduce heart rate, blood pressure, pounding of the heart, and shaking voice and limbs. They may work best when used infrequently to control symptoms for a particular situation, such as giving a speech. They are not recommended for general treatment. As with anti-anxiety medications, try taking them before you need them to see how they affect you.

Stick with it

Don't give up if treatment doesn't work quickly. Finding the right medication for your situation can take some trial and error. In any case, psychotherapy usually takes several weeks or months to be effective.

For some people, the symptoms of social anxiety disorder may fade over time, and medication can be discontinued. Others may need to take medication for years to prevent a relapse.

To make the most of treatment, take medications as directed, and talk to your doctor about any changes in your condition.

What you can do?

Although social anxiety disorder generally requires help from a medical expert or qualified psychotherapist, you can try some self-help techniques to handle situations likely to trigger your symptoms.

First, try and identify the situations which cause you most anxiety. Then gradually practice these activities until they cause you less anxiety. Begin with small steps in situations that aren't overwhelming.

You might like to practice in the following situations:

- Eating with a close relative, friend or acquaintance in a public setting.
- Making eye contact and returning greetings from others, or being the first to say hello
- Giving someone a compliment
- Getting directions from a stranger

- Showing an interest in others — ask about their homes, children, grandchildren, hobbies or travels, for instance
- Calling a friend to make plans

At first, being social when you're feeling anxious is challenging. As difficult or painful as it may seem initially, don't avoid situations that trigger your symptoms. By regularly facing these kinds of situations, you'll continue to build and reinforce your coping skills.

Try these techniques

You might benefit with the following techniques which can help you overcome situations that make you nervous:

- Prepare for conversation. For instance, read the newspaper to identify an interesting story you can talk about.
- Focus on personal qualities you like about yourself.
- Practice relaxation exercises.
- Adopt stress management techniques.
- Set realistic goals.
- Pay attention to how often the embarrassing situations you're afraid of actually take place. You may notice that the scenarios you fear usually don't come to pass.
- When embarrassing situations do happen, remind yourself that your feelings will pass, and you can handle them until they do.

Coping and support

Some coping methods that may help ease your anxiety include:

- Reaching out to people with whom you feel comfortable
- Joining a local support group
- Joining a group that offers opportunities to improve communication and public speaking skills
- Doing pleasurable activities, such as exercise or hobbies, when you feel anxious
- Getting enough sleep
- Eating a well-balanced diet

Over time, these coping methods can help control your symptoms and prevent a relapse. Remind yourself that you can get through anxious moments, that your anxiety is short-lived, and that the negative consequences you worry about so much rarely come to pass.

With proper treatment, nine out of ten people emerge victorious against the disorder!

Continued from page 28 (Herschel Space Telescope with World's Largest Mirror)

years away in the constellation of Hydra. The Herschel observatory also revealed that, contrary to common expectation, the process of planet formation takes place for much longer duration of time. It was also revealed that the stars interact with their environment in strange ways. While passing through the gas and dust clouds they make their presence felt.

Another conclusion that has been drawn from the findings of the Herschel Observatory is that the presence of water in Jupiter is the result of collision between the planet and the Comet Shoemaker Levy 9 that took place in 1994.

In July 2010, more than 150 research papers on the initial results from the Herschel Observatory were published in a special issue of the journal *Astronomy & Astrophysics*. Subsequently, another special issue was brought out in October 2010 in which the failure of HIFI instruments of the observatory was described. On 1 August 2011, it was reported that the presence of molecular oxygen in space was definitely confirmed by Herschel Observatory and this was second time that scientists found these molecules in space.

In October 2011, a report published in the journal *Nature* stated that the measurement of deuterium levels in Comet Hartley 2 has suggested that much of Earth's water had initially come from cometary impacts. On 18 April 2013, the Herschel team reported in *Nature* that it has located a special kind of 'stardust' galaxy where mass was equivalent to 2,000 solar masses.

End of mission

The rising temperature of all the instruments on board the Herschel Observatory due to the running out of the liquid helium coolant was revealed through a ground station in Western Australia. On 29 April 2013, the European Space Agency (ESA) announced the running out of the coolant of the Herschel Observatory. At the time of the announcement, Herschel was at a distance of 1·5 million kilometres from Earth. Because the orbit of the Herschel Space Observatory at the L2 point is unstable, the ESA wanted to guide it on a known trajectory. For this the managers of ESA considered the following two options:

1. Herschel Space Observatory be placed into the solar orbit where it would not come in collision course with Earth for at least several hundred years.
2. Herschel be guided on a course towards the Moon for a destructive high-speed collision and through this collision information be gathered about the availability of water in the polar region of the Moon.

Finally, the managers decided in favour of the first option. The post-operation phase of the mission will continue until 2017. After the end of Herschel mission, ESA is planning another joint-venture project on the Space Infrared Telescope for Cosmology and Astrophysics (SPICA), which is another proposed far infrared observatory.

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Recent developments in science and technology

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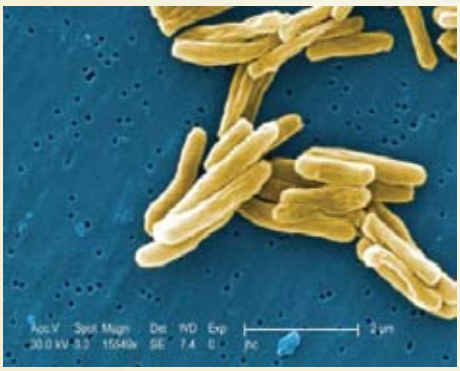
Potential new drug for TB

Tuberculosis (TB) is an infectious disease that is caused by a bacterium called *Mycobacterium tuberculosis*. TB primarily affects the lungs, but it can also affect organs in the central nervous system, lymphatic system, and circulatory system among others. The disease was called "consumption" in the past because of the way it would consume from within anyone who became infected and was fatal in most cases.



TB bacterium known as Mycobacterium tuberculosis is seen magnified 15,500 times in this colourised scanning electron micrograph. (Credit: Janice Haney Carr/CDC)

TB is the second biggest cause of deaths worldwide, second only to HIV/AIDS. India has the highest incidence of TB with about 2.2 million cases out of a global incidence of 8.7 million, according to WHO (2011). It continues to be the biggest health problem in India and remains one of the largest on India's health and wellness scale. What makes the problem worse is the prevalence of multidrug-resistant tuberculosis (MDR-TB) and the recently discovered global phenomenon of extensively drug-resistant tuberculosis (XDR-TB), which is widely prevalent in India. Now there is hope with the discovery of an entirely novel treatment for the disease that is also effective against resistant bacteria that cause MDR-TB and XDR-TB.

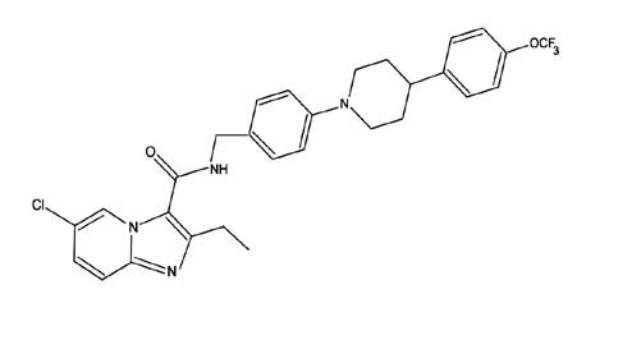
Researchers at the New Jersey Medical School of University of Medicine and Dentistry of New Jersey, USA, have synthesised a small molecule called Q203 that thwarts drug resistant tuberculosis infections in mice by dissolving its protective fatty coating that cripples the TB bacteria – a mechanism distinct from that of existing drugs. The finding could eventually be used to improve TB treatment in humans (*Nature Medicine*, 4 August 2013 | doi:10.1038/nm.3262). Q203 is effective in mice and bears no similarity to existing TB drugs, many of which have become inadequate as drug-resistant bacterial strains have developed. The new compound acts by novel mechanism and is effective in mice, offering a potential new weapon to improve therapeutic options for the treatment of drug-resistant TB in humans.

A few anti-TB drugs are known that disrupt the fatty coating of *M. tuberculosis,* but so far no single drug has been able to kill the bacteria completely. The researchers, Kevin Pethe and colleagues investigated more than 120,000 compounds over 5 years, infecting mouse immune cells called macrophages with *M. tuberculosis* and observing whether the compounds being tested inhibited bacterial growth. They discovered a class of compounds called thiophenes that killed the bacterium in culture without the emergence of drug resistance. And the combination of thiophene and the existing coat-busting drug isoniazid achieved 100 per cent bacterial killing. Subsequent tests showed the compound to be successful at treating TB in mice.

The new drug molecule belongs to a new class of synthetic chemicals with no similarities to existing drugs. The researchers showed that the synthetic antibacterial compound has a novel mechanism of action: it targets part of the *M. tuberculosis* electron chain and inhibits ATP synthesis, which is needed for cellular energy production, and thereby blocks the growth of the bacterium. This factor could make it tougher for the bacteria to develop resistance to it.

In addition, according to the researchers, Q203 displays safety properties compatible with once-daily dosing. Together, the research data indicate that Q203 is a promising new clinical candidate for the treatment of tuberculosis.

However, before Q203 can be used for effectively treating TB in humans, more studies are needed. The candidate drug will be put on phase I clinical trials next year to assess its safety and tolerability in a small group of healthy human volunteers. And only 5% of drugs that make it to phase I in all disease areas ultimately end up as marketed pharmaceuticals. But, still, the new discovery marks significant breakthrough in treatment of drug-resistant TB.



The Q203 molecule

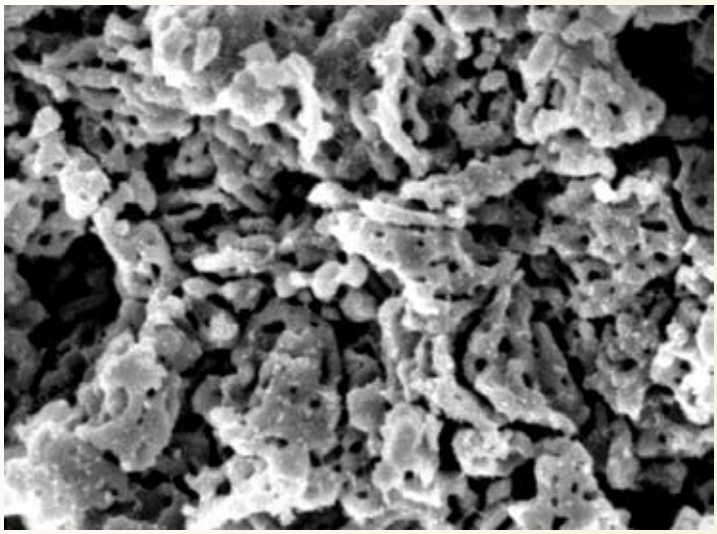
Upsalite: The most powerful water absorbent

Accidental or serendipitous discoveries in science are not uncommon. Penicillin, microwave oven, and radio astronomy are a few of them. Researchers in Uppsala, Sweden have now accidentally stumbled upon a unique product that chemists have been trying to produce for almost hundred years, by mistakenly leaving a reaction running over the weekend. Their work has led to the development of a new material, dubbed Upsalite (after the University of Uppsala), which has remarkable water-binding properties.

Crystalline forms of dry magnesium carbonate ($MgCO_3$), which lack the structure needed to absorb water, are readily synthesised at high temperatures

(over 100°C). As early as 1820, researchers started looking for lower-temperature routes to make dry $MgCO_3$, but none have successfully yielded pure product until now. This is why Upsalite has been described as an "impossible material".

Maria Strømme, Professor of Nanotechnology, and colleagues at Uppsala University have been trying to make a powdered and dry form of magnesium carbonate ($MgCO_3$) by modifying a procedure dating back to 1908. The reaction ingredients are all inexpensive: magnesium oxide (MgO) and carbon dioxide (CO_2) dissolved in methanol, a common industrial solvent.



Electron micrograph of Upsalite. The product absorbs more water than any material previously available

The key modification the Uppsala researchers made was to increase the pressure of CO_2 to three times that of normal atmospheric pressure when the gas is bubbled through a mixture of MgO in methanol. When one mixture was accidentally allowed to react over a long weekend, researchers came back to find a gel. They found that the gel was formed because methanol molecules had been trapped within the material. When heated to 70°C, which is above the boiling point of methanol, the gel "solidified and collapses into a white and coarse powder". Analysis confirmed that the product was just what chemists had been trying to make for more than 100 years – a dry, powdered and highly absorbent form of $MgCO_3$ (*PLoS ONE*, 17 July 2013 | doi:10.1371/journal.pone.0068486).

As it has turned out, Upsalite is a very powerful desiccant, absorbing water better than the zeolites, which are much more expensive materials. The reason is simple. Upsalite is riddled with pores narrower than 10 nanometres. This makes it incredibly water absorbent, even at relatively low humidity, and keeps water locked up tight. Most of the absorbed water is retained when Upsalite is transferred from a humid to a very dry environment. After absorbing water, the dry form can be regenerated by heating to 95°C, in contrast with the zeolites that need to be heated to over 150°C to dry them.

The high absorbent property of Upsalite stems from the very large internal surface area of the material. A single gram of this elusive white, dry, powdered form of magnesium carbonate ($MgCO_3$) has an extraordinarily-large surface area of 800 square metres thanks to numerous minuscule pores, each one a million times smaller than the width of a human hair. While various forms of magnesium carbonate have water bound to their surface and are crystalline, Upsalite has no water integrated into its structure and is not crystalline. According to Stromme, "Upsalite absorbs more water at low relative humidity than the best materials presently available and can be regenerated with less energy consumption than is used in similar processes today".

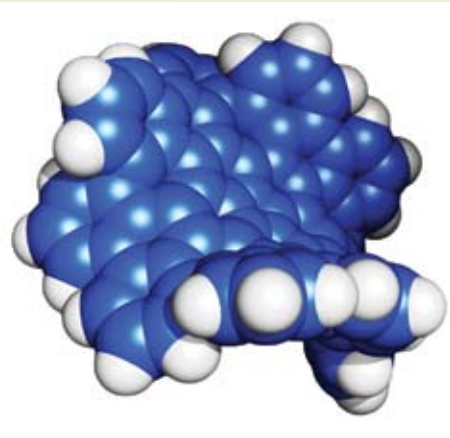
Potential uses of the new material include humidity and moisture control in the electronics and drug formulation industry and warehouses at much reduced cost. Being a strong absorbent it can also be potentially used for collection of toxic waste, chemicals or oil spill and in drug delivery systems, for odour control and sanitation after fire.

Grossly warped nanographene: A new form of carbon

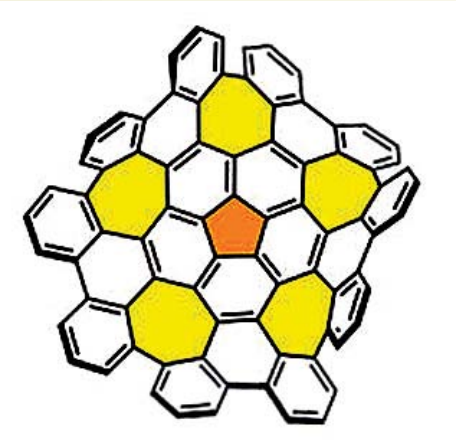
Chemists at Boston College and Nagoya University in Japan have synthesised the first example of a new form of carbon, unknown earlier. It has been named 'grossly warped nanographene'. The unique structure of the new molecule has been found to have optical and electronic properties distinct from other all-carbon families. Till about 30 years ago, scientists had known of only two forms of pure carbon: diamond and graphite. Then in 1985, chemists were stunned by the discovery that carbon atoms could also join together to form hollow balls, which came to be known as fullerenes. Since then, scientists have also learned how to make long, ultra-thin, hollow tubes of carbon atoms, known as carbon nanotubes, and large flat single sheets of carbon atoms, known as graphene. The discovery of fullerenes was awarded the Nobel Prize in Chemistry in 1996, and the preparation of graphene was awarded the Nobel Prize in Physics in 2010.

Graphene is an allotrope of carbon with a structure of a 2-dimensional sheet of hexagonal carbon rings. Graphene is most easily visualised as an atomic-scale chicken wire mesh made of carbon atoms and their bonds. The recently discovered material consists of multiple identical pieces of grossly warped graphene, each containing exactly 80 carbon atoms joined together in a network of 26 rings, with 30 hydrogen atoms arranged along the rim. The distortions are caused by defects in the form of non-hexagonal rings – five 7-membered rings and one 5-membered ring – embedded in the graphene network. Because the individual molecules measure slightly more than a nanometre across, they are referred to as 'nanocarbons,' or more specifically in this case as 'grossly warped nanographenes' (*Nature Chemistry*, 14 July 2013 | doi:10.1038/nchem.1704).

The researchers synthesised the 26-ring $C_{80}H_{30}$ nanographene that incorporates



Space-filling model of grossly warped nanographene



Structure of grossly warped nanographene. The 5-membered ring is coloured orange and the 7-membered rings are coloured yellow.

five 7-membered rings and one 5-membered ring embedded in a hexagonal lattice by stepwise chemical methods. The compound was isolated, purified and fully characterised using spectroscopy. Its grossly warped structure was revealed by single-crystal X-ray crystallography.

According to the researchers, odd-membered-ring defects found in grossly warped nanographene not only distort the sheets of atoms away from planarity, they also alter the physical, optical, and electronic properties of the material. For example, the grossly warped nanographene is dramatically more soluble than a planar nanographene of comparable size. The two also differ significantly in colour. Electrochemical measurements have revealed that the planar and the warped nanographenes are equally easily oxidised, but the warped nanographene is more difficult to reduce. Furthermore, the research team has demonstrated that the electronic properties can be modified in a predictable manner through precisely controlled chemical synthesis. An ability to control the degree of distortion with odd-numbered rings could be a potential means of developing tailor-made graphene for future optoelectronic devices.

Baby owls sleep like human babies

Sleep in mammals including humans, and birds has two phases, REM and non-REM. REM, which stands for "rapid eye movement," gets its name from the quick and random movements the eyes make during this phase although the eyes remain closed. REM sleep is the time when vivid dreams occur. Non-REM sleep comes first, though, and the body cycles through non-REM and REM sleep throughout the night. Adult humans spend about 20 to 25 per cent of their sleep in REM. In contrast, new-born babies spend half their night's sleep in the REM phase.

Now researchers have discovered that baby owls also show a similar sleep pattern. A team of scientists from the Max Planck Institute for Ornithology, Seewiesen, Germany and the University of Lausanne, Switzerland found this out working with barn owls in the wild. They used EEG sensors and movement monitors to record the sleep patterns and movement in 66 owlets of varying age. According to the researchers, during this sleep phase, the owlets' EEG showed awake-like activity, their eyes remained closed, and their heads nodded slowly. During the recordings, the owlets remained in their nest box and were fed normally by their parents. Importantly, the researchers discovered that just as in human babies, the time spent in REM sleep declined as the owlets grew in age (*Frontiers in Zoology*, 26 July 2013 | doi:10.1186/1742-9994-10-42). The team also discovered that this change in sleep was strongly correlated with the expression of a gene involved in producing dark feather spots caused by melanin pigment, a trait known to vary in step with behavioural and physiological traits in adult owls.

According to the researchers, additional research is needed to determine exactly how sleep, brain development, and pigmentation are interrelated, but these findings nonetheless raise several intriguing questions such as: Does variation in sleep during brain development influence adult brain organisation? They hope that "this naturally occurring variation in REM sleep during a period of brain development can be used to reveal exactly what REM sleep does for the developing brain in baby owls, as well as humans". The study could also help researchers understand the function of REM sleep in humans. ■

Baby barn owls. As they get older, baby owls change their sleeping patterns. The older they get, the less time they spent in REM sleep. (Credit: quasarphotos/Fotolia)